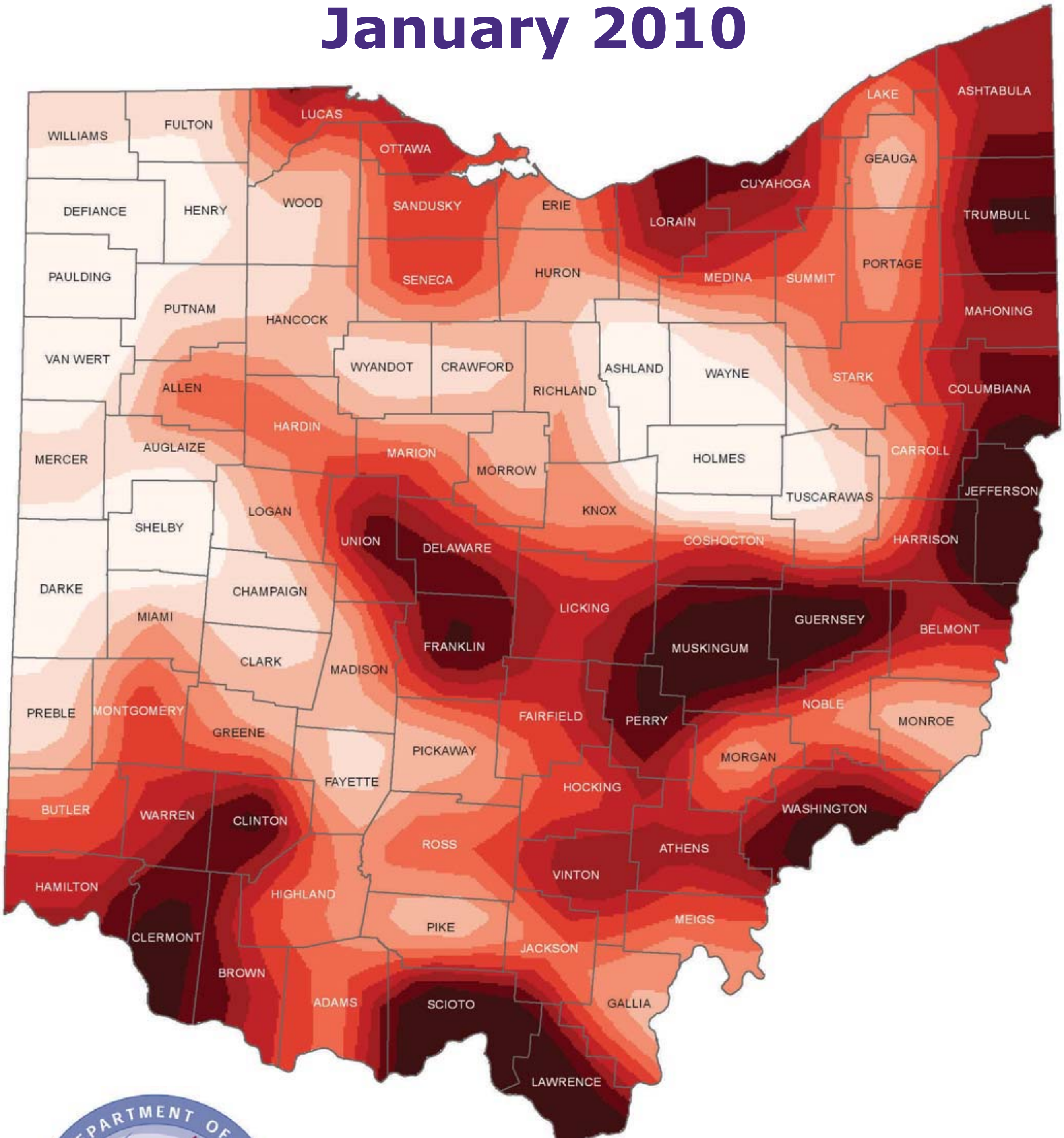
Geographic Patterns of Cancer Incidence in Ohio: 1996 - 2006
January 2010



OHIO DEPARTMENT OF HEALTH
ODH
To protect and improve the health of all Ohioans

Ohio Cancer Incidence Surveillance System

THE OHIO STATE UNIVERSITY
The James

Cover image:

Average Annual Invasive Cancer Incidence Rates

for All Sites and Types Combined per 100,000,

Adjusted for Age and Rates in Neighboring Ohio Counties, 1996-2006

Geographic Patterns of Cancer Incidence in Ohio: 1996 - 2006

January 2010

Ohio Cancer Incidence Surveillance System

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Table of Contents

Page Number

Contact Information ... iii
Acknowledgements ... iii
Suggested Citation ... iii

Introduction and Methods ... 1
Ohio Cancer Incidence Data ... 1
Cancer Mapping Methods ... 2
Interpretation of Maps ... 3
References ... 6

Figures

1. Bladder: Average Annual Cancer Incidence Rates per 100,000, Adjusted for Age and Rates in Neighboring Ohio Counties, 1996-2006 ... 8

2. Brain and Other Central Nervous System: Average Annual Invasive Cancer Incidence Rates per 100,000, Adjusted for Age and Rates in Neighboring Ohio Counties, 1996-2006 ... 9

3. Female Breast: Average Annual Invasive Cancer Incidence Rates per 100,000, Adjusted for Age and Rates in Neighboring Ohio Counties, 1996-2006 ... 10

4. Cervix: Average Annual Invasive Cancer Incidence Rates per 100,000, Adjusted for Age and Rates in Neighboring Ohio Counties, 1996-2006 ... 11

5. Colon and Rectum: Average Annual Invasive Cancer Incidence Rates per 100,000, Adjusted for Age and Rates in Neighboring Ohio Counties, 1996-2006 ... 12

6. Corpus Uterus: Average Annual Invasive Cancer Incidence Rates per 100,000, Adjusted for Age and Rates in Neighboring Ohio Counties, 1996-2006 ... 13

7. Esophagus: Average Annual Invasive Cancer Incidence Rates per 100,000, Adjusted for Age and Rates in Neighboring Ohio Counties, 1996-2006 ... 14

8. Hodgkin's Lymphoma: Average Annual Invasive Cancer Incidence Rates per 100,000, Adjusted for Age and Rates in Neighboring Ohio Counties, 1996-2006 ... 15

9. Kidney and Renal Pelvis: Average Annual Invasive Cancer Incidence Rates per 100,000, Adjusted for Age and Rates in Neighboring Ohio Counties, 1996-2006 ... 16

10. Larynx: Average Annual Invasive Cancer Incidence Rates per 100,000, Adjusted for Age and Rates in Neighboring Ohio Counties, 1996-2006 ... 17

11. Leukemia: Average Annual Invasive Cancer Incidence Rates per 100,000, Adjusted for Age and Rates in Neighboring Ohio Counties, 1996-2006 18

12. Liver and Intrahepatic Bile Duct: Average Annual Invasive Cancer Incidence Rates per 100,000, Adjusted for Age and Rates in Neighboring Ohio Counties, 1996-2006 19

13. Lung and Bronchus: Average Annual Invasive Cancer Incidence Rates per 100,000, Adjusted for Age and Rates in Neighboring Ohio Counties, 1996-2006 20

14. Melanoma of the Skin: Average Annual Invasive Cancer Incidence Rates per 100,000, Adjusted for Age and Rates in Neighboring Ohio Counties, 1996-2006 21

15. Multiple Myeloma: Average Annual Invasive Cancer Incidence Rates per 100,000, Adjusted for Age and Rates in Neighboring Ohio Counties, 1996-2006 22

16. Non-Hodgkin's Lymphoma: Average Annual Invasive Cancer Incidence Rates per 100,000, Adjusted for Age and Rates in Neighboring Ohio Counties, 1996-2006 23

17. Oral Cavity and Pharynx: Average Annual Invasive Cancer Incidence Rates per 100,000, Adjusted for Age and Rates in Neighboring Ohio Counties, 1996-2006 24

18. Ovary: Average Annual Invasive Cancer Incidence Rates per 100,000, Adjusted for Age and Rates in Neighboring Ohio Counties, 1996-2006 25

19. Pancreas: Average Annual Invasive Cancer Incidence Rates per 100,000, Adjusted for Age and Rates in Neighboring Ohio Counties, 1996-2006 26

20. Prostate: Average Annual Invasive Cancer Incidence Rates per 100,000, Adjusted for Age and Rates in Neighboring Ohio Counties, 1996-2006 27

21. Stomach: Average Annual Invasive Cancer Incidence Rates per 100,000, Adjusted for Age and Rates in Neighboring Ohio Counties, 1996-2006 28

22. Testis: Average Annual Invasive Cancer Incidence Rates per 100,000, Adjusted for Age and Rates in Neighboring Ohio Counties, 1996-2006 29

23. Thyroid: Average Annual Invasive Cancer Incidence Rates per 100,000, Adjusted for Age and Rates in Neighboring Ohio Counties, 1996-2006 30

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Acknowledgements

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The following individuals contributed to this report:
Holly L. Sobotka, M.S.; Diana Slone, C.T.R.; Robert W. Indian, M.S.; Sietske de Fijter, M.S.; Ohio Department of Health

James L. Fisher, Ph.D.; Julie A. Stephens, M.S.; John M. McLaughlin, M.S.; Electra D. Paskett, Ph.D.; The Ohio State University

Sincere appreciation to all the cancer registrars, medical records staff and other health professionals reporting cancer cases in Ohio whom made this report possible.

Suggested Citation

Geographic Patterns of Cancer Incidence in Ohio: 1996-2006. Ohio Cancer Incidence Surveillance System, Ohio Department of Health and The Ohio State University, Columbus, Ohio, January 2010.

The OCISS is supported in part by the State of Ohio and the Centers for Disease Control and Prevention (CDC), National Program of Cancer Registries (Cooperative Agreement 5U58DP000795). The contents of this document do not necessarily represent the official views of the CDC.

INTRODUCTION

Cancer is a group of more than 200 different diseases characterized by uncontrolled growth and spread of abnormal cells. In Ohio, cancer ranks as the second leading cause of death and was responsible for an estimated 24,350 deaths among Ohio residents in 2009.[1] Numerous factors that increase the risk of developing cancer have been identified and include tobacco use, poor diet, lack of physical activity, obesity, genetics, infectious agents and environmental factors, among many others. These factors interact with one another to increase cancer risk; although, the primary causes of many cancers have yet to be identified.

Cancer incidence (new case) and mortality (death) rates vary by age group, gender, race/ethnicity, geographic area and site/type of cancer. The 2000 U.S. Census population for Ohio was 11,353,140 with the following demographics: 51.4 percent female, 13.3 percent age 65 or older, 85.0 percent white, 11.5 percent black, 1.2 percent Asian/Pacific Islander and 0.2 percent American Indian/Alaskan Native.[2] Ohio consists of 88 counties and is bordered by Lake Erie to the north and the Ohio River to the south. Thirty-two counties along the eastern and southern border of Ohio are located in the Appalachian region of the United States. Thus, there is demographic variability of Ohio residents across the state which should be accounted for in assessments of cancer rates and risks as well as in the development of cancer prevention, early detection and control programs.

OHIO CANCER INCIDENCE DATA

The Ohio Cancer Incidence Surveillance System (OCISS) at the Ohio Department of Health (ODH) is Ohio's central cancer registry responsible for collecting data on cancers diagnosed among Ohio residents.[3] All primary cancers diagnosed on or after Jan. 1, 1992, with the exception of basal and squamous cell skin cancer and cervical cancer *in situ*, are required to be reported to the OCISS.

Cancer cases were defined as reported primary malignancies diagnosed among Ohio residents from 1996-2006. Cancers were coded to the International Classification of Diseases for Oncology, Third Edition (ICD-O-3), codes C00.0-C80.9.[4] Each cancer was grouped, by ICD code, into 23 major site/type groupings in accordance with the methods of the Surveillance, Epidemiology and End Results (SEER) Program at the National Cancer Institute.[5]

Cancer cases are categorized as *in situ* or invasive. *In situ* cancers are malignant tumors that have not penetrated the basement membrane (supportive tissue underlying the epithelium) of the organ of origin or extended beyond the epithelial tissue; whereas, invasive cancers have infiltrated the tissue of the organ in which the tumor originated. Incidence counts and rates include invasive cancers only, with the addition of *in situ* bladder cancers. The inclusion of *in situ* bladder cancers in the calculation of incidence rates is consistent with the methodology of the SEER Program.

Areas with large populations are likely to have more persons diagnosed with cancer each year, therefore incidence data are adjusted based on population size to give a rate, or the number of new cancer cases per unit of population (i.e., per 100,000 persons). It is also common to statistically adjust rates based on the age distribution of the population, because increasing age is strongly associated with higher cancer rates. The rates presented in this compendium were age-adjusted using the 2000 U.S. Standard Population by 19 five-year age groups (i.e., <1, 1-4, 5-9, 10-14,…,85+).[6]

The vintage 2007 intercensal population estimates for 1996-1999 and post-censal estimates for July 1, 2000-2006, from the National Center for Health Statistics, were used in the calculation of incidence rates.[7,8] The estimates were calculated by bridging the 31 race categories collected in the 2000 Census to the following four categories: white; black or African American; American Indian or Alaskan Native; and Asian or Pacific Islander. Race is collected independently from Hispanic ethnicity; thus, these bridged race categories include persons of both Hispanic and non-Hispanic ethnicity.

From 1996 through 2006, an average of 55,796 Ohio residents were diagnosed with invasive cancer each year. After adjusting for age, this equates to an average of 468.0 cancer cases per 100,000 residents. Black males were found to have the highest incidence rate (611.2 per 100,000), compared to the other gender/race categories (white males, white females and black females).

For all genders and races combined, the leading site/type of cancer incidence in 1996-2006 was lung and bronchus cancer, followed by cancers of the breast, prostate and colon and rectum. Prostate cancer was the leading site/type among both black and white males; although, the incidence rate for black males (208.3 per 100,000) was 59 percent higher than the rate for white males (131.1 per 100,000). Breast cancer was the leading site/type of cancer incidence among both white and black females, with white females having a slightly higher rate (123.8 per 100,000), compared to black females (118.4 per 100,000).

CANCER MAPPING METHODS

Cancer mapping is a useful tool in exploring differences in cancer risk according to geographic region. A common approach to mapping cancer data is to depict the disease rates at a level of areal units across a defined study region. An areal unit is any representation of a geographic area which has fixed boundaries. State, county, census tract, and zip code are commonly used levels of areal units. Choice of areal unit is dependent on many factors including scope of study, accuracy of rate, geographic scale, final map resolution, specificity of areal unit, and frequency of cancer. These factors act in conjunction with, and in opposition to, one another. For example, increasing the specificity of areal units used to represent rates will decrease the accuracy of the rates and decrease map resolution. Therefore, careful choice of the appropriate areal unit is critical to any mapping analysis which uses areal data.

Boundaries of common areal units (such as counties) are often formed for administrative or political reasons. These boundaries are useful in providing demographic data needed to calculate disease rates, but inaccurately represent spatial patterns of disease because the boundaries were not created with the intention of capturing disease distribution. The issue described above is a form of the Modifiable Areal Unit Problem (MAUP) and is a common issue in geographic analyses.[9] When these boundaries are used, disease cases are arbitrarily aggregated in a way which misrepresents the true underlying distribution. This has led to the creation of a method which considers the rates of neighboring areal units.

Images of cancer distribution within this document were created through the spatial averaging of age-adjusted cancer incidence rates. Environmental Systems Research Institute's (ESRI) ArcView® 9.3 software was used in all spatial and cartographic (related to map-making) manipulations described and displayed in this document (Spatial Analyst extension required).[10] County rates were chosen as the basis for the rate calculations. The study region was converted into a grid of one-square mile cells, with each cell having a value equal to the county rate that most greatly comprised the cell. A new rate was then calculated for each cell within the grid, which was equal to the average of all rates within 12.64 miles of the cell in question. Choice of this radius (12.64) was based on a series of evaluations which suggested superiority of this value because it most closely preserved the true underlying rates. Non-Ohio counties were not accounted for in the spatial averaging. Thus, Ohio border counties were not influenced as much from their surrounding counties and were more likely to have a rate similar to their 'true' underlying rate.

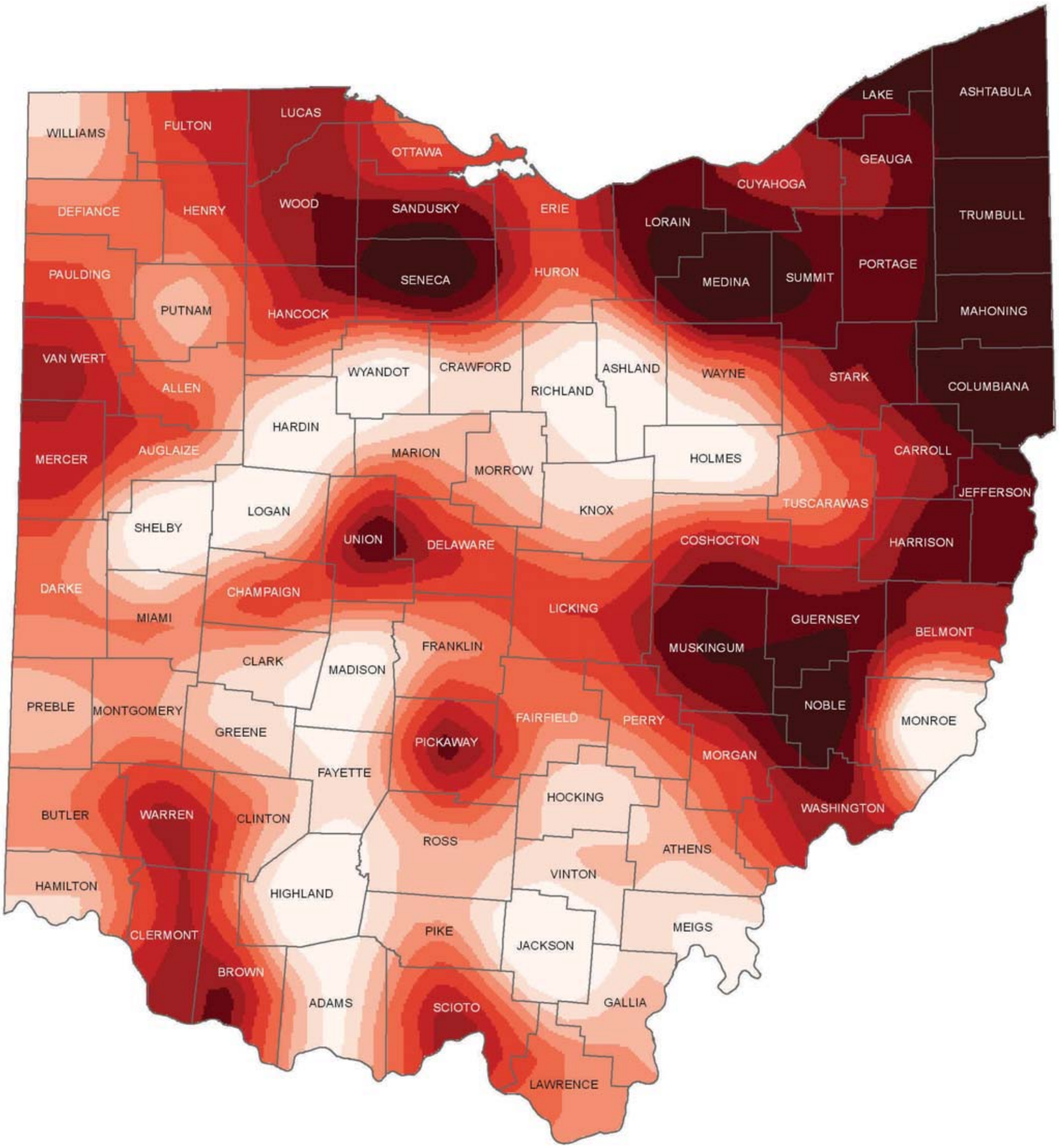
INTERPRETATION OF MAPS

The resulting images can be used to ascertain general trends of cancer within the state of Ohio. **Please note: The technique used does not allow the identification of cancer 'clusters,' as cluster detection should be reserved for formal spatial analysis**. **In addition, completeness of reporting cancer cases to the OCISS varies by county and site/type of cancer, which may lead to erroneous conclusions.** The images contained in this document can be used to subsequently generate hypotheses aimed at explaining the geographic trends observed for each specific cancer site. The legends for the maps have been independently scaled based on the distribution of rates within each cancer type. Each shade represents a 10 percent increment from neighboring shades, with darker shades symbolizing higher rates. This scaling technique easily allows for the comparison of the cancer burden by type of cancer within regions of the state. For example, Lawrence County, in Southern Ohio, has high rates of the following cancers: brain and other central nervous system (CNS), female breast, cervix, colon and rectum, esophagus, lung and bronchus, melanoma of the skin, non-Hodgkin's lymphoma and ovary. These high rates are indicated by the county's darker shades within each of the maps for these anatomic sites/types of cancer.

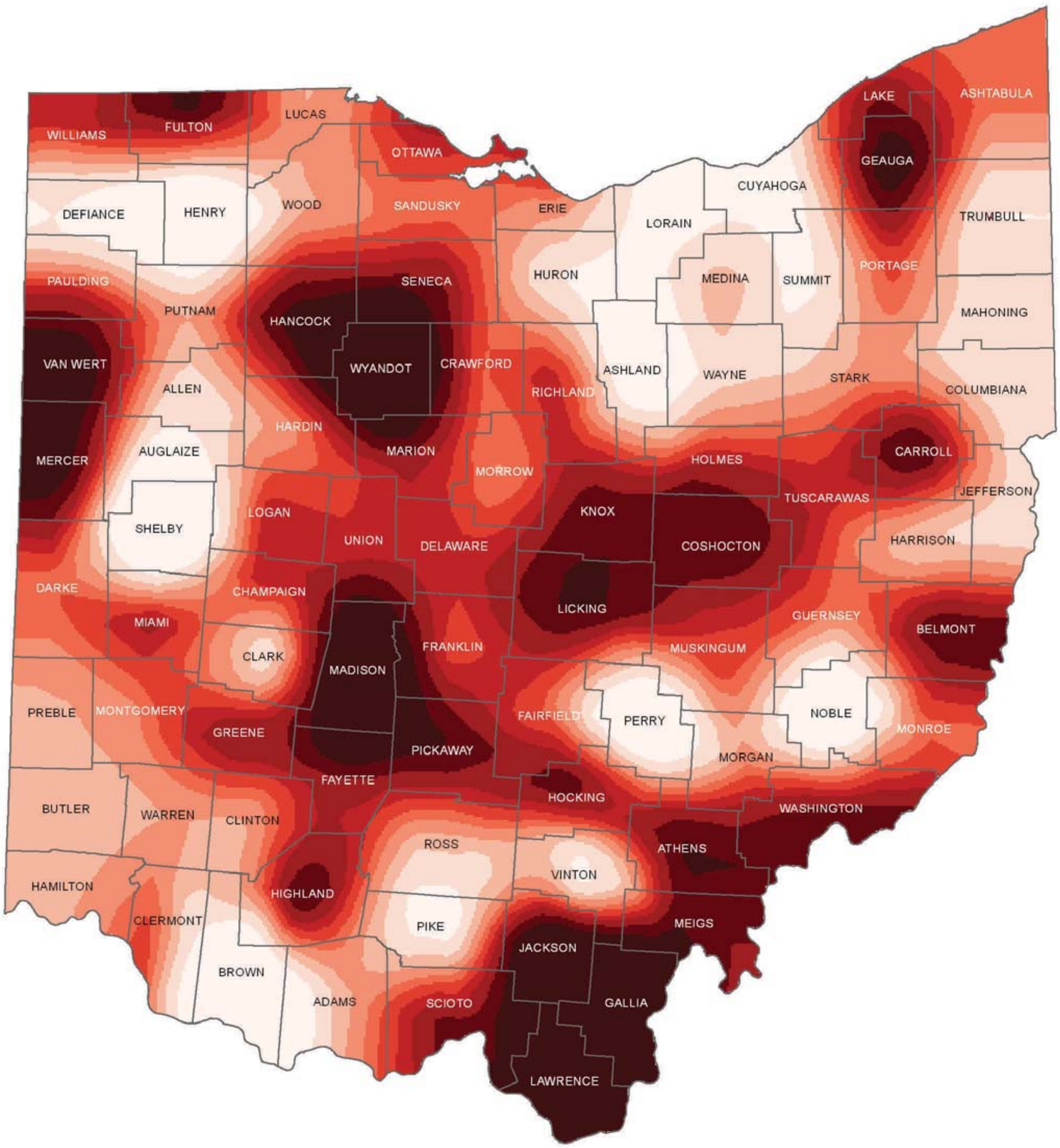
The method and scaling technique used to produce the maps in this compendium retain the capacity for comparison of cancer rates between counties, while simultaneously identifying a geographic trend (if one is present). Bladder cancer and brain and other CNS cancer are excellent examples of cancer types which display characteristic geographic trends and thus are described in more detail below.

The incidence of bladder cancer seems to exhibit a strong geographic trend within Ohio, as higher rates seem to be more concentrated in the Northeast (see figure on page 4). It is also possible to identify the relative relationships between certain counties based on the frequency or width of rate deciles over a given area of the study region. Medina County, in the northeastern portion of the state, contains relatively high bladder cancer incidence rates in comparison to

Holmes County, which is positioned two counties directly south, as shown by the variation in color shading. However, Wayne County, which is positioned between Medina and Holmes Counties, should not be interpreted as containing distinct regions of high and low rates, but rather as having an incidence rate halfway between the Medina and Holmes County rates. This can be concluded because there are numerous, thin bands of deciles that span Wayne County. In ad-



Bladder : Average Annual Cancer Incidence Rates per 100,000, Adjusted for Age and Rates in Neighboring Ohio Counties, 1996-2006 dition, the width of each decile band is inversely proportional to the difference in rates between counties. In contrast, brain and other CNS cancer does not exhibit a very strong geographic trend across the state. This is deduced by the frequency of numerous, thin bands of deciles and the presence of many smaller areas of very high and low rates across the state (see figure below).



Brain and Other Central Nervous System: Average Annual Invasive Cancer Incidence Rates per 100,000, Adjusted for Age and Rates in Neighboring Ohio Counties, 1996-2006

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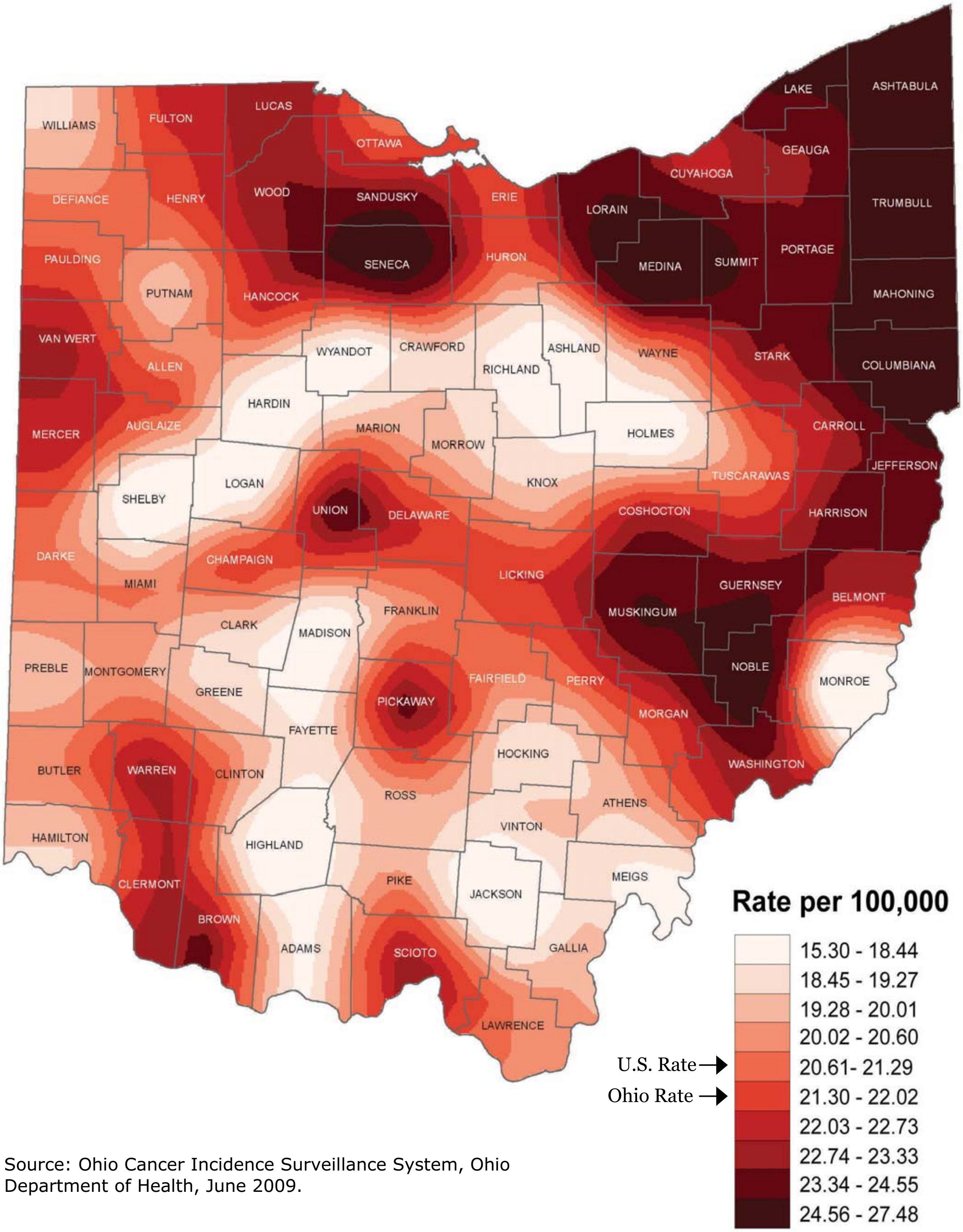
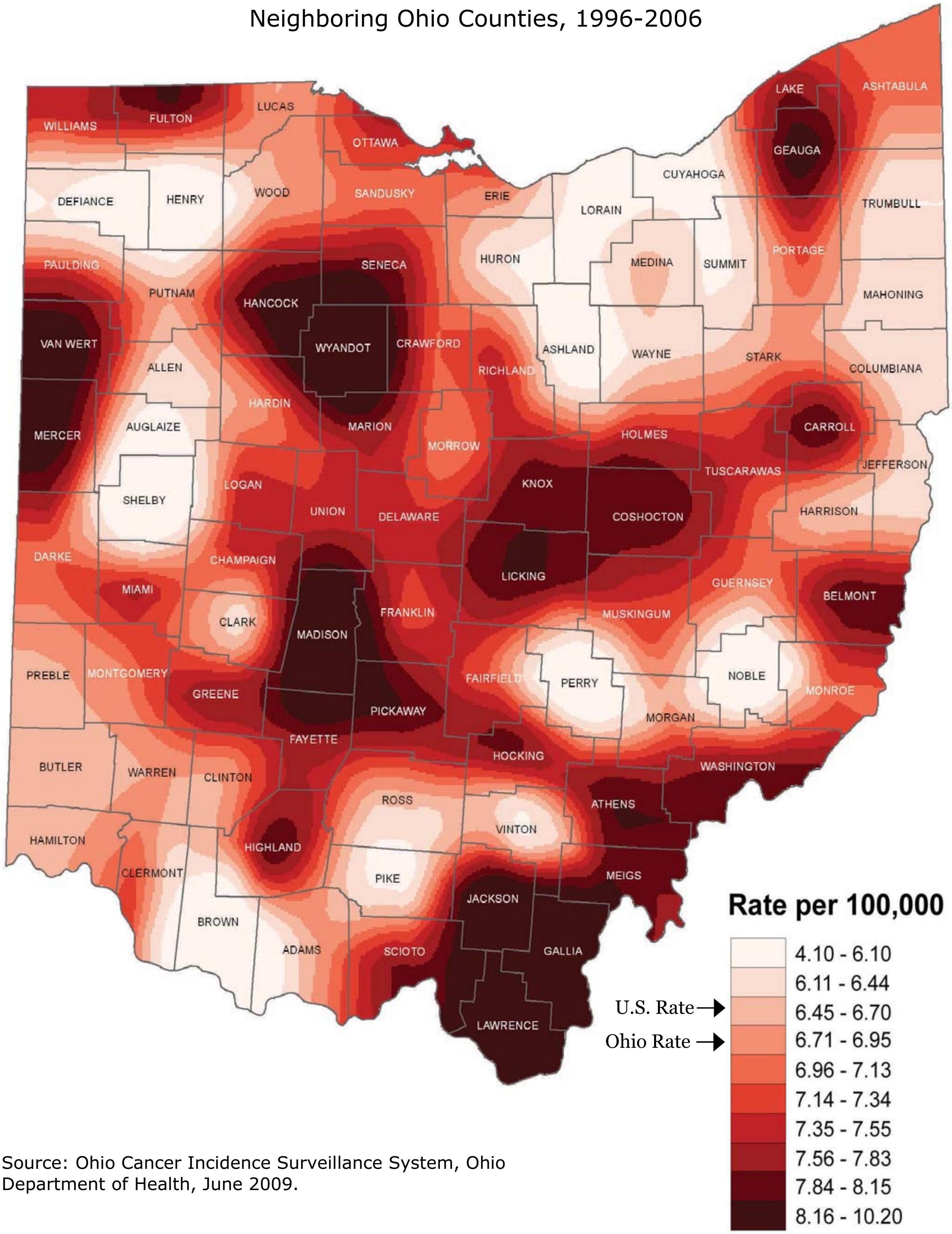
Figure 1. Bladder: Average Annual Cancer Incidence Rates per 100,000, Adjusted for Age and Rates in Neighboring Ohio Counties, 1996-2006



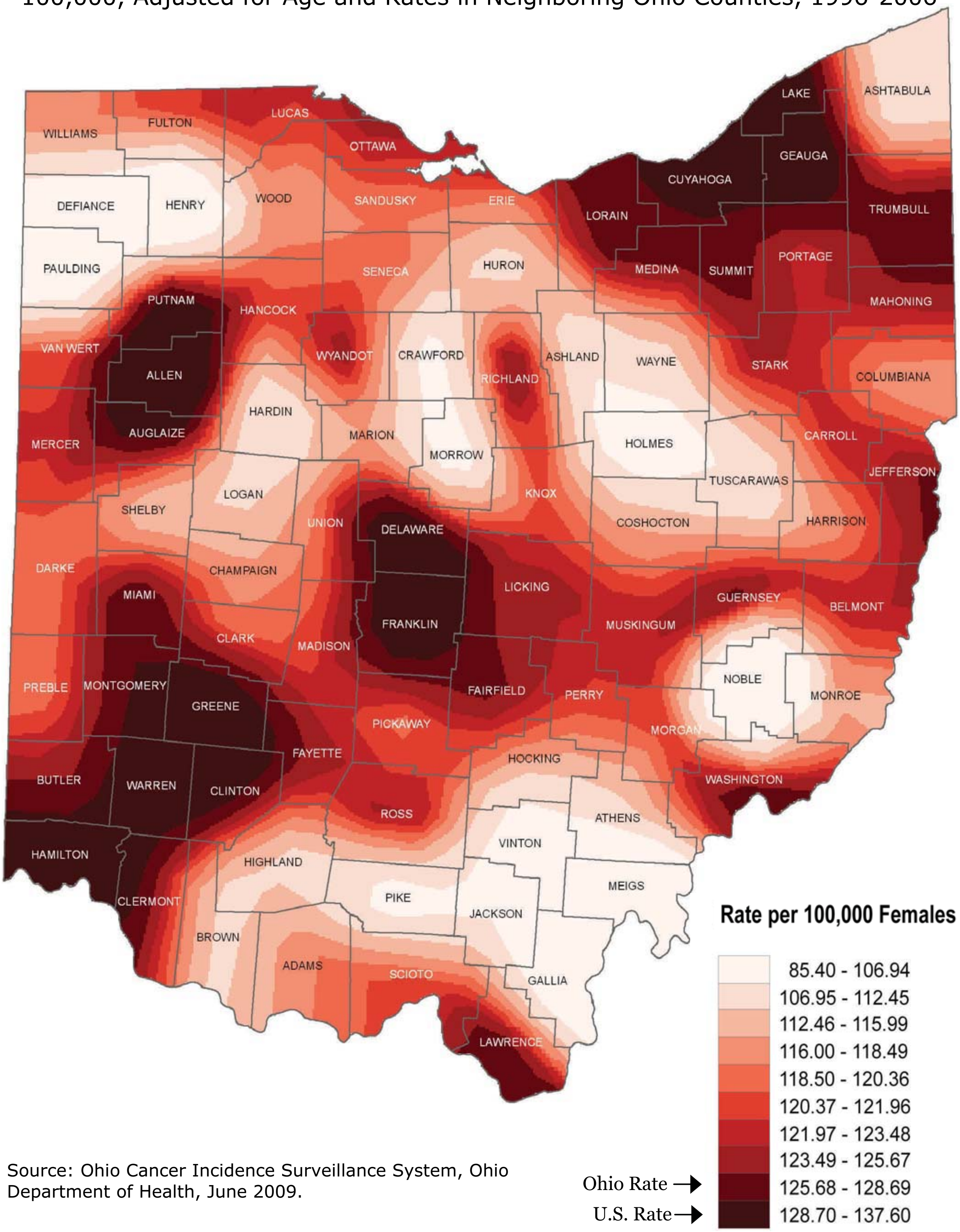
Source: Ohio Cancer Incidence Surveillance System, Ohio Department of Health, June 2009.

Figure 2. Brain and Other Central Nervous System: Average Annual Invasive Cancer Incidence Rates per 100,000, Adjusted for Age and Rates in Neighboring Ohio Counties, 1996-2006



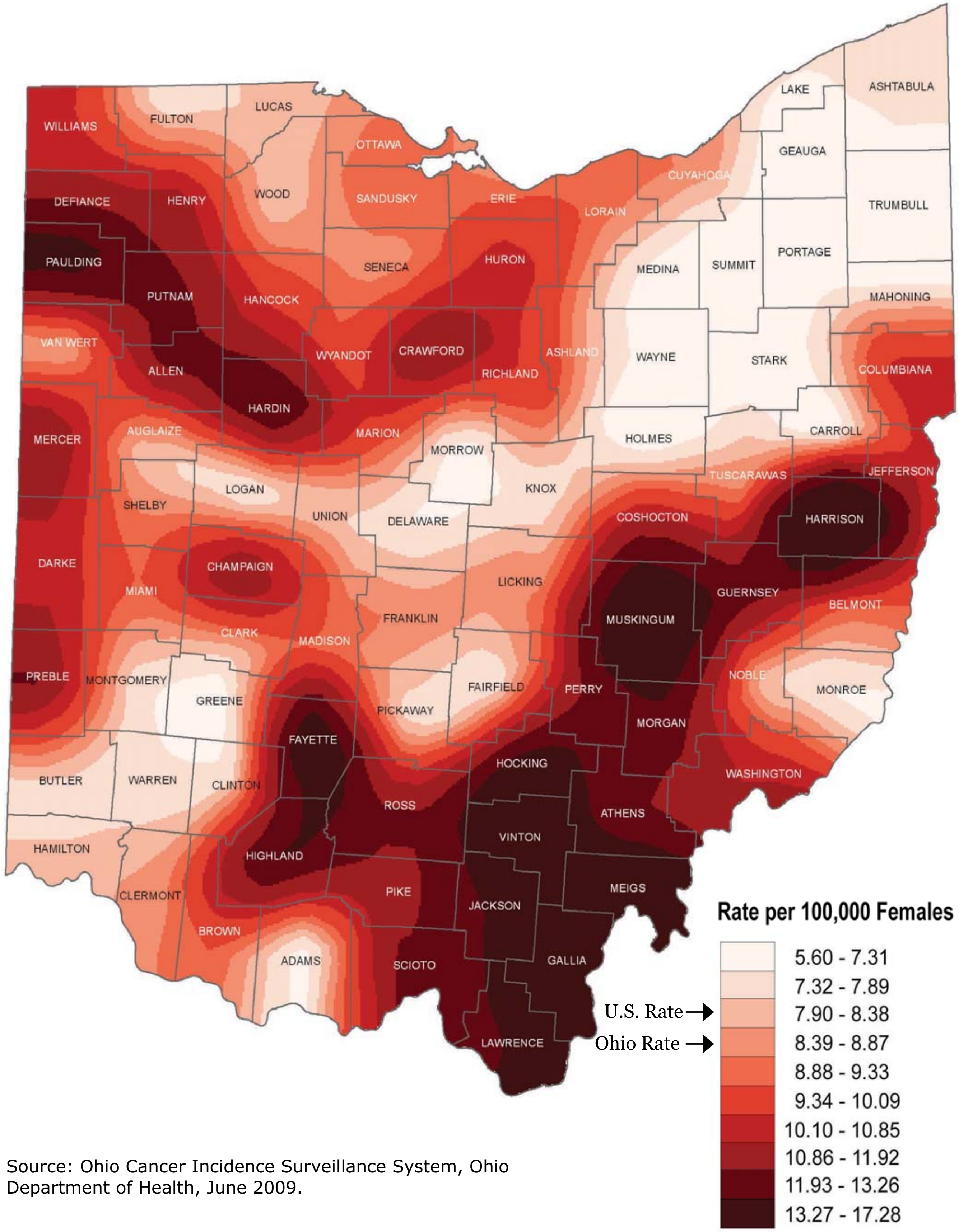
Source: Ohio Cancer Incidence Surveillance System, Ohio Department of Health, June 2009.

Figure 3. Female Breast: Average Annual Invasive Cancer Incidence Rates per 100,000, Adjusted for Age and Rates in Neighboring Ohio Counties, 1996-2006



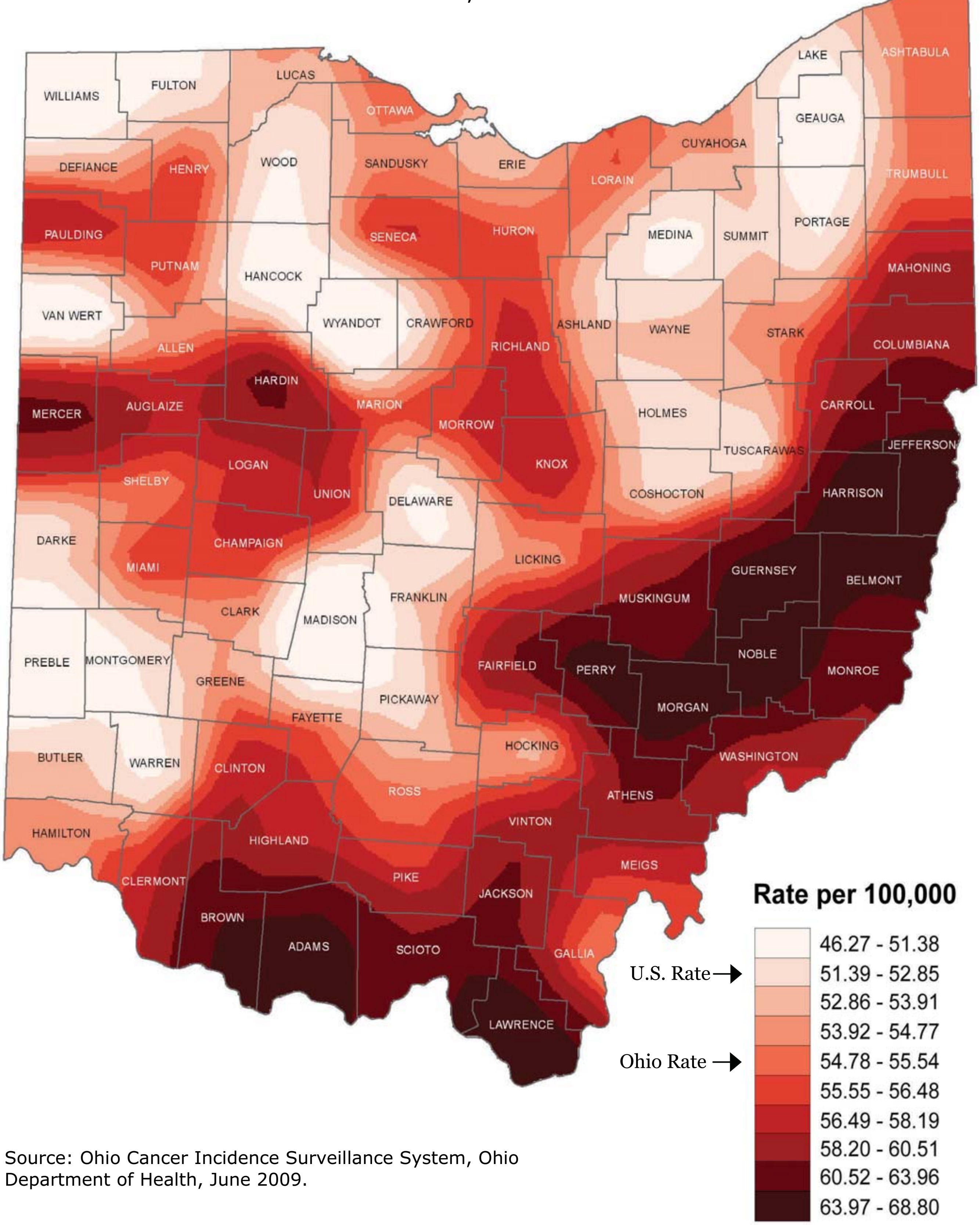
Source: Ohio Cancer Incidence Surveillance System, Ohio Department of Health, June 2009.

Figure 4. Cervix: Average Annual Invasive Cancer Incidence Rates per 100,000, Adjusted for Age and Rates in Neighboring Ohio Counties, 1996-2006



Source: Ohio Cancer Incidence Surveillance System, Ohio Department of Health, June 2009.

Figure 5. Colon and Rectum: Average Annual Invasive Cancer Incidence Rates per 100,000, Adjusted for Age and Rates in Neighboring Ohio Counties, 1996-2006



Source: Ohio Cancer Incidence Surveillance System, Ohio Department of Health, June 2009.