United States Gonorrhea Cases 2008

An Evaluation of STD Surveillance Network (SSuN) Cycle 2

Population Coverage and Geographic Distribution

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Introduction

The purpose of public health surveillance, as defined and supported within the National Notifiable Disease Surveillance System (NNDSS), is to provide disease incidence and prevalence information that informs the development and implementation of effective, responsible and well-orchestrated public health interventions to reduce the impact of many diseases including STDs such as gonorrhea. However in the case of STDs, routine NNDSS surveillance does not provide additional clarifying information that is required to better understand the transmission of the disease and to inform both treatment and preventive measures. Examples of clarifying information that are not included in routine NNDSS surveillance include partner history, drug use, sexual orientation, and treatment history. In 2005, to address the reporting gaps and deficiencies that existed in NNDSS data collection for gonorrhea as well as other STDs, the Centers for Disease Control and Prevention (CDC) established the STD Surveillance Network (SSuN), a sentinel surveillance system composed of a network of local STD surveillance systems that adhere to common protocols. SSuN supports improved collection, reporting, analysis, visualization, and interpretation of clinical, behavioral, and geographic information obtained from a geographically diverse sample of STD patients. The second funding cycle of SSuN (10/2008 – 9/2013) began enhanced surveillance on January 1, 2009 and includes 115 US counties, 42 STD clinics, and 6 laboratories.

The purpose of this cartogram and the accompanying data visualizations is to (1) visually illustrate that SSuN Cycle 2 surveillance, although limited to 115 US counties, includes a substantial and geographically distributed subset of the gonorrhea cases diagnosed annually and reported via routine NNDSS surveillance, and (2) compare and contrast the population demographics of SSuN site counties with the general population of the US.

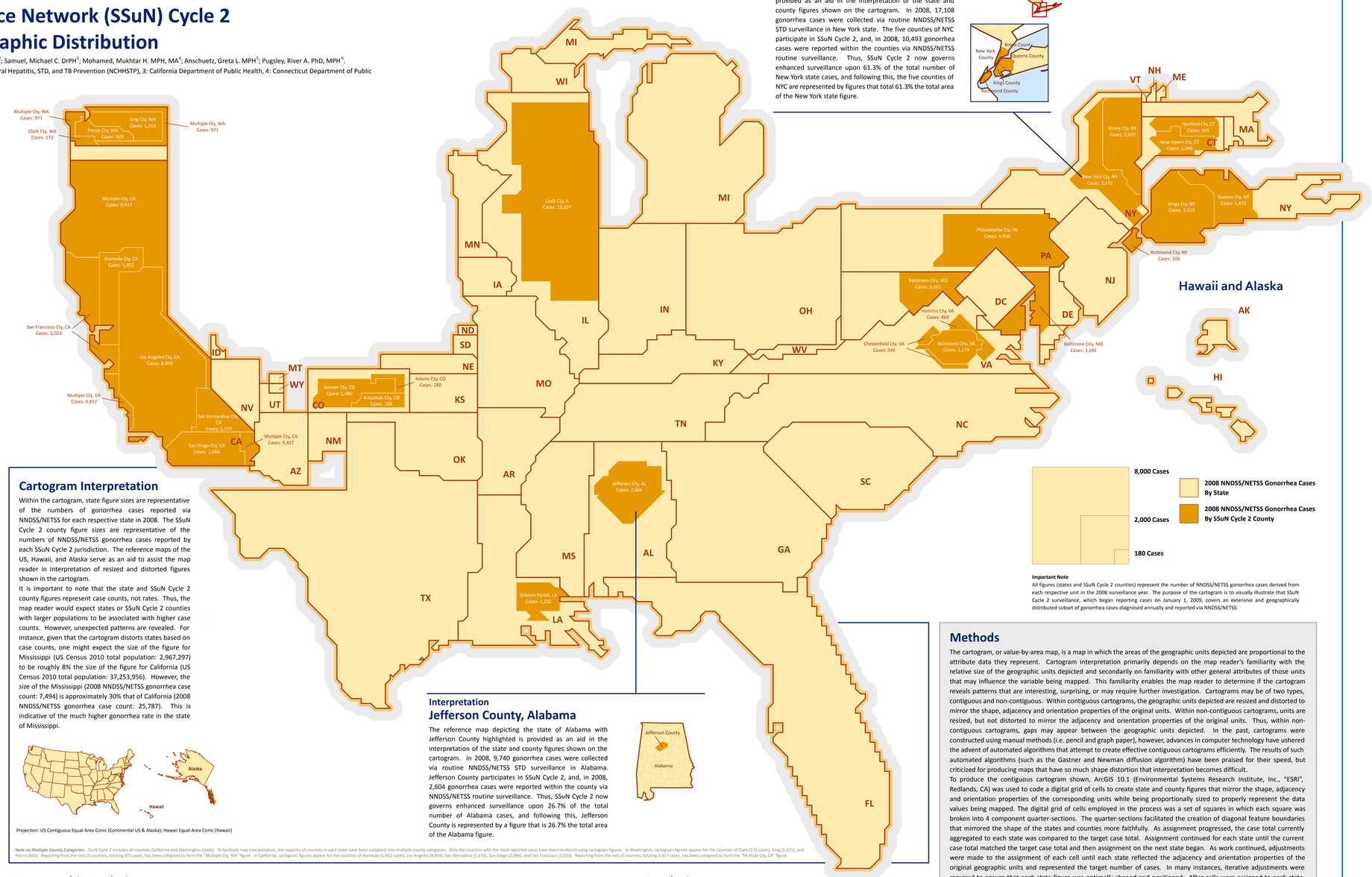
NNDSS STD Surveillance

In the United States, officially sanctioned national surveillance of infectious disease began in 1878 when Congress authorized the forerunner of the Public Health Service (PHS) to collect morbidity reports to support measures designed to contain pestilential diseases such as cholera, smallpox, plague, and yellow fever [Thacker and Berkelman 1988, p.165]. However, the nascent national effort depended upon voluntary collection, compilation, and reporting of disease cases to federal authorities, and it was not until 1925 [Thacker 2010, p.3], that all states participated. In 1961, the responsibility for collecting public health surveillance data from the states and publishing that data in the Morbidity and Mortality Weekly Report (MMWR) was transferred to the Communicable Disease Center (now the Centers for Disease Control and Prevention) [Thacker 2010, p. 3]. As of 2011, the US public health surveillance framework, which subsequently evolved into the National Notifiable Disease Surveillance System (NNDSS), remains an effort in which state, territorial, and municipal authorities legislatively mandate the collection, compilation, and reporting of disease cases to federal authorities.

Most STDs, including gonorrhea, are nationally notifiable diseases as specified within NNDSS, and as such, state and local STD programs report case information to the CDC National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention (NCHHSTP) for national compilation, analysis, reporting, and incorporation into CDC recommendations. By 1989, all 50 states had begun using the National Electronic Telecommunications System for Surveillance (NETSS) to transmit nationally notifiable disease information to the CDC [CDC/OSELS 2011]. However, although NETSS improved NNDSS reporting efficiency, STD data derived from the NNDSS/NETSS were and continue to be notoriously problematic [Reitmeijer et al. p. 73]. Firstly, case reporting for only a limited numbers of STDs (including gonorrhea, syphilis, and chlamydia) is required by all states [Reitmeijer et al. p. 73]. Secondly, the case information passed to CDC/NCHHSTP is limited in scope and constrained in detail. In the case of gonorrhea, via NNDSS/NETSS, state and local STD programs provide no information regarding the treatment regimen employed or the gender of patient sex partners [Reitmeijer et al. p. 73]. Thirdly, case report data are incomplete. For example, in 2008, 20.3% of gonorrhea cases were not associated with a valid race/ethnicity [CDC/NCHHSTP 2009, p.140]. Fourthly, STD case reporting is impacted by under reporting as a result of the significant social stigma associated with diagnosis and treatment [Eng and Butler p.43.]. To supplement problematic NNDSS/NETSS data, researchers have utilized surveys such as the National Health and Nutrition Examination Survey (NHANES), but, although informative, these types of surveys typically do not focus on STDs alone and, thus, are limited in usefulness to address STDs. In the late 1990s, it became apparent that mechanisms needed to be explored that would provide additional data on STD cases including morbidity, etiology, diagnosis, treatment, sociodemographic, and associated risk behaviors. To wit, in 1998, the Outcome Assessment through Systems of Integrated Surveillance (OASIS) project workgroup, comprised of STD epidemiologists from state/local health departments and the CDC, formed to support a cadre of CDC-funded demonstration projects that were dedicated to the promotion of using surveillance data to improve planning and evaluation efforts to prevent STDs, HIV, TB, and other outcomes [Gaffga et al. p.1]. Lessons learned during OASIS STD clinic interview activities, as well as success with subsequent sentinel surveillance projects including the Gonococcal Isolate Surveillance Project (GISP) and the MSM (men who have sex with men) Prevalence Monitoring Project, laid the foundation for the STD Surveillance Network (SSuN), which was established in 2005 to address the reporting gaps and deficiencies that existed in NNDSS/NETSS reporting for gonorrhea as well as other STDs.

STD Surveillance Network (SSuN)

SSuN is a sentinel surveillance system composed of a network of local STD surveillance systems that adhere to uniform protocols and support improved collection, reporting, analysis, visualization, and interpretation of clinical, behavioral, and geographic information obtained from a geographically diverse sample of STD patients [Reitmeijer et al. p. 74]. SSuN Cycle 1 (10/2005 – 9/2008) included 5 geographically distributed partner health departments and focused on enhanced gonorrhea surveillance due to the very limited availability of comprehensive gonorrhea data at that time. The SSuN Cycle 1 enhanced reporting has enabled researchers to better characterize the differences between heterosexuals and MSM with gonorrhea, and also suggested that alternate interventions may be required to reduce transmission among these two populations [Reitmeijer et al. p. 75]. SSuN Cycle 2 (10/2008 – 9/2013) expanded the project scope to include all STDs, and is in operation in 42 STD clinics, 115 US counties, and 6 laboratories [VA Dept. of Health p.1]. The expanded Cycle 2 surveillance jurisdictions include 20.47% of the of the US gonorrhea cases reported via NNDSS/NETSS in 2008. SSuN Cycle 2 has two main components: (1) STD clinic surveillance, and (2) Neisseria gonorrhoeae (NG) population surveillance. The STD clinic surveillance component includes the collection of enhanced information on STD patients in the STD clinic setting via the use of SSuN interview forms. The population surveillance component includes interviewing a random sample of patients diagnosed with gonorrhea in the general population via routine surveillance. The detailed case data yielded by SSuN Cycle 2 activities includes information on sexual behavior, drug use, education, employment, and comorbidity.



Cartogram Interpretation

Within the cartogram, state figure sizes are representative of the numbers of gonorrhea cases reported via NNDSS/NETSS for each respective state in 2008. The SSuN Cycle 2 county figure sizes are representative of the numbers of NNDSS/NETSS gonorrhea cases reported by each SSuN Cycle 2 jurisdiction. The reference maps of the US, Hawaii, and Alaska serve as an aid to assist the map reader in interpretation of resized and distorted figures shown in the cartogram.

It is important to note that the state and SSuN Cycle 2 county figures represent case counts, not rates. Thus, the map reader would expect states or SSuN Cycle 2 counties with larger populations to be associated with higher case counts. However, unexpected patterns are revealed. For instance, given that the cartogram distorts states based on case counts, one might expect the size of the figure for Mississippi (US Census 2010 total population: 2,967,297) to be roughly 8% the size of the figure for California (US Census 2010 total population: 37,253,956). However, the size of the Mississippi (2008 NNDSS/NETSS gonorrhea case count: 7,494) is approximately 30% that of California (2008 NNDSS/NETSS gonorrhea case count: 25,787). This is indicative of the much higher gonorrhea rate in the state of Mississippi.

Projection: US Contiguous Equal Area Conic (Continental US & Alaska); Hawaii Equal Area Conic (Hawaii)

Interpretation
New York City Buroughs

The reference maps depicting the state of New York with the five counties (New York, Kings, Queens, Bronx and Richmond) comprising the buroughs of New York City highlighted are provided as an aid in the interpretation of the state and county figures shown on the cartogram. In 2008, 17,108 gonorrhea cases were collected via routine NNDSS/NETSS STD surveillance in New York state. The five counties of NYC participate in SSuN Cycle 2, and, in 2008, 10,493 gonorrhea cases were reported within the counties via NNDSS/NETSS routine surveillance. Thus, SSuN Cycle 2 now governs enhanced surveillance upon 61.3% of the total number of New York state cases, and following this, the five counties of NYC are represented by figures that total 61.3% the total area of the New York state figure.

Interpretation
Jefferson County, Alabama

The reference map depicting the state of Alabama with Jefferson County highlighted is provided as an aid in the interpretation of the state and county figures shown on the cartogram. In 2008, 9,740 gonorrhea cases were collected via routine NNDSS/NETSS STD surveillance in Alabama. Jefferson County participates in SSuN Cycle 2, and, in 2008, 2,604 gonorrhea cases were reported within the county via NNDSS/NETSS routine surveillance. Thus, SSuN Cycle 2 now governs enhanced surveillance upon 26.7% of the total number of Alabama cases, and following this, Jefferson County is represented by a figure that is 26.7% the total area of the Alabama figure.

Important Note
All figures (states and SSuN Cycle 2 counties) represent the number of NNDSS/NETSS gonorrhea cases derived from each respective unit in the 2008 surveillance year. The purpose of the cartogram is to visually illustrate that SSuN Cycle 2 surveillance, which began reporting cases on January 1, 2009, covers an extensive and geographically distributed subset of gonorrhea cases diagnosed annually and reported via NNDSS/NETSS.

Note on Multiple County Categories: SSuN Cycle 2 includes all counties California and Washington (state). To facilitate map interpretation, the majority of counties in each state have been collapsed into multiple county categories. Only the counties with the most reported cases have been rendered using cartogram figures. In Washington, cartogram figures appear for the counties of Clark (172 cases), King (1,315), and Pierce (669). Reporting from the rest of counties, totaling 971 cases, has been collapsed to form the "Multiple Cty, WA" figure. In California, cartogram figures appear for the counties of Alameda (1,952 cases), Los Angeles (8,959), San Bernadino (1,370), San Diego (2,066), and San Francisco (2,023). Reporting from the rest of counties, totaling 9,417 cases, has been collapsed to form the "Multiple Cty, CA" figure.

Demographic Analysis

The following figures enable a comparison of the general US population with the population of SSuN Cycle 2 counties. A visual examination of Figure 1 (US vs. SSuN Race Analysis) reveals that whites are relatively less populous within SSuN Cycle 2 counties than the within the US population in general. Additionally, SSuN Cycle 2 counties are more racially diverse than the US population as a whole. Finally, a visual inspection of Figure 2 (US vs. SSuN Age and Sex Structure) reveals that the sex and age structure of the two populations is not substantially different.

Census Data Source: US Census, 2010.

Figure 1: US vs. SSuN Race Analysis

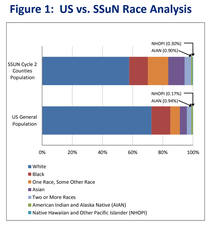
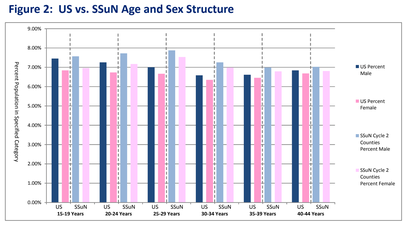


Figure 2: US vs. SSuN Age and Sex Structure



Conclusion

The cartogram visually depicts that 21.47% of US gonorrhea cases gathered via NNDSS/NETSS in 2008 are within counties, boroughs, or independent cities participating within SSuN Cycle 2, which began collecting data on January 1, 2009. Although the coverage of SSuN Cycle 2 includes only 115 jurisdictions, the inclusion of sites in very populous cities (e.g. New York City, Chicago, and Los Angeles) has positively impacted the proportion of US gonorrhea cases now covered within Cycle 2. Additionally, the cartogram depicts that SSuN Cycle 2 has good regional distribution of its sites with locations in the northeast (New York City, Philadelphia PA, Hartford/New Haven CT, Baltimore MD), south (Richmond VA, Birmingham AL, New Orleans LA), Midwest (Chicago IL) and west (all WA counties, all CA counties, and Denver CO). Furthermore, the inclusion of Richmond City (VA) is important because it has historically experienced one of the highest gonorrhea rates of any US city [VA Dept. of Health, p.2]. A visual examination of Figure 1 (US vs. SSuN Race Analysis) reveals that whites are relatively less populous within SSuN Cycle 2 jurisdictions than within the US population in general. SSuN Cycle 2 sites are more racially diverse than the US population as a whole. Finally, a visual inspection of Figure 2 (US vs. SSuN Age and Sex Structure) reveals that the sex and age structure of these two populations is not substantially different.

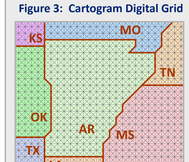
Methods

The cartogram, or value-by-area map, is a map in which the areas of the geographic units depicted are proportional to the attribute data they represent. Cartogram interpretation primarily depends on the map reader's familiarity with the relative size of the geographic units depicted and secondarily on familiarity with other general attributes of those units that may influence the variable being mapped. This familiarity enables the map reader to determine if the cartogram reveals patterns that are interesting, surprising, or may require further investigation. Cartograms may be of two types, contiguous and non-contiguous. Within contiguous cartograms, the geographic units depicted are resized and distorted to mirror the shape, adjacency and orientation properties of the original units. Within non-contiguous cartograms, units are resized, but not distorted to mirror the adjacency and orientation properties of the original units. Thus, within non-contiguous cartograms, gaps may appear between the geographic units depicted. In the past, cartograms were constructed using manual methods (i.e. pencil and graph paper), however, advances in computer technology have ushered the advent of automated algorithms that attempt to create effective contiguous cartograms efficiently. The results of such automated algorithms (such as the Gastner and Newman diffusion algorithm) have been praised for their speed, but criticized for producing maps that have so much shape distortion that interpretation becomes difficult.

To produce the contiguous cartogram shown, ArcGIS 10.1 (Environmental Systems Research Institute, Inc., "ESRI", Redlands, CA) was used to code a digital grid of cells to create state and county figures that mirror the shape, adjacency and orientation properties of the corresponding units while being proportionally sized to properly represent the data values being mapped. The digital grid of cells employed in the process was a set of squares in which each square was broken into 4 component quarter-sections. The quarter-sections facilitated the creation of diagonal feature boundaries that mirrored the shape of the states and counties more faithfully. As assignment progressed, the case total currently aggregated to each state was compared to the target case total. Assignment continued for each state until the current case total matched the target case total and then assignment on the next state began. As work continued, adjustments were made to the assignment of each cell until each state reflected the adjacency and orientation properties of the original geographic units and represented the target number of cases. In many instances, iterative adjustments were required to ensure that each state figure was optimally shaped and positioned. After cells were assigned to each state, another layer of cells was used for the county data.

In this case, state figure sizes are representative of the numbers of gonorrhea cases reported via NNDSS/NETSS by each respective state in 2008. The SSuN Cycle 2 county figure sizes are representative of the numbers of NNDSS/NETSS gonorrhea cases reported in each SSuN Cycle 2 jurisdiction in 2008. The purpose of the cartogram is to visually illustrate that SSuN Cycle 2 surveillance, which began reporting cases on January 1, 2009, includes a substantial and geographically distributed subset of gonorrhea cases diagnosed annually and reported via NNDSS/NETSS.

Figure 3: Cartogram Digital Grid



Cartogram Creation Process

1. Create digital grid of cells and subdivide each cell into 4 quarter-sections, which facilitates the creation of diagonal feature boundaries.
2. Determine the number of cases to be represented by each cell/quarter-section. Fewer cases represented by each quarter-section results in more geographic feature detail and increases the time required for the cartogram creation process. More cases represented by each quarter-section results in less geographic detail and decreases the time required for the creation process. A balance must be achieved to ensure that the resulting cartogram communicates the desired message effectively. For this cartogram, each cell represents 20 cases, and each quarter-section represents 5 cases.
2. Progress through geographic features (states, then counties) and assign each quarter-section to each feature (e.g. state or county) until the case count for each feature equals the case count the unit is supposed represent.
3. Make iterative reassignments along feature boundaries to ensure that (1) the properties of shape, orientation, and adjacency are preserved as best possible, and (2) the sizes of the features are appropriate for the target case counts the units represent.

Figure 3 Note: This figure depicts the quarter-sections used to compile the cartogram. At this stage, the final iteration of quarter-section assignment has occurred. Thus, each quarter-section has been assigned to a state and each state figure has been iteratively adjusted to ensure that (1) its properties of shape, orientation and adjacency are preserved as best possible, and (2) its size represents the total target case count as closely as possible. For example, the state of Arkansas, which recorded 4,514 NNDSS/NETSS cases in 2008, is represented by a total of 902 quarter-sections. At 5 cases per quarter-section, the aggregate Arkansas feature represents a total of 4,510 cases.

References 1. Berkelman RL, Bryan RT, Osterholm MT, LeDuc JW, Hughes JW. 1994. Infectious Disease Surveillance: A Crumbling Foundation 1994(264):368-370. 2. Centers for Disease Control and Prevention. 2001. Updated Guidelines for Evaluating Public Health Surveillance Systems: Recommendations from the Guidelines Working Group. MMWR 2001(50):(RR-13)1-35. 3. Centers for Disease Control and Prevention. 2008. NETSS Gonorrhea Cases and Rate per 100,000 Population, 2008. Report Date: 2/10/2010. 4. Centers for Disease Control and Prevention (NCHHSTP/Division of STD Prevention). 2009. Sexually Transmitted Disease Surveillance 2008 (November 2009). 5. Centers for Disease Control and Prevention (Office of Surveillance, Epidemiology,and Laboratory Services). 2011. National Electronic Telecommunications System for Surveillance (http://www.cdc.gov/osels/ph_surveillance/nndss/netss.htm). 6. Council of State and Territorial Epidemiologists. 2010. List of Nationally Notifiable Conditions (November 2010). 7. Dent BD, Torguson JS, Hodler TW. 2009. Cartography: Thematic Map Design. 6th ed. New York: The McGraw-Hill Companies, Inc. 8. Eng TR, Butler WT, editors. 1997. The Hidden Epidemic: Confronting Sexually Transmitted Diseases. Washington DC: National Academy Press. p.43. 9. Gaffga NH, Samuel MC, Stenger MR, Stover JA, Newman LM. 2009. The OASIS Project: Novel Approaches to Using STD Surveillance Data. Public Health Reports 2009(Supplement 2, 124):1-4. 10. Reitmeijer CA, Donnelly J, Bernstein KT, Bissette JM, Martins S, Pathela P, Schillinger JA, Stenger MR, Weinstock H, Newman LM. 2009. Here Comes the SSuN: Early Experiences with the STD Surveillance Network: Improving Disease Surveillance 2009(Supplement 2, 124):72-77. 11. Thacker SB, Berkelman RL. 1988. Public Health Surveillance in the United States. Epidemiologic Reviews 1988(10):164-190. 12. Thacker SB. 2010. Historical Development. In: Lee LM, Teutsch SM, Thacker SB, St. Louis ME, editors. Principles and Practice of Public Health Surveillance. 3rd ed. New York: Oxford University Press, Inc. p.1-17. 13. Virginia Department of Health, Office of Epidemiology, Division of Disease Prevention. 2011. STD Surveillance Network Overview. Richmond, Virginia. p.1-16(Available at: http://www.vdh.virginia.gov/epidemiology/diseasesprevention/data/Annual/SSuN/SSuN%20Annual%20Report%2007-05-11_WebVersion.pdf).

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The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention and/or the Agency for Toxic Substances and Disease Registry.
Contact: Andrew L. Dent (adent@cdc.gov) Geospatial Research, Analysis, and Services Program, Division of Toxicology and Human Health Sciences (proposed), Agency for Toxic Substances and Disease Registry | Project 03634 (SSuN Cartogram v12 ArcGIS 101.mxd) | Documentum Accession Number NCEH-DTHHS-10/12/12-22419.