California Breast Cancer Mapping Project:

Identifying Areas of Concern in California

November 2012

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Contents

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Preface

As advocates committed to breast cancer prevention, detection, treatment and survivorship, we are well aware of the devastating impact of breast cancer on women, men, families and communities. We are also aware of the increased lifetime risk of getting breast cancer, a risk that has grown from 1 in 20 in the 1960s to 1 in 8 today. Progress to reduce the overall burden of breast cancer requires increasingly-sophisticated health tracking tools that address geographic variability, particularly given California's robustly diverse populations. We are proud to present this report, which uses sophisticated statistical methods to produce important geographic maps of elevated invasive breast cancer in California. We urge advocates and researchers to focus attention and resources on these areas to better understand the population, prevention, early detection, treatment and survivorship needs in the state of California. Such efforts will require that stakeholders work across city or county lines in a spirit of true interdisciplinary collaboration to address yet-unknown and unmet needs. We also hope that public health departments in these areas and beyond remain highly responsive to communities that have continuing questions and needs for more granular and timely data on cancer rates among specific populations.

Beyond the findings presented in this report, we also want to underscore the importance of community-based participatory research (CBPR) to ensure that health mapping and tracking informs breast cancer control policy and practice. The California Breast Cancer Mapping Project Advisory Group involved a broad cross-section of advocates from breast cancer and community advocacy organizations, environmental health breast cancer organizations, clinical and public health practitioners, and researchers. Together, we informed every step of this study, including identifying the most informative statistical approach (using the Scan Statistic described in the report), identifying criteria for minimizing false positive areas, and guiding the development of this report. Such a process showed great respect for the diversity of advocacy opinions. We are proud to have modeled a process that values such substantive input on the study, and are committed to continuing to serve as bridges to our respective communities to ensure the translation of this science to practice. We urge breast cancer researchers everywhere to use such CBPR protocols and processes to maximize the responsiveness and relevance of research to communities' needs around breast cancer. Indeed, given the importance of health tracking and disease mapping, we hope the processes and protocols described in this report become models for preventing and/or addressing health disparities throughout California.

— The CBCMP Advisory Group

Executive Summary

Breast cancer is the most common cancer among women in California, with an average of 26,300 new cases diagnosed every year and 4,175 deaths from breast cancer occurring annually.[1] Data about who is affected by breast cancer is essential to the efforts of the broad array of stakeholders working to identify, treat, and support women with breast cancer and to understand and prevent the disease. These stakeholders include breast cancer and community advocacy organizations, clinical and public health practitioners, researchers, and other concerned citizens.

The Need for Breast Cancer Maps

Disease mapping, or the display of disease data on maps, is one of the most commonly requested services among local and state public health agencies.[2,3,4] Although state agencies such as cancer registries often produce cancer maps for the public, such maps generally show only the cancer rate for each county. This can be limiting for stakeholders who are interested in cancer as it relates to towns and neighborhoods. Fortunately, advances in the fields of epidemiology and statistics now enable the creation of statistically reliable maps that are not limited by county boundaries and still maintain patient confidentiality.

The California Breast Cancer Mapping Project (CBCMP) was funded by the California Breast Cancer Research Program from 2009 through 2011 to explore the technical feasibility of mapping areas in the state with elevated cancer rates in a manner that is determined to be useful by the breast cancer stakeholder community. An advisory group (AG) of breast cancer advocates, clinicians, and public health practitioners engaged in a process to develop a protocol for creating such maps. In addition to the statistical method used to identify areas with elevated rates of breast cancer, the CBCMP protocol includes steps to remove misleading results arising from limitations in the data themselves, to characterize the women diagnosed with cancer, and to describe the population living in areas with elevated rates.

Project staff used the CBCMP protocol to analyze and map invasive breast cancer among women in California from 2000 through 2008.

Areas of Concern Identified for California

For the first time in California, the CBCMP has produced maps identifying areas — no longer restricted by county boundaries — with elevated rates of invasive breast cancer for the entire state. These maps, along with the protocol used to create them, are presented in this report.

The maps show four areas, two in the San Francisco Bay region and two in the Los Angeles-Orange County region, for which the age-adjusted incidence of invasive breast cancer appears to be 10–20% higher than for the rest of the state. Further analyses were conducted to characterize the women diagnosed with breast cancer and the general population in these areas of concern. With a few exceptions,

1 California Cancer Registry (2009). *Trends in Cancer Incidence, Mortality, Risk Factors, and Health Behaviors in California.*

2 Bell B, Hoskins R, Pickle L, Wartenberg D. *Current practices in spatial analysis of cancer data: Mapping health statistics to inform policy makers and the public.* International Journal of Health Geographics. 2006;5.

3 Roberts E, English P, Wong M, Wolff C, Falade M. *Continuous Local Rate Modeling for Communication in Public Health: A Practical Approach.* Journal of Public Health Management and Practice. 2008;14(6):562-568.

4 Roberts EM, English P, Wong M, et al. *Progress in Pediatric Asthma Surveillance II: Geospatial Patterns of Asthma in Alameda County, California.* Preventing Chronic Disease. 2006;3(3).

the findings reflect known sociodemographic patterns in breast cancer risk for the state.

Because the statistical method used in the CBCMP protocol differs from those used conventionally, individual counties that may have been previously identified as having significantly elevated rates through other statistical methods may not show up in these maps. Previously documented information about rates for specific counties is still valid and should not be considered undermined by the CBCMP maps.

Conclusions

The CBCMP successfully demonstrated the ability to identify areas with elevated breast cancer risk in California irrespective of county boundaries, while maintaining confidentiality, eliminating false positives, and accounting for the age distribution within the population as well as large increases in population size. Because the maps are based on census tracts, additional information from the U.S. Census about the sociodemographics of the areas of concern can also be presented and compared to that for the state.

The project also identified limitations of the CBCMP protocol, most notably the size of the detectable area. For a group of 50 census tracts, an invasive breast cancer rate that is 50% greater than that of the overall state can be reliably detected. An area composed of fewer tracts will require a larger increase for detection, while an area composed of more tracts will require less of an increase. In our findings, the areas that came to attention had rate increases smaller than 50% but were detectable because they included a much larger numbers of tracts.

Where Do We Go from Here? Implications for Statewide Mapping

Details of the process and deliberations of the CBCMP AG have been published in a peer-reviewed manuscript.[5] The AG concluded that public agencies should augment their surveillance activities to include the CBCMP protocol (or an adapted form thereof) to detect and characterize regions of the state with elevated breast cancer risk on a routine basis. While in general very little is known about what causes the rates of invasive breast cancer in one population to be higher than another, mapping variations in breast cancer risk can enable communities, breast cancer advocates, public health practitioners, and other breast cancer stakeholders to identify communities most impacted by breast cancer, explore resource needs and opportunities, and define concerns.

5 Roberts EM, et al (in press). *Guidelines for the Mapping of Cancer Registry Data: Results from a Breast Cancer Expert Panel Study.* Journal of Public Health Management and Practice. Available at www.californiabreastcancermapping.org.

Introduction

Breast Cancer Data for the General Public

Breast cancer is the most common cancer among women in California, with an average of 26,300 new cases diagnosed every year and 4,175 deaths from breast cancer occurring annually.[6] According to the American Cancer Society, the chance of a woman having invasive breast cancer some time during her life is about 1 in 8.[7]

The need for breast cancer data by communities, advocates, and other breast cancer stakeholders is often motivated by the desire to ensure sufficient breast cancer services are available, to understand behavioral and environmental risk factors for breast cancer, and to understand why breast cancer affects so many women. Not surprisingly, one of the most common requests made to local and state public health agencies is for data in the form of maps.[8,9,10] When effective, disease maps present critical information in a manner useful to a broad array of stakeholders, and they can be valuable for any community seeking to understand its collective vulnerability and access to resources.[11,12,13]

In California, local public health departments and the California Cancer Registry (CCR) frequently receive such requests for breast cancer data and information. Although these agencies often produce maps for public dissemination, these maps generally only show the breast cancer rate for each county. This "county-level only" restriction can be frustrating, since there is often a need to understand risk, explore resources, or take action at the town or neighborhood level.

Challenges in Mapping Breast Cancer

There are numerous challenges to mapping cancer rates by areas smaller than counties (such as census tracts). The smaller the area in question or the rarer the disease, the greater the following problems become: (1) rates becoming less reliable and less informative and (2) the possibility of disclosing patient identity — which is both unethical and restricted by law — increases.

With the methods most often used by public agencies, it is virtually impossible to calculate rates and create maps for areas smaller than a county without running into the above problems, even for a disease as common as breast cancer. Using these methods, the only option is to combine several years of breast cancer data, which limits one's ability to know how patterns may change over time.

Fortunately, since the 1990s, statisticians have developed methods for calculating and mapping rates for small areas that both protect confidentiality and avoid unreliable rates. With so many statistical methods to choose from, it is important to engage stakeholders who use breast cancer data to determine which methods best meet their needs and priorities.

6 See note 1.

7 American Cancer Society (2011). *Breast Cancer Overview: How many women get breast cancer?* Retrieved from www.cancer.org/cancer/breastcancer/overviewguide/breast-cancer-overview-key-statistics, July 18, 2011.6.

8 See note 2.

9 See note 3.

10 See note 4.

11 Beyer K, Rushton G. *Mapping Cancer for Community Engagement.* Preventing Chronic Disease. 2009;6(1):1-8.

12 Driedger S, Kothari A, Morrison J, Sawada M, Crighton E, Graham I. *Using Participatory Design to Develop (Public) Health Decision Support Systems through GIS.* International Journal of Health Geographics. 2007;6.

13 Heitgerd J, Dent A, Holt J, et al. *Community Health Status Indicators: Adding a Geospatial Component.* Preventing Chronic Disease. 2008;5(3):1-5.

The California Breast Cancer Mapping Project

The California Breast Cancer Mapping Project (CBCMP) was created in response to these challenges in mapping breast cancer. The CBCMP, funded by the California Breast Cancer Research Program from 2009 through 2011, consisted of project staff and an Advisory Group (AG) of advocates, clinicians, and public health professionals in California's breast cancer community, all working together to develop a protocol for statewide breast cancer mapping.

Before initiating the protocol development process, the AG engaged in discussions exploring whether sub-county maps would be useful in their work. The AG determined that sub-county maps could be used for identifying vulnerable communities, targeting services, and increasing knowledge about the social and environmental factors contributing to breast cancer in affected communities. The AG also acknowledged that while mapped data can be useful for generating research questions, the maps themselves cannot provide information about what causes breast cancer in a community. Details of the AG deliberations have been published in a peer-reviewed manuscript.[14]

For the development of the protocol, the AG reviewed the characteristics of several statistical methods and articulated priorities to guide how they could be used. Among their decisions was that the statistical method known as the Scan Statistic, when combined with steps to correct for data limitations, should be used to detect and characterize sub-county regions of the state with elevated breast cancer risk.

The CBCMP Protocol

The CBCMP protocol is centered on the Scan Statistic, which is among the most reviewed and analyzed approaches to disease mapping in the epidemiological literature. In addition to this method, the protocol includes steps to (1) remove misleading results arising from limitations inherent in the data and (2) define the boundaries of areas of concern so that they can be examined consistently over time.

The CBCMP protocol identifies "areas of concern", which we define as collections of census tracts in California with elevated age-adjusted rates of invasive breast cancer that cannot be attributed to population growth, limitations inherent in the data, or random chance. Within an area of concern, the specific groups of census tracts identified by Scan Statistic as having elevated rates can differ from year-to-year.

An overview (page 5) and a more detailed discussion (page 63) of the analysis using the CBCMP protocol are included in this report.

About this Report

To demonstrate and explore the implications of the CBCMP protocol, project staff used the protocol to analyze and map nine years of data on women diagnosed with invasive breast cancer in California.

Included in this report are:

- Statewide maps of areas of concern for invasive breast cancer
- Time-series maps showing changes in census tracts identified by the Scan Statistic over time within each area of concern
- Demographic analysis of the women diagnosed with breast cancer for each area of concern
- Demographic analysis of the general population living in each area of concern
- Overview and detailed description of the analytic process

Breast cancer risk does not affect all communities in California the same way. The more that is known about how different people are

14 See note 5.

affected, the better our collective ability will be to identify communities at risk, provide services, and increase knowledge about potential causes of breast cancer. In the future, public agencies and others may consider adapting this protocol on a routine basis to better understand the burden of cancer in California. The CBCMP hopes to assist in that process by sharing effective methods to map breast cancer data at the sub-county level.

Companion Piece to This Report

A complete description of the CBCMP AG's deliberation process — including a briefer, more technical discussion of the analytic findings — is available in the a manuscript titled *Guidelines for the Mapping of Cancer Registry Data: Results from an Expert Panel Study,* available at www.californiabreastcancermapping.org.

A Note on the Term *Cancer Cluster*

The term cancer cluster is commonly used to refer to a distinct geographic area, such as a school, neighborhood, or workplace, with a higher number of cancer cases than would be expected. The clustering of cancer cases in a small geographic area, time period, and/or among a defined group of people can raise concerns that the cancer may be caused by a specific environmental contaminant or pollution source.

The CBCMP results are related to the idea of clusters since the analysis identified localized areas with increased rates of disease unrelated to random chance. Therefore, the CBCMP AG and staff held many discussions on whether or not to use the term "cluster" to describe project findings. **There is no common or agreed upon definition of *cluster,* and reservations about using the term stemmed from two connotations that would be misleading if used in the context of this report:**

- **The term may imply specific environmental or industrial pollution is causing the elevated number of cases:** Scientists believe that it may take decades between exposure to environmental contaminants and the subsequent development of breast cancer, during which time people who have been exposed frequently move out of the area and unexposed people move in. Therefore, although the CBCMP is very concerned about the possibility that exposure to environmental chemicals may lead to breast cancer, it is very unlikely that our project would identify such a phenomenon.
- **The term may imply government negligence or malfeasance:** The second connotation is that a public agency has willfully ignored or hidden the existence of the cluster, with phrases like *alleged cluster* and *cluster allegation* commonly used. In contrast, agencies such as the California Cancer Registry (CCR) have been consistently transparent and forthcoming with providing data to the CBCMP after legal provisions were made to maintain patient confidentiality. As the CBCMP is composed of independent researchers, CCR is not responsible for the findings, but they have expressed interest in them and have not acted to prevent their dissemination.

Because **these connotations do not apply** to the project results, **the group decided to use the term *area of concern*** to describe the collection of census tracts that had elevated breast cancer rates and to **avoid the term *cluster* when at all possible.**

Overview of CBCMP Analytic Protocol

Below is a brief overview of the CBCMP protocol only. A complete, technical description and list of citations are available in the *Methods* section (page 63). For details on how the AG guided the method selection and protocol development, see *Guidelines for the Mapping of Cancer Registry Data: Results from an Expert Panel Study*, available at www.californiabreastcancermapping.org.

Summary of Analysis

The steps involved in conducting the analysis and developing maps are summarized below. All work was conducted under the supervision of the Committee for the Protection of Human Subjects of the California Department of Public Health and the Institutional Review Board of the Public Health Institute.

- **Obtain data:** Data were obtained from the California Cancer Registry describing the numbers of cases of invasive breast cancer among women by age, year of diagnosis, and census tract of residence at the time of diagnosis for the years 2000–2008. Population data, or denominators, and information about the populations in the areas of concern were taken from the 2000 and 2010 U.S. Census. For years between 2000 and 2010, the population data were estimated mathematically.
- **Apply statistical method:** Of the statistical methods reviewed, the AG collectively determined that the Scan Statistic was the most effective for mapping breast cancer data at the sub-county level (i.e., using census tracts as the unit of mapping) and was preferred over other methods due to its ability to accurately identify a true breast cancer elevation at this level. Breast cancer data were processed using SatScan™, a computer program developed specifically for the Scan Statistic method. SatScan™ allows the user to choose settings in order to customize the analysis. Settings were selected to reflect the AG priorities as closely as possible (page 63). For example, the software was set to calculate age-adjusted rates, allowing for comparisons of different areas across the state that may have different proportions of elderly residents.
- **Review results and make corrections:** SatScan™ identified groups of contiguous census tracts in California with elevated breast cancer rates. The raw results were then systematically reviewed to identify and remove those groups whose elevated rates were very likely attributable to the rapid population growth in that area during that time period. Once these misleading groups of census tracts were removed from the analysis, a review of the remaining groups showed that they were concentrated in a small number of specific geographic areas over time. These areas were designated as "areas of concern." To be considered part of an "area of concern", each census tract had to show up in a group identified by SatScan™ at least once during the nine years analyzed (2000–2008).[15]
- **Characterize areas of concern:** After the maps were created, the age-adjusted invasive breast cancer rates for each area of concern for all nine years were calculated, along with rates for the state as a whole for purposes of comparison. The demographic composition of the women diagnosed in each area was compiled, along with the proportion of women for whom their cancer had spread at the time of diagnosis ("late-stage") and the proportion of women who received government-assisted insurance or who

15 An exception to this rule occurred for the 2008 data. For this year, Scan Statistic identified elevated risk in a collection of tracts that overlapped both the North San Francisco Bay and South San Francisco Bay areas of concern (plus tracts in between). Staff calculated rates for subsets of these data (e.g., by county within each area) and determined that the findings were more honestly represented by treating these as two separate areas of concern (based on 2000–2007 data) rather than as a single large area of concern (as implied by the 2008 data only).

were uninsured at the time of diagnosis. Finally, demographic information about the general population living in each of the areas of concern was compiled.

Capabilities and Limitations

Notable capabilities and limitations of the CBCMP protocol include:

- **Detectable size and rate:** The ability for the Scan Statistic (or any other statistical method) to detect a rate elevation is a function of (1) the size of the area in question — in this case, the number of census tracts, (2) the degree to which the rate has increased, and (3) the overall rate of the disease in question. For a group of 50 tracts, Scan Statistic appears to reliably detect an invasive breast cancer rate elevation if it is 50% above that of the state overall. As detailed in the results sections, all of the areas of concern had much smaller rate increases (generally 10–20%) but they were detectable because they included much larger numbers of tracts.
- **Eliminating false positives:** Scan Statistic has the ability to ignore elevations in cancer rates that may have occurred due to random chance (i.e., false positive findings). This is particularly crucial when examining all census tracts in a state as large as California on a yearly basis. For example, with the traditional method used in public health agencies, one would expect that between 150 and 200 of the census tracts identified would have elevated cancer rates ***due solely to random chance*** for every year of data analyzed. In contrast, the SatScan™ settings for this protocol were selected to reduce this false positive rate to ***once for every 1,000 years of data analyzed.*** Therefore, with Scan Statistic, there is very high confidence that the areas identified actually have elevated rates of breast cancer and are not due to random chance.
- **Uncertainty about boundaries:** The boundaries of each area of concern are highly imprecise. The time-series maps in this report demonstrate how the census tracts identified by SatScan™ as having elevated breast cancer rates fluctuate from year to year, illustrating how difficult it is to know actual boundaries with certainty.
- **Urban versus rural areas:** The Scan Statistic functions equally well in both urban and rural areas. However, the SatScan™ settings selected for this protocol restricted raw results to areas less than 30 kilometers (about 19 miles) in radius. This may have disproportionately limited detections in rural areas because rural census tracts are much larger. SatScan™ provides workarounds for this limitation, the exploration of which is recommended for future work.

Because the Scan Statistic differs from statistical methods used conventionally, some counties that have been identified in previous analyses as having significantly elevated rates may not show up in the CBCMP findings. This is because the Scan Statistic uses higher standards for statistical significance. Previously documented information about breast cancer rates in individual counties is still valid and should not be considered undermined by the CBCMP results.

Overall Results

The CBCMP protocol was applied to data describing invasive breast cancer among women in California for each year from 2000 through 2008. See *Overview of CBCMP Analytic Protocol* (page 5) for details, capabilities, and limitations of protocol.

Areas with Elevated Invasive Breast Cancer Rates in California

Our analysis identified four distinct areas in California with invasive breast cancer rates that were between 10% and 20% higher than the statewide rate (Figure 1).

The areas are located in North San Francisco Bay (360 tracts); South San Francisco Bay (264 tracts); western Los Angeles and eastern Ventura counties (699 tracts); and southern Orange County, with a small portion of western Riverside County (177 tracts).

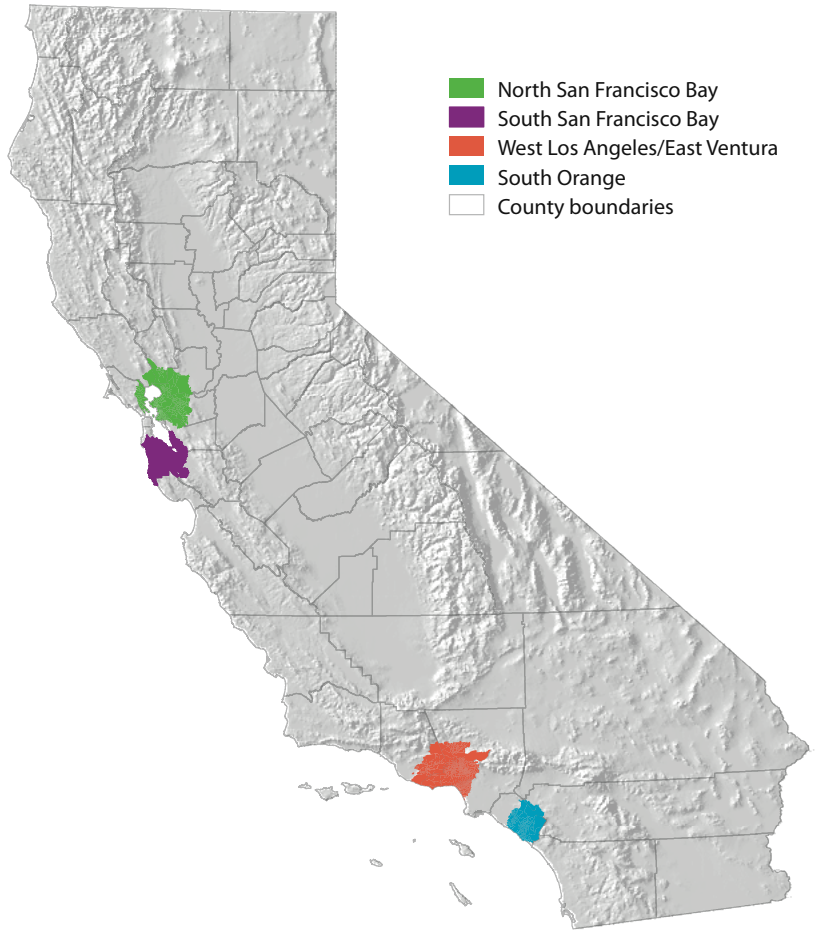
Characteristics of Areas of Concern

In general, trends for women diagnosed with invasive breast cancer were similar across the four areas of concern.

For all four areas of concern:

- Invasive breast cancer incidence rates have declined slightly, mirroring the decline of the statewide rate
- White women are over-represented among cases compared to the overall state population, which is consistent with the fact that White women face an increased risk of breast cancer
- Hispanic women are under-represented among cases compared to the overall population, which is consistent with the fact that Hispanic women face a decreased risk of breast cancer

Figure 1. Areas of concern in California for invasive breast cancer among women



Data Source: California Cancer Registry, 2000-2008, prepared by the California Breast Cancer Mapping Project

- African-American women are diagnosed at a rate proportional to their representation in the state overall
- Asian women are generally under-represented among cases compared to the overall population, which is consistent with the fact that some groups of Asian women face a decreased risk of breast cancer (but note that risk for Asian women differs by sub-group)

For all areas of concern except West Los Angeles/East Ventura:

- Women were slightly more likely to be diagnosed at an earlier stage (i.e., before their cancer had spread) compared to women diagnosed statewide
- Women were more likely to have private insurance at the time of diagnosis than women in the state overall

For West Los Angeles/East Ventura, women were slightly more likely to rely on government-assisted insurance or to be uninsured compared to women diagnosed statewide.

More detail about each area of concern is provided in the results sections following this section. Each section focuses on a single area of concern and includes the following data and information:

- A description and map of the area of concern
- Time-series maps and data for annual breast cancer rates from 2000–2008 for the area of concern and the state as a comparison
- Sociodemographic data describing the women diagnosed with breast cancer
- Sociodemographic data describing the general population living in the area of concern and the state as a comparison for the years 2000 and 2010

Cancer Surveillance in Rural Areas

To calculate a reliable rate for any disease, epidemiologists require a certain number of cases to occur (scientists call this "statistical power"). For this reason, it is more difficult to calculate a rate for rare diseases than it is for common ones, and it is more difficult to calculate rates for places where few people live than it is for places where many live. For this reason, there is a long-standing problem that information about cancer rates in rural areas is difficult to come by.

Most commonly, scientists studying rural areas combine ("aggregate") data from multiple years together to obtain enough cases. Since we are relying on annual estimates when checking the validity of our data (for example, ruling out population shifts as a cause of rate elevations), we do not have this option. We notice, furthermore, that none of the areas of concern include particularly rural areas. Is this because the Scan Statistic is unable to detect rate elevations in rural areas or because there are no rate elevations in these areas?

While we cannot answer this question with certainty, we suspect that the latter possibility is the case. This conclusion is supported by the following observations:

- CBCMP staff studied the ability of the Scan Statistic to detect invasive breast cancer rate elevations in rural areas of California using simulated data. They found that areas of concern with pronounced increases in rates (say 50% higher than elsewhere), particularly when of sufficient size (say, 50-100 census tracts), could be detected quite reliably.
- In California, rural counties themselves tend not to be those with the highest invasive breast cancer rates over the long term. As seen in Figure 2 (page 12), only one of the ten counties with the highest rates in the state (Tuolumne) is located far from an urban center, and the majority of such counties have rates lower than the state overall.

It may be that changing the Scan Statistic parameters will enable us to define areas of concern in rural areas — if there are any to be found — but we are leaving that to future work. It is also important to keep in mind that although elevated rates of invasive breast cancer tend to occur in urban areas, the same may not be true for other types of cancer.

Implications

In general, very little is known about what causes the rates of invasive breast cancer for one population to be higher those for another. However, mapping variations in breast cancer risk can enable communities, breast cancer advocates, public health practitioners, and other breast cancer stakeholders to identify communities most impacted by breast cancer, explore resource needs and opportunities, and raise other community concerns.

The sub-county maps produced by the CBCMP protocol are valuable not as a replacement to other modes of presenting breast cancer surveillance data, but rather as a supplement to them. For example, funding and interventions are often conceived as county-level initiatives, so there will always be a need for county level figures describing incidence and prevalence. In contrast, sub-county mapping provides communities with information on breast cancer rates both ***within*** and ***across*** county boundaries.

Breast Cancer in California: New Information

The ability to search for and identify areas of concern that cross county boundaries represents a substantial improvement over methods traditionally used by public agencies and provides new information that can inform local breast cancer efforts within that area of concern. For example:

- Because of its relatively small population, Ventura County has never been noted to have consistently elevated rates of invasive breast cancer on an annual basis relative to the state overall. Los Angeles County is much larger, but taken as a whole has a lower rate of invasive breast cancer than the state overall. We now see that an area partially overlapping each of these counties possesses a consistently elevated rate (page 41), providing communities in both counties a focus for outreach and education, problem solving, resource management, and fundraising.
- Similarly, Orange County on the whole has previously only been seen to have a slightly elevated invasive breast cancer rate (with intermittent statistical significance), while Riverside County has had, in general, a lower rate than the state. We now see that women living in the southern portion of Orange County and a small portion of western Riverside County face a significantly higher risk of disease in nearly every year examined (pages 53 and 56).
- The elevated rate of invasive breast cancer among women living in Marin County has been well documented. The findings in this report, however, raise the possibility that communities elsewhere in the northern San Francisco Bay may be similarly affected (page 17).
- In the South San Francisco Bay, only women in San Mateo County have been previously noted to have consistently elevated risk for invasive breast cancer. We now see that it is relevant to discuss communities throughout the South Bay, including those in northern Santa Clara and southern Alameda counties (page 29).

In summary, as demonstrated in Figure 2 (page 12), the consideration of areas of concern in addition to counties provides a more comprehensive picture of breast cancer risk in California than the consideration of counties alone.

Implications for Cancer Surveillance and Public Communication

In the future, public agencies and others may consider conducting this type of analysis on a routine basis in California to better understand the burden of cancer in the state. The CBCMP hopes to assist in that

process by sharing effective methods to map breast cancer data at the sub-county level. The augmentation of surveillance activities to include routine analyses of this type would have the following benefits:

- Improved understanding by state and county officials of the populations most susceptible to invasive breast cancer
- Guidance for both communities and research scientists seeking to refine their understandings of breast cancer risk
- Reassurance of the public that geographic surveillance of cancer is being conducted with both the highest possible geographic resolution and the exclusion of findings arising from random chance (false positive findings)

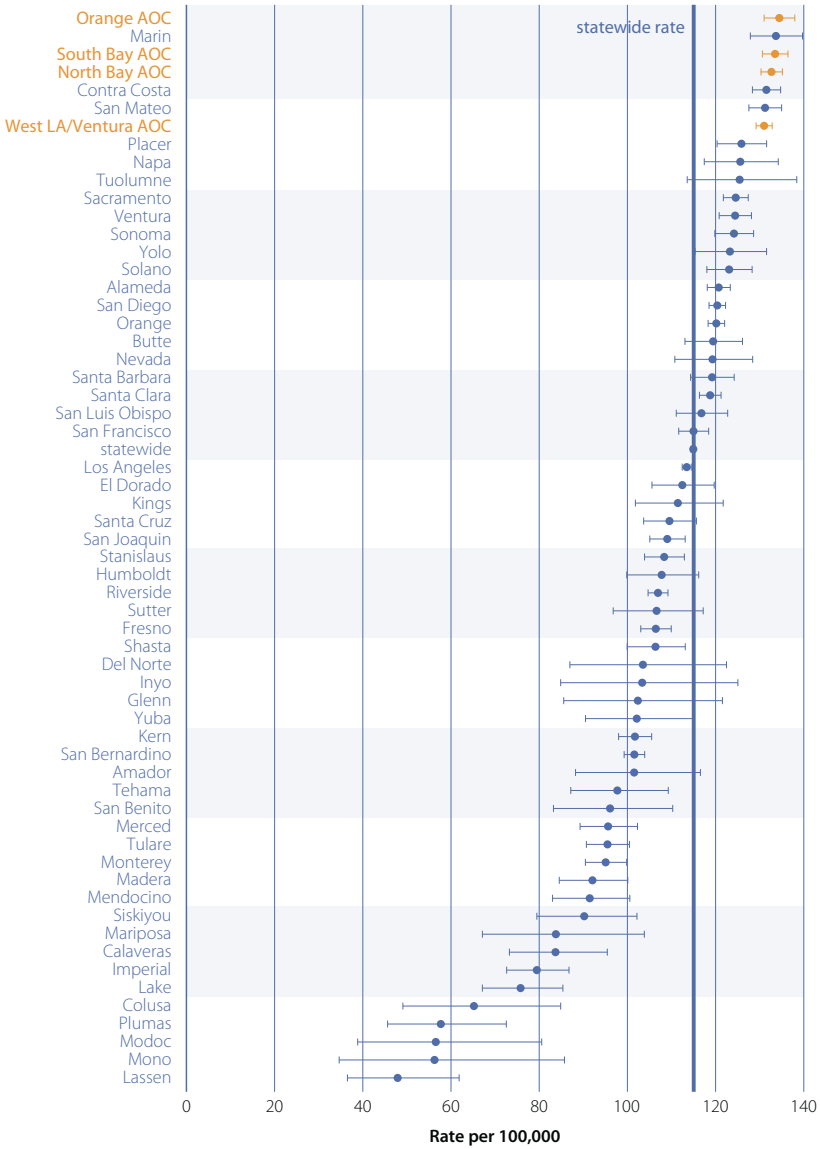
Topics for Future Inquiry

As much as the protocol developed by the CBCMP provides us with information, it also presents us with questions that we should strive to answer in the future. Possibly the most immediate of these arise from the many decisions we have made in how we implement the Scan Statistic for analysis. Available software allows us to choose from a variety of maximum sizes for the raw results, adjustments for population characteristics, and algorithms for choosing between overlapping areas with elevated rates. All of these decisions affect both the results themselves and how they might be described and communicated to the public. We strove to design our implementation of the Scan Statistic to maximize both reliability and utility of the results, but we recognize that our approach is only one among many possibilities.

Particularly because this is the first time information of this kind has been made generally available, the CBCMP staff and Advisory Group are intensely interested in how these findings might be utilized and communicated among different groups in California and elsewhere.

While the present findings demonstrate geographic variations in the risk of invasive breast cancer, most discussions up to this point have focused on how demographic characteristics are related to cancer risk. Because of the details about how various data are generated, it

Figure 2. Invasive breast cancer rates in areas of concern (AOCs, orange) and counties (blue) using nine-year aggregations of surveillance data



Data Source: California Cancer Registry, 2000-2008, prepared by the California Breast Cancer Mapping Project

can be difficult to tell whether the CBCMP results are telling a similar story in a different way, or if new information is being added (see inset box: *Breast Cancer, Race, and Ethnicity*).

Finally, we wonder how much the CBCMP protocol could be applied to the analysis of cancers besides breast cancer. We note that this involves more than just swapping out one set of data for another. For example, the questions people have about breast cancer may be different from those people have about cancers of the lung, brain, or immune system. The role of environmental factors is a persistent question for any cancer, but concerns about how these may occur are unique to each type. Also, the number of invasive breast cancer cases diagnosed each year in California is quite high relative to other cancers, which mathematically results in different trade-offs between sensitivity and specificity. Considering both of these differences, would similar analyses for different cancers still be useful? This is a relevant question, and we encourage further discussion on this matter.

Breast Cancer, Race, and Ethnicity

Since both one's genes and one's history of exposure to environmental hazards are believed to determine cancer risk, it is not surprising that women with different racial/ethnic backgrounds have different rates of invasive breast cancer. Speaking generally for US populations, White women have the highest rates, followed by African-Americans, Hispanics,* Asians and Pacific Islanders, and Native Americans. These are big generalizations, however, because sub-groups of women in each category may have cancer rates that are higher or lower than the category as a whole.

Because of the complicated history of California (and elsewhere), people of one racial/ethnic group are often over-represented in one area and under-represented in another. For example, all of the areas of concern described here have relatively greater numbers of White women than the state overall. Therefore, relative elevations in breast cancer in these areas may simply be a reflection of higher rates among White women. On the other hand, it would be equally valid to argue that the geographic patterns in breast cancer are the underlying cause and the racial/ethnic patterns are simply a reflection of this geography; this is a chicken-or-egg question that scientists currently have no way to address.

We are frequently asked if women in the areas of concern are facing the usual risk of breast cancer for their race and ethnicity, or whether their risk is even higher than one would expect based on their race and ethnicity. Because the California Cancer Registry and the US Bureau of the Census use different categories for race and ethnicity, answering this question is complex and unfortunately beyond the scope of our project. All we can say is that the areas of concern that we found are consistent with what we know about cancer rates among racial/ethnic groups in the United States overall and hope that more resources will be available in the future to address this important question.

* Although many people find it counter-intuitive, demographers consider *Hispanic* to be an ethnic — rather than a racial — category; this means it refers more to the geographic area from which one's ancestors came than it does to one's physical characteristics such as skin color (either type of category can be very complicated, of course). Therefore, Hispanic women may be any race (e.g., White, African-American, etc.), and women in the other groups are assumed to be *non-Hispanic*.

Results: North San Francisco Bay Area of Concern

Maps of North San Francisco Bay Area of Concern

Invasive Breast Cancer Data for North San Francisco Bay Area of Concern

Sociodemographic Data for Invasive Female Breast Cancer Cases in North San Francisco Bay Area of Concern

U.S. Census 2000 and 2010 Population Data for North San Francisco Bay Area of Concern and California

Maps of North San Francisco Bay Area of Concern

Description

The North San Francisco Bay area of concern is shown in Figure 3 in green. The South San Francisco Bay area of concern, shown in purple, is discussed in the next chapter of results. Each area overlaps small portions of Alameda County.

- **Counties overlapping North San Francisco Bay area of concern include:** Alameda, Contra Costa, Solano, Napa, Sonoma, Marin, and San Francisco
- **Population size:** 1,723,658 in 2010, a 7% increase from the year 2000 census population

Figure 3. Regional view of North and South San Francisco Bay areas of concern

Data Source: California Cancer Registry, 2000–2008, prepared by the California Breast Cancer Mapping Project

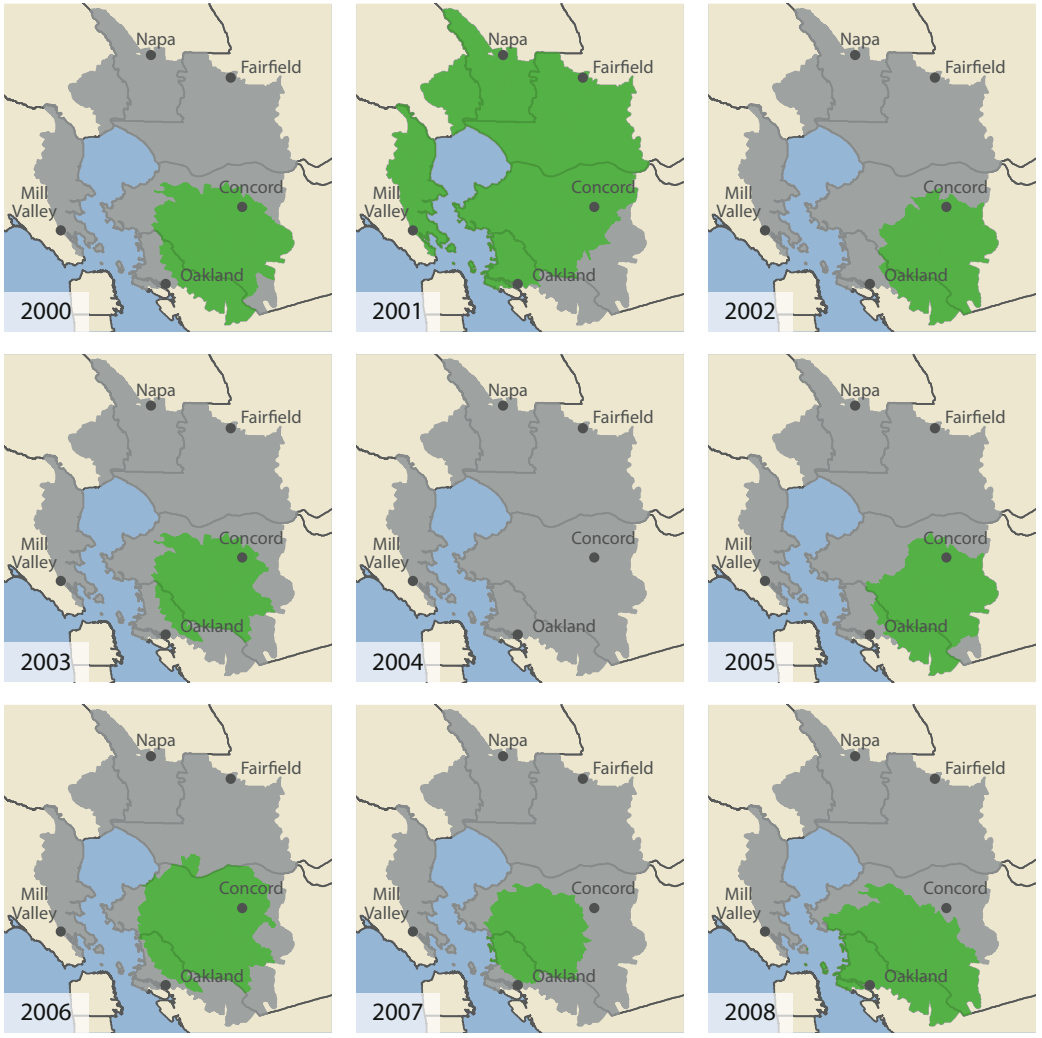
A detailed census tract view of the North San Francisco Bay area of concern is shown in Figure 4.

Figure 4. Census tracts in the North San Francisco Bay area of concern, 2000–2008

Data Source: California Cancer Registry, 2000–2008, prepared by the California Breast Cancer Mapping Project

In the time-series maps (Figure 5), the area of concern is shown in gray, while the green areas indicate groups of census tracts with elevated rates of invasive breast cancer for the given year. The area of concern is composed of all groups of census together that had an elevated rate of invasive breast cancer at any time during 2000–2008.

Figure 5. Time-series maps of census tracts with elevated rates of invasive breast cancer within the North San Francisco Bay area of concern



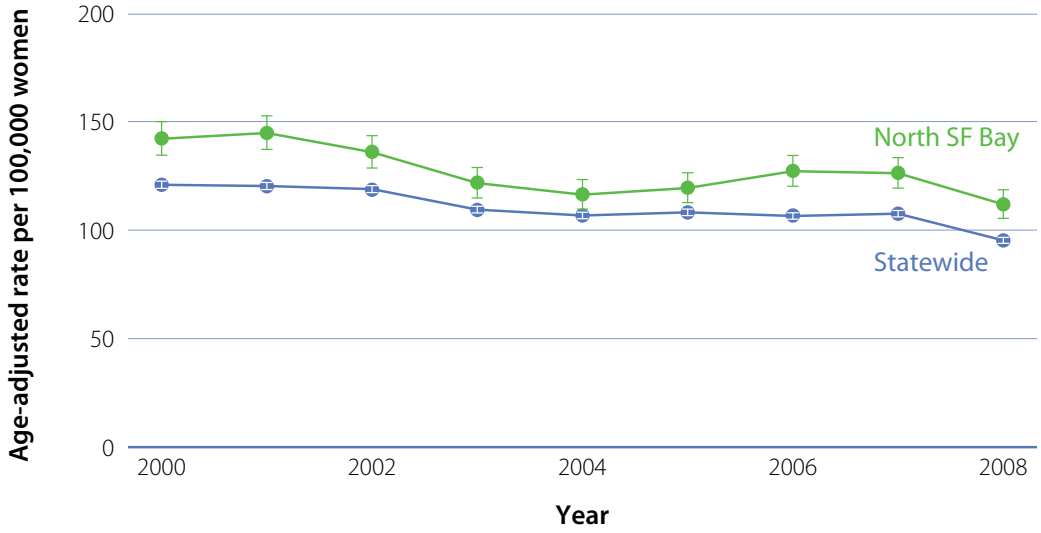
Data Source: California Cancer Registry, 2000–2008, prepared by the California Breast Cancer Mapping Project

Invasive Breast Cancer Data for North San Francisco Bay Area of Concern

Breast Cancer Rates over Time

Age-adjusted rates of female invasive breast cancer generally declined from 2000 to 2008, but were steadily higher in the North San Francisco Bay area of concern compared to statewide (Figure 6 and Table 1).

Figure 6. Age-adjusted invasive breast cancer rates (per 100,000 women) for the North San Francisco and California, 2000–2008



Data Source: California Cancer Registry, 2000–2008, prepared by the California Breast Cancer Mapping Project

Table 1. Invasive breast cancer cases and age-adjusted rates (per 100,000 women) for the North San Francisco Bay and California, 2000–2008

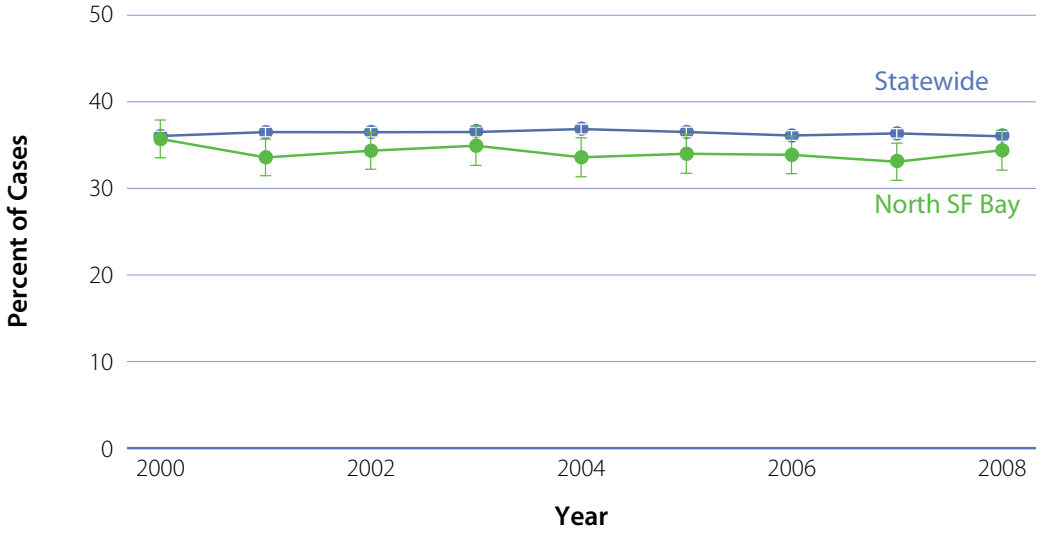
	North San Francisco Bay			California		
Year	Number of cases	Age-adjusted rate	95% confidence interval	Number of cases	Age-adjusted rate	95% confidence interval
2000	1,330	142.1	134.5–150.0	20,545	120.9	119.2–122.5
2001	1,373	144.7	137.2–152.6	20,902	120.3	118.7–122.0
2002	1,310	135.9	128.6–143.5	21,106	118.9	117.3–120.5
2003	1,188	121.7	114.8–128.8	19,817	109.4	107.9–111.0
2004	1,155	116.3	109.7–123.3	19,722	106.7	105.2–108.2
2005	1,200	119.4	112.7–126.4	20,381	108.2	106.7–109.7
2006	1,287	127.1	120.2–134.4	20,436	106.5	105.0–108.0
2007	1,303	126.2	119.3–133.4	21,094	107.6	106.1–109.0
2008	1,174	111.8	105.4–118.6	19,005	95.3	93.9–96.6

Data Source: California Cancer Registry, 2000–2008, prepared by the California Breast Cancer Mapping Project

Stage at diagnosis

A slightly lower percent of women were diagnosed at a late-stage in the North San Francisco Bay compared to statewide (Figure 7 and Table 2). Overall, the percent of women diagnosed at a late-stage was relatively stable in both California and the North San Francisco Bay.

Figure 7. Percent of women diagnosed with invasive breast cancer at a late-stage in the North San Francisco Bay and California, 2000–2008



Data Source: California Cancer Registry, 2000–2008, prepared by the California Breast Cancer Mapping Project

Table 2. Women diagnosed with invasive breast cancer at a late-stage in the North San Francisco Bay and California, 2000–2008

	North San Francisco Bay		California	
Year	Cases diagnosed at a late-stage	Percent of all cases	Cases diagnosed at a late-stage	Percent of all cases
2000	475	36%	7,407	37%
2001	461	34%	7,630	37%
2002	450	35%	7,701	37%
2003	415	35%	7,236	37%
2004	388	34%	7,268	37%
2005	408	34%	7,442	37%
2006	436	34%	7,379	36%
2007	431	33%	7,668	37%
2008	404	35%	6,845	36%
All Years	3,868	34%	66,576	37%

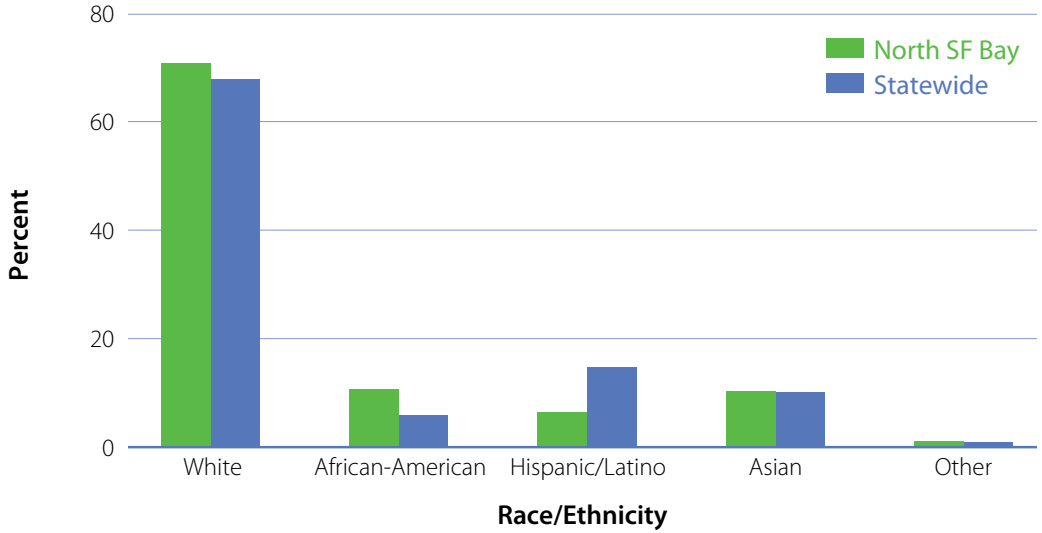
Data Source: California Cancer Registry, 2000–2008, prepared by the California Breast Cancer Mapping Project

Sociodemographic Data for Invasive Female Breast Cancer Cases in North San Francisco Bay Area of Concern

Race/ethnicity

In the North San Francisco Bay, White women accounted for 71% of invasive breast cancer cases diagnosed from 2000–2008 (Figure 8 and Table 3), though according to census data White females represent about half of the 2010 female population (Table 5 and Figure 10). Hispanic women, on the other hand, accounted for less than 7% of invasive breast cancer cases diagnosed from 2000–2008, though they represent almost 20% of the population. African-American women accounted for 11% of breast cancer cases from 2000–2008 while representing 11% of the female population, while Asian women accounted for 10% of breast cancer cases diagnosed from 2000–2008 while representing 17% of the population.

Figure 8. Race/ethnicity of women diagnosed with invasive breast cancer in the North San Francisco Bay and California, 2000–2008



Data Source: California Cancer Registry, 2000-2008, prepared by the California Breast Cancer Mapping Project

Table 3. Race/ethnicity of women diagnosed with invasive breast cancer in the North San Francisco Bay and California, 2000–2008

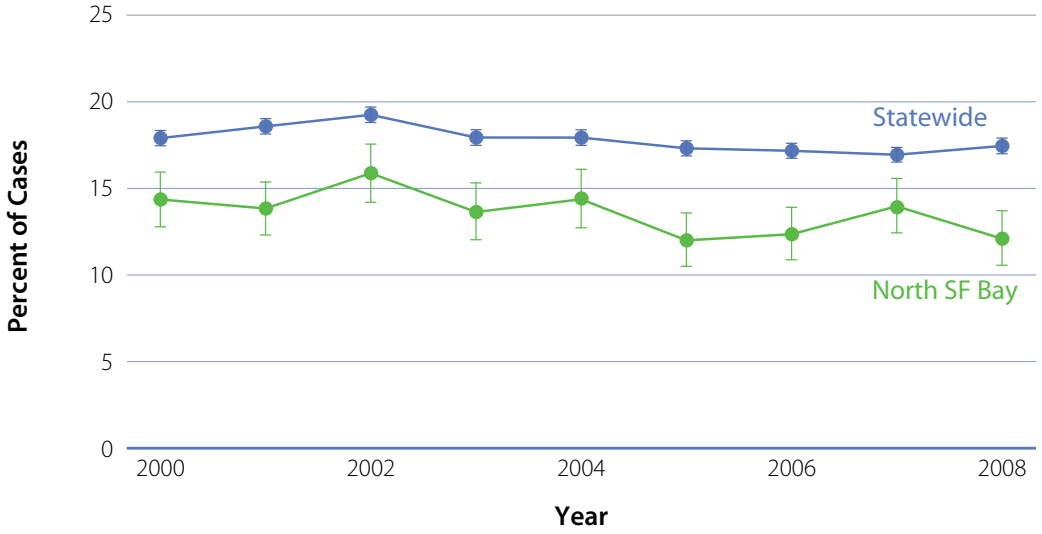
	North San Francisco Bay		California	
Race/Ethnicity	Cases	Percent	Cases	Percent
White	8,037	71%	124,541	68%
African-American	1,228	11%	11,161	6%
Hispanic/Latino	759	7%	27,318	15%
Asian	1,166	10%	18,383	10%
Other	130	1%	1,605	1%
All Cases	11,320	100%	183,008	100%

Data Source: California Cancer Registry, 2000-2008, prepared by the California Breast Cancer Mapping Project

Insurance Status

A smaller proportion of women diagnosed with invasive breast cancer in the North San Francisco Bay were uninsured or received government-assisted insurance at the time of diagnosis in comparison to patients across California (Figure 9 and Table 4). On average, 14% of women with breast cancer in the North San Francisco Bay were uninsured or received government-assisted insurance.

Figure 9. Percent of women diagnosed with invasive breast cancer who receive government-assisted insurance or are uninsured, North San Francisco Bay and California, 2000–2008



Data Source: California Cancer Registry, 2000–2008, prepared by the California Breast Cancer Mapping Project

Table 4. Percent of women diagnosed with invasive breast cancer who receive government-assisted insurance or are uninsured, North San Francisco Bay and California, 2000–2008

	North San Francisco Bay		California	
Year	Government-assisted insurance or uninsured	Percent of all cases	Government-assisted insurance or uninsured	Percent of all cases
2000	191	14%	3,678	18%
2001	190	14%	3,884	19%
2002	208	16%	4,063	19%
2003	162	14%	3,555	18%
2004	166	14%	3,537	18%
2005	144	12%	3,529	17%
2006	159	12%	3,509	17%
2007	182	14%	3,574	17%
2008	142	12%	3,317	17%
All Years	1,544	14%	32,646	18%

Data Source: California Cancer Registry, 2000–2008, prepared by the California Breast Cancer Mapping Project

Population Data: U.S. Census 2000 and 2010 for North San Francisco Bay Area of Concern and California

We analyzed data from the 2000 and 2010 U.S. Census to better understand who lives in areas of concern, how these communities compare to the state as a whole, and how the demographics have or have not changed in the past decade.

Overall, the North San Francisco Bay experienced a decrease in the proportion of young females, and an increase in the proportion of females aged 45–64 years, similar to statewide trends (Table 5 and Figure 11). In addition, there was a decline in the proportion of White and African-American females and increases in the proportion of Asian and Hispanic females (Table 5 and Figure 10).

Table 5. Population demographics of North San Francisco Bay and California, years 2000 and 2010

	North San Francisco Bay				California			
Population	2000		2010		2000		2010	
Total population	1,607,322		1,723,658		33,871,648		37,253,956	
Female	823,008	51%	882,247	51%	16,996,756	50%	18,736,126	50%
Male	784,314	49%	841,411	49%	16,874,892	50%	18,517,830	50%
Age (female)								
0–24 years	252,598	31%	260,295	30%	6,112,204	36%	6,422,590	34%
25–44 years	253,704	31%	239,189	27%	5,248,109	31%	5,182,849	28%
45–64 years	203,431	25%	253,708	29%	3,554,659	21%	4,731,190	25%
65+ years	113,870	14%	129,055	15%	2,081,784	12%	2,399,497	13%
Race (female)								
White	445,031	54%	425,037	48%	8,008,532	47%	7,510,531	40%
African-American	110,031	13%	97,144	11%	1,111,726	7%	1,094,910	6%
Asian	116,927	14%	149,576	17%	1,946,293	12%	2,580,855	14%
Hispanic or Latino	117,050	14%	170,468	19%	5,351,525	31%	6,933,591	37%
Other	34,564	4%	40,022	5%	578,680	3%	616,239	3%
Housing tenure								
Owner-occupied	366,312	59%	384,779	58%	6,546,334	57%	7,035,371	56%
Renter-occupied	252,378	41%	277,791	42%	4,956,536	43%	5,542,127	44%

Data source: U.S. Census, 2000 and 2010, prepared by the California Breast Cancer Mapping Project

However, the North San Francisco Bay continues to encompass a higher proportion of White and African-American females, and a markedly lower proportion of Hispanic females, compared to California as a whole. The North San Francisco Bay female population also tends to be older compared to the California population.

Interpreting the line charts (Figures 10 and 11)

These figures show comparisons between statewide population (blue lines) and the North San Francisco Bay area of concern (green lines), and between 2000 and 2010.

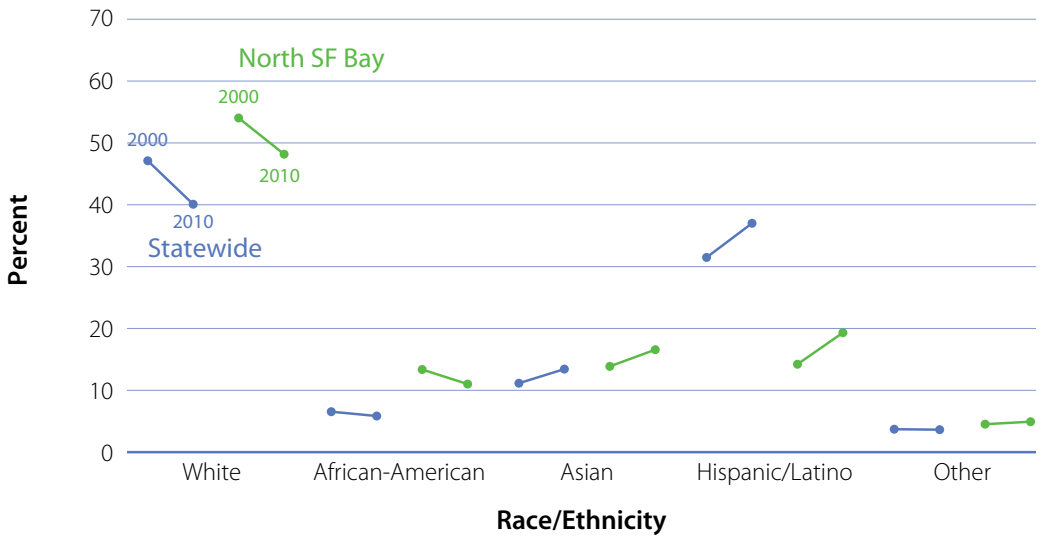
Comparing 2000 to 2010:

- The line's slope indicates the amount of change from 2000 to 2010. Downward-slanted lines indicate a decrease in the percentage of women from 2000 to 2010. Upward-slanted lines indicate an increase in the percentage of women from 2000 to 2010. Relatively flat lines indicate little or no change between 2000 and 2010.

Comparing the area of concern to statewide:

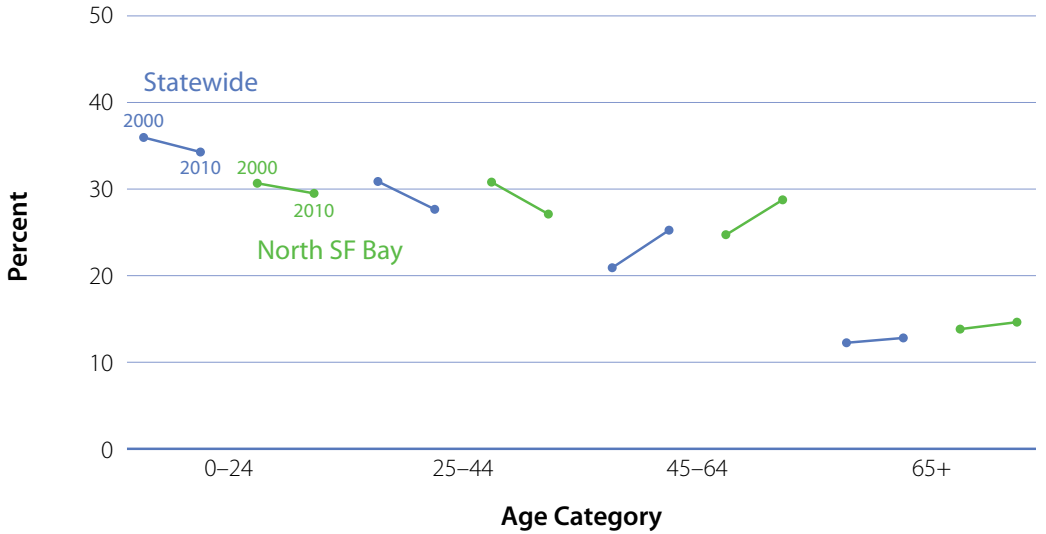
- Where the blue line is above the green line, the percentage of women statewide is higher than in the area of concern. Where the green line is above the blue line, the percentage of women in the area of concern is higher than the statewide population.

Figure 10. Female residents by race/ethnicity for North San Francisco Bay and California, 2000 and 2010



Data source: U.S. Census, 2000 and 2010, prepared by the California Breast Cancer Mapping Project

Figure 11. Female residents by age for North San Francisco Bay and California, 2000 and 2010



Data source: U.S. Census, 2000 and 2010, prepared by the California Breast Cancer Mapping Project

Results: South San Francisco Bay Area of Concern

Maps of South San Francisco Bay Area of Concern

Invasive Breast Cancer Data for South San Francisco Bay Area of Concern

Sociodemographic Data for Invasive Breast Cancer Cases in South San Francisco Bay Area of Concern

U.S. Census 2000 and 2010 Population Data for South San Francisco Bay Area of Concern and California

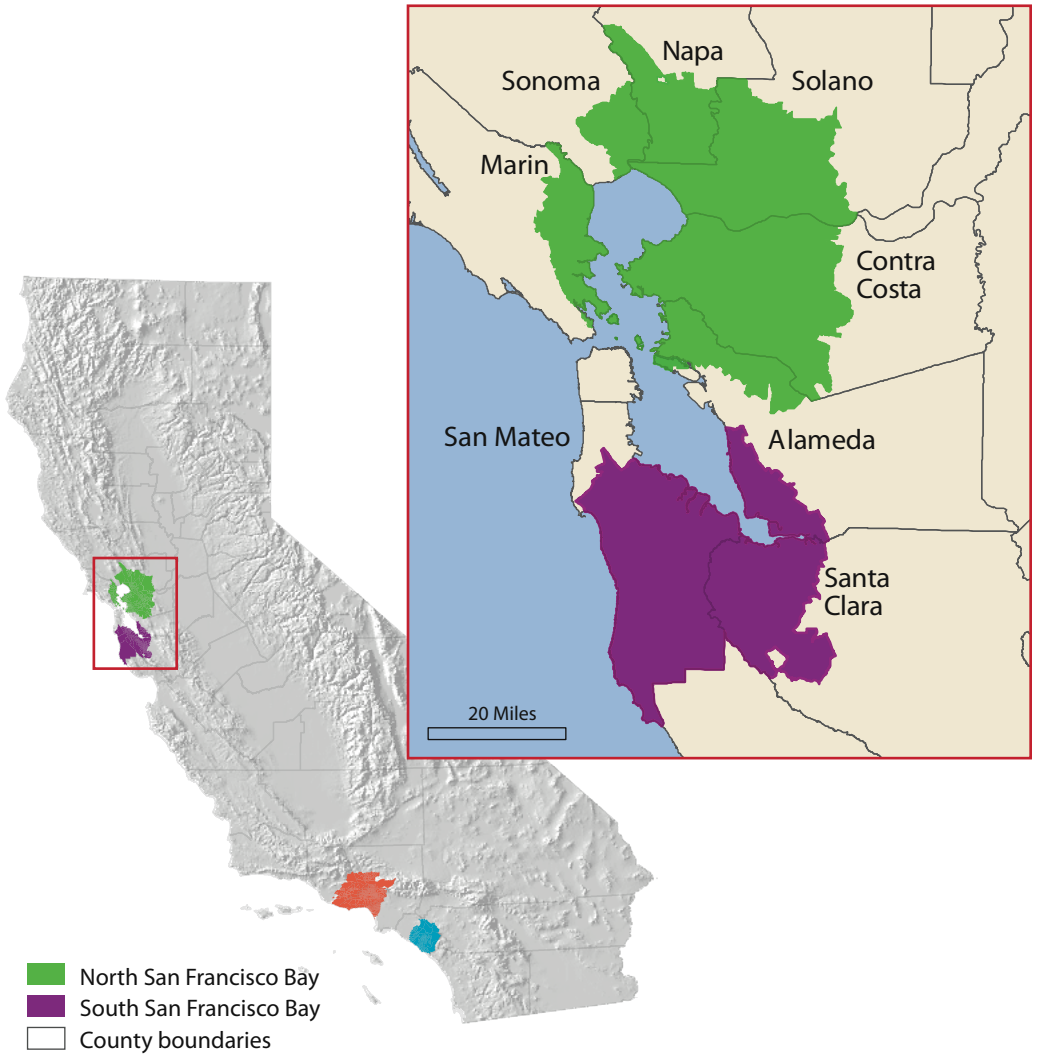
Maps of South San Francisco Bay Area of Concern

Description

The South San Francisco Bay is designated in purple and sits just south of the North San Francisco Bay area of concern, shown in green and described in the preceding chapter (Figure 12). Each area overlaps portions of Alameda County.

- **Counties overlapping South San Francisco Bay area of concern:** Alameda, Santa Clara, and San Mateo
- **Population size:** 1,285,291 in 2010, a 5% increase from the year 2000 census

Figure 12. Regional view of the North San Francisco Bay and South San Francisco Bay areas of concern



Data Source: California Cancer Registry, 2000–2008, prepared by the California Breast Cancer Mapping Project

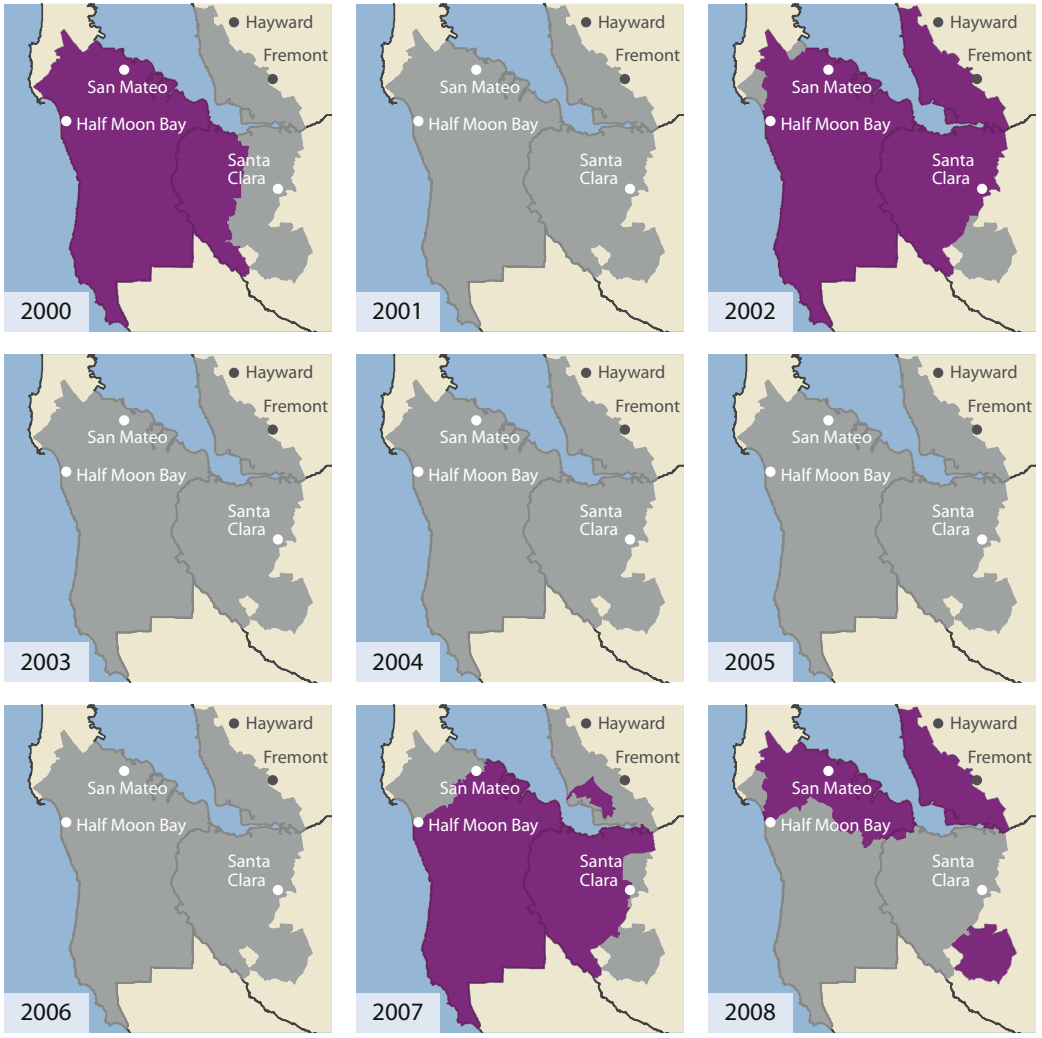
A detailed census tract view of the South San Francisco Bay area of concern is shown in Figure 13.

Figure 13. Census tracts in the South San Francisco Bay area of concern, 2000–2008

Data Source: California Cancer Registry, 2000–2008, prepared by the California Breast Cancer Mapping Project

In the time-series maps (Figure 14), the area of concern is shown in gray, while the purple areas indicate groups of census tracts with elevated rates of invasive breast cancer for the given year. The area of concern is composed of all groups of census together that had an elevated rate of invasive breast cancer at any time during 2000–2008.

Figure 14. Time-series maps of census tracts with elevated rates of invasive breast cancer within the South San Francisco Bay area of concern



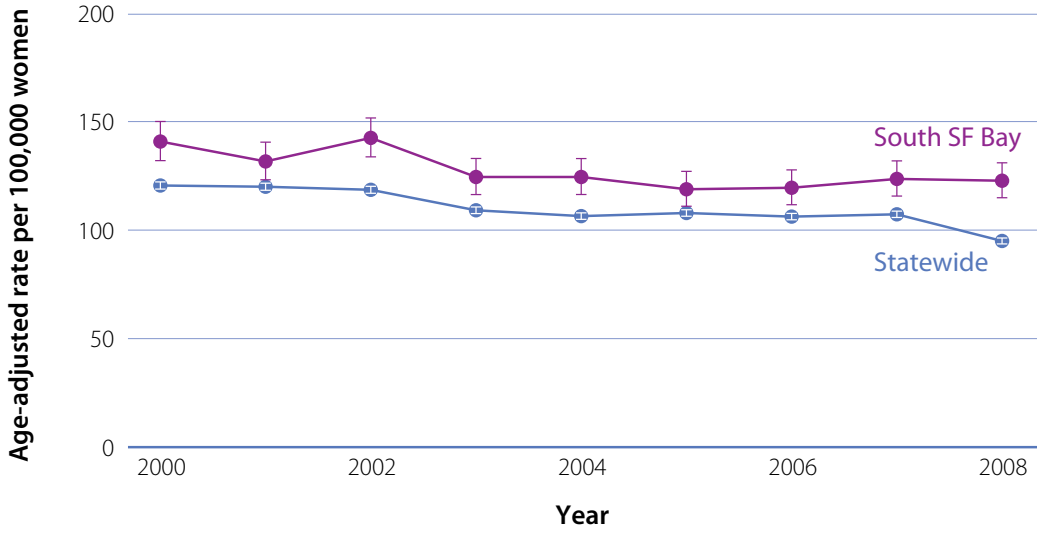
Data Source: California Cancer Registry, 2000–2008, prepared by the California Breast Cancer Mapping Project

Invasive Breast Cancer Data for South San Francisco Bay Area of Concern

Breast Cancer Rates over Time

Age-adjusted rates of female invasive breast cancer declined slightly from 2000 to 2008, but were steadily higher in the South San Francisco Bay when compared to California (Figure 15 and Table 6).

Figure 15. Age-adjusted invasive breast cancer rates (per 100,000 women) for the South San Francisco Bay and California, 2000–2008



Data Source: California Cancer Registry, 2000–2008, prepared by the California Breast Cancer Mapping Project

Table 6. Invasive breast cancer cases and age-adjusted rates (per 100,000 women) for the South San Francisco Bay and California, 2000–2008

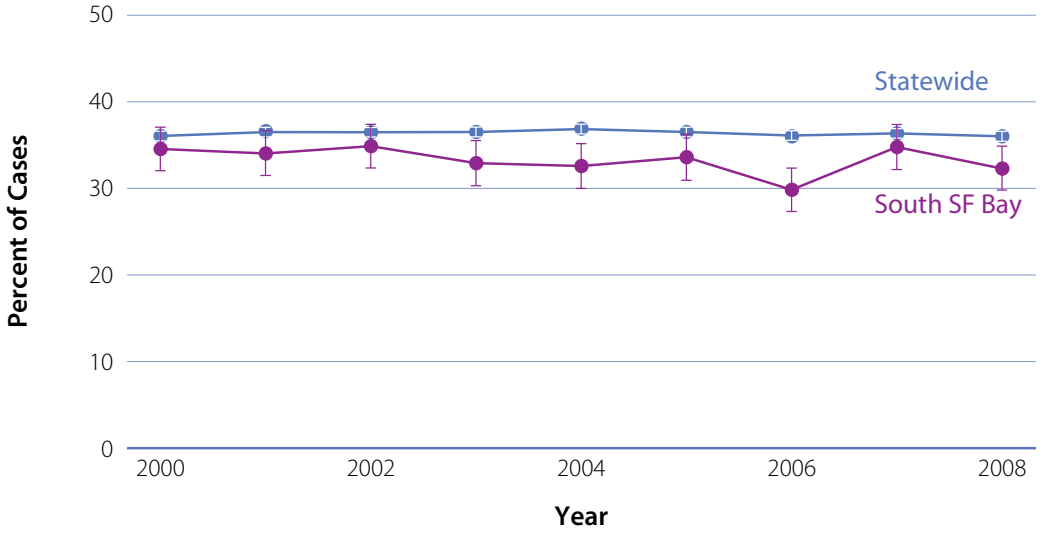
	South San Francisco Bay			California		
Year	Number of cases	Age-adjusted rate	95% confidence interval	Number of cases	Age-adjusted rate	95% confidence interval
2000	955	141.2	132.4–150.1	20,545	120.9	119.2–122.5
2001	905	132.0	123.5–140.9	20,902	120.3	118.7–122.0
2002	992	142.9	134.1–152.1	21,106	118.9	117.3–120.5
2003	881	124.8	116.7–133.4	19,817	109.4	107.9–111.0
2004	890	124.8	116.7–133.3	19,722	106.7	105.2–108.2
2005	863	119.1	111.3–127.4	20,381	108.2	106.7–109.7
2006	878	119.8	112.0–128.1	20,436	106.5	105.0–108.0
2007	923	123.9	116.0–132.3	21,094	107.6	106.1–109.0
2008	926	123.1	115.2–131.4	19,005	95.3	93.9 –96.6

Data Source: California Cancer Registry, 2000–2008, prepared by the California Breast Cancer Mapping Project

Stage at diagnosis

A slightly lower percent of women were diagnosed at a late-stage in the South San Francisco Bay area of concern compared to statewide (Figure 16 and Table 7). Overall, the percent of women diagnosed at a late-stage was relatively stable in California, with small fluctuations in the South San Francisco Bay area of concern.

Figure 16. Percent of women diagnosed with invasive breast cancer at a late-stage in the South San Francisco Bay and California, 2000–2008



Data Source: California Cancer Registry, 2000–2008, prepared by the California Breast Cancer Mapping Project

Table 7. Women diagnosed with invasive breast cancer at a late-stage in the South San Francisco Bay and California, 2000–2008

	South San Francisco Bay		California	
Year	Cases diagnosed at a late-stage	Percent of all cases	Cases diagnosed at a late-stage	Percent of all cases
2000	330	35%	7,407	37%
2001	308	34%	7,630	37%
2002	346	35%	7,701	37%
2003	290	33%	7,236	37%
2004	290	33%	7,268	37%
2005	290	34%	7,442	37%
2006	262	30%	7,379	36%
2007	321	35%	7,668	37%
2008	299	32%	6,845	36%
All Years	2,736	33%	66,576	37%

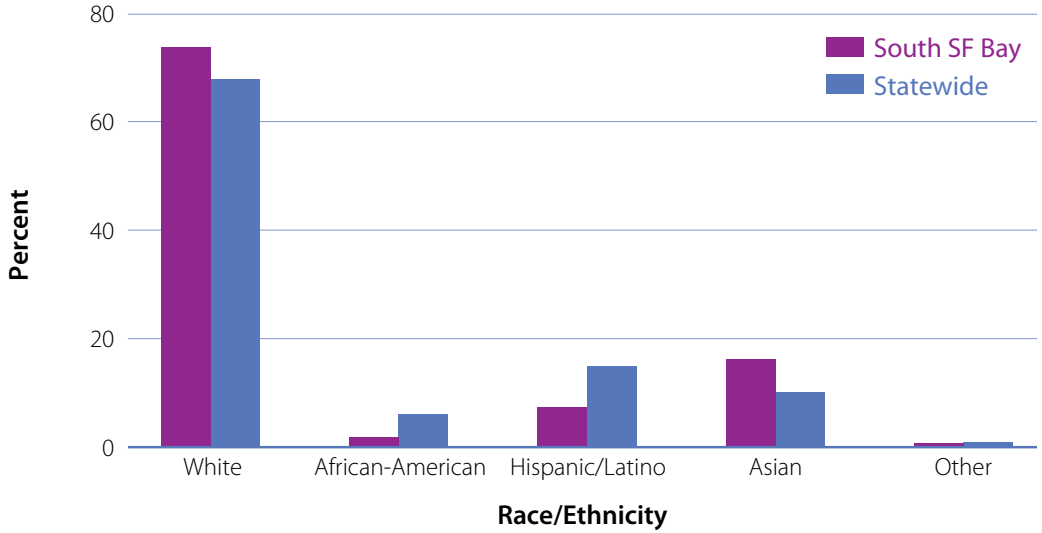
Data Source: California Cancer Registry, 2000–2008, prepared by the California Breast Cancer Mapping Project

Sociodemographic Data for Invasive Female Breast Cancer Cases in South San Francisco Bay Area of Concern

Race/ethnicity

In the South San Francisco Bay, White females accounted for 74% of invasive breast cancer cases diagnosed from 2000-2008 (Figure 17 and Table 8), though according to census data White females represent 44% of the 2010 female population (Table 10 and Figure 19). Hispanic females accounted for just 7% of invasive breast cancer from 2000–2008, but they represent 18% of the population in the South San Francisco Bay. African-American women accounted for 2% of breast cancer cases from 2000–2008 while representing 2% of the female population, and Asian women accounted for 16% of breast cancer cases diagnosed from 2000–2008 while representing 31% of the population.

Figure 17. Race/ethnicity of women diagnosed with invasive breast cancer in the South San Francisco Bay and California, 2000–2008



Data Source: California Cancer Registry, 2000–2008, prepared by the California Breast Cancer Mapping Project

Table 8. Race/ethnicity of women diagnosed with invasive breast cancer in the South San Francisco Bay and California, 2000–2008

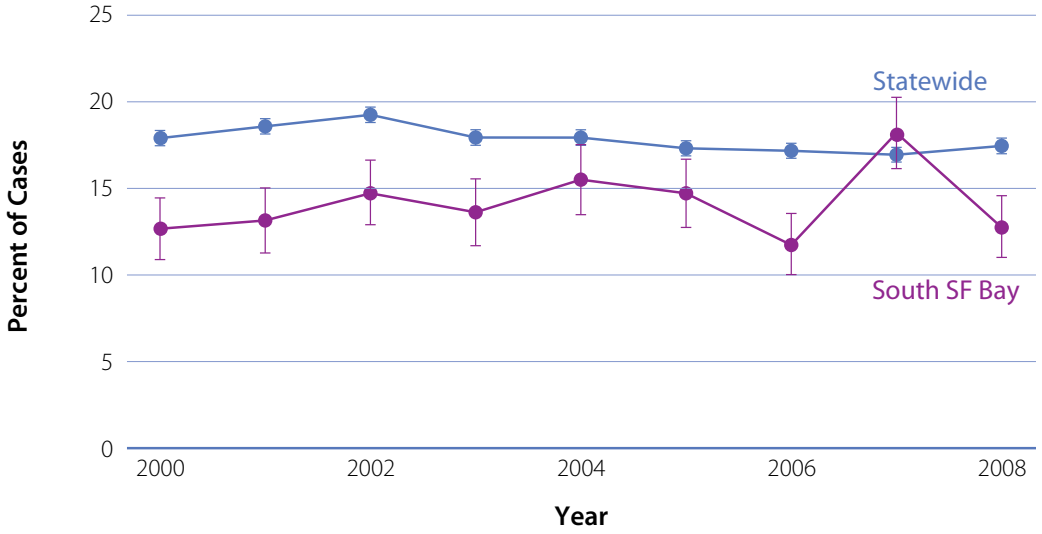
	South San Francisco Bay		California	
Race/Ethnicity	Cases	Percent	Cases	Percent
White	6,067	74%	124,541	68%
African-American	146	2%	11,161	6%
Hispanic/Latino	606	7%	27,318	15%
Asian	1337	16%	18,383	10%
Other	57	1%	1,605	1%
All Cases	8,213	100%	183,008	100%

Data Source: California Cancer Registry, 2000–2008, prepared by the California Breast Cancer Mapping Project

Insurance Status

A smaller proportion of women diagnosed with invasive breast cancer in the South San Francisco Bay were uninsured or received government-assisted insurance at the time of diagnosis in comparison to patients across California (Figure 18 and Table 9). On average, 14% of women with breast cancer in the South San Francisco Bay were uninsured or received government-assisted insurance. In 2007, this percentage rose to be approximately the same as that of the state overall, but this increase did not persist and may not be reliable.

Figure 18. Percent of women diagnosed with invasive breast cancer who receive government-assisted insurance or are uninsured, South San Francisco Bay and California, 2000–2008



Data Source: California Cancer Registry, 2000–2008, prepared by the California Breast Cancer Mapping Project

Table 9. Percent of women diagnosed with invasive breast cancer who receive government-assisted insurance or are uninsured, South San Francisco Bay and California, 2000–2008

	South San Francisco Bay		California	
Year	Government-assisted insurance or uninsured	Percent of all cases	Government-assisted insurance or uninsured	Percent of all cases
2000	121	13%	3,678	18%
2001	119	13%	3,884	19%
2002	146	15%	4,063	19%
2003	120	14%	3,555	18%
2004	138	16%	3,537	18%
2005	127	15%	3,529	17%
2006	103	12%	3,509	17%
2007	168	18%	3,574	17%
2008	118	13%	3,317	17%
All Years	1,160	14%	32,646	18%

Data Source: California Cancer Registry, 2000–2008, prepared by the California Breast Cancer Mapping Project

Population Data: U.S. Census 2000 and 2010 for South San Francisco Bay Area of Concern and California

We analyzed data from the 2000 and 2010 U.S. Census to better understand who lives in these areas of concern, how these communities compare to the state as a whole, and how the demographics have or have not changed in the past decade.

Overall, the South San Francisco Bay has experienced a small increase in the proportion of females aged 45–64 years, similar to statewide trends (Table 10 and Figure 20). In addition, there was a decline in the proportion of White females, and increases in the proportion of Asian and Hispanic populations (Table 10 and Figure 19).

Table 10. Population demographics of South San Francisco Bay and California, years 2000 and 2010

	South San Francisco Bay				California			
Population	2000		2010		2000		2010	
Total population	1,226,313		1,285,291		33,871,648		37,253,956	
Female	612,067	50%	647,790	50%	16,996,756	50%	18,736,126	50%
Male	614,246	50%	637,502	50%	16,874,892	50%	18,517,830	50%
Age (female)								
0–24 years	180,776	30%	190,553	29%	6,112,204	36%	6,422,590	34%
25–44 years	207,470	34%	193,421	30%	5,248,109	31%	5,182,849	28%
45–64 years	141,295	23%	171,580	26%	3,554,659	21%	4,731,190	25%
65+ years	82,526	13%	92,236	14%	2,081,784	12%	2,399,497	13%
Race (female)								
White	341,532	56%	287,853	44%	8,008,532	47%	7,510,531	40%
African-American	16,356	3%	15,284	2%	1,111,726	7%	1,094,910	6%
Asian	139,299	23%	200,612	31%	1,946,293	12%	2,580,855	14%
Hispanic or Latino	92,653	15%	118,022	18%	5,351,525	31%	6,933,591	37%
Other	22,227	4%	26,019	4%	578,680	3%	616,239	3%
Housing tenure								
Owner-occupied	273,589	60%	275,354	58%	6,546,334	57%	7,035,371	56%
Renter-occupied	184,643	40%	198,841	42%	4,956,536	43%	5,542,127	44%

Data source: U.S. Census, 2000 and 2010, prepared by the California Breast Cancer Mapping Project

The South San Francisco Bay continues to encompass a higher proportion of White and Asian females, and a markedly lower proportion of Hispanic females, compared to California as a whole. The South San Francisco Bay female population also tends to be slightly older compared to the California population.

Interpreting the line charts (Figures 19 and 20)

These figures show comparisons between statewide population (blue lines) and the North San Francisco Bay area of concern (purple lines), and between 2000 and 2010.

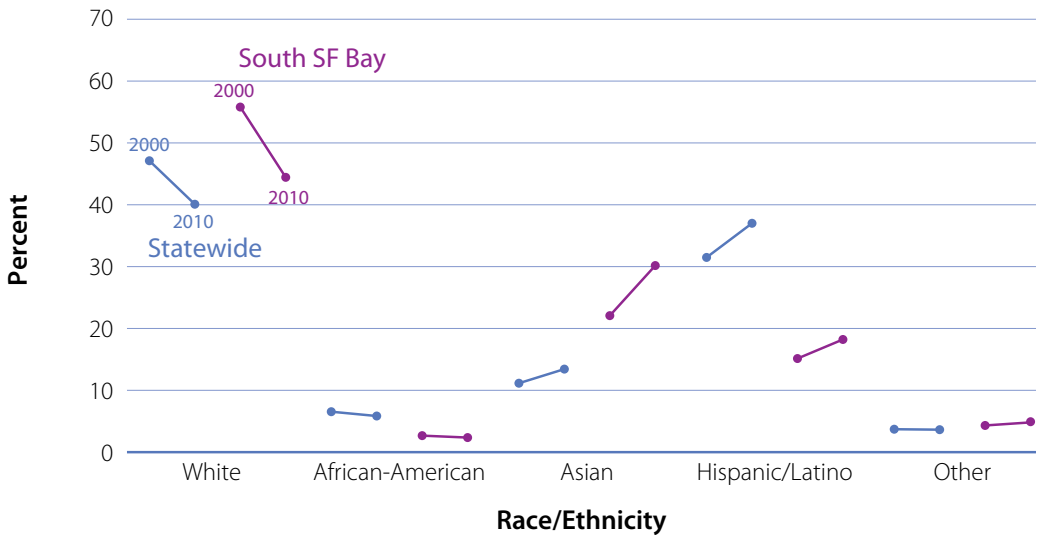
Comparing 2000 to 2010:

- The line's slope indicates the amount of change from 2000 to 2010. Downward-slanted lines indicate a decrease in the percentage of women from 2000 to 2010. Upward-slanted lines indicate an increase in the percentage of women from 2000 to 2010. Relatively flat lines indicate little or no change between 2000 and 2010.

Comparing the area of concern to statewide:

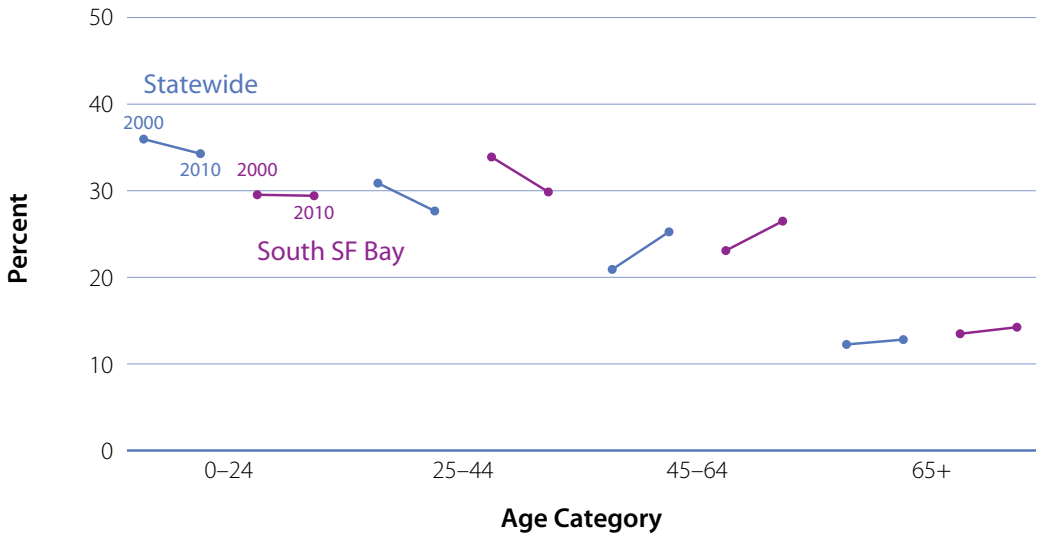
- Where the blue line is above the purple line, the percentage of women statewide is higher than in the area of concern. Where the purple line is above the blue line, the percentage of women in the area of concern is higher than the statewide population.

Figure 19. Female residents by race/ethnicity for South San Francisco Bay and California, 2000 and 2010



Data source: U.S. Census, 2000 and 2010, prepared by the California Breast Cancer Mapping Project

Figure 20. Female residents by age for South San Francisco Bay and California, 2000 and 2010



Data source: U.S. Census, 2000 and 2010, prepared by the California Breast Cancer Mapping Project

Results: West Los Angeles/ East Ventura Area of Concern

Maps of West Los Angeles/East Ventura Area of Concern

Invasive Breast Cancer Data for West Los Angeles/East Ventura Area of Concern

Sociodemographic Data for Invasive Female Breast Cancer Cases in West Los Angeles/ East Ventura Area of Concern

U.S. Census 2000 and 2010 Population Data for West Los Angeles/East Ventura Area of Concern and California

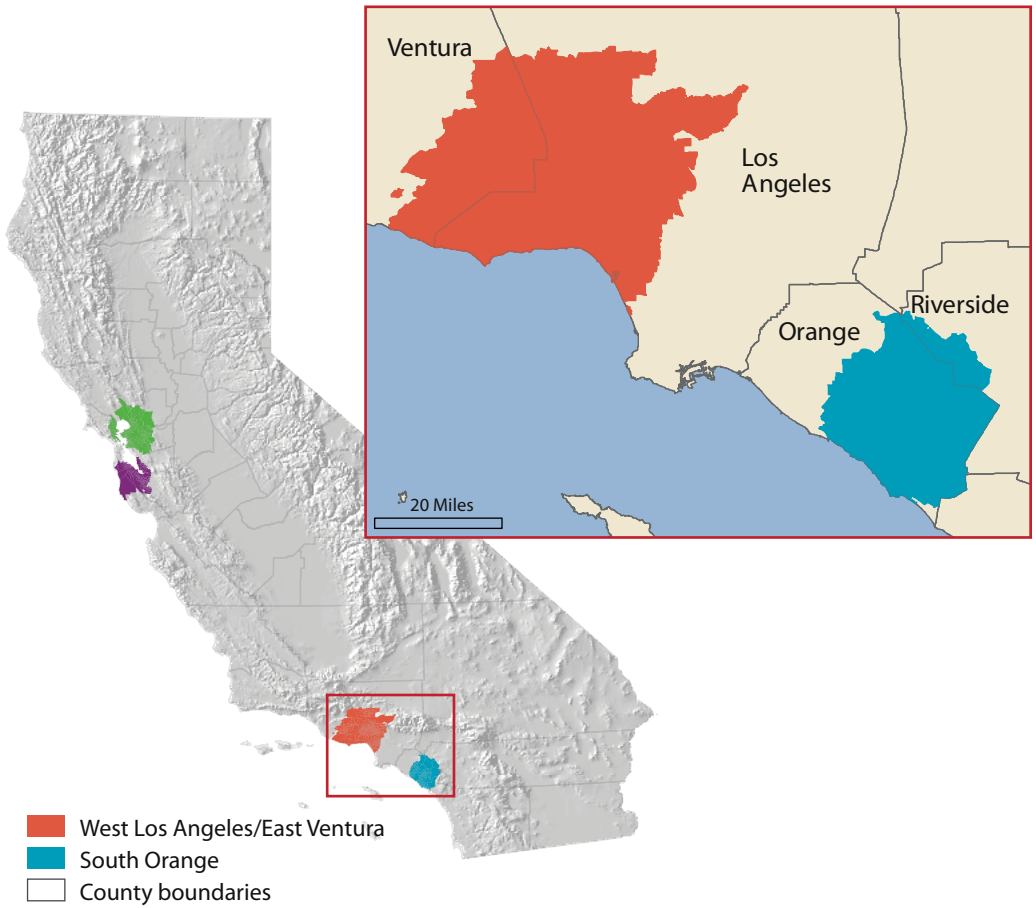
Maps of West Los Angeles/East Ventura Area of Concern

Description

The West Los Angeles (LA)/East Ventura area of concern overlaps portions of western Los Angeles and eastern Ventura counties, as shown in the red area (Figure 21). The South Orange area of concern (shown in aqua) is discussed in the following section.

- **Counties overlapping West Los Angeles/East Ventura area of concern include:** Los Angeles and Ventura
- **Population size:** 3,412,378 in 2010, a 7% increase from the year 2000 census

Figure 21. Regional view of the West Los Angeles/East Ventura and South Orange areas of concern



Data Source: California Cancer Registry, 2000–2008, prepared by the California Breast Cancer Mapping Project

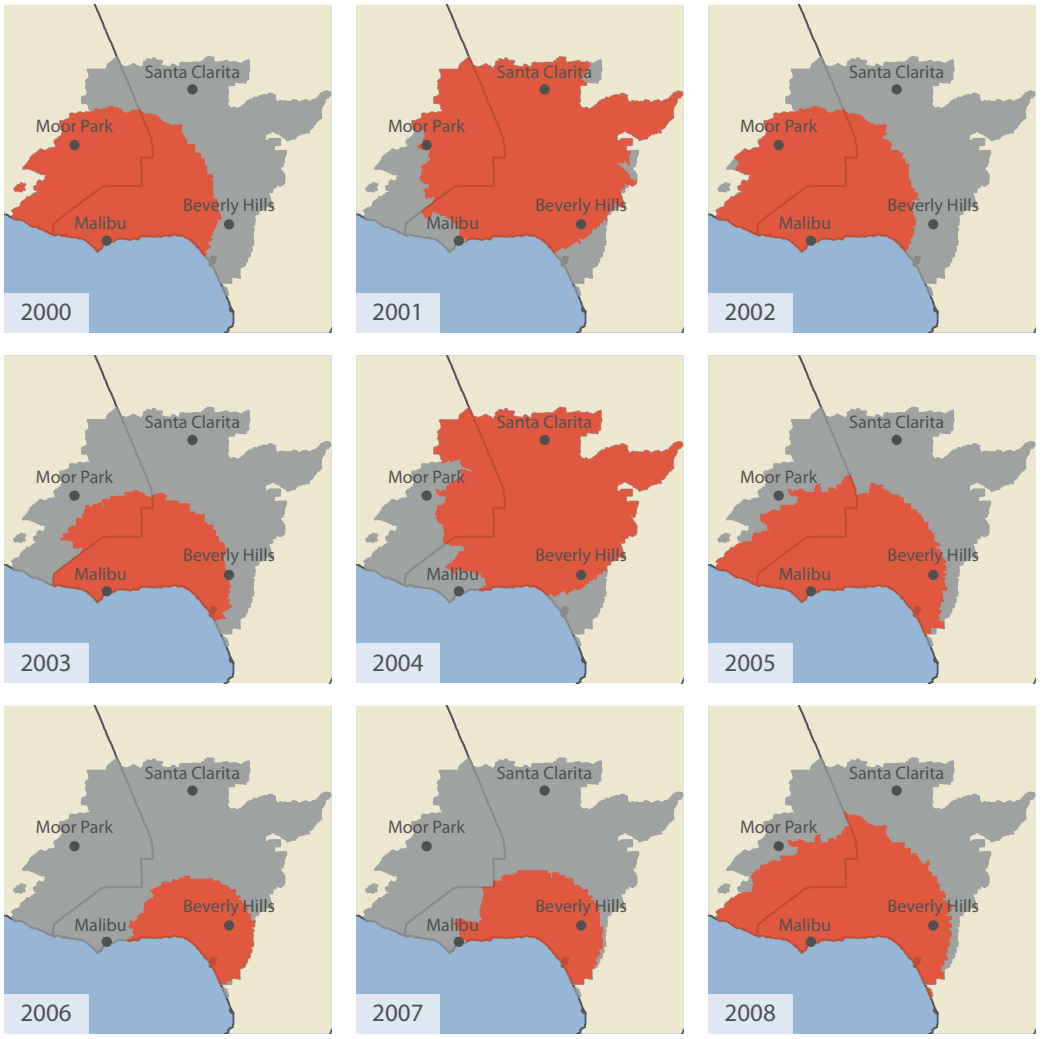
A detailed census tract view of the West Los Angeles/East Ventura area of concern is shown in Figure 22.

Figure 22. Census tracts in the West Los Angeles/East Ventura area of concern, 2000–2008

Data Source: California Cancer Registry, 2000–2008, prepared by the California Breast Cancer Mapping Project

In the time-series maps (Figure 23), the area of concern is shown in gray, while the red areas indicate groups of census tracts with elevated rates of invasive breast cancer for the given year. The area of concern is composed of all groups of census together that had an elevated rate of invasive breast cancer at any time during 2000–2008.

Figure 23. Time-series maps of census tracts with elevated rates of invasive breast cancer within West Los Angeles/East Ventura area of concern



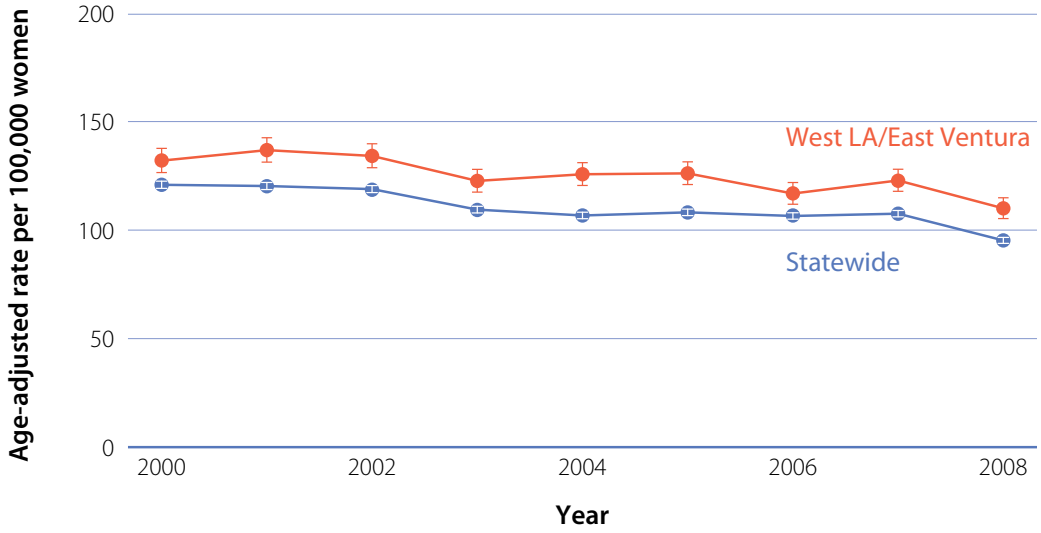
Data Source: California Cancer Registry, 2000–2008, prepared by the California Breast Cancer Mapping Project

Invasive Breast Cancer Data for West Los Angeles/East Ventura Area of Concern

Breast Cancer Rates over Time

Age-adjusted rates of female invasive breast cancer declined from 2000 to 2008, but were steadily higher in the West Los Angeles/East Ventura area of concern compared to statewide (Figure 24 and Table 11).

Figure 24. Age-adjusted invasive breast cancer rates (per 100,000 women) for West Los Angeles/East Ventura and California, 2000–2008



Data Source: California Cancer Registry, 2000–2008, prepared by the California Breast Cancer Mapping Project

Table 11. Invasive breast cancer cases and age-adjusted rates (per 100,000 women) for West Los Angeles/East Ventura and California, 2000–2008

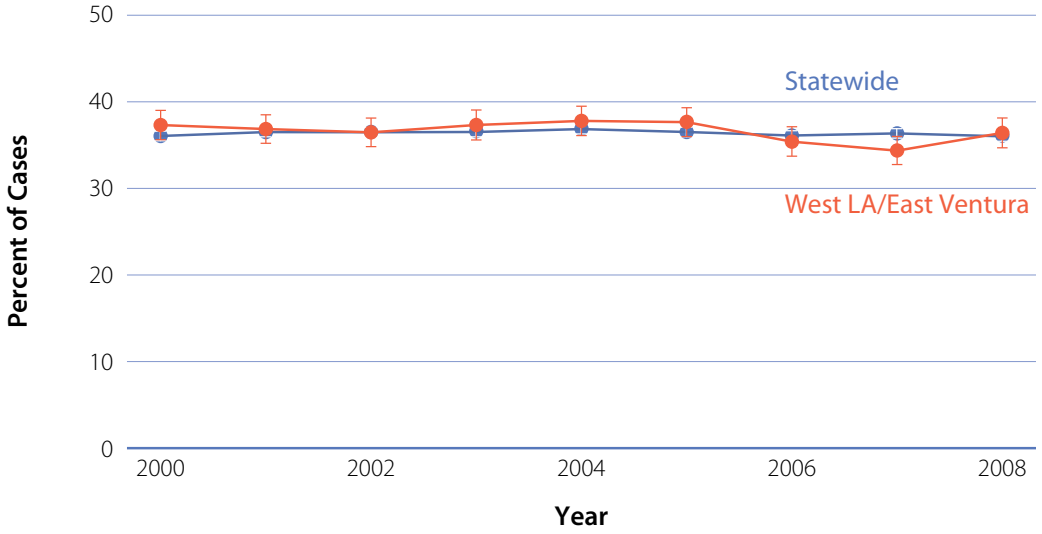
	West LA/East Ventura			California		
Year	Number of cases	Age-adjusted rate	95% confidence interval	Number of cases	Age-adjusted rate	95% confidence interval
2000	2,184	132.4	126.9–138.0	20,545	120.9	119.2–122.5
2001	2,309	137.2	131.7–142.9	20,902	120.3	118.7–122.0
2002	2,303	134.5	129.1–140.2	21,106	118.9	117.3–120.5
2003	2,138	123.0	117.8–128.3	19,817	109.4	107.9–111.0
2004	2,241	126.1	120.9–131.4	19,722	106.7	105.2–108.2
2005	2,284	126.5	121.3–131.8	20,381	108.2	106.7–109.7
2006	2,147	117.2	112.2–122.3	20,436	106.5	105.0–108.0
2007	2,308	123.2	118.2–128.4	21,094	107.6	106.1–109.0
2008	2,090	110.3	105.6–115.2	19,005	95.3	93.9–96.6

Data Source: California Cancer Registry, 2000–2008, prepared by the California Breast Cancer Mapping Project

Stage at diagnosis

A similar proportion of women were diagnosed at a late-stage in both the West Los Angeles/East Ventura area of concern and statewide (Figure 25 and Table 12). Overall, the percent of women diagnosed at a late-stage was relatively stable in California and the West Los Angeles/East Ventura area of concern.

Figure 25. Percent of women diagnosed with invasive breast cancer at a late-stage in West Los Angeles/East Ventura and California, 2000–2008



Data Source: California Cancer Registry, 2000–2008, prepared by the California Breast Cancer Mapping Project

Table 12. Women diagnosed with invasive breast cancer at a late-stage in West Los Angeles/East Ventura and California, 2000–2008

	West LA/East Ventura		California	
Year	Cases diagnosed at a late-stage	Percent of all cases	Cases diagnosed at a late-stage	Percent of all cases
2000	815	38%	7,407	37%
2001	851	37%	7,630	37%
2002	840	37%	7,701	37%
2003	798	38%	7,236	37%
2004	847	38%	7,268	37%
2005	860	38%	7,442	37%
2006	760	36%	7,379	36%
2007	793	35%	7,668	37%
2008	761	37%	6,845	36%
All Years	7,325	37%	66,576	37%

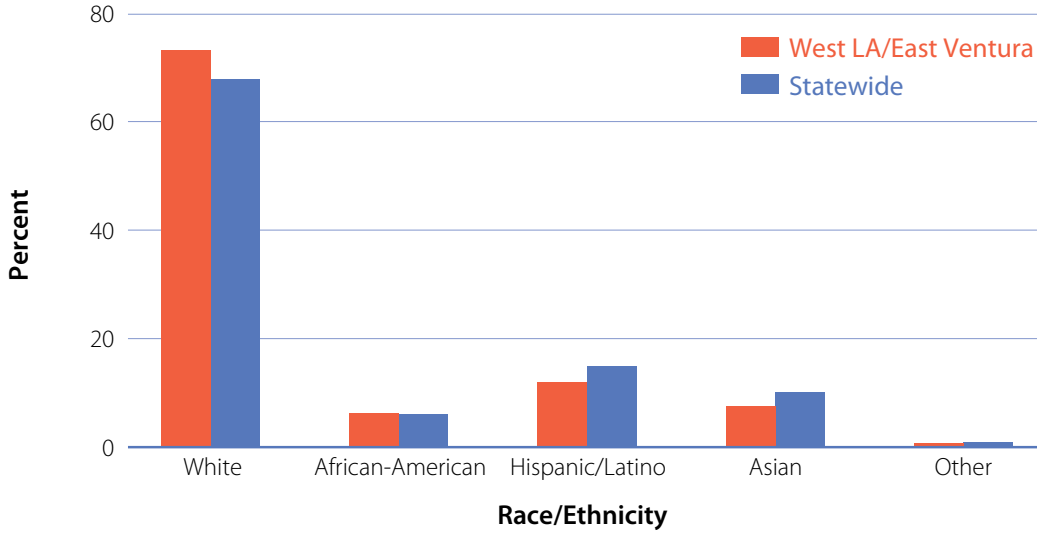
Data Source: California Cancer Registry, 2000–2008, prepared by the California Breast Cancer Mapping Project

Sociodemographic Data for Invasive Female Breast Cancer Cases in West Los Angeles/East Ventura Area of Concern

Race/ethnicity

In West Los Angeles/East Ventura, White women accounted for 73% of invasive breast cancer cases diagnosed from 2000–2008 (Figure 26 and Table 13), though according to census data, White women represent 48% of the female population in 2010 (Table 15 and Figure 28). Hispanic women, on the other hand, accounted for 12% of invasive breast cancer from 2000–2008, but they represent nearly 32% of the female population in West Los Angeles/East Ventura. African-American women accounted for 6% of breast cancer cases from 2000–2008 while representing 6% of the female population, and Asian women accounted for 8% of breast cancer cases diagnosed from 2000–2008 while representing 11% of the population.

Figure 26. Race/ethnicity of women diagnosed with invasive breast cancer in the West Los Angeles/East Ventura and California, 2000–2008



Data Source: California Cancer Registry, 2000-2008, prepared by the California Breast Cancer Mapping Project

Table 13. Race/ethnicity of women diagnosed with invasive breast cancer in West Los Angeles/East Ventura and California, 2000–2008

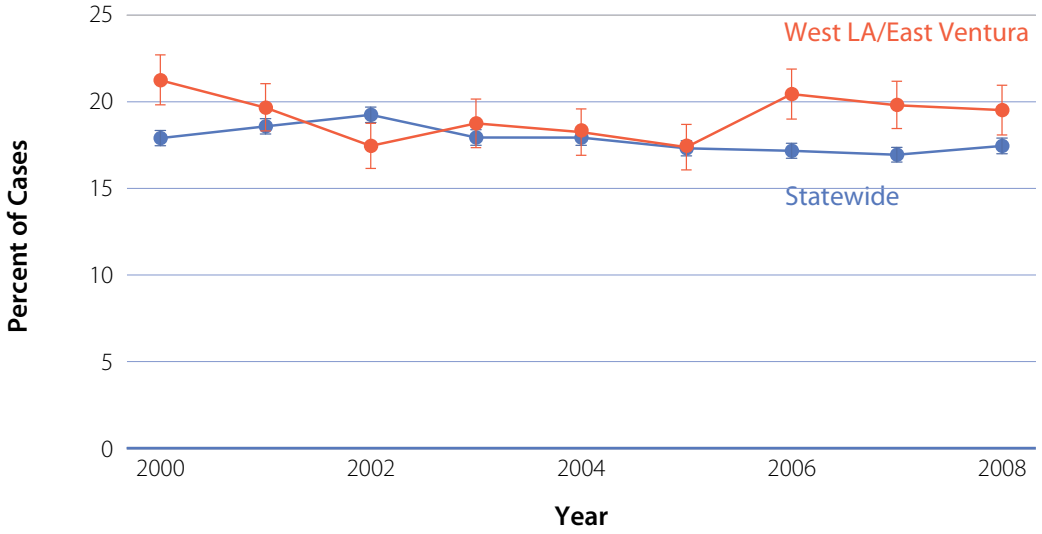
	West LA/East Ventura		California	
Race/Ethnicity	Cases	Percent	Cases	Percent
White	14,675	73%	124,541	68%
African-American	1,256	6%	11,161	6%
Hispanic/Latino	2,407	12%	27,318	15%
Asian	1,523	8%	18,383	10%
Other	143	1%	1,605	1%
All Cases	20,004	100%	183,008	100%

Data Source: California Cancer Registry, 2000-2008, prepared by the California Breast Cancer Mapping Project

Insurance Status

Unlike other areas of concern identified by the CBCMP protocol, a slightly higher proportion of female invasive breast cancer patients in West Los Angeles/East Ventura were uninsured or received government-assistance at the time of diagnosis in comparison to patients across California (Figure 27 and Table 14). On average, 19% of women with breast cancer in West Los Angeles/East Ventura were uninsured or received government-assisted insurance.

Figure 27. Percent of women diagnosed with invasive breast cancer who receive government-assisted insurance or are uninsured, West Los Angeles/East Ventura and California, 2000–2008



Data Source: California Cancer Registry, 2000–2008, prepared by the California Breast Cancer Mapping Project

Table 14. Percent of women diagnosed with invasive breast cancer who receive government-assisted insurance or are uninsured, West Los Angeles/East Ventura and California, 2000–2008

	West LA/East Ventura		California	
Year	Government-assisted insurance or uninsured	Percent of all cases	Government-assisted insurance or uninsured	Percent of all cases
2000	464	21%	3,678	18%
2001	454	20%	3,884	19%
2002	402	17%	4,063	19%
2003	401	19%	3,555	18%
2004	409	18%	3,537	18%
2005	397	17%	3,529	17%
2006	439	20%	3,509	17%
2007	457	20%	3,574	17%
2008	408	20%	3,317	17%
All Years	3,831	19%	32,646	18%

Data Source: California Cancer Registry, 2000–2008, prepared by the California Breast Cancer Mapping Project

Population Data: U.S. Census 2000 and 2010 for West Los Angeles/East Ventura Area of Concern and California

We analyzed data from the 2000 and 2010 U.S. Census to better understand who lives in these areas of concern, how these communities compare to the state as a whole, and how the demographics have or have not changed in the past decade.

Overall, West Los Angeles/East Ventura has experienced an increase in the proportion of older females, similar to statewide trends (Table 15 and Figure 29). Demographic changes in the West Los Angeles/East Ventura mirrored patterns across the state with a decreasing proportion of White and African-American females and an increasing proportion of Asian and Hispanic females. However, the shift in these populations was not as marked for West Los Angeles/East Ventura compared to the state overall (Table 15 and Figure 28).

Table 15. Population demographics of West Los Angeles/East Ventura and California, years 2000 and 2010

	West LA/East Ventura				California			
Population	2000		2010		2000		2010	
Total population	3,177,184		3,412,378		33,871,648		37,253,956	
Female	1,604,537	51%	1,727,599	51%	16,996,756	50%	18,736,126	50%
Male	1,572,647	49%	1,684,779	49%	16,874,892	50%	18,517,830	50%
Age (female)								
0–24 years	517,495	32%	526,771	30%	6,112,204	36%	6,422,590	34%
25–44 years	539,533	34%	519,669	30%	5,248,109	31%	5,182,849	28%
45–64 years	348,837	22%	450,941	26%	3,554,659	21%	4,731,190	25%
65+ years	198,672	12%	230,218	13%	2,081,784	12%	2,399,497	13%
Race (female)								
White	834,829	52%	833,018	48%	8,008,532	47%	7,510,531	40%
African-American	111,555	7%	102,287	6%	1,111,726	7%	1,094,910	6%
Asian	143,352	9%	190,352	11%	1,946,293	12%	2,580,855	14%
Hispanic or Latino	458,268	29%	545,516	32%	5,351,525	31%	6,933,591	37%
Other	56,533	4%	56,426	3%	578,680	3%	616,239	3%
Housing tenure								
Owner-occupied	595,443	49%	632,448	49%	6,546,334	57%	7,035,371	56%
Renter-occupied	610,177	51%	647,932	51%	4,956,536	43%	5,542,127	44%

Data source: U.S. Census, 2000 and 2010, prepared by the California Breast Cancer Mapping Project

The West Los Angeles/East Ventura area of concern continues to encompass a higher proportion of White females, and a lower proportion of Hispanic females, compared to California as a whole. The female population also tends to be slightly older compared to the California population.

Interpreting the line charts (Figures 28 and 29)

These figures show comparisons between statewide population (blue lines) and the West Los Angeles/East Ventura area of concern (red lines), and between 2000 and 2010.

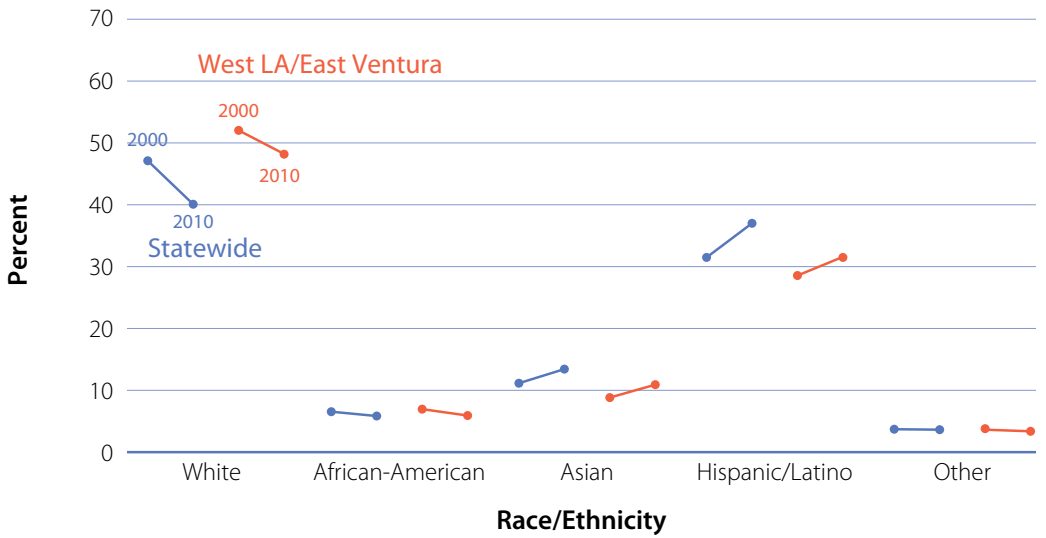
Comparing 2000 to 2010:

- The line's slope indicates the amount of change from 2000 to 2010. Downward-slanted lines indicate a decrease in the percentage of women from 2000 to 2010. Upward-slanted lines indicate an increase in the percentage of women from 2000 to 2010. Relatively flat lines indicate little or no change between 2000 and 2010.

Comparing the area of concern to statewide:

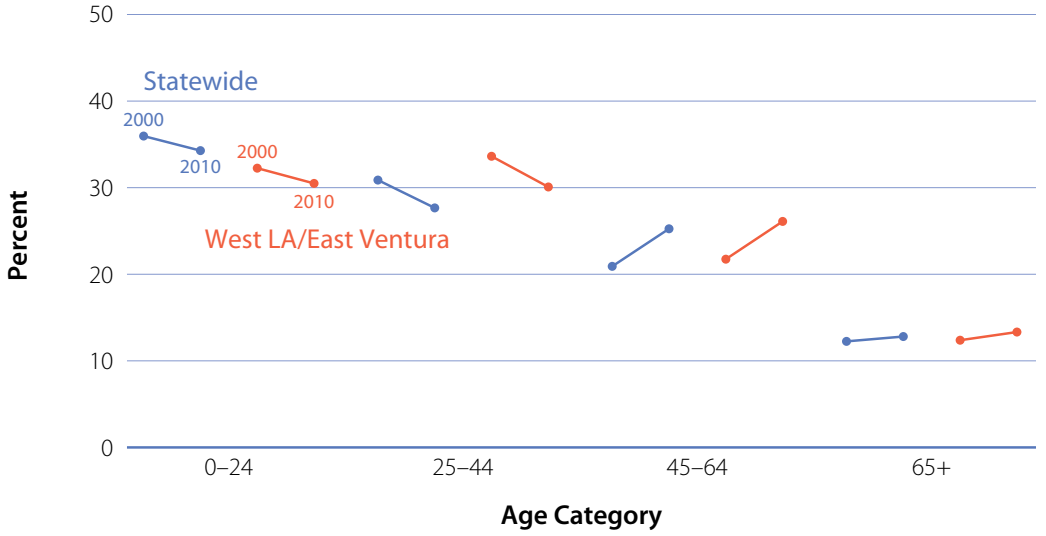
- Where the blue line is above the red line, the percentage of women statewide is higher than in the area of concern. Where the red line is above the blue line, the percentage of women in the area of concern is higher than the statewide population.

Figure 28. Female residents by race/ethnicity for West Los Angeles/East Ventura and California, 2000 and 2010



Data source: U.S. Census, 2000 and 2010, prepared by the California Breast Cancer Mapping Project

Figure 29. Female residents by age for West Los Angeles/East Ventura and California, 2000 and 2010



Data source: U.S. Census, 2000 and 2010, prepared by the California Breast Cancer Mapping Project

Results: South Orange Area of Concern

Maps of South Orange Area of Concern

Invasive Breast Cancer Data for South Orange Area of Concern

Sociodemographic Data for Invasive Female Breast Cancer Cases in South Orange Area of Concern

U.S. Census 2000 and 2010 Population Data for South Orange Area of Concern and California

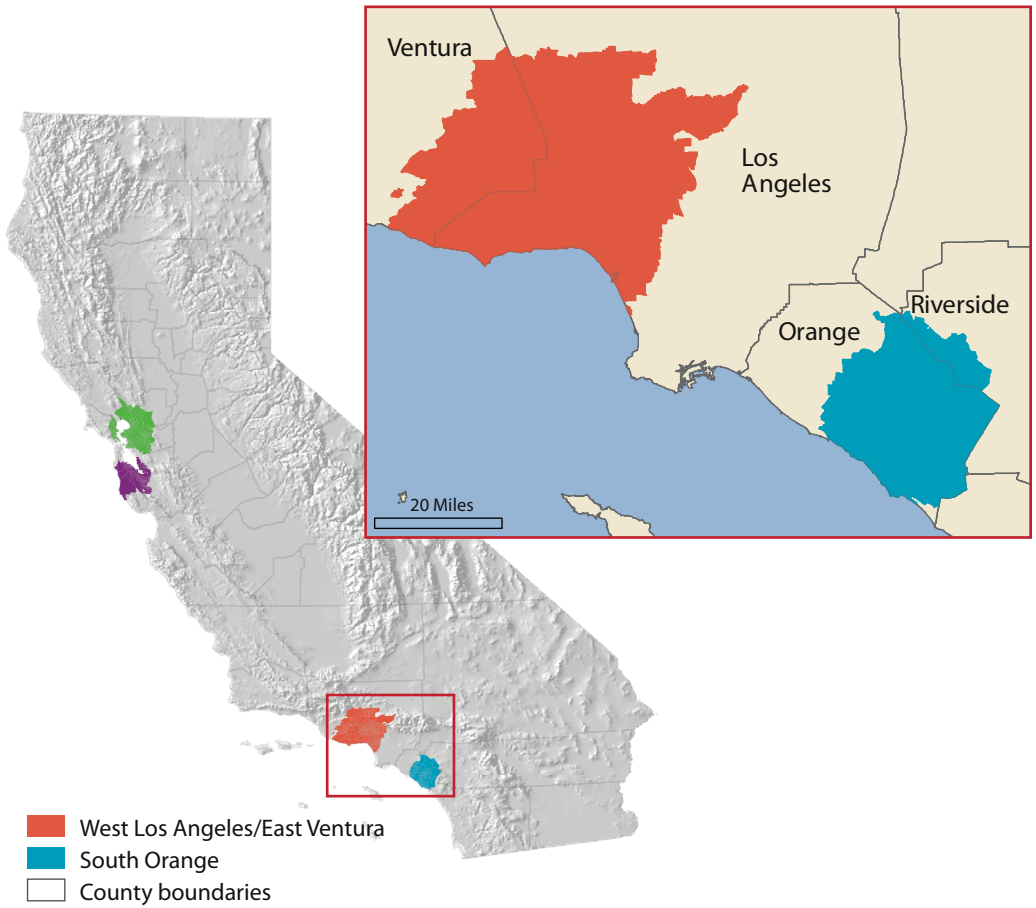
Maps of South Orange Area of Concern

Description

The South Orange area of concern is designated in aqua and overlaps portions of southern Orange and western Riverside counties (Figure 30). The West Los Angeles/East Ventura area of concern (shown in red) is discussed in the previous section.

- **Counties overlapping South Orange area of concern:** Orange and Riverside
- **Population size:** 1,010,576 in 2010, a 21% increase from the year 2000 census

Figure 30. Regional view of the South Orange and West Los Angeles/East Ventura areas of concern



Data Source: California Cancer Registry, 2000–2008, prepared by the California Breast Cancer Mapping Project

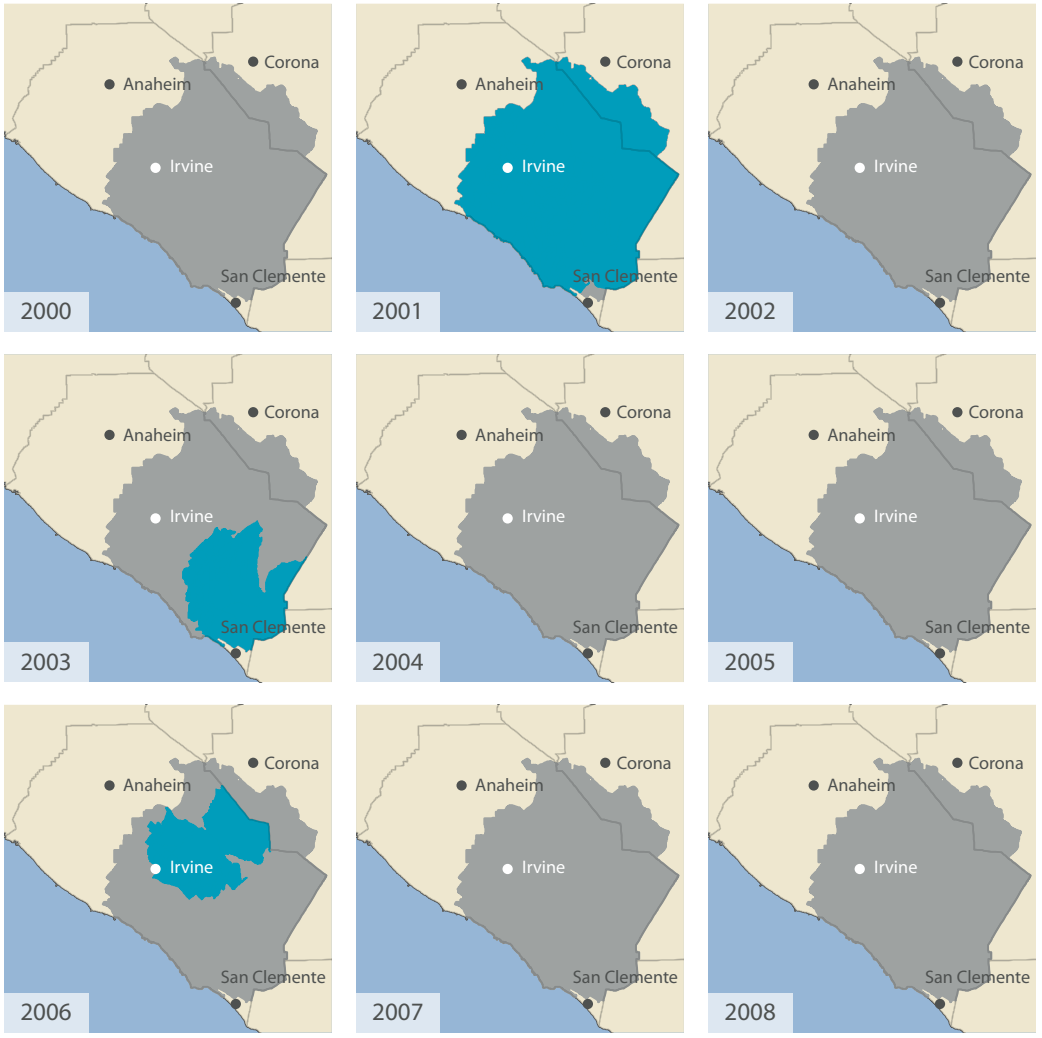
A detailed census tract view of the South Orange area of concern is shown in Figure 31.

Figure 31. Census tracts in the South Orange area of concern, 2000–2008

Data Source: California Cancer Registry, 2000–2008, prepared by the California Breast Cancer Mapping Project

In the time-series maps (Figure 32), the area of concern is shown in gray, while the aqua areas indicate groups of census tracts with elevated rates of invasive breast cancer for the given year. The area of concern is composed of all groups of census tracts together that had an elevated rate of invasive breast cancer at any time during 2000–2008.

Figure 32. Time-series maps of census tracts with elevated rates of invasive breast cancer within the South Orange area of concern



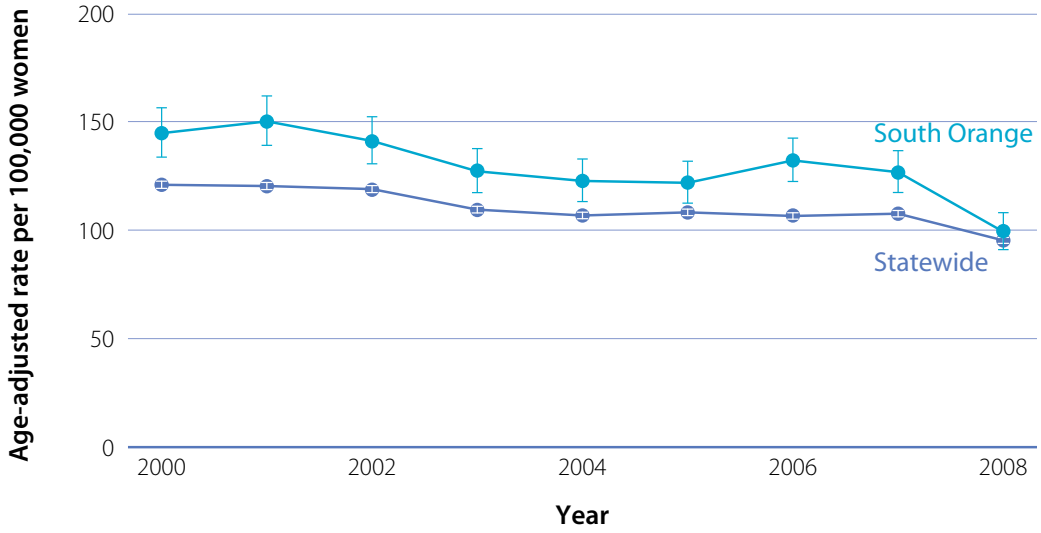
Data Source: California Cancer Registry, 2000–2008, prepared by the California Breast Cancer Mapping Project

Invasive Breast Cancer Data for South Orange Area of Concern

Breast Cancer Rates over Time

Age-adjusted rates of female invasive breast cancer declined from 2000 to 2008, but were higher in the South Orange area of concern when compared to statewide for every year except 2008 (Figure 33 and Table 16).

Figure 33. Age-adjusted invasive breast cancer rates (per 100,000 women) for South Orange and California, 2000–2008



Data Source: California Cancer Registry, 2000–2008, prepared by the California Breast Cancer Mapping Project

Table 16. Invasive breast cancer cases and age-adjusted rates (per 100,000 women) for South Orange and California, 2000–2008

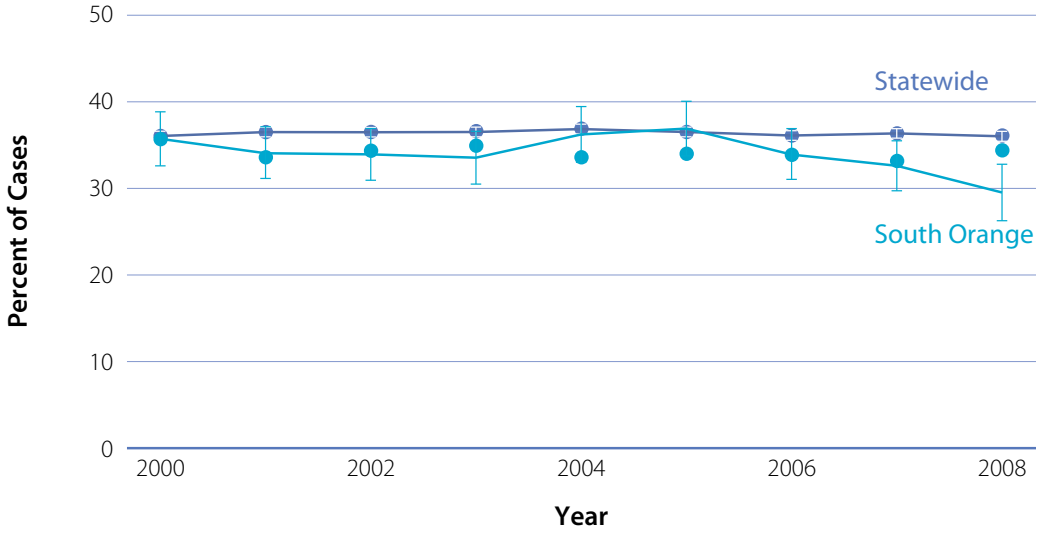
	South Orange			California		
Year	Number of cases	Age-adjusted rate	95% confidence interval	Number of cases	Age-adjusted rate	95% confidence interval
2000	641	145.1	134.0–156.8	20,545	120.9	119.2–122.5
2001	687	150.5	139.4–162.3	20,902	120.3	118.7–122.0
2002	669	141.5	130.9–152.6	21,106	118.9	117.3–120.5
2003	623	127.4	117.6–137.9	19,817	109.4	107.9–111.0
2004	621	123.0	113.5–133.1	19,722	106.7	105.2–108.2
2005	634	122.1	112.7–132.1	20,381	108.2	106.7–109.7
2006	699	132.5	122.7–132.1	20,436	106.5	105.0–108.0
2007	693	127.0	117.6–137.0	21,094	107.6	106.1–109.0
2008	552	99.5	91.3–108.3	19,005	95.3	93.9–96.6

Data Source: California Cancer Registry, 2000–2008, prepared by the California Breast Cancer Mapping Project

Stage at diagnosis

A slightly lower percent of women were diagnosed at a late-stage in the South Orange area of concern (Figure 34 and Table 17). Overall, the percent of women diagnosed at a late-stage was relatively stable in California, with a small overall decrease in the South Orange area of concern.

Figure 34. Percent of women diagnosed with invasive breast cancer at a late-stage in South Orange and California, 2000–2008



Data Source: California Cancer Registry, 2000–2008, prepared by the California Breast Cancer Mapping Project

Table 17. Women diagnosed with invasive breast cancer at a late-stage in South Orange and California, 2000–2008

	South Orange		California	
Year	Cases diagnosed at a late-stage	Percent of all cases	Cases diagnosed at a late-stage	Percent of all cases
2000	229	36%	7,407	37%
2001	234	35%	7,630	37%
2002	227	35%	7,701	37%
2003	209	34%	7,236	37%
2004	225	36%	7,268	37%
2005	234	37%	7,442	37%
2006	237	34%	7,379	36%
2007	226	33%	7,668	37%
2008	163	30%	6,845	36%
All Years	1,984	34%	66,576	37%

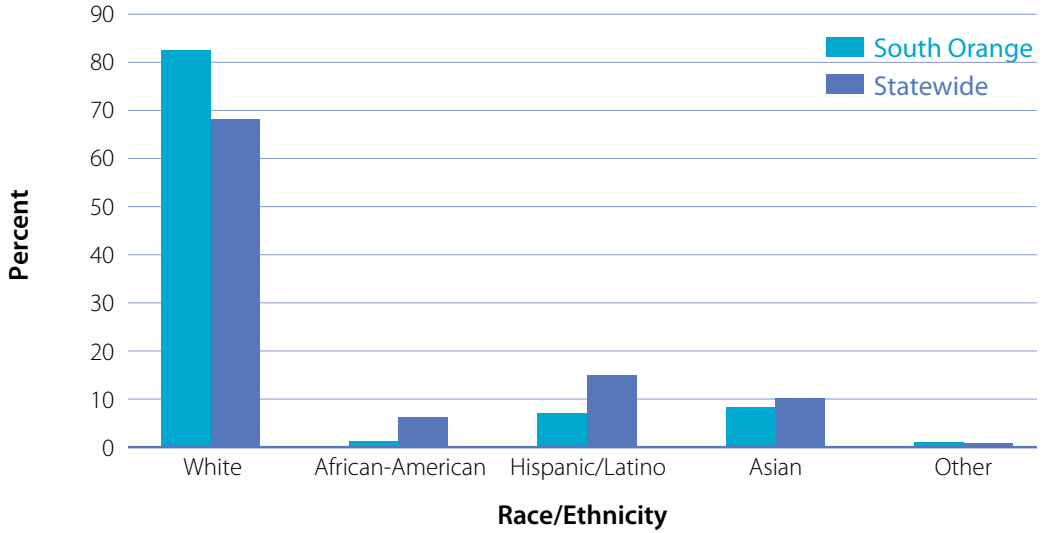
Data Source: California Cancer Registry, 2000–2008, prepared by the California Breast Cancer Mapping Project

Sociodemographic Data for Invasive Female Breast Cancer Cases in South Orange Area of Concern

Race/ethnicity

In the South Orange area of concern, White women accounted for 83% of invasive breast cancer cases diagnosed from 2000–2008 (Figure 35 and Table 18), though according to census data White females represent 59% of the female population in 2010 (Table 20 and Figure 37). Hispanic women, on the other hand, accounted for 7% of invasive breast cancer cases diagnosed from 2000–2008, but they represent nearly 20% of the female population in the South Orange area of concern in 2010. African-American women accounted for 1% of breast cancer cases from 2000–2008 while representing 1% of the female population, and Asian women accounted for 8% of breast cancer cases diagnosed from 2000–2008 while representing 17% of the population.

Figure 35. Race/ethnicity of women diagnosed with invasive breast cancer in South Orange and California, 2000–2008



Data Source: California Cancer Registry, 2000-2008, prepared by the California Breast Cancer Mapping Project

Table 18. Race/ethnicity of women diagnosed with invasive breast cancer in South Orange and California, 2000–2008

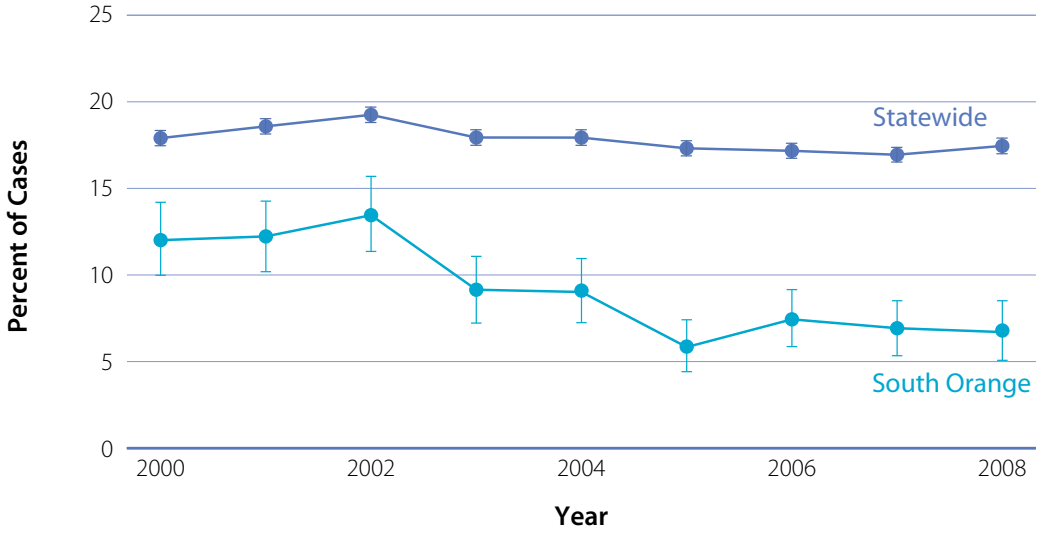
	South Orange		California	
Race/Ethnicity	Cases	Percent	Cases	Percent
White	4,804	83%	124,541	68%
African-American	67	1%	11,161	6%
Hispanic/Latino	406	7%	27,318	15%
Asian	483	8%	18,383	10%
Other	59	1%	1,605	1%
All Cases	5,819	100%	183,008	100%

Data Source: California Cancer Registry, 2000-2008, prepared by the California Breast Cancer Mapping Project

Insurance Status

A smaller proportion of women diagnosed with invasive breast cancer in the South Orange area of concern were uninsured or received government-assisted insurance at the time of diagnosis in comparison to patients across California (Figure 36 and Table 19). On average, 9% of women with breast cancer in the South Orange Area were uninsured or received government-assisted insurance.

Figure 36. Percent of women diagnosed with invasive breast cancer who receive government-assisted insurance or are uninsured, South Orange and California, 2000–2008



Data Source: California Cancer Registry, 2000–2008, prepared by the California Breast Cancer Mapping Project

Table 19. Percent of women diagnosed with invasive breast cancer who receive government-assisted insurance or are uninsured, South Orange and California, 2000–2008

	South Orange		California	
Year	Government-assisted insurance or uninsured	Percent of all cases	Government-assisted insurance or uninsured	Percent of all cases
2000	77	12%	3,678	18%
2001	84	12%	3,884	19%
2002	90	13%	4,063	19%
2003	57	9%	3,555	18%
2004	56	9%	3,537	18%
2005	37	6%	3,529	17%
2006	52	7%	3,509	17%
2007	48	7%	3,574	17%
2008	37	7%	3,317	17%
All Years	538	9%	32,646	18%

Data Source: California Cancer Registry, 2000–2008, prepared by the California Breast Cancer Mapping Project

Population Data: U.S. Census 2000 and 2010 for South Orange Area of Concern and California

We analyzed data from the 2000 and 2010 U.S. Census to better understand who lives in these areas of concern, how these communities compare to the state as a whole, and how the demographics have or have not changed in the past decade.

Overall, the South Orange area of concern has seen an increase in the proportion of females aged 45–64 years, similar to statewide trends (Table 20 and Figure 38). In addition, there was a 9% decline in the proportion of White females, and an increase in the proportion of Asian and Hispanic females (Table 20 and Figure 37).

Table 20. Population demographics of South Orange and California, years 2000 and 2010

	South Orange				California			
Population	**2000**		**2010**		**2000**		**2010**	
Total population	836,057		1,010,576		33,871,648		37,253,956	
Female	427,834	51%	517,862	51%	16,996,756	50%	18,736,126	50%
Male	408,223	49%	492,714	49%	16,874,892	50%	18,517,830	50%
Age (female)								
0–24 years	137,623	32%	163,105	31%	6,112,204	36%	6,422,590	34%
25–44 years	142,536	33%	142,981	28%	5,248,109	31%	5,182,849	28%
45–64 years	96,992	23%	143,772	28%	3,554,659	21%	4,731,190	25%
65+ years	50,683	12%	68,004	13%	2,081,784	12%	2,399,497	13%
Race (female)								
White	290,483	68%	304,313	59%	8,008,532	47%	7,510,531	40%
African-American	5,483	1%	7,375	1%	1,111,726	7%	1,094,910	6%
Asian	51,452	12%	89,140	17%	1,946,293	12%	2,580,855	14%
Hispanic or Latino	67,397	16%	98,548	19%	5,351,525	31%	6,933,591	37%
Other	13,019	3%	18,486	4%	578,680	3%	616,239	3%
Housing tenure								
Owner-occupied	214,426	70%	241,052	65%	6,546,334	57%	7,035,371	56%
Renter-occupied	92,680	30%	128,094	35%	4,956,536	43%	5,542,127	44%

Data source: U.S. Census, 2000 and 2010, prepared by the California Breast Cancer Mapping Project

The South Orange area of concern continues to encompass a higher proportion of White females and a lower proportion of African-American and Hispanic females, compared to statewide. The female population also tends to be slightly older compared to the California population.

Interpreting the line charts (Figures 37 and 38)

These figures show comparisons between statewide population (blue lines) and the South Orange area of concern (aqua lines), and between 2000 and 2010.

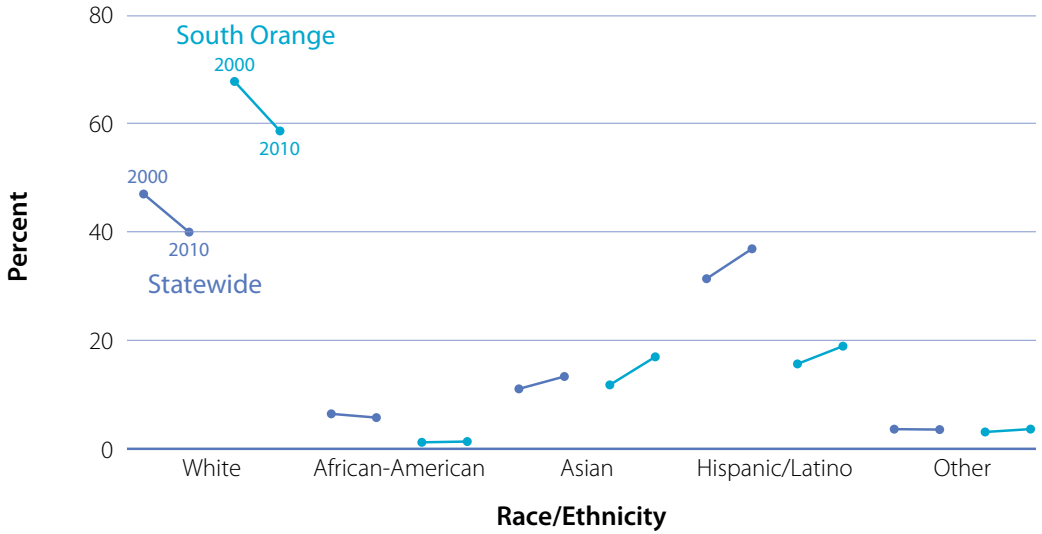
Comparing 2000 to 2010:

- The line's slope indicates the amount of change from 2000 to 2010. Downward-slanted lines indicate a decrease in the percentage of women from 2000 to 2010. Upward-slanted lines indicate an increase in the percentage of women from 2000 to 2010. Relatively flat lines indicate little or no change between 2000 and 2010.

Comparing the area of concern to statewide:

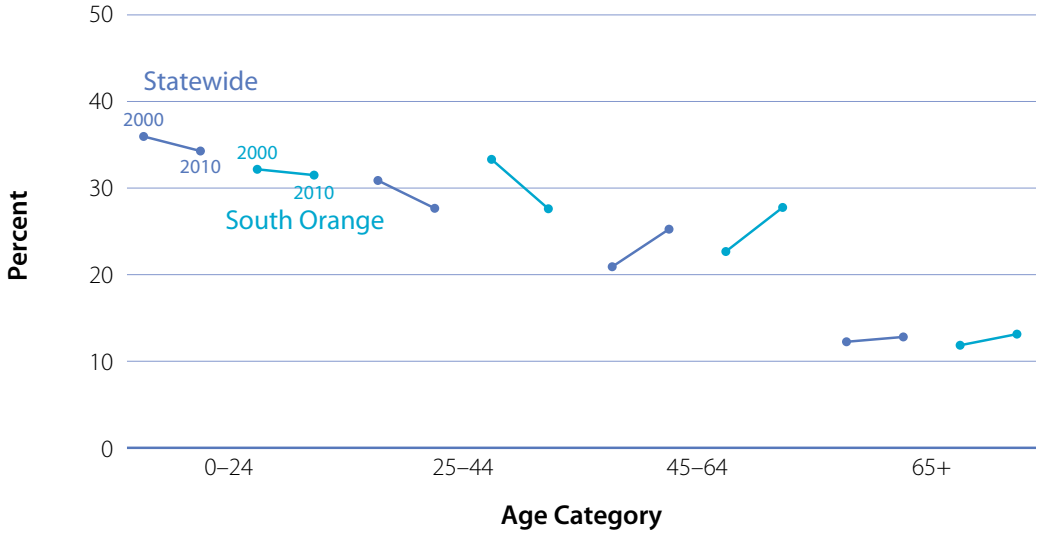
- Where the blue line is above the aqua line, the percentage of women statewide is higher than in the area of concern. Where the aqua line is above the blue line, the percentage of women in the area of concern is higher than the statewide population.

Figure 37. Female residents by race/ethnicity for South Orange and California, 2000 and 2010



Data source: U.S. Census, 2000 and 2010, prepared by the California Breast Cancer Mapping Project

Figure 38. Female residents by age for South Orange and California, 2000 and 2010



Data source: U.S. Census, 2000 and 2010, prepared by the California Breast Cancer Mapping Project

Methods

The main goal of the CBCMP AG was to guide the project in selecting a statistical method and defining related parameters for producing breast cancer maps that would be responsive to the needs of breast cancer stakeholders. Details about the AG, their considerations, and their decision-making process for selecting a method and developing it into a protocol are dedescribed in detail in *Guidelines for the Mapping of Cancer Registry Data: Results from an Expert Panel Study*.[16] Below is a description of the final protocol used to create the maps in this report.

Rationale

The AG identified two technical requirements that any mapping method must meet if it is going to produce useful information: (1) minimizing false positives, and (2) taking into account data limitations.

1. Minimizing false positives

The first requirement is that the method must avoid reporting areas as having elevated rates of breast cancer if they arise due to random chance (false positive findings). For example, a community that averages five cases of breast cancer in a year may have only four cases in one year, and then six the next. Every once in a while the number may be much smaller or larger than five simply because of random chance.

Much of the field of statistics is dedicated to telling the difference between findings due to random chance and those that arise from real phenomena, and many approaches to this problem in the context of disease mapping have been put forward during recent decades. The AG chose the Scan Statistic (page 64) because (1) it was extremely effective in avoiding false positives, and (2) it was particularly effective at communicating the findings to various groups, including those without statistical backgrounds.

2. Taking into account data limitations

The second requirement is the ability to recognize findings that may result from limitations in the data themselves. Breast cancer mapping requires two sources of data — one for the number of breast cancer cases (the numerator) and another for the total number of women (the denominator) living in a specific time and place. Fortunately, the information on cancer cases came from the California Cancer Registry, which is recognized as one of the leading cancer registries in the world.

Knowing the number of women living in a specific place at a specific time is much more complicated, however. The United States Census provides counts of women by age and census tract only once every ten years. Thus, the denominators will only be known precisely in years like 2000 and 2010. When populations change slowly and at a constant pace, estimating populations for the in-between years (2001–2009) is straightforward. We know that in California (particularly during the last decade), the population has changed dramatically, however.

We tackled this problem by examining the Scan Statistic results for signs of sudden population changes and removing such findings from consideration (page 66).

16 See note 5.

Data Sources

Data were obtained from the California Cancer Registry (CCR) describing the numbers of cases of invasive breast cancer among women by age, year of diagnosis, and census tract of residence at the time of diagnosis for the years 2000–2008. CCR collects and manages patient information according to standards set by the Centers for Disease Control and Prevention's National Program of Cancer Registries and the National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) program. Cases were defined as new diagnoses of breast cancer (SEER diagnostic code 26000) among females for which the stage was not recorded as *in situ*. Cases lacking confirmation through microscopy or solely reported through autopsy, death certificate, or an outpatient center were excluded. All records included a residence address for the time of diagnosis that was geocoded by a commercial geocoder as an exact street match; failing an exact match, the centroid of the ZIP+5 boundary was used.

Because of the sensitive nature of these data, the project was conducted under the legal oversight of the Institutional Review Boards of the Public Health Institute and the California Department of Public Health.

Denominator data were drawn from the U.S. Census counts from 2000 and 2010. Since age-specific counts of women for year 2000 census tracts were not available for 2010, these numbers were calculated from year 2010 census tracts through re-apportionment according to the population weights supplied by the Bureau of the Census. Denominators for between-census years were then generated through linear interpolation.

What is the Scan Statistic?

The Scan Statistic is a method used for disease mapping that produces findings with a high degree of certainty and fewer false positives compared to many other approaches. The method was first published in an academic journal in 1995 by Dr. Martin Kulldorff,[17] a professor and biostatistician now at the Department of Population Medicine, Harvard Medical School and Harvard Pilgrim Health Care Institute. Under the auspices of Dr. Kulldorff, the National Cancer Institute, and Dr. Farzad Mostashari (of the New York City Department of Health and Mental Hygiene), software and documentation for the use of the Scan Statistic (called SatScan™) were developed. SatScan™ has enabled statisticians and epidemiologists to experiment and study how the method works. Over the years, both method and software have been revised so they can be applied in a greater number of situations. There are now several hundred published scientific articles exploring and utilizing the Scan Statistic and/or methods based on it.

Analysis Using SatScan™

Because of its flexibility, the actual algorithms employed by SatScan™ can vary.[18] Here we discuss the algorithm we used, based on guidance from the AG, to produce the breast cancer maps presented in this report. The specific SatScan™ settings utilized for these analyses are summarized in Table 21 (page 65).

We ran SatScan™ independently for each of the nine years for which we had data (2000–2008). Input data consisted of counts of newly diagnosed invasive breast cancer cases by age group by year 2000 census tract, along with decimal degree latitude and longitude values for the centroids of each census tract. SatScan™ began by generating the universe of potential "spatial windows," all of which are circular buffers centered on one of the tract centroids. For each centroid, window radii were allowed to range from zero kilometers up to the maximum value we specified (page 65). Each resulting unique combination of tracts was considered part of the set of potential windows to be examined.

17 Kulldorff M, Nagarwalla N. *Spatial disease clusters: Detection and inference. Statistics in Medicine, 1995;* 14:799–810.

18 Kulldorff M. and Information Management Services, Inc. SatScanTM v8.0: Software for the spatial and space-time scan statistics. www.satscan.org, 2009.

Table 21. Details of SatScan™ settings

Decision Point	Setting	Comments
Probability model type	Poisson	Dictated by data format
Coordinates	Latitude/Longitude	Employed 2000 census-based tract centroids
Type of analysis	Purely spatial	Based on AG interest
Scan for areas with…	High rates	Based on AG interest
Monte Carlo replications	9,999	Enables calculation of *p*-values down to 10^{-4}
Maximum spatial cluster size	30 kilometer radius	Maximal resolution based on data exploration. For details, see *Choice of Window Radius Maximum*.
Spatial window shape	Circular	Elliptical shapes require *a priori* specification of non-compactness penalty, etc.
Criteria for reporting secondary clusters	No geographical overlap	Alternatives yield large numbers of areas of concern, thus limiting communication utility of results

The centerpiece of the algorithm is a likelihood function that is calculated for every window in the set of candidates. For our purposes, this function is:

$$\left(\frac{C}{E[C]}\right)^{c}\left(\frac{C-c}{C-E[c]}\right)^{C-c} I(c > E[c])$$

Here C is the total number of cases, c is the observed number of cases within the window, and *E[c]* is the age-adjusted expected number of cases within the window under the null hypothesis. *I(c>E[c])* is a function equal to one if *c>E[c]* and zero otherwise.

The larger the likelihood function for a given window, the less likely the configuration of cases described by that window would arise through chance alone. The set of candidate windows is then sorted by likelihood ratio (the ratio of the value from the above formula inside the window to that outside of the window). For our purposes, candidate windows were not allowed to overlap, so those that intersected with windows having higher likelihood ratios were removed from consideration.

To assess significance, cases were randomly reassigned to census tracts under the null hypothesis for 9,999 replications, with each replication yielding a maximum likelihood ratio for the entire set of candidate windows. Only candidate windows with higher likelihood ratios than the maxima calculated for 9,990 of these simulations are considered further; this corresponds to requiring reportable windows to have *p*-values of less than or equal to 0.001.

Note that, because only the maximum likelihood ratio from each simulation is considered, this quantity is a ***set-wise*** *p*-value. Conventional methods for analyzing every tract in a state independently generally yield ***case-wise*** *p*-values, so $p \leq 0.001$ suggests that a state with as many tracts as California (7,035 in the year 2000) would have approximately 7 false-positive findings for each year of data considered. In contrast, the set-wise *p*-value can be expected to produce a single false-positive finding for every 1,000 years of data considered.

Choice of Window Radius Maximum

Although much of the logic behind most of the SatScan™ parameter settings is self-explanatory, our choice of window radius maximum requires discussion. AG consensus suggested that only non-overlapping circular buffers would be reported to keep findings simple and easy to present. Under this condition when the maximum radius is high, small numbers of large spatial windows covering entire regions

of the state are reported, and AG discussions suggested that such results would have limited utility. When the maximum radius is low, few areas of the state have sufficient population density such that any elevation of reasonable severity can be detected.

We reasoned that there would be a radius setting between these two extremes that would result in the greatest amount of information, which would be reflected in the highest number of unique windows identified within the nine years of data. We tested various maximum radius settings and found that the greatest number of reportable windows occurred when we used the 30-kilometer radius limit.

Post-SatScan™ Processing

Generally speaking, if a group of census tracts were identified using the Scan Statistic as having elevated breast cancer rates in one year, adjacent or partially overlapping set of tracts with elevated rates were found in other years. To make it possible to examine areas of interest over time, we needed consistent boundaries for which rates could be calculated for each of the nine years. We defined "areas of concern" as continuous geographic areas comprised of groups of census tracts that were identified as having elevated breast cancer rates at any time over the nine years using the Scan Statistic method and for which a rate elevation appeared in some collection of tracts within that area of concern in at least three of the nine years.[19]

The exclusion of areas with identified groups of tracts in fewer than three years was designed to address two important threats to validity in post-processing that had been identified by the AG:

1. Denominators were known to be imprecise or misleading for areas of the state that experienced rapid housing construction during the period. As expected, several areas known to have undergone rapid population increases were flagged in the raw results as having transient elevations in rates during one or two years in the middle of the decade (that is, farthest from either census).
2. A small number of areas not known to have undergone population shifts experienced transient elevations for a single year. The simplest explanation for these was thought to be an improvement in screening practices, which would lead to a temporary increase in the observed incidence of new cases.

Under this reasoning, areas with groups of tracts identified in only one or two of the years analyzed were considered to be representative of transient elevations in rate due to either population growth or a temporary increase in the incidence of newly diagnosed cases.

Reporting of Results

To represent invasive breast cancer risk in each area of concern, age-adjusted rates for each of the nine years were calculated. These are presented along with rates for the state as a whole for purposes of comparison. We further described each area by calculating its demographic composition, the proportion of women who were diagnosed after their cancer was in a later stage, and the proportion of women who received government-assisted insurance or who were uninsured at the time of diagnosis.

19 An exception to this rule occurred for the 2008 data. For this year, Scan Statistic identified elevated risk in a collection of tracts that overlapped both the North San Francisco Bay and South San Francisco Bay areas of concern (plus tracts in-between). Staff calculated rates for subsets of these data (e.g., by county within each area) and determined that the findings were more honestly represented by treating these as two separate areas of concern (based on 2000–2007 data) rather than as a single large area of concern (as implied by the 2008 data only).

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Resources

Below are some selected resources related to this report. This list is not intended to be comprehensive.

General Resources and Research

American Cancer Society

Breast Cancer Overview
www.cancer.org/Cancer/BreastCancer/OverviewGuide

Breast Cancer Facts & Figures
www.cancer.org/Research/CancerFactsFigures/BreastCancerFactsFigures

Breast Cancer Fund

Understanding Environmental Links to Breast Cancer
www.breastcancerfund.org/clear-science/

State of the Evidence 2010
www.breastcancerfund.org/assets/pdfs/publications/state-of-the-evidence-2010.pdf

Reduce Your Risk
www.breastcancerfund.org/reduce-your-risk/

Breast Cancer & the Environment Research Program

Research studies on breast cancer and the environment
www.bcerc.org

California Breast Cancer Research Program

Position Papers and Reports
www.cbcrp.org/publications/papers

California Department of Health Care Services

Cancer Screening Programs: Every Woman Counts
www.dhcs.ca.gov/services/Cancer/ewc

Centers for Disease Control and Prevention

Cancer Clusters
www.cdc.gov/nceh/clusters

Environmental Health Investigations Branch, California Department of Public Health

Community Health Studies & Environmental Contamination
www.communityhealthstudies.org

Susan G. Komen for the Cure

General breast cancer information and resources
www.komen.org

Zero Breast Cancer

The Breast Biologues: A Biology Dialogue About Breast Cancer and the Environment
http://vimeo.com/16609300

Data Resources

California Cancer Registry

Web query tool and publications
www.ccrcal.org

California Environmental Health Tracking Program

Data query tool and other cancer information
www.cehtp.org/p/cancer

California Health Interview Survey

Data and publications on health by county
www.chis.ucla.edu

Cancer Prevention Institute of California

Cancer data for the general public and for researchers
www.cpic.org

U.S. Census Bureau

Information and data from the American Community Survey
www.census.gov/acs

Data from the Census
http://factfinder2.census.gov

Community Health Indicators

Community Health Status Indicators

Health data by state and county for 2008 and 2009
www.communityhealth.hhs.gov

County Health Rankings and Roadmaps

Counties ranked by health outcomes, health measures, and other measures
www.countyhealthrankings.org

California Cancer Registries

Region 1 and 8: Cancer Prevention Institute of California

2201 Walnut Avenue, Suite 300
Fremont, CA 94538
(510) 608-5000, FAX: (510) 608-5095

Counties:
Region 1: Santa Clara Region (Monterey, San Benito, Santa Clara, and Santa Cruz)
Region 8: Bay Area Region (Alameda, Contra Costa, Marin, San Francisco, and San Mateo)

Region 2: Cancer Registry of Central California

1625 East Shaw Ave., Suite 155
Fresno, CA 93710
(530) 345-2483, FAX: (530) 345-3214

Counties: Central Region (Fresno, Kern, Kings, Madera, Mariposa, Merced, Stanislaus, Tulare, and Tuolumne)

Region 3: Cancer Surveillance Program

1825 Bell Street, Suite 102
Sacramento, CA 95825
(916) 779-0300, FAX: (916) 779-0264
Fax for confidential data: (916) 779-0352

Counties: Sacramento Region (Alpine, Amador, Calaveras, El Dorado, Nevada, Placer, Sacramento, San Joaquin, Sierra, Solano, Sutter, Yolo, and Yuba)

Region 4: Tri-Counties Cancer Surveillance Program

1825 Bell Street, Suite 102
Sacramento, CA 95825
(916) 779-0300, FAX: (916) 779-0264
Fax for confidential data: (916) 779-0352

Counties: Tri-County Region (San Luis Obispo, Santa Barbara, and Ventura)

Region 5: Desert Sierra Cancer Surveillance Program

11306 Mountain View Ave., Suite B-100
Loma Linda, CA 92354
(909) 558-6174, FAX: (909) 558-6178

Counties: Inland Empire Region (Inyo, Mono, Riverside, and San Bernardino)

Region 6: Cancer Registry of Northern California

25 Jan Court, Suite 130
Chico, CA 95928
(530) 345-2483, FAX: (530) 345-3214

Counties: North Region (Butte, Colusa, Del Norte, Glenn, Humboldt, Lake, Lassen, Mendocino, Modoc, Napa, Plumas, Shasta, Siskiyou, Sonoma, Tehama, and Trinity)

Region 7 and 10: Cancer Surveillance Program of Orange County and San Diego Imperial Organization for Cancer Control

1825 Bell Street, Suite 102
Sacramento, CA 95825
(916) 779-0300, FAX: (916) 779-0264
Fax for confidential data: (916) 779-0352

Counties:
Region 7: San Diego Region (Imperial and San Diego)
Region 10: Orange County

Region 9: Cancer Surveillance Program

1540 Alcazar St., CHP-204
Los Angeles, CA 90089-9007
(323) 442-2300, FAX: (323) 442-2301

Counties: Los Angeles

Glossary

Age-adjusted rates The calculation of age-adjusted rates takes into account how many people of different ages live in an area. For example, we know that breast cancer is more common among older women. If there are more older women living in a County A, then you can expect a higher breast cancer rate in County A. If there are fewer older women living in County B, then you can expect a lower breast cancer rate in County B. If, after adjusting for age, one of the counties is still higher than the other, then you might explore other reasons for that difference. All the rates presented in this report are age-adjusted rates.

Area of concern This report uses this term to refer to areas with higher breast cancer rates than would be expected, as identified by the Scan Statistic method followed by specific steps to exclude spurious results.

California Cancer Registry California's statewide population-based cancer surveillance system (www.ccrcal.org).

Cancer cluster Typically, cancer cluster refers to a collection of cancer cases that are grouped together in time and space, believed to be higher than expected, and reported to a health agency. This term is often used when a local environmental hazard is expected to be causing cancer.

Census data Census data, or data about populations, are collected by the United States Census Bureau (www.census.gov). Though many forms of data are collected in the United States on an ongoing basis, a comprehensive survey is administered and released every ten years.

Census tracts A census tract is a geographic unit designated by the U.S. Census Bureau. Census tracts are designed to be relatively homogeneous with respect to population characteristics, economic status, and living conditions. On average, they represent about 4,000 residents. The geography of census tracts can change from one census to the next. In the 2000 Census, California had 7,049 census tracts, compared to 8,057 census tracts in the 2010 Census. The tract boundaries used for this analysis are from the 2000 Census.

Centroid The geographical center of an area.

Contiguous In this report, contiguous is used to describes two states, counties, or census tracts that share a common boundary. For example, the state of California is contiguous with Oregon but not with Washington. The term can also be used to describe a block of states, counties, or census tracts that form a single, uninterrupted area (for example, the lower 48 states can be considered a contiguous group, but all 50 states — which include Alaska and Hawaii — cannot).

Denominator In this report, denominator refers to the total number of a specific population (e.g., women) living in a defined area at a specific time.

Disease mapping Displaying patterns of illness and disease through maps.

False positives When the results or findings of a test are positive for an event even though the event did not occur, this is called a false positive. For the purpose of this report, false positives refer to census tracts that are identified as having elevated rates of breast cancer when the risk of breast cancer for women living in that census tract was not elevated.

Geocoding The assignment of a precise latitude, longitude, and census tract to an address.

Incidence Incidence is a measure of the risk of developing a disease within a specified period of time. This is different from prevalence, which is the total amount of disease in a population. Incidence can be expressed as the number of new cases during a time period. Incidence can also be expressed as a proportion or a rate with a denominator. In this report, the incidence rate is the number of newly diagnosed invasive breast cancer cases per 100,000 women per year.

Institutional Review Board Also known as IRB, an Institutional Review Board is a committee that has been formally designated to approve, monitor, and review biomedical and behavioral research involving humans with the aim to protect the rights and welfare of the research subjects.

Invasive breast cancer Cancer that begins in the milk duct, but has grown into the surrounding normal tissue inside the breast is called invasive breast cancer. This is the most common type of breast cancer.

Late-stage This refers to tumor tissue that demonstrates non-localized spread at the time of diagnosis, whether via direct extension, nodular infiltration, or distant metastasis.

Population shift A change in the relative numbers of individuals that compose a certain group or community is called a population shift. For example, an increase in the number or relative proportion of Hispanic women in a certain community would constitute a population shift. A population shift may also occur when a large amount of new housing is constructed and more people move into a community. In both situations, populations shifts may make it difficult to know how many people lived in an area (for the calculation of a rate) or how to interpret a rate that is calculated.

Prevalence Prevalence is a measure of the total amount of all cases of a disease in a population. This is different from incidence, which is the occurrence of new cases in a specified time period. For this report, prevalence refers to the total amount of women living with breast cancer in a population. Prevalence is often expressed as a percentage.

Public agency A public agency is an organization that is publicly funded (usually by the local, state, or federal government). Many public agencies collect or maintain health data, such as the data used in this report.

Rate In this report, a rate is a number describing the incidence or prevalence of a disease in a specific population (see above for definitions). The calculation of rates always requires a numerator and a denominator

SatScan™ A free software that analyzes spatial, temporal, and space-time data using the Scan Statistic methodology.

Scan Statistic A statistical method to identify clusters of events in space and time.

Sociodemographic data Data relating to demographic and social factors describing a population, such as race, ethnicity, income, and housing.

Surveillance Surveillance is the continuous collection, analysis, interpretation, and dissemination of health-related data to improve public health and health services. Surveillance enables detection of changes in disease patterns over time.

Time-series map A way to visually present data to show how the data change over time.

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www.californiabreastcancermapping.org