

A. Purpose, Objectives and Significance

Recent years have seen a rapid growth in interest in the addition of a spatial perspective to population research, and in part this growth has been driven by the ready availability of georeferenced data, and the tools to analyze and visualize them: geographic information systems (GIS), spatial analysis, and spatial statistics. The term “geographic information science” has emerged as something of an umbrella in this arena, implying both the use of GIS and other spatial tools for scientific research, and the study of the fundamental principles and issues underlying a spatial perspective (Longley, Goodchild, Maguire, and Rhind, 2001). In this proposal we request funding to provide standardized, intensive training to young population researchers in geographic information science specifically tailored toward population science. A two-week Population Science and GIS workshop will be offered four times over two years and will primarily target interdisciplinary pre-doctoral students studying demography at NICHD-supported population training centers, and institutional members of the wider Association of Population Centers (APC). We also expect to attract other graduate students in demography-related disciplines from both APC and non-APC institutions (including agricultural economics, anthropology, economics, geography, public health, rural sociology, sociology) as well as young faculty, and researchers employed in population agencies.

This proposal brings together faculty from the Population Research Institute (PRI) at Penn State and the Center for Spatially Integrated Social Science (CSISS) at the University of California at Santa Barbara as well as drawing on faculty from two of the top four departments of geography in the United States (National Research Council, 1995). The Penn State and UC Santa Barbara partnership builds up on both shared expertise (GIS instruction, geography, workshop and conference management) and complementary expertise (demographic science, distance learning, and digital libraries).

A.1. Objectives

The GIS Training Program for Population Scientists has two main goals.

Our *primary* goal is to jump-start the adoption and use of spatial methods in population research among the current cohort of young population scientists and our *secondary* goal is to provide the infrastructure for continuing diffusion of such methods during and after the Population Science and GIS workshop series has been completed in 2006. To achieve the primary goals we propose to provide standardized, intensive training in a demography-tailored GIS course for 80-100 young demographers via four 2-week workshops (20-25 participants per workshop) over two years (September 2004-August 2006). To achieve the secondary goal, we will supplement the existing CSISS website resources and most importantly adapt the course materials generated for and during the workshop for self-paced training via web-based delivery.

The Population Science and GIS workshop will provide: (i) a basic introduction to GIS, spatial analysis, spatial statistics, mapping, and visualization; (ii) a strong focus on applications in population research; (iii) coverage of the most important basic issues of spatial methods, including problems of inference, spatial dependence, spatial heterogeneity, scale, uncertainty, and the ecological fallacy; (iv) opportunities for participants to work with their own data; (v) activities that foster peer-to-peer interaction, through group projects and small-group

discussions; and, (vi) social activities that foster peer-to-peer interactions and help to build a community of scholars.

An external advisory board composed of demographers will review and comment on course content and material well before the first planned workshop. We will conduct a thorough evaluation of the Population Science and GIS workshop after each workshop and the end of each year, including feedback from participants.

By offering this workshop four times we will potentially reach a significant proportion of the cohort of young US demographers enrolled in formal demography training programs in 2004-2006. We estimate that approximately 500 graduate students are associated with Association of Population Center institutions nationwide (See Appendix A – these numbers are somewhat crude as incomplete information is not readily available on graduate student totals and specifically on who are the “demography” students). Given that we certainly do not expect every demography student to be interested in GIS and spatial analysis, we do expect to recruit graduate students outside of the APC institutions as well as junior faculty and other research scientists at domestic and internationally focused population agencies. Of the 82 applications we received for the 1-week CSISS sponsored workshop on Population Science and GIS held at Penn State in May 2003, 18 were Ph.D. students, 22 masters students, 6 post-docs, 8 untenured faculty, 7 tenured faculty, and 21 were non-academic typically affiliated with government or international agencies (see Appendix B – CSISS Materials).

All participants in the two-week Population Science and GIS workshop will earn a certificate from Environmental Systems Research Institute (ESRI) by successfully completing “Introduction to ArcGIS” training from an ESRI-authorized instructor during the first three days of the workshop. Note, we are planning to use a variety of software in the workshop, some commercial, some open-source, but for the basic GIS training components we will use ESRI products as both institutions currently use them in their courses and ESRI accounts for the largest share of the GIS software market (ESRI licenses one million seats of its software products worldwide, including 500,000 in the U.S.); see Phoenix, 2000. In addition, participants in all workshops will receive a certificate of completion from Penn State/UCSB. We will negotiate with UCSB and Penn State for formal course credit for the graduate student participants, and assist participants in making arrangements to transfer such credit. We will explore opportunities for graduate students to receive three academic credits to apply towards their academic training in core demographic scholarship through their own institutions (e.g., based on work undertaken during the Population Science and GIS workshop).

We will adapt materials generated for and during the workshops for web-based delivery via training websites, thus providing access to learning materials beyond the lifetime of the grant (i.e., post August 2006) to a wider demographic and social science audience. By 2006 we will make instructional materials available over the web for self-paced learning, hosted on both Penn State (PRI) and UCSB (CSISS) websites. An individual who completes the on-line self-paced training program will receive a certificate of completion. We have thought carefully about other activities that will help longer-term sustainability of this project. For example, the workshops will include an explicit emphasis on the submission of materials from participants to the training website (e.g., electronic or e- portfolios) as well as the promotion of poster and/or paper sessions by workshop participants at conferences such as the Population Association of America (PAA) meetings in 2006 and 2007. A less tangible aim will be to provide opportunities for young

scientists to forge new collaborations based on shared interests in spatial demographic research. We intend to explore the feasibility of other strategies that promote sustainability. For example, we will assess the demand for specialized spatial analysis workshops for demographers and whether or not to consider fee-based workshops (following the University of Michigan Summer School model).

A.2. Significance

The proposed training program fits squarely within the priority areas of the Demographic and Behavioral Sciences Branch (DBSB) of NICHD, as evidenced by their 2002-2006 “Goals and Opportunities” report. This strategic planning document specifically cites *Spatial Demography* as a topic area to explore or expand. Recognizing contributions that have been made “to the areas of neighborhood effects, stratification and segregation, population and the environment, and migration” (p. 16), the report notes that spatial demographic research needs to address issues of theory, improving data accessibility and compatibility with spatial techniques, and fostering interdisciplinary research. Elsewhere (p. 20), the DBSB report identifies “improved application of spatial data and methods to demographic research” as a critical methodological challenge facing demographers today. Finally, the DBSB report cites macro-level population research as an important new area of emphasis, but recognizes that “accomplishing this goal will require attention to data needs and accessibility of data on population characteristics and change” (p. 27). Ultimately, the goal is to promote high quality research that bridges the micro-macro divide, an effort that DBSB places at the scientific frontier. Clearly the achievement of these goals will require that the next generation of demographers, and some of those already working in the field, be multi-disciplinary and well trained in state-of-the-art tools, techniques and theories of GIS and spatial analysis. This is precisely what we seek to achieve through this proposed GIS training program for population scientists.

The capacity to gather and organize spatial data on demographic and health events on individuals, families, households, neighborhoods, health facilities, routes and networks, as well as a host of environmental phenomena will continue to grow dramatically during the first decade of the twenty-first century. It is inevitable that geographic information systems and related technologies will be increasingly employed to explore possibilities to integrate and analyze such data (Calkins and Eagles, 1996; Liverman, Moran, Rindfuss and Stern, 1998; Fox, Rindfuss, Walsh and Mishra. 2003).

The growing popularity of GIS and spatial analysis in demography is clear as evidenced by conference sessions and the over-subscribed short GIS workshops at conferences such as the Population Association of America (Matthews, PI, has organized GIS Workshops at each of the last six PAA conferences and all have been over-subscribed – lab sizes have varied between 20-40 seats – see Appendix C) and the CSISS Population Science and GIS workshop at Penn State (where 82 applicants formally applied for 20 places). The PAA sessions and workshops are beginning to focus on how GIS techniques and methods can be used to derive new variables, how to build and integrate spatial databases, and how to create contextual databases. Moreover, demographic studies are beginning to pay attention to the spatial characteristics of the phenomenon being studied, and some studies are applying spatial statistical techniques that explicitly incorporate spatial relationships between geographic objects. As illustration of the growing interest in GIS and spatial perspectives in population science consider the following research areas.

While most studies of maternal and child health outcomes focus on individual-level data from large-scale surveys, population scientists have become particularly interested in contextual issues and multilevel modeling (Entwisle, Mason and Hermalin, 1986; Entwisle, Casterline, and Sayed, 1989; Entwisle et al, 1997; Hirschman and Guest, 1990; Pebley, Goldman, and Rodriguez 1996; Sastry, 1996; Degraff, Bilborrow, and Guilkey 1997). Similarly, multi-level modeling has been particularly evident in U.S. studies that focus on family and child wellbeing in the context of residential neighborhoods, typically urban, where researchers have begun to move beyond a limited set of census derived variables; i.e., to seek out practical and innovative uses of alternative data sets (e.g. on crime, health, land-use, transportation, etc.) to create global rather than aggregated variables that describe and capture dimensions and characteristics of neighborhoods not previously contemplated (Coulton, 1997; Coulton, Korbin, Chan and Su 2001; Sampson, Moronoff and Earls 1999). This methodological focus on multilevel or hierarchical modeling is relevant when examining the effects of contextual factors on social behavior played out at a lower level. It is also important to assess how much individual behavior is influenced by one's own characteristics as well as attributes of the larger community. Multilevel models allow for the integration of more than one level or scale simultaneously and for the relationships between variables to vary from place-to-place and according to context. Thus, because of the explicit focus on place, context, and scale within GIS, great potential exists for integrating multilevel analyses techniques and GIS.

Considerable research indicates that racial and socioeconomic segregation are persistent features of the US metropolitan landscape (Farley and Frey 1994; Jargowsky, 1997; Lewis Mumford Center for Comparative Urban and Regional Research, 2001; Logan, 2001; Massey and Denton, 1989) and that this segregation is associated with negative outcomes for families, youth, and children living in isolated poor and minority neighborhoods (Brooks-Gunn, Duncan, and Aber, 1997; Duncan and Brooks-Gunn, 1997; Wilson, 1987). Reliable and meaningful measurement of residential segregation is essential to the study of the causes, patterns, and consequences of racial and socioeconomic segregation. Nonetheless, prior work on residential segregation has been limited by a reliance on methodological tools that do not fully capture the spatial distributions of race and poverty. In brief, prior work has generally relied on measures of segregation that ignore the spatial proximity of neighborhoods and focus instead only on the racial composition of neighborhoods. A variety of *ad hoc* measures have been proposed to deal with these methodological limitations (Grannis, 2002; Massey and Denton, 1988; White, 1986; Wong, 1993 and 2002), but these have been rarely used in empirical research. In part, the proposed measures have been ignored because of their relatively *ad hoc* nature—most lack a conceptually and mathematically solid basis for measurement, and so they can produce results that are inconsistent with theoretically useful definitions of segregation. And in addition, these measures have been ignored because they are computationally intensive and no software tools exist to implement them, meaning that researchers must write their own programs if they want to use them. In a recent paper, Reardon and Firebaugh (2002) suggested a general approach to developing conceptually meaningful and mathematically tractable measures of spatial segregation. Work in progress by Reardon and O'Sullivan at Penn State employs the tools of geographic information analysis (see O'Sullivan and Unwin, 2002) to operationalize this approach using Census data.

In the ethnographic component of the Three City Welfare Study and in a recently underway study of family and child wellbeing in rural settings, Burton, Matthews and their colleagues have

begun to explore how GIS can be used to study the geographies of families and to re-visit important conceptual and methodological issues regarding definitions of neighborhood or context. In particular, they are interested in different forms of spatial behavior (Golledge and Stimson, 1997) expressed by individual and groups of families. Their application of GIS focuses on both building multi-scale contextual databases and the integration of both quantitative and qualitative data on families and neighborhoods to help better understand the spatial and temporal rhythms of families and in doing so shed light on the complex and reciprocal relationship between families and neighborhoods (Burton *et al*, 2000; Matthews, Detwiler and Burton, 2001; Skinner, Matthews and Burton, in press).

There are other social science research areas where a spatial perspective is evident. For example, in the areas of labor market research and explorations of the spatial mismatch hypothesis (see Mouw 2000, 2002), environmental justice (Anderton et al., 1994; McMaster, Leitner and Sheppard, 1997; Davidson and Anderton, 2000; Heitgerd and Lee, 2003), health inequality (Duncan, Jones and Moon, 1993; LeClere, Rogers and Peters 1997, 1998; Roberts, 1998; Yen and Kaplan, 1999; Browning, Cagney and Wen, 2003) and crime analysis (Block, Dabdoub and Fregley 1995; Morenoff and Sampson, 1997; Bowers and Hirschfield 1999; Morenoff, Sampson, and Raudenbush, 2001; Baller et al., 2001). Similarly, in recent years a number of social science discipline journals have carried special issues focusing on spatial analysis: *Political Analysis* (2002) issue 10:3 on “spatial methods in political science” edited by Michael Ward; *Political Geography* (2002) issue 21:2 on “the development and application of spatial analysis for political methodology” edited by Michael Ward and John O’Loughlin; and, *Agricultural Economics* issue 27:3 on “spatial analysis for agricultural economists” edited by Gerald Nelson.

Demographic researchers have also explored population and environment linkages (Pebley, 1998). Remote sensing, GIS, and spatial econometrics have already been used effectively to analyze the relationship between human activities and local environmental change, in particular in the area of deforestation and changing patterns of land use (Chomitz and Gray, 1996, Moran and Brondizio, 1998; Nelson and Hellerstein, 1997, and Wood and Skole, 1998). Empirical research on the reciprocal relations between population dynamics and the natural environment at the local level have been quite rare but as shown in the recent edited collection by Fox, Rindfuss, Walsh and Mishra (2003) the research environment is changing fast as population scientists begin to integrate GIS, remote sensing and spatial analysis methods (see also Liverman, Moran, Rindfuss and Stern, 1998).

While such activities are encouraging and are promoting GIS and spatial analysis in the population science community, at present the number of population scientists that have embraced GIS-related technology as research tools capable of making significant contributions in their research remains quite small. That is, while many recognize the increasing availability of spatial data, few population scientists understand the special features and intricacies of spatial databases (from data handling and analytical concerns through to legal issues associated with confidentiality and individual privacy) and therefore few have the skills to integrate spatial data in their demographic research. As Menken, Blanc and Lloyd (2002) state in a recent review of training and support of population scientists, “the broadening of the field has also necessitated the acquisition of additional skills and familiarity with the concepts and tools of related disciplines” and “there is an urgent need to adapt traditional models of training to prepare population scientists to work in a rapidly and continually changing environment” (p.1). We note that the shortfall in GIS skills is not confined to population science. Gaudet, Annulis, and Carr

(2003, p.21) report on “a serious shortfall of professionals and trained specialists who can utilize geospatial technologies.” And, Phoenix (2000, p.13) estimates that “the shortfall in producing individuals with an advanced level of GIS education is around 3,000 to 4,000 in the U.S. alone.” In particular, he stresses that “the few graduate programs now in place cannot meet the needs of the marketplace ... the shortage outside the United States is even greater.”

Of critical importance to population scientists (and others) is the availability of high quality training opportunities and teaching-related resources. Only a handful of U.S. graduate training programs in demography and related fields provide exposure to and the opportunities to use geographic information systems for basic mapping and data integration, let alone exploratory and confirmatory spatial analysis methods. Fewer still offer a spatial demography course as part of their formal programs (Appendix D). To be sure many GIS research applications have emerged at population centers (for example, the Brown University’s Population Studies and Training Center, the Carolina Population Center, the Minnesota Population Center, Penn State’s Population Research Institute, and the University of Wisconsin’s Center for Demography and Ecology) but formal GIS training opportunities tailored to demographers are few and far between, even on the campuses where GIS courses and resources exist.

A.3. Existing GIS training and resource opportunities

This section provides a brief review of opportunities for non-discipline specific training in GIS and spatial analysis techniques.

A.3.a. Academic Opportunities

There are many GIS resources available on campuses across the United States. For example, over sixty US universities are fee-paying members of the University Consortium for Geographic Information Science (UCGIS). To qualify for membership of UCGIS the applicant institution must describe relevant academic programs, courses, faculty, research and public service activities contributing to the advancement of geographic information science at the institution. This information on GIS resources at the member institutions is usually linked to the UCGIS website. Appendix E identifies for the list of university-based APC’s those based at institutions that are members of UCGIS.

UCGIS also maintains a listing of the GIS Certificate and Masters programs available in the US, Canada and elsewhere. As of 2002 only about eighteen specialized masters programs in GIS were in operation worldwide (Wikle and Finchum, 2002). There were eight distance-learning programs in GIS available with the most notable including Birkbeck College-London in the United Kingdom, and in the United States, The Pennsylvania State University, the University of Southern California (the U.S. home of the international UNIGIS program), and the University of Colorado at Denver. While on the subject of university-based programs it is also worth mentioning, attempts to develop model GIS curricula (e.g., by the National Center for Geographic Information and Analysis and more recently by UCGIS).

To be sure, there are universities that are not members of UCGIS that also offer GIS-related courses but as mentioned above formal GIS training opportunities tailored to population science appear to be rare.

A.3.b. Commercial Opportunities

There are many GIS resources including training programs (of varying durations) available via the Internet. For example, ESRI offers an example of the corporate model approach based on their “Virtual Campus.” ESRI commissioned researchers to develop GIS courses related to technological issues as well as GIS applications. They currently offer 60+ short five or six module courses mostly covering GIS technology with a smaller set of applications driven courses. Some ESRI courses are free but usually they are in the \$40-\$300 range (typically, the first module is free and then you pay for the others – a 40% education discount is available). Across all their Virtual Campus courses ESRI provides 100+ hours of free online instruction. While such training courses clearly have value for meeting some of the needs found within the geospatial labor market they do not adequately cover topic areas and materials that will help push research frontiers in population science.

ESRI is also a leader, though by no means alone, in hosting a variety of instructor-led short courses (2, 3 and 5 days) at numerous sites scattered around the country (indeed the world). These courses, more than thirty, are offered by ESRI authorized instructors at authorized training sites and focus explicitly on ESRI software and typically cost \$400 a day or between \$800-\$2000 per workshop (not including travel and accommodation costs). In addition to ESRI, other GIS vendors provide training courses and web-based workshops (e.g., MapInfo, Intergraph, Erdas). For the most part these short courses are aimed at users and would-be users in the commercial sector, hence their price. The vendor short-courses have an intended audience somewhat different from the average academic demographic researcher – but an applied demographer is most likely to benefit from some of these offerings. Young population scientists, particularly graduate students, are unlikely to pursue GIS training through vendor-based courses unless they have no other local alternatives (i.e., own university) and/or if cost is not an obstacle.

A.3.c. Other Training Resources

The overall commercial vendor-driven training environment is not helped by the lack of coverage of geographic information systems and spatial analysis within demography textbooks or by the lack of attention to demographic issues and applications in GIS texts. Among demography textbooks the eighth edition to John Weeks’ *Population* printed in 2002 is almost alone in offering some coverage to GIS and spatial issues though even here it is a limited three pages. In the academic GIS textbook market very few focus explicitly on demographic or socioeconomic issues; a notable, though now somewhat dated, exception is Martin, 1996. Recently, GIS texts in allied fields have appeared on the market, a good example is Cromley and McLafferty (2002) *GIS and Public Health* and some primers are available in other fields such as crime research: see Harries (1999) *Mapping Crime: Principles and Practice* and Goldsmith, McGuire, Mollenkopf, and Ross (2000) *Analyzing Crime Patterns: Frontiers of Practice*. In applied GIS there are now numerous short introductory guides or case study booklets on topics such as emergency management, health planning, policing, transportation planning, and public policy typically produced by GIS vendors (a good example are those produced by ESRI Press) but these rarely make good texts appropriate for graduate training and rarely provide adequate coverage to complex spatial data handling issues let alone spatial statistical analysis.

Similarly, curricula materials in spatial demography are rarely disseminated to the field (a notable exception being Dr. Paul Voss’s University of Wisconsin course description available on

the CSISS website). The latest edition of the American Sociological Association's *Syllabi and Instructional Material in Demography* edited by Bass (1999) does not include methods or specialized courses that emphasize GIS or spatial analysis.

A.4. Summary

Spatial Demography is a priority area of the Demographic and Behavioral Sciences Branch (DBSB) of NICHD, as evidenced by their 2002-2006 "Goals and Opportunities" report. The report notes that spatial demographic research needs to address issues of theory, improving data accessibility and compatibility with spatial techniques, and fostering interdisciplinary research. The improved application of spatial data and methods to demographic research is identified as a critical methodological challenge facing demographers today. Young population scientists are not adequately prepared for the geospatial data onslaught they are likely to face in the next decade nor are they exposed to ongoing methodological developments and new software products in GIS and spatial statistical analysis. Furthermore, the targeted application of academic GIS and spatial analysis courses, workshops, and methods to population science professionals and scholarship is inadequate and poorly developed.

Our goals are to provide exposure to GIS and spatial analytic methods in a series of tailored workshops. We envision a standardized intensive two-week training workshop to be delivered four times to a total of 80-100 young demographers, and to include among them a significant proportion of the current U.S. graduate student population with identifiable demographic research interests. We also propose to create from the workshops on-line materials for self-paced instruction that will be available to researchers in the field after the two-year funding cycle has concluded.

B. Educational Program

To address the issues identified in the previous section, we propose to conduct a two-year program aimed at reaching a substantial proportion of the current cohort of young researchers and senior graduate students in demography and population research. The program will consist of residential workshops in the summer months of 2005 and 2006, augmented by extensive Web resources. We aim to create a community of scholars, in academic institutions, non-governmental organizations, agencies, and the private sector, and by doing so to jump-start the use of spatial methods in population research.

We believe that the basic objectives of the program can be met with a two-year project, and that our proposal will create sufficient momentum for future years. Support in the form of Web resources will continue after the two-year period, and we expect graduates from the project to lead their own instructional programs and to use these methods in their own collaborative research in a steadily expanding ripple effect. While recognizing junior faculty frequently are unable to determine the classes they teach, it is the case that GIS and spatial analysis skills and experience are marketable. At Penn State we can identify population graduate students who have secured positions in and outside academia, and for whom GIS skills were beneficial to securing interviews and getting hired (e.g., in 2002 Karen Hayslett-McCall was hired as an assistant professor in the interdisciplinary School of Social Sciences at University of Texas at Dallas, and Jim Cameron is currently the director of statistical analysis at Claritas). We know that GIS skills

continue to be marketable in disciplines with a longer GIS history such as geography. We do not anticipate that every participant will within a few years be offering courses in GIS and spatial analysis, however it is not unreasonable to expect that of some attendees. It is more likely that we will generate an extended interest in spatial demography and social science that may possibly lead to the local promotion of GIS infrastructure (i.e., software and data acquisitions) and that some participants will be GIS catalysts at their current and future workplaces.

B.1. Workshop program

The core of our proposed program is the development and delivery of a standardized, intensive 2-week workshop on Population Science and GIS, to be delivered four times to young population researchers (graduate students, junior faculty, and early-career full-time researchers). Each workshop will enroll 20–25 participants, which is optimal in our experience for this kind of activity. That is, while GIS workshops frequently face hardware/software capacity limitations in the range of 20-25 person/seats, this is also a participant size that works well in terms of manageability and internal social cohesion. In the first year we will offer the Population Science and GIS workshop twice (once at UC Santa Barbara and once at Penn State) to a total of 40-50 participants. We will base our workshop content in the second year on feedback received during the first; including an analysis of the responses to entry and exit surveys (i.e., workshop evaluations) as well as drawing on the advice of our advisory board (see below). Thus, we may repeat the Population Science and GIS workshop without significant changes during the second year to a second group 40-50 participants. However, the evaluations and advisory board feedback could reveal specific topic areas that ought to be covered in greater depth and other areas that could be reduced in emphasis. In this instance, we will revise course content and structure before offering the Population Science and GIS workshop during the second year.

The Population Science and GIS workshop will be designed for young population researchers, and will introduce them to spatial methods: GIS, spatial analysis, spatial statistics, mapping, and visualization. We will place emphasis on new and rapidly developing areas that are being driven by advances in software, statistics, data dissemination technologies, data acquisition methods, and new information technologies for integrated support of research. For example, we will feature place-based methods of spatial analysis such as geographically weighted regression and local indicators of spatial association; techniques of exploratory spatial data analysis; Grid computing and cyber-infrastructure; data on space-time life histories; and tracking data derived from GPS. In advertising the workshop we will clearly state course content and requirements regarding knowledge of basic statistics and familiarity with common computing applications such as Microsoft's Office suite.

B.1.a. Workshop content

We have planned the introductory workshops in order to provide:

- A basic introduction to GIS, spatial analysis, spatial statistics, mapping, and visualization.
- A strong focus on applications in population research.
- Opportunities for participants to work with their own data.

- Coverage of the most important basic issues of spatial methods, including problems of inference, spatial dependence, spatial heterogeneity, scale, uncertainty, and the ecological fallacy.
- Activities that foster peer-to-peer interaction, through group projects and small-group discussions.
- Social activities including a fieldtrip collecting and using geospatial data that will foster peer-to-peer interactions and help to build a community of scholars.

The application process (described in greater detail in Section B.3) will be coordinated through the CSISS website (as with past CSISS workshops). The application forms will include items that gather data on past GIS/spatial analysis experience, reasons for applying as well as information on their demographic research interests. Before a workshop begins (after participants have been invited and they have accepted) we will use the project website to both share preparatory reading materials as well as encourage invited participants to begin to discuss their spatial demographic research interests, and specifically some of their data and analytical needs. Workshop conveners will post welcome comments and questions to stimulate discussion among participants. The intent is that we provide the opportunity for participants to begin to get to know each other and the workshop conveners and presenters before the workshop formally begins. This approach has been used successfully in other CSISS workshops including the Population Science and GIS workshop at Penn State.

Table 1 shows our proposed two-week outline, to be repeated in the first year with as much as is possible and practical the same instructors at UC Santa Barbara and Penn State. We see this double offering as having several distinct advantages:

- It enables us to reach 40–50 students in the first year while limiting each group to 20–25.
- The two sites provide better geographic coverage, helping to reduce travel costs for participants.
- Both sites have strong but distinct programs of related activities, for example UC Santa Barbara's National Center for Geographic Information and Analysis, CSISS, and the Alexandria Digital Library, and Penn State's Population Research Institute, GeoVISTA Center, John A. Dutton e-Education Institute, and Gould Center for Geography Education and Outreach (an ESRI-authorized Learning Center).

Table 1: Draft Workshop Outline
Week 1

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Morning	<p>Introductions. Nature of Spatial Data</p> <p>Invited presentation by population scientist on how GIS and spatial analysis have influenced his or her work.</p>	Data Issues: Digitizing, Data Access	ArcGIS training by certified instructor	<p>Cartographic Theory</p> <p>Invited presentation and/or demonstration by a population scientist on demographic applications</p>	<p>Spatial Analysis, Spatial Statistics</p> <p>Invited presentation and/or demonstration by a population scientist on demographic applications</p>	Personal
Afternoon	ArcGIS training by certified instructor	ArcGIS training by certified instructor	ArcGIS training by certified instructor	Work with personal data	Spatial analysis lab	Personal
Evening	Reception	Participant-Faculty interaction	Participant-Faculty interaction	Participant-Faculty interaction	Participant-Faculty interaction	Personal

Week 2

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday
Morning	<p>Field trip that will include opportunities to gather data via GPS units as well as well provide exposure to air photos, topographic maps, and ground truthing techniques</p>	<p>Ecological Fallacy, Scale</p> <p>Invited presentation and/or demonstration by a population scientist on demographic applications</p>	Data Access, Cyber-infrastructure	Group projects	<p>Groups report. Exploratory Analysis</p> <p>Invited presentation and/or demonstration by a population scientist on demographic applications</p>	<p>Analysis Prospects</p> <p>Invited presentation and/or demonstration by a population scientist on demographic applications</p>
Afternoon	Field trip (continued)	Spatial analysis lab	Data access lab	Group projects	Spatial analysis lab	Open Issues, Methodology
Evening	BBQ	Organize groups	Group interaction	Group projects	Workshop party	

The workshop will expose population scientists to the vast array of spatial data that are available, encourage them to think critically and creatively about how different forms of spatial data can be integrated in their research, and introduce them to the spatial analytical methods that are increasingly encountered in demographic inquiry. Hands-on exercises and demonstrations will cover issues associated with spatial data handling (e.g., address-matching, global positioning systems, deriving new variables, integrating different types of contextual data as well as using spatial analysis tools within a GIS for data visualization and modeling). The workshop will focus on applications and demonstrations drawn from studies of urban poverty, neighborhood research, racial/ethnic diversity, maternal and child health and wellbeing, and population-environment relations. Similarly, workshop lab exercises will be based on demographic and other socio-economic and health-related data commonly used by population scientists.

The draft program shown in Table 1 allocates mornings to formal lectures, afternoons to hands-on exercises, and evenings to informal interaction where we intend to promote one-on-one (or small group) faculty-participant interaction. Participants will be required to commit to one of the two evaluation options (see below) in the middle of the first week, and to small groups early in the second week. Groups will be expected to develop research projects, and to report the results on the second Thursday of the workshop.

It is assumed participants will arrive at the workshop site the Sunday before the workshop begins. The workshop proper will begin on a Monday with a basic introduction to the nature of spatial data, and the particular benefits and problems associated with this research perspective. Starting in the first afternoon we will offer a hands-on training in a basic GIS package (both institutions currently use ESRI's ArcGIS 8.x in their GIS courses). We will introduce data access issues in detail on the second morning, cartographic theory on the first Thursday, and spatial analysis on the first Friday. Throughout the first week, evenings will be set aside for faculty-participant interactions. In past CSISS workshops this has taken the form of students presenting their research questions, data and analytical issues to small groups that include faculty, that then discuss pertinent data issues and analytical strategies. We also have found that participants use coffee breaks and lunch as opportunities to discuss their research ideas with faculty and instructors.

Saturday will be a day for personal activities, and Sunday a working field trip where we will expose participants to global positioning system (GPS) units as well as air photos, topographic maps, and ground truthing techniques. The morning of the second Monday will be allocated to a discussion of scale issues, including the ecological fallacy and the modifiable areal unit problem. The second Tuesday will focus on developments in cyber-infrastructure, including Grid computing, digital libraries, metadata standards, and distributed services. We have set aside Wednesday for group projects based on publicly available data sets. Exploratory spatial data analysis will be the focus of the second Thursday, with hands-on exercises in the afternoon. On the second Friday we will focus on the future, with a discussion of trends in analysis, open methodological issues, and a participant-led panel discussion. This outline is of course tentative at this stage, but it represents our thinking on how best to achieve the primary objective of the GIS training program to jump-start the use of spatial methods in population research.

B.1.b. Workshop instructors

Each workshop will be led by a convener responsible for all aspects of its organization and operation, and for the evaluation of participant performance. Dr. Stephen Matthews (PI) will be the convener of workshops at Penn State while Dr. Michael Goodchild will convene the UC Santa Barbara workshops. Briefly, Matthews was organizer of the successful CSISS workshop held at Penn State in May 2003 on GIS in population research, and has led GIS-related workshops at the Population Association of America annual meeting for the past six years and will be doing so again in 2004. Goodchild is PI of CSISS and has many years of experience in organizing GIS training workshops. Additional information on key personnel is provided below (Section C).

The early hands-on training in ArcGIS (based on latest version available, likely 9.x) will be conducted by a team from Penn State consisting of instructors who are qualified GIS instructors and/or teaching faculty within the World Campus Certificate Program in Geographic Information Systems. For other aspects of the program we will draw on additional faculty at Penn State and UC Santa Barbara, including the following (grouped by topic area):

<i>Cartographic theory</i>	Sara Fabrikant (UC Santa Barbara) Waldo Tobler (UC Santa Barbara) David DiBiase (Penn State)
<i>GIS analysis, scale and aggregation</i>	Keith Clarke (UC Santa Barbara) James Macgill (Penn State)
<i>Cyberinfrastructure, visualization</i>	Mark Gahegan (Penn State)
<i>Spatial analysis</i>	Stuart Sweeney (UC Santa Barbara) David O'Sullivan (Penn State)

Additional information on the faculty listed above is presented in Section C.

We will also draw on population specialists from both hosts and other institutions in application areas to be covered during the workshops, anticipating up to six guest presentations per workshop. Specifically, we will draw on faculty from other centers of population research with interests in spatial methods, such as those at Brown University, the University of Minnesota, the University of North Carolina at Chapel Hill, and the University of Wisconsin, and on faculty at other institutions and agencies with special expertise in key areas such as the Census Bureau and Macro International. We will specifically recruit guest presenters in research areas where spatial issues are salient in his or her work. That is, we will seek to invite population scientists known for their work in one or more of the following areas: neighborhood and contextual analysis, child poverty, spatial inequality, race and segregation, labor market research, health and mortality, spatial variation in access to health services (e.g., family planning), adolescent risk behaviors, migration, urbanization, and population and environment relations. Given PRI's status as a Population Center and past experience in hosting population-related conferences and workshops as well as the expertise of the UC Santa Barbara/CSISS team in similar events we do not anticipate problems recruiting well-known population scientists to be guest presenters (see Appendix B and F for outlines and invited guest speaker lists of recent conferences organized by

CSISS and PRI, respectively). While the first workshop would not be until Summer 2005 Matthews has secured the guest participation of collaborators and colleagues at Penn State (e.g., Linda Burton on GIS and ethnographic research on low-income families; Diane McLaughlin on spatial inequalities in health and mortality; and Sean Reardon on spatial inequality, race and segregation) and we anticipate being able to recruit others. We will identify local speakers for the UC Santa Barbara based workshops (e.g., Stuart Sweeney on small-area population projections using stochastic simulation, and Barbara Herr-Harthorn on spatial dimensions of risk among farmworkers). We will encourage the participation and attendance at workshop events by local faculty colleagues with demographic interests (at Penn State based workshops we will draw on faculty from the Population Research Institute). That is, we will encourage attendance at guest lectures, and participation in evening discussions and social events.

B.2. Web resources

We will build the Web resources of the project on the existing base of the Center for Spatially Integrated Social Science. This Web resource has been growing for four years, funded by the National Science Foundation under its program of support for research infrastructure in the social and economic sciences (Goodchild, Anselin, Applebaum and Herr Harthorn, 2000, see Appendix B). The CSISS website is aimed at building support for research using spatial techniques, including geographic information systems (GIS) and spatial analysis, and will be adapted in this project to enhance the resources available in support of spatial perspectives on population research. The site currently receives over 1,000 visits per day from unique addresses that are probably associated with research interest.

Specifically, the CSISS website features the following elements:

- *Learning resources.* CSISS has built a substantial library of resources aimed at researchers wishing to learn more about spatial methods. These include resources accumulated from the CSISS summer workshops, conference workshops, and specialist meetings, including presentations, position papers, and online resources; links to course curricula and other sites offering substantial learning resources; vignettes or *Classics* documenting seminal contributions to the literature of spatial methods, and the lives of their contributors; and *Cookbook recipes* that take users through simple step-by-step illustrations in the use of GIS for standard operations likely to be used by social scientists, with no assumptions about background skills. We will adapt and extend these resources, adding new material emphasizing population research, and archiving materials from our proposed workshops.
- *Bibliography.* CSISS has developed methods for searching and cataloging the research literature relevant to spatial perspectives in the social sciences, and has built a database that currently includes over 10,000 entries. For the new project we will expand the coverage of population research, and provide catalog tools that will allow population researchers to identify the entries most relevant to their interests.
- *Tools.* With NSF funding CSISS has supported the development of several tool sets specifically relevant to spatial analysis in the social sciences. The tools have been developed by Luc Anselin at the University of Illinois at Urbana Champaign under subcontract to CSISS. The tools are available at the CSISS Web site for free download, together with an extensive directory to tools from other sources, tutorials, test data sets, and documentation.

Most recently the set has been augmented by GeoDa, a package for exploratory spatial data analysis that features techniques suitable for initial exploration of data, such as linked maps, tables, and statistical windows, and includes some of the most popular spatial analysis methods. In the proposed project we will continue to make these tools available, and add tutorials showing their use in population research. We will continue to develop the tools in the remaining 12 months of the currently funded CSISS program.

- *Support for a virtual community.* The CSISS Web site uses various collaborative tools to support peer-to-peer interaction between its users, including email lists and chat rooms. We will use similar approaches to foster communication between population researchers, both before and after the proposed workshops.
- *Assessment and evaluation tools.* CSISS has conducted an extensive program of summer residential workshops over the past four years, together with specialist meetings for senior scholars, and shorter workshops in conjunction with disciplinary conferences in the social sciences. CSISS has developed arms-length methods for surveying participants before, during, and after these events, in order to provide statistical data in support of refinements of the CSISS program (See Appendix G for a blank evaluation questionnaire). The results of these assessments provide both ample demonstration of the value of the program, and useful input for development. We propose to adapt and extend existing methods and procedures to provide feedback and arms-length evaluation of the proposed program.
- *Specialized search engines* that are tuned to finding Web pages relevant to the objectives of CSISS. These engines are more specialized than Google and other traditional search engines, being "primed" through the identification of specific Web resources, and then left to find new sites automatically with related and relevant contents by crawling the Web. CSISS "primed" the engine with approximately 1500 search terms and with an initial set of websites, and has allowed it to expand this list to some 30,000, all scanned weekly to ensure that the engine's catalog is fully current. CSISS has also constructed an engine to search for spatial tools, and has used the same technology to build an extensive index of the site's contents. To adapt these tools to the new project, we will "re-prime" the engine with additional websites with specialized vocabulary specific to population research, in order to create rich catalogs of Web resources relevant to spatial analysis and GIS applied to population research, and will continue to update these catalogs weekly.

At the end of the two-year period of this proposed project CSISS will move the Web site to maintenance mode to ensure that it remains a viable resource into the future. We will do this by emphasizing automation wherever possible, as in the automated search engines. We will also submit a proposal to NSF for continued maintenance of the CSISS resource after the current funding period ends in September 2004; and will propose to UC Santa Barbara's library that they adopt the site as a long-term resource. In addition it is likely that new proposals already submitted for related future activities will provide funding for further evolution of the site (for example, UCSB has already submitted a proposal for a major new initiative in cyber-infrastructure for the social sciences).

We will supplement existing web resources by developing self-paced learning modules based on the workshop materials. Matthews will work with an instructional designer based in the John A. Dutton e-Education Institute within the College of Earth and Mineral Science at Penn State to

convert workshop materials to self-paced learning modules that can be delivered through the Internet. Our goal is to provide a GIS training resource tailored to and used by population scientists after 2006.

B.3. Participants and Recruitment Strategies

B.3.a. Participant Recruitment

The proposed workshops will be designed for young population researchers. We will use methods already pioneered by CSISS to reach potential participants, including:

- mailing fliers to contacts (e.g., directors, department head, graduate chair) at all population research centers, aging centers, state data centers, and other institutions belonging to the association of population centers;
- printing announcements in the newsletters of relevant learned societies, centers, etc.;
- acquiring mailing lists from the PAA, SDA, ASA, and other societies with substantial population research interests;
- disseminating announcements on relevant list servers;
- posting announcements on the Websites of CSISS, the population research centers, relevant learned societies, etc.;
- distributing announcements at relevant professional conferences;
- distributing announcements to existing CSISS lists that have been compiled from previous workshop applicant lists, specialist meeting lists, etc.

In the most recent round of workshops CSISS received 328 applications for approximately 90 places in its 2003 summer workshops. The number of potential applicants in the proposed workshops is hard to estimate, but we are confident that we will be able to reach a large proportion through these methods. We estimate the total size of the annual PhD cohort in population research to be on the order of 100, suggesting a total of about 500 PhD students currently enrolled (see Appendix A). We estimate that by including junior faculty, professional researchers, the staffs of agencies such as state data centers, and the private sector we have a total target audience for our workshops over 1000. We propose to enroll a total of 80-100 participants in the four Population Science and GIS workshops over the two years of the program. We will emphasize the recruitment of current Ph.D. students and anticipate training at least 50; that is, approximately ten-percent of the Ph.D. target audience (we do not include in the minimum target of 50 Penn State graduate students in the Demography Training Program). The target of at least 50 Ph.D. students seems a reasonable objective for a one-time program to introduce spatial methods to the field, and noting that spatial perspectives and methods will not appeal to everyone.

In selecting participants from the applicant pool we will pay attention to:

- *Home institution.* We will strive for a mix of representation, to take advantage of the potential for a residential workshop to produce lasting collaborations between institutions and across sub-disciplines. We will consider non-North American-based participants, but with a limit of 10% of the participant total (Any reimbursement to non-U.S. participants will follow federal guidelines). As some North American-based demography graduate students come from developing countries, we will contribute to the promotion and diffusion of GIS methods and applications more broadly (Menken, Blanc and Lloyd, 2002).
- *Gender and ethnicity.* We will strive for a mix of students that is as representative as possible of the general population, and give particular attention to participation by traditionally under-represented groups. In 2003, over fifty percent of the Population Science and GIS applicants and accepted participants were women (see tables in Appendix B reporting on 2003 workshops).
- *Background.* Applicants will complete an application form that will provide self-report data on experience with statistical methods, mapping and data as well as demographic research interests. Our intent is to select participants in order to create a representative mix of interests. In the interests of cross-fertilization and community building we will consider a limited number of participants with backgrounds in areas related to population research, such as geographical analysis and population biology, but will not actively recruit in these communities (e.g., CSISS while known among the academic geography community has tended to accept applicants from non-geographers over geographers).

When PRI and CSISS hosted the Population Science and GIS workshop (May 2003) we received eighty-two applications. The applicant list included researchers from demography, sociology, economics, geography, environmental studies and policy, public health, political science, anthropology, regional science, criminology, and urban and regional planning, with a few simply listing their area as GIS. About half the applicants were graduate students, with approximately 15% junior faculty or postdoctoral researchers, 10% tenured faculty, and 25% non-academic professionals. The participants of the workshop included demographers, sociologists, anthropologists, economists, public health and urban planning researchers, and tended to include slightly more graduate students, junior faculty and postdoctoral researchers than the applicant pool.

The Dual-degree Demography Training Program at Penn State is one of the largest demographic graduate training programs in the US (n=65 dual-degree demography students based on Fall 2003 registration data) and represents over 10% of the known demography student enrollment at APC Centers housing a formal training program in demography (DeJong, 2003). Special arrangements will be made for interested Penn State demography students who are unable to take advantage of other formal GIS training opportunities (i.e., enroll in the Spatial Demography course or other graduate GIS courses on campus such as those offered through the Department of Geography). During the CSISS workshop held at Penn State in May 2003 all local students who participated attended the lecture sessions (morning) and participated in lab sessions (afternoon) in a nearby computer lab linked via audio/video hookup. These students received a certificate of completion at the end of the workshop as did the formal attendees. If during the years 2005 and 2006 the Spatial Demography course is not offered for credit at Penn State we intend to let Penn State students participate in the proposed workshop based at Penn State. Penn State graduate

students will have to apply to attend the workshop through a separate mechanism (i.e., not via the CSISS website) and they will not be eligible for any student stipends. As with the 2003 CSISS workshop Penn State graduate student laboratory participation will be in a second lab and will not compromise the workshop instruction of other invited participants. Indeed, having Penn State participants will, we hope, contribute to group dynamics in a positive way (e.g., guides to local resources on campus/community). Matthews and Dr. Gordon DeJong (Director, Graduate Training Program in Demography at Penn State) will seek to ensure that Penn State graduate students receive course credit from the University. We have emphasized Penn State because of the large number of demography students based there but we will pursue a similar strategy for facilitating local graduate student participation at UC Santa Barbara in the two workshops based there.

B.3.b. Participant Funding

We anticipate substantial variation among participants in their ability and willingness to pay for the workshops. Full-time employees of non-governmental organizations, corporations, and state data centers may be able to obtain funding from their organizations; graduate students on the other hand will likely have very limited access to funds. We estimate the costs of participation in a two-week workshop to be on average \$600 for airfare, \$35 per day for meals, and \$65 per day for accommodation, for a total of \$2,000. Accordingly we propose the following approach:

- A fund of \$30,000 per workshop (maximum of \$1,500 per applicant) to be allocated as scholarships to defray the costs of travel, accommodation, and participation. Please note the minimum size of the workshop will be 20 participants, but we intend to accommodate up to 25.
- A two-stage process of application that addresses first the qualifications of the candidate to participate in the workshops, and second the need for scholarship support, using separate Web-based forms. We will award scholarships based on the candidate's alternative sources of funding, as revealed in the scholarship application form, and on the candidate's qualifications for participation. In the past CSISS has been successful in gathering relevant data and making stipend award decisions, including decisions to admit without stipend to selected applicants (who subsequently attended).

C. Program Leadership and Management

This proposal brings together faculty from the PRI at Penn State and CSISS at UC Santa Barbara as well as drawing on faculty from two of the top four departments of geography in the United States (National Research Council, 1995). The Penn State and UC Santa Barbara team first seriously discussed collaboration in response to PA-02-099 at the CSISS workshop held in State College in May 2003. In July 2003, Drs. Michael Goodchild and Stuart Sweeney of UC Santa Barbara/CSISS visited Penn State to discuss application logistics and training program design issues (with Drs. Matthews, Gahegan, O'Sullivan, DiBiase, Jensen and DeJong). The application is coordinated from the Population Research Institute at Penn State, with a subcontract to CSISS at UC Santa Barbara.

As mentioned above, the conveners are Dr. Stephen Matthews (Penn State) and Dr. Michael Goodchild (UC Santa Barbara). Matthews and Goodchild are responsible for all aspects of workshop planning and implementation at their specific site. In addition to coordinating Penn State activities, Matthews will take the lead on workshop evaluation issues, coordinating the advisory board review as well as supervising the conversion of materials to web-based instruction. Dr. Don Janelle (Program Director, CSISS) and support staff at CSISS will be responsible for coordination of recruitment for both sites and project website management. A professional instructional design specialist with Penn State's John A. Dutton e-Education Institute will facilitate the creation of self-paced learning materials based on materials used during the Population Science and GIS workshop.

There are three key personnel: Matthews, Goodchild and Janelle. All other faculty and personnel listed below are instructors or invited faculty from the two host sites (i.e., PHS biosketches are not required unless they are key personnel). A brief description of faculty and instructor personnel by site follows (convener listed first, then other personnel alphabetically).

Penn State

The Penn State team is drawn from the Population Research Institute (an NICHD R24 Population Center) an inter-college research institute and the Department of Geography in the College of Earth and Mineral Science (including the GeoVISTA Center, the Gould Center for Geography Outreach and Education, and the John A. Dutton e-Education Institute).

Stephen A. Matthews is an Associate Professor of Geography, Demography and Sociology and Director of the Geographic Information Analysis Core within the Population Research Institute and Social Science Research Institute at Penn State. He is currently the co-chair of the University-wide GIS Council (2002-2005). His interests focus on studies of health inequality and wellbeing among low-income families, medical geography, and population and environment interactions. Matthews has coordinated GIS, spatial analysis and demography workshops at the Population Association of America (PAA) Conference each year since 1998, and in 2003 a CSISS sponsored workshop on Population Science and GIS (see Appendix H). At Penn State, Matthews has twice taught a Spatial Demography course in the Dual-title Demography Training Program and coordinated on campus workshops developed for postdoctoral trainees attending the Summer Workshop for Minority Partners (1998) and the Family Research Consortium (1999, 2001), and for faculty affiliated with the Children, Youth and Families Consortium at Penn State (1999 and 2000). Matthews serves on the advisory board for the on-line Masters in GIS being launched at Penn State. Matthews will be available throughout the Penn State workshops.

Jim Detwiler is a GIS Analyst at PRI, GIS Instructor for the World Campus Certificate Program in GIS, and a course developer for the emerging Masters in GIS. He is an ESRI authorized ArcGIS instructor, and will present during the first three days of the workshop.

David DiBiase is the Director of the John A. Dutton e-Education Institute within the College of Earth and Mineral Science at Penn State and Director of the Gould Center for Geography Education and Outreach within the Department of Geography. DiBiase was responsible for building a team to design, develop, and deliver a sequence of four courses that formed the basis for the Certificate Program in GIS offered via Penn State's virtual "World Campus." He is currently working with Gahegan to launch an on-line Masters in GIS. DiBiase and Matthews will

work with an instructional designer (to be named) on transfer of workshop materials to the web for self-paced instruction. DiBiase's research interests are in distance-learning and geographic information science education. DiBiase will be a presenter in the Penn State workshop on cartographic theory.

Beth Fletcher-King is a GIS Instructor for the World Campus Certificate Program in GIS, and a course developer for the emerging Masters in GIS. She is an ESRI authorized ArcGIS instructor, and will present during the first three days of the workshop.

Mark Gahegan is Professor of Geography and Associate Director of the GeoVISTA Center at Penn State. Together with DiBiase, Gahegan is leading the Penn State initiative to launch an on-line Masters in GIS. Gahegan has written numerous articles on geocomputation, artificial intelligence, GIS, and data visualization. Gahegan is credited as the first to launch an undergraduate degree program in GIS (at Curtin University, Australia). Gahegan will be a presenter in the workshop on visualization techniques.

James Macgill is a research associate of the GeoVISTA Center at Penn State. He is the lead developer of *GeoTools* software (Open source mapping toolkit) with research interests in spatial analysis, particularly scale and aggregation effects. He will present on these topics during the Penn State workshop.

David O'Sullivan is an assistant professor of Geography at Penn State. His primary interests are in spatial modeling, complexity theory and geocomputation. He has begun working with Sean Reardon (Education and Sociology at Penn State) on exploring new methods for measuring spatial segregation. He is the coauthor, with David Unwin, of *Geographic Information Analysis* (2002). O'Sullivan will present on spatial analysis, and scale and aggregation effects during the Penn State workshop.

Michelle Zeiders is a GIS Analyst at PRI. She is an ESRI authorized ArcGIS instructor, and will present during the first three days of the workshop.

Instructional Designer (to be named) will be responsible for converting materials presented in workshops and electronic portfolios into web course materials.

UC-Santa Barbara

The UC Santa Barbara team is drawn from the Department of Geography and the Center for Spatially Integrated Social Science.

Michael Goodchild is Professor of Geography at the University of California, Santa Barbara; Chair of the Executive Committee, National Center for Geographic Information and Analysis (NCGIA); Associate Director of the Alexandria Digital Library Project; and, Principal Investigator of the Center for Spatially Integrated Social Science. Goodchild is recognized internationally for contributions to GIScience. He is a member of the National Academy of Sciences and was recently honored with a Founder's Medal, Royal Geographical Society, United Kingdom (2003). Goodchild is the author, coauthor or editor of numerous GIS books and articles. His current research interests center on geographic information science, spatial analysis,

the future of the library, and uncertainty in geographic data. Goodchild will be available during workshops based at UC Santa Barbara and intends to participate in workshops at Penn State.

Christian Brown is Visitor/Program Coordinator for both the National Center for Geographic Information Analysis and CSISS. He will assist Goodchild and Janelle in workshop logistics.

Keith Clarke is Chair of the Department of Geography at UC-Santa Barbara. His primary research interests are in cartography and GIS, and in dynamic simulation models of urban growth. He is author of a leading introductory text on GIS. Clarke will present on GIS analysis during the Santa Barbara workshop.

Sara Fabrikant is an Assistant Professor of Geography. She was the CSISS workshop coordinator for "Map Making and Visualization of Spatial Data." Her current interests include geographic information visualization, GIScience and cognition, graphical user interface design and usability evaluation, geographic knowledge discovery and dissemination, dynamic cartography and hypermedia. Fabrikant will present on cartographic theory issues during the UC Santa Barbara workshop.

Don Janelle is Research Professor and Program Director for the Center for Spatially Integrated Social Science at the University of California Santa Barbara. Research specializations focus on temporal patterns of human spatial behavior in cities, the use of space-time diaries to recreate census-like data for different times of the day, and social issues associated with the introduction of transportation and communication technologies. Janelle will be available during the workshops at UC Santa Barbara.

Stuart Sweeney is an Assistant Professor of Geography and an Executive Committee member of the Center for Spatially Integrated Social Science and a faculty affiliate/advisor for the Quantitative Methods for Social Sciences graduate emphasis at UC Santa Barbara. His research is broadly focused on modeling local labor market dynamics in an interregional setting. Specific research themes related to local labor markets include modeling occupational migration and mobility processes, studying the economic effects of depopulation, and modeling agglomeration as spatial point process. Sweeney will present on spatial statistical analysis during the UC Santa Barbara workshop.

Waldo Tobler is Professor Emeritus of Geography. He is a distinguished scholar with numerous national and international awards, including being a member of the National Academy of Sciences. He was Senior Scientist in the National Science Foundation sponsored NCGIA. He has used computers in geographic research for over forty years, with emphasis on mathematical modeling and graphic interpretations. Well known for his publications, he formulated the "first law of geography" in 1970 while producing a computer movie, and is the inventor of novel and unusual map projections, among which was the first derivation of the partial differential equations for area cartograms. Tobler will present on cartographic theory and methods during the UC Santa Barbara workshop.

Gamiel Zavala is the webmaster for the CSISS site.

Advisory Board

We have created an advisory board that includes both demographers and GIScience faculty. This advisory board consists of internal and external members that will be directly involved in reviewing curricula and workshop evaluation materials. We anticipate two tasks for board members. First, we will seek guidance and review from the advisory board regarding the overall curricula and some selected training materials that are developed. The material must provide a solid grounding in GIScience and be tailored to demographic issues, theory, data and methods. This advisory board activity is likely during Fall 2004-Spring 2005. Second, we will seek feedback from the advisory board as part of an evaluation of the workshops at the end of the first year, including expert advice on identification of topic areas to add/remove or redesign for year two workshops. This second activity would be scheduled during late Summer 2005-early Fall 2005.

Internal members include Leif Jensen (Professor of Rural Sociology and Demography, Director of the Population Research Institute, Penn State), Gordon DeJong (Distinguished Professor of Sociology & Demography and Director, Graduate Program in Demography, Penn State), Barbara Herr Harthorn (Research Anthropologist, Director of Social Science Research Development for the Office of Research at the University of California and co-Director of the Center for Global Studies, Institute for Social, Behavioral and Economic Research, UC Santa Barbara), Helen Couclelis (Professor of Geography, UC Santa Barbara), and Peter Kuhn (Professor of Economics at the UC Santa Barbara).

External members include Ted Mouw (Assistant Professor of Sociology, Carolina Population Center, UNC-Chapel Hill), Paul Voss (Professor of Rural Sociology, Center for Demography and Ecology, University of Wisconsin), and John Weeks (Professor of Geography and Director, International Population Center, San Diego State University). Letters of support from the external advisory board members are included in Section I of the proposal.

D. Evaluation Plan

D.1. Workshop participant performance evaluation

Each participant will be expected to submit a creative contribution at the end of the workshop, such as a lab exercise suitable for use in a course, a set of course notes, a paper reporting research into a topic covered in the course, or a research proposal involving an innovative GIS application to population science. Each contribution will be the subject of a proposal to be submitted before the end of the first week of the workshop, and accepted by the workshop convener. We will offer two forms of assessment of participant performance, based on these creative contributions and on workshop participation. First, we will negotiate with the respective host institutions for appropriate amounts of graduate credit, and assist participants wanting to transfer this credit to other institutions. Second, for participants who are more interested in peer-reviewed assessment as a contribution to career advancement, we will offer a formal process of review following the workshop and using reviewers drawn from the population research community, will mount the contribution on the CSISS Website, and will define an authorized form of citation for their work. We intend that all students will generate an electronic portfolio of their work that can be shared with each other via the project website. We acknowledge that

some participants may work on their own data, to be strongly encouraged, but that data access restrictions may prevent the sharing of material. We will remind attendees of appropriate data access and use issues prior to the workshop. We will make sample data and facilitate the use of easily accessible public domain data to all participants for use in individual projects during the workshop.

D.2. Workshop evaluation

We will conduct an extensive program of evaluation of the workshop program and its support through the project website. We will conduct an entry survey of all participants to determine his or her background knowledge and expectations of the workshop. We will conduct an exit survey to gather initial opinions and information on immediate plans following the workshop (See Appendix G for an example of an exit survey). For the first cohort of 40-50 participants, we will also conduct a survey twelve months after their workshop, gathering details on the longer-term impacts of the workshop. We are particularly interested in whether the workshop experience led to modifications of research plans and approaches, modifications of teaching content and curriculum (if applicable), changes in collaborations, and other indicators of fundamental impact. We will conduct these surveys using Web forms, and compile the results using the services of the UC Santa Barbara Survey Research Center, an arms-length organization with a reputation for rigorous and independent survey research. Time limitations will prevent us from following up the second cohort in such a formal way but as we mention below we anticipate meeting participants at future population conferences, events and through the project website.

D.3. Follow-on activities

In our experience, the success of a program like this depends very much on the extent to which the initial momentum created by workshops is sustained, through collaboration between participants, and continued interaction with faculty and instructors at the lead institutions. We propose several activities designed to foster continued interaction:

- *The Project Website.* We will use the Web site as the focus of a virtual community of alumni. We will maintain chatrooms and list servers, continually update the site with news of potential interest to the community, and add to its resources through contributions from alumni (particularly contributions resulting from participant performance evaluation, as detailed above; contributions of curriculum content; and research results).
- *Conference reunions.* We will encourage and facilitate gatherings at population research conferences, including PAA, SDA, and ASA. We will structure these gatherings to provide opportunities for presentations on continuing research and education activities. For example, we will promote the submission of poster and/or paper sessions by workshop participants at the Population Association of America meetings in both 2006 and 2007.
- *Consultation.* We will encourage and maintain access to workshop leaders, for purposes of advice and consultation.

At this point in time we intend to consider two strategies to continue the delivery of GIS instruction to population scientists through workshops. First, while recognizing the 2-year limit

of this Educational Programs Announcement, we will seek alternative funding post 2006. Second, we will explore the demand for fee-based workshops on GIS and Population Science.

D.4. Timeline

The table below provides a detailed timeline for the proposed project with a start date of September 1, 2004 and a completion date of August 31, 2006.

<u>Tasks</u>	<u>Date</u>
Year 1	
• Coordinators, local presenters, instructors develop first year sequence of workshops plus evaluation criteria and seek feedback from Advisory Board and selected consultants	September-December 2004
• Advertise workshops for 2005 and explain selection criteria	January-March 2005
• Logistics for workshop (accommodation, guest presenters, events, preparatory materials, web issues, etc.)	January-June 2005
• Selection of participants	April-May 2005
• Population Science and GIS workshop at Penn State	June 2005
• Repeat Population Science and GIS workshop at UCSB	July 2005
• Post-workshop review and feedback from Advisory Board	July-August 2005
Year 2	
• Transfer of instructional materials and salient projects to the website	June-December 2005
• Revise workshop, adding and subtracting material as necessary and seek feedback from Advisory Board.	September-December 2005
• Advertise workshops for 2006 and explain selection criteria	January-March 2006
• Logistics for workshop (accommodation, guest presenters, events, preparatory materials, etc.)	January-June 2006
• Selection of participants	April-May 2006
• Repeat Population Science and GIS workshop at Penn State	June 2006
• Repeat Population Science and GIS workshop at UCSB	July 2006
• Post-workshop review	August 2006
• Transfer of revised and new instructional materials plus student projects to the website	June-August 2006
• Final Report	August 2006

D. 5. Conclusions and Significance

The current DBSB *Goals and Opportunities* report identifies spatial demography as a priority area, stating that spatial demographic research needs to address issues of theory, improving data accessibility and compatibility with spatial techniques, and fostering interdisciplinary research. There are many areas of demography where a spatial perspective has relevance and work is emerging in applications focusing on family/neighborhood research, race/ethnic segregation, poverty, labor market research, environmental justice, health inequality, crime analysis, and population and environment linkages. However, demographers are not prepared for the geospatial data onslaught they are likely to face in the next decade nor are they exposed to ongoing methodological developments and new software products in GIS and spatial statistical analysis. Furthermore, targeted application of academic GIS and spatial analysis courses, workshops, and methods to population science professionals and scholarship is inadequate and poorly developed.

Our goal is to address this GIS and spatial perspective training shortfall head-on. We will provide exposure to GIS and spatial analytic methods in a series of tailored workshops. We envision a standardized intensive 2-week training workshop to be delivered four times to a total of 80-100 young population scientists, and to include among them a significant proportion of the current U.S. graduate student population with identifiable demographic research interests. We also propose to create from the workshops on-line materials for self-paced instruction that will be available to researchers in the field after the two-year funding cycle has concluded. All participants in the workshops will receive certificates of completion. In the case of the workshop participants we will negotiate with Penn State and UC Santa Barbara for formal course credit and assist participants in making arrangements to transfer such credit (i.e., explore opportunities for graduate students to receive three academic credits to apply towards their academic training in core demographic scholarship through their own institutions).

E. Human Subjects

First and foremost this is a training grant and exempt from human subjects regulations. That said, we are going to collect data on workshop applicants and participants. Applicants will provide basic profile data and a justification statement identifying reasons why they would benefit from the workshop. Participants will provide entry and exit (i.e., evaluation) data on the workshop experience during and at the conclusion of the workshop. Finally, first year (2005) workshop participants will provide information in a one-year follow-up survey that will be designed to capture information on the degree to which participants have used GIS and spatial analysis in their own demographic research and teaching. The various pieces data listed above are to be collected for workshop management and pedagogic purposes. Matthews (PI) has submitted an "application for the use of human participants (for social science research)" to Penn State's Office of Research Protection as he has an interest in using the one-year follow-up data to investigate the impact of this training program should it be funded.

The Internet-based entry, exit and follow-up surveys will include "I agree" or "I do not agree" buttons on the website for workshop participants to click their choice of whether or not they consent to participate in the surveys. Documented consent forms will be used instead of "signed" informed consent. That is, we will email the consent form to participants who may then

type their name and the date into the spaces provided on the consent form, and return via email. Confidentiality will be maintained to the degree permitted by the technology used. Specifically, no guarantees can be made regarding the interception of data sent via the Internet by any third parties.

Gender and minority inclusion: We will strive for a mix of participants that is as representative as possible of the population of demography scholars and practitioners, and give particular attention to participation by traditionally under-represented groups. While we did not collect race/ethnicity data on participants in CSISS workshops, in 2003 over fifty percent of the Population Science and GIS applicants and accepted participants were women (see tables in Appendix B reporting on 2003 workshops).

Participation of Children: Workshop participants will likely have a minimum of a Bachelors degree and/or be non-academic professionals in population-related employment. It is unlikely that any participants will be under age 21.

F. Vertebrate Animals

Does not apply

G. Literature Cited

Anderton, Douglas L. 1996. Methodological Issues in the Spatiotemporal Analysis of Environmental Equity. *Social Science Quarterly* 77, 508-515.

Anderton, Douglas L., Andrew B. Anderson, John M. Oakes and Michael R. Fraser. 1994. Environmental Equity: The Demographics of Dumping. *Demography* 31, 229-48.

Baller, Robert. D., Luc Anselin, Steven F. Messner, Glenn Deane and Darnell F. Hawkins 2001. Structural Covariates of U.S. County Homicide Rates: Incorporating Spatial Effects. *Criminology*, 39(3), 561-590.

Bass, Loretta [Ed]. 1999. *Syllabi and Instructional Material in Demography (Third Edition)*. New York: American Sociological Association.

Block, C. Rebecca, M. Dabdoub and S. Fregley S. [Eds]. 1995. Crime Analysis Through Computer Mapping. Washington D.C.: Police Executive Research Forum.

Bowers, Kate and Alex Hirschfield. 1999. "Exploring links between crime and disadvantage in North-west England: An analysis using geographic information systems." *International Journal of Geographic Information Science* 13: 159-184.

Brooks-Gunn, Jeanne, Greg J. Duncan, and J. Lawrence Aber. 1997. *Neighborhood Poverty: Context and Consequences for Children (Vol. 1)*. New York: Russell Sage Foundation.

Browning, Christopher R., Kathleen A. Cagney and Ming Wen. 2003. Explaining Variation in Health Status Across Space and Time: Implications for Racial and Ethnic Disparities in Self-Related Health. *Social Science and Medicine* 57, 1221-1235.

Burton, Linda M., Stephen A. Matthews, James Quane, Frank Avenilla, Deborah Graefe, and Alan Benjamin. 2000. Ethnography, Geographic Information Analysis, and Minority Health: Navigating Space, Place and Health Events. Presented at *Towards Higher Levels of Analysis: Progress and Promise in Research on Social and Cultural Dimensions of Health*. NIH: Bethesda. June 2000.

Calkins, Hugh and Munroe Eagles. 1996. *Geographic Information Analysis and Human Capital Research: A Report to the National Science Foundation and the Department of Housing and Urban Development*. Buffalo, NY: University at Buffalo Office of Publications.

Chomitz, Kenneth M and David A. Gray. 1996. Roads, Land Use, and Deforestation: A Spatial Model Applied to Belize. *The World Bank Economic Review* 10, 487-512.

Coulton, Claudia, J. 1997. "Potential and Problems in Developing Community-level Indicators of Children's Well-being" pp 372-391 in Robert M. Hauser, Brett V. Brown and William R. Prosser [eds.] *Indicators of Children's Well-Being* New York: Russell Sage Foundation.

Coulton, Claudia J., Jill Korbin, Tsui Chan and Marilyn Su. 2001. "Mapping Residents' Perception of Neighborhood Boundaries: A Methodological Note." *American Journal of Community Psychology* 29 (2), 371-383.

Cromley, Ellen K., and Sara L. McLafferty. 2002. *GIS and Public Health*. New York: Guilford Press.

Davidson, Pamela and Douglas L. Anderton. 2000. Demographics of Dumping II: A National Environmental Equity Survey and the Distribution of Hazardous Materials Handlers. *Demography* 37, 461-466.

Degraff, Deborah S., Richard E. Bilsborrow and David K. Guilkey. 1997. Community-level Determinants of Contraceptive Use in the Philippines: A Structural Analysis. *Demography* 34(3): 385-398.

DeJong, Gordon F. 2003. Paradigms for Graduate Training in Population Studies. *PAA Affairs* Spring 2003, 3-4.

Duncan, Greg, J. and Jeanne Brooks-Gunn. 1997. *Consequences of Growing Up Poor*. New York: Russell Sage Foundation.

Duncan, Craig, Kelvyn Jones and Graham Moon. 1993. Do Places Matter? A Multilevel Analysis of Regional Variations in Health-related Behavior in Britain. *Social Science and Medicine* 37, 725-733.

Entwisle, Barbara, William M. Mason and Al I. Hermalin. 1986. The Multilevel Dependence of Contraceptive Use on Socioeconomic Development and Family Planning Program Strength. *Demography* 23(2): 199-216.

Entwisle, Barbara, John B. Casterline and H.A.A. Sayed. 1989. Villages as Context for Contraceptive Behavior in Rural Egypt. *American Sociological Review* 54(6): 1019-1034.

Entwisle, Barbara, Ronald R. Rindfuss, Stephen J. Walsh, Tom P. Evans and Sara R. Curran. 1997. Geographic Information Systems, Spatial Network Analysis, and Contraceptive Choice. *Demography* 34(2): 171-187.

Farley, Reynolds and William H. Frey. 1994. Changes in the Segregation of Whites from Blacks During the 1980s: Small Steps Toward a More Integrated Society. *American Sociological Review* 59, 23-45.

Fotheringham, A. Stewart, and Peter Rogerson [Eds.]. 1994. *Spatial Analysis and GIS*. Bristol, PA: Taylor and Francis Inc.

Fox, Jefferson, Ronald R. Rindfuss, Stephen J. Walsh and Vinod Mishra [Eds.]. 2003. *People and the Environment: Approaches for Linking Household and Community Surveys to Remote Sensing and GIS*. Norwell, MA: Kluwer Academic Publications.

Gaudet, Cyndi, Heather Annulis and Jon. C. Carr. 2003. Building the Geospatial Workforce. *URISA Journal* 15, 21-30.

Goodchild, Michael, F. Luc Anselin, Richard P. Applebaum, and Barbara Herr Harthorn. 2000. Toward Spatially Integrated Social Science. *International Regional Science Review* 23, 139-159.

Golledge, Reginald G., and Robert J. Stimson. 1997. *Spatial Behavior: A Geographical Perspective*. Guilford Press: New York, NY.

Goldsmith, Victor, Philip G. McGuire, John H. Mollenkopf and Timothy A. Ross. 2000. *Analyzing Crime Patterns: Frontiers of Practice*. Thousand Oaks, CA: Sage Publications.

Grannis, Rick. 2002. Discussion: Segregation Indices and Their Functional Inputs. *Sociological Methodology* 32, 69-84.

Harries, Keith. 1999. *Mapping Crime: Principles and Practice*. Washington D.C.: Crime Mapping Research Center, U.S. Department of Justice.

Heitgerd, Janet L. and C. Virginia Lee. 2003. A new look at neighborhoods near National Priority List sites. *Social Science and Medicine* 57, 1117-1126.

Hirschman, Charles, and Avery Guest. 1990. Multilevel Models of Fertility Determination in Four Southeast Asian Countries: 1970 and 1980. *Demography* 27(3): 369-396.

Jargowsky, Paul A. 1997. *Poverty and Place: Ghettos, Barrios, and the American City*. New York: Russell Sage Foundation.

- LeClere, Felicia B., Richard G. Rogers and Kimberley D. Peters. 1997. Ethnicity and Mortality in the United States: Individual and Community Correlates. *Social Forces* 76, 169-198.
- LeClere, Felicia B., Richard G. Rogers and Kimberley D. Peters. 1998. Neighborhood Social Context and Racial Differences in Women's Heart Disease Mortality. *Journal of Health and Social Behavior* 39, 91-107.
- Lewis Mumford Center for Comparative Urban and Regional Research. 2001. Ethnic Diversity Grows, Neighborhood Integration Lags Behind. Albany, NY: Lewis Mumford Center for Comparative Urban and Regional Research, State University of New York, Albany.
- Liverman, Diana, Emilo F. Moran, Ronald R. Rindfuss and Paul C. Stern [Eds.] 1998. *People and Pixels: Linking Remote Sensing and Social Science*. Washington D.C.: National Academy Press.
- Logan, John. 2001. Living Separately: Segregation Rises for Children. Albany, NY: Lewis Mumford Center for Comparative Urban and Regional Research, State University of New York, Albany.
- Longley, Paul A., Michael F. Goodchild, David J. Maguire and David W. Rhind. 2001. *Geographic Information Systems and Science*. New York: John Wiley.
- Mark, David, M. [Ed.]. 1999. Geographic Information Science: Critical Issues in an Emerging Cross-Disciplinary Research Domain. Report from a National Science Foundation on GIScience. February 1999.
- Martin, David. 1996. *Geographic Information Systems: Socioeconomic Applications (Second Edition)*. London: Routledge.
- Massey, Douglas S. and Nancy A. Denton. 1988. The Dimensions of Residential Segregation. *Social Forces* 67, 281-315.
- Massey, Douglas S. and Nancy A. Denton. 1989. Hypersegregation in U.S. Metropolitan Areas: Black and Hispanic Segregation Along Five Dimensions. *Demography* 26, 373-391.
- Matthews, Stephen A., James E. Detwiler and Linda M. Burton. 2001. Viewing People and Places: Coupling Geographic Information Analysis with Ethnographic Research. Paper presented at *The First GIS and Critical Geographic Research Conference*, Hunter College, New York, February 2001 (submitted for an edited book on "Critical GIS").
- McMaster, Robert B., Helga Leitner and Eric Sheppard. 1997. GIS-based Environmental Equity and Risk Assessment: Methodological Problems and Prospects. *Cartography and Geographic Information Systems* 24, 172-189.
- Menken, Jane Ann K. Blanc, and Cynthia B. Lloyd [Eds.], 2002. *Training and Support of Developing-Country Population Scientists: A Panel Report*. New York: Population Council.

- Moran, Emilio F. and Eduardo S. Brondizio. 1998. Land-use Change After Deforestation in Amazonia. Pp. 94-120 in Diana Liverman, Emilio F. Moran, Ronald R. Rindfuss and Paul C. Stern [Eds.] *People and Pixels: Linking Remote Sensing and Social Science*. Washington D.C.: National Academy Press.
- Morenoff, Jeffrey D., and Robert J. Sampson. 1997. Violent Crime and the Spatial Dynamics of Neighborhood Transition: Chicago, 1970-1990. *Social Forces* 76, 31-64.
- Morenoff, Jeffery D., Robert J. Sampson, R. J., and Stephen W. Raudenbush. 2001. Neighborhood Inequality, Collective Efficacy, and the Spatial Dynamics of Urban Violence. *Criminology*, 39, 517-560.
- Mouw, Ted. 2002. Are Black Workers Missing the Connection? The Effect of Spatial Distance and Employee Referrals on Interfirm Racial Segregation. *Demography* 39(3):507-528.
- Mouw, Ted 2000. Job Relocation and the Racial Gap in Unemployment in Detroit and Chicago, 1980-1990. *American Sociological Review*. 65(5): 730-753.
- National Institute of Child Health and Human Development. 2002. *Demographic and Behavioral Sciences Branch, Goals and Opportunities: 2002-2006*. Demographic and Behavioral Sciences Branch, Center for Population Research, National Institute of Child Health and Human Development (available on-line at http://www.nichd.nih.gov/publications/pubs/dbsb_plan.htm).
- National Research Council. (Marvin L. Goldberger, Brendan A. Maher, and Pamela Ebert Flattau [Eds.]). 1995. *Research Doctorate Programs in the United States: Continuity and Change*. Washington, DC: National Academies Press.
- Nelson, Gerald C. and Daniel Hellerstein. 1997. Do Roads Cause Deforestation? Using Satellite Images in Econometric Analysis of Land Use. *American Journal of Agricultural Economics* 79, 80-88.
- O'Sullivan, David and David J. Unwin. 2002. *Geographic Information Analysis*. New York: John Wiley.
- Pebley, Anne, R. 1998. Demography and the Environment. *Demography* 35, 377-89.
- Pebley, Anne, R., Noreen Goldman and Germán Rodriguez. 1996. Prenatal and Delivery Care and Childhood Immunization in Guatemala: Do family and Community Matter? *Demography* 33(2): 231-247.
- Peterson's *Graduate Programs in the Humanities, Arts, and Social Science, 2003 (37th Edition)*.
- Phoenix, Michael. 2002. Geography and the Demand for GIS Education. *Association of American Geographers Newsletter*. June, p. 13.
- Plane, David A. and Peter A. Rogerson. 1994. *The Geographical Analysis of Population*. New York: John Wiley.

- Reardon, Sean F. and Glenn Firebaugh. 2002. Measures of Multi-Group Segregation. *Sociological Methodology* 32, 33-67.
- Roberts, Stephanie. 1998. Community-level Socioeconomic Status Effects on Adult Health. *Journal of Health and Social Behavior* 39, 18-37.
- Sampson, Robert J., Jeffery D. Morenoff and Felton Earls, 1999 "Beyond Social Capital: Spatial Dynamics of Collective Efficacy for Children" *American Sociological Review* 64: 633-660.
- Sastry, Narayan. 1996. Community Characteristics, Individual and Household Attributes, and Child Survival in Brazil. *Demography* 33(2): 211-229.
- Skinner, Debra, Stephen A. Matthews and Linda M. Burton (in press). Combining Ethnography and GIS to Examine Constructions of Developmental Opportunities in Contexts of Poverty and Disability. In T. Weisner (Ed.). *Discovering Successful Pathways in Children's Development: New Methods in the Study of Childhood and Family Life*. Chicago: University of Chicago Press.
- White, Michael J. 1986. Segregation and Diversity Measures in Population Distribution. *Population Index* 52: 198-221.
- Wikle, Thomas A. and G. Allen Finchum. 2003. The Emerging GIS Degree Landscape. *Computers, Environment and Urban Systems* 27, 107-122.
- Wilson, William Julius. 1987. *the Truly Disadvantaged: The Inner City, The Underclass, and Public Policy*. Chicago: University of Chicago Press.
- Wong, David. W. S. 1993. Spatial Indices of Segregation. *Urban Studies* 30, 559-572.
- Wong, David, W.S. 2002. Spatial Measures of Segregation and GIS. *Urban Geography* 23, 85-92.
- Wood, Charles H. and David L., Skole. 1998. Linking Satellite, Census, and Survey Data to Study Deforestation in the Brazilian Amazon. Pp. 70-93 in Diana Liverman, Emilio F. Moran, Ronald R. Rindfuss and Paul C. Stern [Eds.] *People and Pixels: Linking Remote Sensing and Social Science*. Washington D.C.: National Academy Press.
- Yen, Irene and George A. Kaplan. 1999. Neighborhood Social Environment and 11-year Risk of Death: Multilevel Evidence from the Alameda County Study. *American Journal of Epidemiology* 149, 898-907.

H. Consortium/Contractual Agreements

This proposal includes hosting workshops and instructional development at two sites: Penn State and UC Santa Barbara. The UC Santa Barbara site is a subcontract.

Principal Investigator/Program Director (Last, first, middle): Matthews, Stephen A.

UC Santa Barbara will conduct the work described in detail in the proposal being submitted by the Pennsylvania State University to NICHD. Specifically, they will organize and conduct two-week workshops at UC Santa Barbara during the summer of 2005 and 2006, for approximately 20 young researchers in demography and population. UC Santa Barbara will also develop the project website, building on the resources already available as a result of the Center for Spatially Integrated Social Science (CSISS) efforts over the past four years. Professor Goodchild will convene the proposed workshops, and will be responsible for their assessment and for student evaluation. UC Santa Barbara will also provide instructors to both the UC Santa Barbara and Penn State workshops in both years, as detailed in the proposal. The following page includes a letter from Professor Goodchild.

I. Consultants

The following page includes letters from the three external members of the advisory board: Dr. Paul Voss (Professor of Rural Sociology and Center for Ecology and Demography at the University of Wisconsin), Dr. John Weeks (Professor of Geography and Director, International Population Center, San Diego State University), and Dr. Ted Mouw (Assistant Professor of Sociology, Carolina Population Center, UNC-Chapel Hill). Letters are not provided for any of the internal (Penn State and UC Santa Barbara) advisory board members though we emphasize that all have agreed to participate.

A letter is also included from David DiBiase (Director of the John A. Dutton e-Education Institute and Director of the Gould Center for Geography Education and Outreach, Department of Geography, Penn State). DiBiase and Matthews will coordinate activities of the three GIS Instructors (all of whom work with one or both DiBiase and Matthews) and the activities of the instructional designer who will be based in the John A. Dutton e-Education Institute at Penn State.

Letters are not provided for any of the internal (Penn State, UC Santa Barbara) faculty participants named in the proposal. All are colleagues and/or collaborators with the PI and Co-PIs, and all have provided verbal or written support for this training program either by participating in planning meetings and providing feedback on earlier versions of this proposal.