DISTRIBUTIONAL DIFFERENCES IN SOCIO-DEMOGRAPHIC CHARACTERISTICS OF RESIDENTS IN THE FRINGE OF FEDERAL PROTECTED LANDS

by

UTTIYO RAYCHAUDHURI

(Under the Direction of Michael A. Tarrant)

ABSTRACT

This study examines the spatial distribution of federal protected lands in the contiguous United States and the changing socio-demographic characteristics of residents in fringe areas (counties and census block groups) surrounding these protected lands. Information from the census and protected area land databases were mapped together in geographic information systems. Protected areas were examined as per the World Conservation Union categories and the National Wilderness Preservation System lands were classified as per category A (strict preservation zone) areas with maximum protection and other protected lands were regrouped in category B, as areas with varying degrees of use and conservation. All counties and census block groups on the fringe of protected areas were examined for socio-demographic characteristics (race, education, occupation, and income). Counties were also examined temporally (1980, 1990 and 2000) to illustrate change. Multivariate statistical analysis was conducted to determine distributional differences between fringe areas and areas outside the fringe. Implications of this study address the need for understanding distributional differences in residents in fringe areas bordering protected lands. Understanding the socio-demographic characterization of residents in these areas will aid in future planning and management concerning these areas.

INDEX WORDS: Census data, federal protected lands, fringe areas, geographic information systems, and socio-demographics.

DISTRIBUTIONAL DIFFERENCES IN SOCIO-DEMOGRAPHIC CHARACTERISTICS OF RESIDENTS IN THE FRINGE OF FEDERAL PROTECTED LANDS

by

UTTIYO RAYCHAUDHURI

B.Arch., School of Planning and Architecture, India, 1994

M.A., University of Georgia, 2003

A Dissertation Submitted to the Graduate Faculty of The University of Georgia in Partial Fulfillment of the Requirements for the Degree

DOCTOR OF PHILOSOPHY

ATHENS, GEORGIA

2006

DISTRIBUTIONAL DIFFERENCES IN SOCIO-DEMOGRAPHIC CHARACTERISTICS OF RESIDENTS IN THE FRINGE OF FEDERAL PROTECTED LANDS

by

UTTIYO RAYCHAUDHURI

Major Professor: Michael A. Tarrant

Committee: H. Kenneth Cordell
David H. Newman
Nathan P. Nibbelink

Electronic Version Approved:

Maureen Grasso
Dean of the Graduate School
The University of Georgia
December 2006

DEDICATION

To Dadaiya, Kakaiya, and Buban

Krishna Kumar Raychaudhuri (30th November, 1915 – 1st December, 1985)

For your honesty and with Mamma for being my biggest cheer leader!

Subir Raychaudhuri (25th July, 1945 – 24th December, 1998)

For wanting me to win!

Samir Raychaudhuri (27th January, 1942 - ☺)

For Nanami and you are the reason I am!

"Asato Ma Sadgamaya,
Tamso Ma Jyotirgamaya,
Mrityor Ma Amritamgamaya,
Om Shanti! Shanti! Shanti!"

- Brihadaranyaka Upanishad (1.3.28)

ACKNOWLEDGEMENTS

This research and my higher education were only possible through the support, guidance, spirit, and contributions of many great people. First and foremost, this doctoral education and my stay at the University of Georgia are a result of unfailing support from my advisor, mentor, and friend, Dr. Michael Tarrant. Mike has been instrumental for providing me with inspiration, direction, and clarity in not only doing this research but also in life skills. It has been a truly pleasurable experience to have had the opportunity to work with him and I am glad that we shall continue to do so in the future.

The contribution and insights from Dr. Ken Cordell made my academic experience more profound and it has been a privilege to work with a great scientist. Dr. David Newman's constructive feedback provided grounding for my research. His approachability and critical insight helped shape this document. This research required considerable amount of GIS analysis and Dr. Nate Nibbelink's help was invaluable in reviewing manuscripts and providing feedback. I also value the advice and support from Dr. Gary Green and Dr. Mike Bowker. Gary has been a friend and guide through this academic process. Mike Bowker's vision on economics and policy, combined with his knowledge on single malt's has kept my spirits soaring high.

This education has also been enhanced with the support received from other mentors. I am fortunate to have Dr. Gwynn Powell as a friend and advisor who has always provided encouragement and direction. Gwynn and Katie Bemisderfer were a source of comfort and support always. I am indebted to the support from Dr. John Datillo who helped me orient into higher education and teaching by providing me opportunities. My education has been enriched by the scholarly discussions and learning experiences that I received from Dr. Diane Samdahl, Dr. Doug Klieber, Dr Lynn Usery, and Dr. Steve Olejnik. Dean Grasso's vision, support, and help by providing me opportunities have reshaped my graduate education.

My source of strength, love, and encouragement throughout this educational process were my friends and family and I especially appreciate the help from Tara and Maggie. They were there when I need them and provide unquestionable support and cheer in innumerable ways. I thank Dr. Laura Sessions, Dr. Bob Mathews, Michael Menon and countless other supporters and friends who always motivated me. Maa and Kaku's constant encouragement and Mamoni's support have borne fruit. This journey has been possible because Swati and Buban believed in me and were always proud of my achievements, cheering me on to scale new heights. I wish Mamma and Nanami were here to see this day in person. This is a milestone in the culmination of formal education, however, I shall strive to continue the learning process and knowledge discovery with the support of my family, friends, peers, and with the blessings of Sai Baba. Thank you team ☺

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Page

CHAPTER 1

INTRODUCTION AND LITERATURE REVIEW

Population projections show that the United States population will double in the next 100 years (Figure 1.1). This growth will bring about unprecedented changes to the landscape and environment we live in. To understand this change it is required that we examine population demographic trends. Also an understanding of the spatial characteristics of this change is important. Understanding where this growth is occurring and how it interacts with our natural environment is critical to assess the footprint on the land (Cordell and Overdevest, 2001). Recognizing the need to understand our footprint on the landscape, this study is an assessment of the socio-demographic distribution of residents in the contiguous United States in relationship to Federal protected lands. The intent is to seek a clear and scientific picture of the current state of the ecosystem interaction at multiple scales.

Purpose of Study

The purpose of this study was to examine the spatial distribution of Federal protected lands in the contiguous United States and the changing socio-demographic characteristics of residents in fringe areas (counties and census block groups) surrounding these protected lands.

Protected Areas

Humans appropriate at least 40% of the planets primary productivity (Vitousek, Mooney, Lubchenco and Melello, 1997), therefore in order for other species to co-exist with humans they must be offered some protection. This protection is provided by protected areas (managed explicitly for conservation). Protected areas are considered to be the most effective means of conserving biological diversity (McNeely & Miller, 1984; MacKinnon, MacKinnon and Thorsell, 1986; Leader-Williams, Harrison and Green, 1990) and international treaties and conventions such as the Convention on Biological Diversity (CBD, 1999), required signatory nations to respond to erosion of biological diversity by establishing protected area systems.

The International Union for Conservation of Nature (IUCN), now known as the World Conservation Union is an international non-governmental organization whose World Commission on Protected Areas (WCPA), is the leading forum for protected area professionals around the globe. Established in 1872 as a public park or pleasuring ground for the benefit and enjoyment of the people, the first protected area in the world was Yellowstone National Park in the United States. Since then, most countries have established and planned national systems of protected areas. The United Nations ‘list of protected areas’ provides a single definitive list of the world's protected areas, classified according to IUCN's system of management categories. Protected areas establish management zones for the protection of fragile environments, wildlife, bio-diversity, aesthetics, and provide avenues for outdoor recreation, to name a few.

Protected Area Categories

IUCN has defined a series of six protected area management categories, based on primary management objective. These are:

a) Category Ia: Strict Nature Reserve – protected area managed mainly for science. It is an area of land and/or sea possessing some outstanding or representative ecosystems, geological or physiological features and/or species, available primarily for scientific research and/or environmental monitoring.

b) Category Ib: Wilderness Area – protected area managed mainly for wilderness protection. It is a large area of unmodified or slightly modified land, and/or sea, retaining its natural character and influence, without permanent or significant habitation, which is protected and managed so as to preserve its natural condition.

c) Category II: National Park – protected area managed mainly for ecosystem protection and recreation. It is a natural area of land and/or sea, designated to (i) protect the ecological integrity of one or more ecosystems for present and future generations, (ii) exclude exploitation or occupation inimical to the purposes of designation of the area and (iii) provide a foundation for spiritual, scientific, educational, recreational and visitor opportunities, all of which must be environmentally and culturally compatible.

d) Category III: Natural Monument – protected area managed mainly for conservation of specific natural features. It is an area containing one, or more, specific natural or natural/cultural feature which is of outstanding or unique value because of its inherent rarity, representative or aesthetic qualities or cultural significance.

e) Category IV: Habitat/Species Management Area – protected area managed mainly for conservation through management intervention. It is an area of land and/or sea subject to active intervention for management purposes so as to ensure the maintenance of habitats and/or to meet the requirements of specific species.

f) Category V: Protected Landscape/Seascape – protected area managed mainly for landscape/seascape conservation and recreation. It is an area of land, with coast and sea as appropriate, where the interaction of people and nature over time has produced an area of distinct character with significant aesthetic, ecological and/or cultural value, and often with high biological diversity. Safeguarding the integrity of this traditional interaction is vital to the protection, maintenance and evolution of such an area.

g) Category VI: Managed Resource Protected Area – protected area managed mainly for the sustainable use of natural ecosystems. These are areas containing predominantly unmodified natural systems, managed to ensure long term protection and maintenance of biological diversity, while providing at the same time a sustainable flow of natural products and services to meet community needs (IUCN, 1994).

As per the IUCN definitions, the United States had 7448 protected areas (excluding marine protected areas) as of 2002. This study includes Federal protected lands classified as per the IUCN protected area categories from the Bureau of Land Management, Forest Service, Fish and Wildlife Service, and National Park Service.

New Paradigm for Protected Areas

The World Parks Congress organized by the IUCN and held every decade provides direction for global initiatives in the field of protected areas. After the IVth Worlds Park Congress there were new categories introduced in the classification of protected areas which paved the way for new areas being classified as protected and there was rapid growth in global numbers and size of protected areas. These new categories allowed resource extraction (Locke and Dearden, 2005) and were the areas where most growth occurred. IUCN's President Yolande Kakabadse states that, 'the Congress celebrated the establishment of over 12% of earth's land surface as protected areas – an impressive doubling of the world's protected areas estate since the IVth World Park Congress in Caracas, Venezuela in 1992' (Kakabadse 2003, p. 3). IUCN's current classification of categories V and VI for protected areas reflects this shift in ideology. They were modeled as networks linked by nature-friendly corridors within a bioregional landscape rather than ‘islands’ in a sea of development. According to Phillips (2003, pp. 13 and 21), the new paradigm was created to address, ‘important conceptual and operational advances in conservation in general and protected areas in particular’ and ‘cultural and social awareness, the acknowledgment of human rights, political developments, . . . technological advances and economic forces.’

Category V (culturally modified landscapes) and category VI (managed resource areas) are being increasingly viewed as sustainable development areas with a protected area mandate thus linking conservation and development. Currently 23.3 percent of all protected areas in the world are category VI areas (which did not exist a decade ago) and 5.6 percent of protected areas are category V areas. The category V areas are more about sustainable development rather than conservation of wild biodiversity. ‘The focus of management of category V areas is not conservation per se, but about guiding human processes so that the area and its resources are protected, managed and capable of evolving in a sustainable way (Phillips 2002, p. 10).’ They are landscapes that humans have modified on a regular basis for sustaining their needs. Category VI was created at the 1992 World Parks Congress to give recognition to efforts in developing countries to link conservation and sustainable resource use. These echo with the views on sustainable areas by Pinzon and Feitosa (1999, p. 217), ‘a balance between development, environmental conservation and social justice.’ The United States included all its National Forests, including areas that were heavily logged and used for mining and oil and gas extraction, as category VI areas and therefore has almost 40% of its forest area classified as ‘protected’ (Locke and Dearden, 2005).

Protected Areas as LDLU

Locally desirable land uses (LDLU) are areas which are preferred/desired by people and it applies to places of residence, work, playgrounds (as different land uses) etc. LDLU are land/water categories which act as magnets to attract humans because of the nature of their use or the opportunities that they may provide because of their designation. Federal protected land areas fit the criteria of a LDLU because they exhibit characteristics which are desirable for people. Protected areas provide great scenic/aesthetic value (Hendee, Stankey and Lucas, 1990), and nature provides opportunities and social roles (see for example, Driver, Nash and Haas, 1987; Landres, Marsh, Merigliani, Ritter and Norman, 1988), in the form of use and non-use values. Protected areas provide avenues for advancement of spiritual and mental well being (Rolston, 1985), therapeutic benefits, and skill development as part of personal and social benefits (Rossman and Ulehla, 1977; Young and Crandall, 1984).

Environmental values associated with protected areas are provisions of clean air and water. Federal protected land areas also provide economic benefits in the form of tourism generated dollars (Eadington and Redman, 1991). The non-use values of Federal protected land areas are: a) option values (where people have the option of physically using and benefiting from protected areas say for recreation), b) existence values (where people benefit from the knowledge that protected areas exist), and c) bequest values (where people benefit from the fact that protected areas exist and are being maintained for future use and generations) (see the works of Freeman, 1984; Hass, Herman and Walsh, 1986; Walsh and Loomis, 1989). All these values combine to make Federal protected land areas an attraction for people and therefore a LDLU.

Designated wilderness areas on national forests and other Federal public lands permanently protect spectacular scenic vistas, high-quality drinking water supplies, cold-water fisheries, the capacity of the land for carbon storage, vital habitat for wildlife, a wide variety of backcountry recreation opportunities, and many other values that are of benefit to society and the environment. Some of these values have economic dimensions, including the enhancement that wilderness brings to nearby property values as reflected in land prices. A number of studies document this enhancement value near urban greenways, in historical districts, and along urban boundaries (Fausold and Lilieholm, 1999).

Impacts of Protected Areas

With the growth of ex-urbanization, populations are locating themselves on areas proximate to natural areas (which included Federal protected lands). Aesthetic amenities such as clean air, open land, scenic beauty etc. appears threatened as a result. The resulting changes in demographics in these areas have resulted in land use planning crisis, development roadblocks, issues of social/environmental justice and forest management conflicts. To foster a sustainable development framework in these areas it is critical to understand the nature of local communities.

The impacts due to growth in exurban populations and change in land use at the fringe of protected areas are decreases in native wildlife populations owing to decreased wildlife habitat quantity and quality. Also increased predation, mortality, and other consequences of human activity that change the relationships wildlife has with their environments is impacting protected areas (Engels and Sexton, 1994; Harris, 1984; Theobald, Miller and Hobbs, 1997; Vogel, 1989; and Wear and Greis 2002a, 2002b). Other impacts to protected areas are long-term modifications and reductions in water quality and aquatic diversity (Booth and Henshaw, 2001; Bryan, 1972; Fisher, Steiner, Endale, et al., 2000; Jones and Holmes, 1985; Paul and Meyer 2001); decreased timber production due to change in forest cover (Gobster and Rickenbach, 2004; Kline, Azuma and Alig, 2004; Wear, Liu, Foreman and Sheffield, 1999), and increase in fire risk because increased housing densities in forested landscapes generate more potential for ignitions (Grace and Wade; 2000, Podur, Martell and Knight, 2002; Russel and McBride, 2003). Landscape changes due to urbanization also change the scenic quality and recreational opportunities leading to increased likelihood of land use conflicts (Gobster and Rickenbach, 2004; Patterson, Montag and Williams, 2003).

Urban studies have shown that proximity to parks can raise property values (Barnett, 1985; Do and Grudnitski, 1991; Doss and Taff, 1996; Lee and Linneman, 1998; Vaughn, 1981). That is, property values increase as distance to a park decreases. Brown and Alessa (2005), found that wilderness protected areas reflect values associated with indirect, intangible, or deferred human uses of the landscape (such as life-sustaining, intrinsic, and future values), whereas landscape values outside of wilderness areas reflect more direct, tangible, and immediate uses of the landscape (such as economic, recreation, and subsistence values).

Wilderness values in the United States have been measured via the process of surveying the general public as part of the National Survey on Recreation and the Environment (NSRE) (Cordell, Tarrant and Green, 2003 and Cordell, Tarrant, McDonald and Bergstrom, 1998). The 13-item Wilderness Values Scale used in the survey measures both use and non-use values (e.g., preservation) for wilderness in the National Wilderness Preservation System. The most recent results suggest that ecological and existence values are central to Americans' viewpoint on wilderness (Cordell et al., 2003) and that direct use values are generally less important than ecological, environmental quality, and off-site values (Cordell et al., 1998).

Development on the Fringe of Protected Areas

Rural living provides a variety of amenities including cleaner air, cleaner water, and a quieter lifestyle. These amenable environmental attractions in the wild land areas is driving people to build many primary residences, second homes, retirement homes, and mobile homes adjacent to the nation's wild lands (Hughes, 1987). The postwar generation is attracted by the amenable environment closer to public lands and non-metropolitan locales. They have been shifting from urban to suburban and rural living since the mid-1940's and therefore the number of people living adjacent to public forested land areas has significantly increased (Bogue, 1985). Between 1970 and 1988, the population around Federal public land grew 23% compared the national average of 11% (Bailey, 1991).

The urban expansion into the Federal protected land fringe is causing a series of ecological and environmental issues such as loss of agricultural land and fragmentation of wildlife habitat (Beateley and Manning 1997; Diamond and Noonan, 1996; Rome, 1998). Protected areas in the United States face increasing pressure from growing populations and as a result, there are greater numbers of people living in closer proximity to natural areas and forests. The expansion of residential and other developed land uses onto forested landscapes threatens protected lands as ecological resources. This expansion is redefining the characteristic of the fringe of protected areas. The fringe of the protected areas is a zone or buffer bordering the protected areas which lies between the natural open spaces and exurban areas on the wilderness to urban core continuum (see Figure 1.2).

New in-migrants who settle in fringe areas surrounding protected lands bring new expectations and diverse values with them (Brown, 1995, Schwartzweller, 1979), and the evolving ethnic and racial character of the population is bringing with them different perceptions of what goods and services public lands should produce. While the growth and development of fringe communities around Federal protected lands has strengthened the economic viability of rural areas through increased spending, enhanced employment opportunities, and a growing tax base, but it has also stressed the capacity of these places to provide needed services. Despite the concern over commodity extraction from public lands, these lands offer recreational opportunities, scenic vistas, solitude, and relatively unmodified environments that many people seek to live in or near.

The increasing growth of human populations and resulting settlement in the fringe of formerly wild land or pristine settings has brought changes in how people interact with protected natural environments. In the United States, the counties high in natural resource-based amenity values (e.g., forested mountains, rivers, and lakes; access to recreational settings for fishing, hiking, camping, river floating, etc., and the presence of clean air and water), are havens for retirement and have demonstrated dramatic increases in population throughout the 1990's with the majority of this owing to net in-migration (McCool, Burchfield and Allen,, 1997).

Areas on the fringe of Federal protected lands are associated with higher than average population growth (Rudzitis and Johansen 1989). According to Johnson and Beale (1998), 94 percent of the counties in the United States with 30 percent or more of their land under Federal management saw population growth, and for most, net in-migration was an important factor. This trend arose from people's, "desire for a retreat from big-city strains and hazards, the desire to enjoy nature and live in a community where one can be known and make a difference, that made the suburbs grow, and now that technological and economic change allow, it may continue to benefit rural areas (p.24)."

The presence of natural resource-based amenities as pull factors and deteriorating urban conditions as push factors have helped change the fundamental forces influencing migration (Ullman, 1954). Migrants who began settling in areas proximate to natural areas were drawn by cheaper housing, lower crime rates, and a slower pace of life often found and associated with rural communities. Studies of migrants and migration patterns suggest an increasing significance for such amenities in migration decisions (Haas and Serow, 1997). Environmental amenities such as climate, topography, and water are highly correlated with rural county population growth (1970 to 1996), according to McGranahan (1999). This study will encompass the new paradigm of understanding protected public lands and view protected areas in the contiguous United States from a sustainable development perspective.

Sustainable Development

In 1987, the World Commission on Environment and Development (WCED) published ‘Our Common Future,’ commonly referred to as the ‘Brundtland Report.’ It examined critical environment and development problems and presented proposals to solve them. The report was influential in a number of ways, most notably by introducing the concept of sustainable development. It defined sustainable development as development that, “meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987, p. 8), and discussed initiatives and actions that could lead to it.

The term sustainable development recognizes that the world is contained in systems with limited resources that need to be managed so future generations enjoy the bounty of the earth. Sustainable development has three distinct yet interrelated areas: economy, environment, and society. Good planning processes need to balance economic development with environmental protection and social equity. Sustainability that is reflected by ethical concerns (social, political, cultural and economical), local involvement (in the planning and development process), equitable resource distribution (of cost and benefits), integrated planning (with other sectors and industries), and continuous assessment (monitoring) is required to efficiently manage the fringe of Federal protected land areas to make them desirable places/land uses for people. Sustainable ecosystems are comprised of sustainable physical, biological, and human processes (Bright, Cordell, Hoover and Tarrant, 2003). Sustainable development is the basis for the design of processes that examine the way the economy, society and ecology function, and the relationships that exist between them. This study examines the related issues of land management and protected areas from the sustainability point of view.

Framework for this Study

This study is based on the Human Dimensions Framework (HDF). The HDF is guided by ten fundamental human dimension principles and five dimensions of social information which are historical background, population characteristics, community resources, social organization and processes, and public perceptions and well-being (Tarrant, Bright and Cordell, 1999).

An example of the application of the HDF model is the Interior Columbia Basin Ecosystem Management Project (ICBEMP, 1996), in the Pacific Northwest which illustrated that ecosystems are evolutionary and both natural and human interactions have shaped the ecosystems which are constantly evolving. Also the ICBEMP model emphasized that ecosystems should be studied at a variety of scales (small is a subset of a larger system) and that the biophysical nature of the ecosystem is linked to economic and social elements (human use and demands). The HDF explores not only how humans affect resources, but also how resource management affects humans. This dissertation is conceptually framed around the following guiding principles of the human dimensions framework:

Principle 1: A prerequisite for integrating human dimensions information with biophysical information in ecosystem management is an understanding of the social environment of the affected region; Principle 4: The social assessment should provide both an historical and a current description of the social environment and include predictions of future trends; and Principle 8: An HDF should be built from social information collected and analyzed on multiple scales (Bright et al., 2003, p. 7).

The understanding of the distributional differences in the socio-demographic fabric in the contiguous United States will help in identifying new approaches for achieving integrated management of living resources while strengthening regional, national, and local capacities. Reviewing the scale characterizations will help improve policy and decision-making at all levels between scientists and policy-makers. Multi-scale assessment provides information and perspectives from other scales which permits social and ecological processes to be assessed at their characteristic scale, allow greater spatial and temporal detail to be considered as scale becomes finer, allows comparison and evaluation between scales, and aids in developing an understanding which resonates with the response options matched to the scale where decision making and policy formation takes place.

"Human society is dynamic, as are the individuals, groups, organizations, communities, and populations of which it is composed. The effects of ecosystem management decisions on society as a whole are therefore also subject to changing attitudes, values, preferences, and dependence on the resources that support it. Historical data are useful in describing the current social environment of a region. By analyzing past and present, the social scientist may begin identifying potential trends or changes in a region's social environment (Bright et al, 2003, p. 18)."

Data

The dataset for this study was created by extracting public land data from the National Atlas map layer – Federal lands of the United States. Protected land shape files were downloaded from the National Atlas of the United States web-site (2006), and county/Census Block Groups (CBG) data (shape files and attribute information), were retrieved from the Census CD Version 2.0 (GeoLytics, 2002). The Census Bureau collects data on individuals and households through a survey process and then enumerates that information in its socio-demographic database. The data is represented in terms of areal units or 'geographic entities.' The Census Bureau classifies all geographic entities into two classifications – a) administrative and legal entities and b) statistical entities (Census, 2006). While both the categories of entities serve the common purpose of presenting data, the concept, principles and category of recognizing the entities for each category are different. See Figure 1.3 for a hierarchical distribution on geographical entities.

Administrative and legal entities have well defined and stable boundaries (e.g. counties) which are created by government legislation. Statistical units (e.g. CBG) do not have a fixed definition for boundaries and are enumerated based on various statistical preferences of aggregation, homogeneity, and data representation. While administrative and legal entities because of their stable nature can have historical comparisons (time-series), the same is not true for statistical entities always since their boundary definitions may have changed between census surveys.

The county is the primary administrative division for most states (exception being Louisiana which has Parishes and Alaska which has Boroughs), and function as units of local government and administration. The census block is the smallest geographical entity for which the U.S. Census Bureau collects and tabulates data. Census blocks are combined to form CBG.

There are regional variations in the patterns of CBG and counties. In places such as Louisiana where riparian features are abundant, the census block shapes are elongated strips and in the Western United States the relatively low population density causes larger census blocks. As a result, the CBG and counties follow the same spatial hierarchy. The census bureau now maintains this geo-referenced data in a geographic database called the Topologically Integrated Geographic Encoding and Referencing (TIGER) system.

Social Science research usually requires spatial prediction of data associated with one set of units based on data associated with another set of units. Working with data often involves up-scaling (aggregation) and down-scaling (dis-aggregation). There are two distinct types of spatial units that are commonly used in geographic analysis – artificial and natural units. Census data collected for individuals, but aggregated and represented as areas, presents a major problem in interpretation, and cannot be treated in the same way as areal data such as land cover type which are both collected and represented as areas. In particular, the scale effect is very much a concern in many studies since statistical inference changes with scale. Census data in combination with geographic information systems (GIS) is increasingly being used to analyze population studies and develop models for identifying landscape change in the fringe. This research addresses the modifiable areal unit problem (MAUP) of census data by comparing the scale characterization of socio-demographic data from the U.S. Census Bureau at various levels of aggregation (county and CBG). To represent the characteristics of the population, this study evaluated four socio-economic variables: race, education, occupation, and income. These were aligned with previous studies by Tarrant and Cordell (1999), Porter and Tarrant (2001), and Green, Tarrant, Raychaudhuri and Zhang (2005), who evaluated these variables on environmental justice research concerning locally desirable land use studies. Race is an indicator of the communities’ makeup and the cultural conditions of a community are representative of the values, perceptions and attitudes it holds with regard to the environment (See NSRE, 2006). Income and occupation provide the economic and employment characteristics of the community.

Layout of this Study

To understand the characterization of residents in fringe areas using the HDF, this study examines the spatial distribution of Federal protected lands in the contiguous United States and the distributional differences in socio-demographic characteristics of residents in fringe areas surrounding these protected lands. The study is laid out accordingly:

Chapter 2 examines the spatial distribution of socio-demographic characteristics of residents in the contiguous United States. By using information from the U.S. census which is mapped together in GIS, all counties and CBG in the contiguous United States are examined for socio-demographic characteristics (race, education, occupation, and income). Descriptive statistical analyses are conducted to illustrate differences between scales of measurement in census data between the county and CBG levels. Hotspot analysis based on regional distribution (Eastern and Western United States) illustrates areas of significant differences in socio-demographics (at the county level).

Chapter 3 examines the spatial distribution of Federal protected lands in the contiguous United States and the differences in distribution of socio-demographic characteristics of residents in fringe areas (counties and CBG) surrounding these protected lands. Using multivariate statistical analysis and GIS, protected areas are examined as per the IUCN categories and socio-demographics are analyzed in a temporal scale to illustrate change.

Chapter 4 synthesizes the findings and discusses implications of this study and directions for future research.

References

Bailey, D. W. (1991). The wildland-urban interface: social and political implications in the 1990's. *Fire Management Notes, 52*(1): 11-18.

Barnett, C.J. (1985). An application of the hedonic price model to the Perth residential land market. *The Economic Record, 61*(172):476-481.

Beateley, T. & Manning, K. (1997). *The Ecology of Place: Planning for Environment, Economy, and Community*. Washington, D.C.: Island Press.

Bogue, R. J. (1985). *The population of the United States, historical trends and future projections.* The free press: New York, NY

Booth, D.B. & Henshaw, P.C. (2001). Rates of channel erosion in small urban streams. In M.S. Wigmosta and S.J. Burges (Eds.) Land use and watersheds: Human influence on hydrology and geomorphology in urban and forest areas - AGU monograph series, water science and application. Washington, DC: *American Geophysical Union, 2*:17–38.

Bright, A.D.; Cordell, H.K.; Hoover, A.P.; Tarrant, M.A. (2003). A human dimensions framework: Guidelines for conducting social assessments. *Gen. Tech. Rep. SRS-65*. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station.

Brown, B.A. (1995). *In timber country: Working people's stories of environmental conflict and urban flights*. Philadelphia, PA: Temple University.

Brown, G. & Alessa, L. (2005). A GIS based inductive study of wilderness values. International Journal of Wilderness, 11(1): 14-18.

Bryan, E.H. (1972). Quality of storm water drainage from urban land. *Water Resources Bulletin, 8*: 578–588.

CBD. (1999). *In-situ conservation.* Article 8. Retrieved on March 13, 2006 from http://www.biodiv.org/convention/default.shtml

Census (2006). U.S. Census Bureau. Retrieved on April 24, 2006 from http://www.census.gov/geo/www/GARM

Chaudhry, S., Lynch, O.J. & Magraw, D.B. (2002). One species one planet. Washington, DC: Environmental Justice and Sustainable Development Center for International Environmental Law (CIEL)

Cordell, H. K. & Overdevest, C. (2001). *Footprints on the land: An assessment of demographic trends and the future of natural lands in the United States.* Champaign, IL: Sagamore Publishing.

Cordell, H. K, Tarrant, M.A. & Green, G.T. (2003). Is the public viewpoint of wilderness shifting? *International Journal of Wilderness, 9*(2): 27–32.

Cordell, H. K, Tarrant, M.A., McDonald, B.L. & Bergstrom, J.C. (1998). How the public views wilderness: More results from the U.S.A. survey on recreation and the environment. *International Journal of Wilderness, 4*(3): 28–31.

Diamond, H. L. & Noonan, P.F. (1996). *Land use in America.* Wasington, D. C.: Island Press.

Do, A.Q. & Grudnitski, G. (1991). Golf courses and residential housing prices: An empirical examination. *Journal of Real Estate Finance and Economics, 10*(3):261-270.

Doss, C.R. & Taff, S.J. (1996). The influence of wetland type and wetland proximity on residential property values. *Journal of Agricultural and Resource Economics, 21*(1):120-129.

Driver, B., Nash, R., & Haas, G. (1987). Wilderness benefits: A state of knowledge review. In R.C. Lucas (compiler), *National wilderness research conference: issues, state-of knowledge, future directions* (pp. 294-319). Gen. Tech. Rep. INT-220.Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station.

Eadington, W.R., & Redman, M. (1991). Economics and tourism. *Annals of tourism research, 18,* 41-56.

Engels, T. & Sexton, C. (1994). Negative correlation of blue jays and golden-cheeked warblers near an urbanizing area. *Conservation Biology*, *8*: 286–290.

Fausold, C.F., & Lilieholm, R.J. (1999). The economic value of open space: A review and synthesis. *Environmental Management, 23*(3): 307-320.

Fisher, D.S., Steiner, J.L., Endale, D.M., Stuedemann, J.A., Schomberg, H.H., Franzluebbers, A.J. & Wilkinson, S.R. (2000). The relationship of land use practices to surface water quality in the upper Oconee Watershed of Georgia. *Forest Ecology and Management, 128*: 39–48.

Freeman, A.M. (1984). The sign and size of option value. *Land Economics, 60*(1), 1-12.

GeoLytics, (2002). Census CD+ maps. East Brunswick, NJ: GeoLytics, Inc.

Gobster, P.H. & Rickenbach, M.G. (2004). Private forestland parcelization and development in Wisconsin's North woods: Perceptions of resource-oriented stakeholders. *Landscape and Urban Planning*, *69*(2–3): 165–182.

Grace, S. & Wade, D. (2000). *Ecological and economic consequences of the 1998 Florida wildfires.* Florida Department of Forestry. Retrieved on March 17, 2006 from http://flame.fl-dof.com/joint_fire_sciences/exec_sum.pdf.

Green, G., Tarrant, M., Raychaudhuri, U., & Zhang, Y. (2005). Wilderness in whose backyard? *International Journal for Wilderness*, *11*(3): 31-38

Haas, W.H., III & Serow, W.J. (1997). Retirement migration decision making: Life course mobility, sequencing of events, social ties and alternatives. *Journal of the Community Development Society, 28*(1): 116–130.

Hass, G.E., Herman, E., & Walsh, R. (1986). Wilderness values. *Natural Areas Journal*, *6*(2), 37-43.

Harris, L.D. (1984). *The fragmented forest: Island biogeography theory and the preservation of biotic diversity*. Chicago, IL: University of Chicago Press.

Hendee, J.C., Stankey, G.H., & Lucas, R.C. (1990). *Wilderness management.* Golden, CO: North American Press.

Hughes, J. B. (1987). Development in the Pine Barrens: A design for disaster. *Fire Manager Notes, 47*(4): 24-27.

ICBEMP (1996). Interior Columbia basin ecosystem management project. Retrieved on April 24, 2006 from www.icbemp.gov

IUCN. (1994). *Guidelines for protected areas management categories.* Gland, Switzerland: IUCN.

Johnson, K.M. & Beale, C.A. (1998). The rural rebound (revival of rural America). *Wilson Quarterly, 22*(2): 16–27.

Jones, R.C. & Holmes, L.F. (1985). Effects of land use practices on water resources in Virginia. *Virginia Water Resources Research Center Bulletin 144*. Blacksburg, VA: Virginia Polytechnic Institute and State University.

Kakabadse, Y. (2003) A milestone in Durban. *World Conservation Bulletin (2)*, 3.

Kline, J.D., Azuma, D.L. & Alig, R.J. (2004). Population growth, urban expansion, and private forestry in western Oregon. *Forest Science*, *50*(1): 1–11.

Landres, P., Marsh, S., Merigliani, L, Ritter, D., & Norman, A. (1988). Boundary effects on wilderness and other natural areas. In Knight, R., & Landres, P. (Eds.), *Stewardship across boundaries* (pp. 117-139). Covelo, CA: Island press.

Leader-Williams, N., Harrison J., & Green, M.J.B. (1990). Designing protected areas to conserve natural resources. *Science Progress, 74*: 189-204.

Lee, C.M. & Linneman, P. (1998). Dynamics of the greenbelt amenity effect on the land market: The case of Seoul's greenbelt. *Real Estate Economics*, *26*(1):107-129.

Locke H. & Dearden P. (2005). Rethinking protected area categories and the new paradigm. *Environmental Conservation 32*(1) 1-10.

MacKinnon, J., MacKinnon, K., Child, G. & Thorsell, J. (1986). *Managing protected areas in the tropics.* IUCN: Gland, Switzerland.

McCool, S.F., Burchfield, J. & Allen, S. (1997). Social assessment. In T.M. Quigley & S.J. Arbelbide (Eds.). An assessment of ecosystem components in the interior Columbia basin and portions of the Klamath and Great Basins. Gen. Tech. Rep. PNW-GTR-405. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.

McGranahan, D.A. (1999). Natural amenities drive rural population change. *Agric. Econ. Rep. 781*. Washington, DC: U.S. Department of Agriculture, Food and Rural Economics Division, Economic Research Service.

McNeely, J. & Miller, K. (1984). *National Parks, conservation and development: The role of protected areas in sustaining society.* Smithsonian Institution Press, Washington DC.

National Atlas of the United States. (2005). Retrieved November 10, 2005, from http://nationalatlas.gov/atlasftp.html

NSRE (2006). National survey on recreation and the environment. Retrieved on April 24, 2006, from http://www.srs.fs.usda.gov/trends/Nsre/nsre2.html

Patterson, M.E., Montag, J.M. & Williams, D.R. (2003). The urbanization of wildlife management: social science, conflict, and decision-making. *Urban Forestry and Urban Greening, 1*(3): 71–183.

Paul, M.J. & Meyer, J.L. (2001). Streams in the urban landscape. *Annual Review of Ecological Systems, 32*: 333–365.

Phillips, A. (2002). *IUCN Category V protected areas guidelines: Protected landscapes/seascapes*. Cambridge, UK & Gland, Switzerland: IUCN.

Phillips, A. (2003). Turning ideas on their heads: a new paradigm for protected areas. *George Wright Forum (20)*, 8–32.

Pinzon, R.R. & Feitosa, M.L. (1999) Extractive reserves: The use of protected areas to promote sustainable management. In S. Stolton & N. Dudley (Eds.), *Partnerships for Protection/New Strategies for Planning and Management for Protected Areas*, pp. 215–223. London, UK: WWF International & IUCN, Earthscan Publications.

Podur, J., Martell, D.L. & Knight, K. (2002). Statistical quality control analysis of forest fire activity in Canada. *Canadian Journal of Forest Research, 32*(2): 195–205.

Porter, R. P. & Tarrant, M.A. (2001). A case study of environmental justice and Federal tourism sites in southern Appalachia: A GIS application. *Journal of Travel Research 40*, 27–40.

Rolston, H. (1985). Valuing wild lands. *Environmental Ethics, 7,* 23-48.

Rome, A. W. (1998). William white, open space, and environmental activism. *Geographical Review*, *88*(2): 259-274.

Rossman, B., & Ulehla, Z.J. (1977). Psychological reward values associated with wilderness use: a bifunctional-reinforcement approach. *Environment and Behavior, 9*(1), 41-65.

Rudzitis, G. & Johansen, H.E. (1989). Migration into western wilderness counties: Causes and consequences. *Western Wild lands, Spring*: 19–23.

Russel, W.H.& McBride, J.R. (2003). Landscape scale vegetation-type conversion and fire hazard in the San Francisco Bay area open spaces. *Landscape and Urban Planning*, *64*: 201–208.

Schwartzweller, H.K. (1979). Migration and the changing rural scene. *Rural Sociology, 44*(1): 7–23.

Tarrant, M.A., Bright, A.D. & Cordell, H.K. (1999). A World Wide Web Human Dimensions Framework and Database for Wildlife and Forest Planning. *Human Dimensions of Wildlife*, 3(4), pp. 18-43.

Tarrant, M. A., & Cordell, H.K. (1999). Environmental justice and the spatial distribution of outdoor recreation sites: An application of geographic information systems. *Journal of Leisure Research, 31*(1): 18–34.

Theobald, D.M., Miller, J.R. & Hobbs, N.T. (1997). Estimating the cumulative effects of development on wildlife habitat. *Landscape and Urban Planning, 39*: 25–36.

Ullman, E.L. (1954). Amenities as a factor in regional growth. *Geographical Review, 44*: 119–132.

Vaughn, R.J. (1981). The value of urban open space. *Research in Urban Economics, 1*:103-130.

Vitousek, P.M., Mooney, H.A., Lubchenco, J. & Melello, J.M. (1997). Human domination of Earth's ecosystems. *Science (277),* 494–499.

Vogel, W.O. (1989). Response of deer to density and distribution of housing in Montana. *Wildlife Society Bulletin, 17*: 406–413.

WCED (1987). *Our Common Future*. Oxford University Press: Oxford

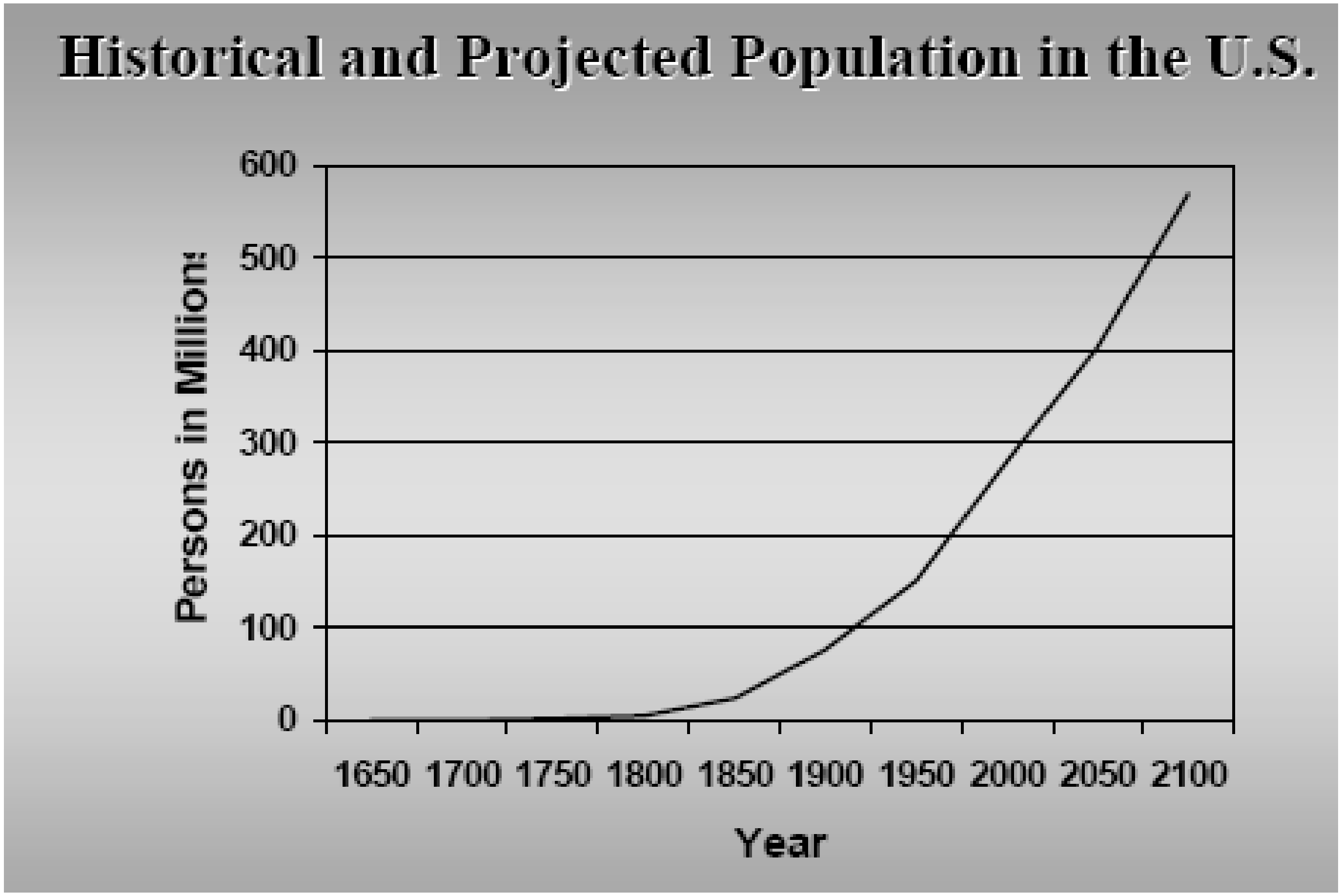
Wear, D.N. & Greis, J.G. (2002a). *Southern forest resource assessment.* Gen. Tech. Rep. SRS-53. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station.

Wear, D.N. & Greis, J.G. (2002b). Southern forest resource assessment: Summary of findings. *Journal of Forestry, 100*(7): 6–15.

Wear, D.N., Liu, R., Foreman, J.M. & Sheffield, R.M. (1999). The effects of population growth on timber management and inventories in Virginia. *Forest Ecology and Management, 118*: 107–115.

Young, R., & Crandall, R. (1984). Wilderness use and self-actualization. *Journal of Leisure Research, 16*(2), 149-160.

Figure 1.1: Historical and Projected Population in the United States



Source: http://www.srs.fs.usda.gov/recreation/2004ISSRM/slide23.html

Figure 1.2: The Urban Core – Wilderness Continuum with the Fringe

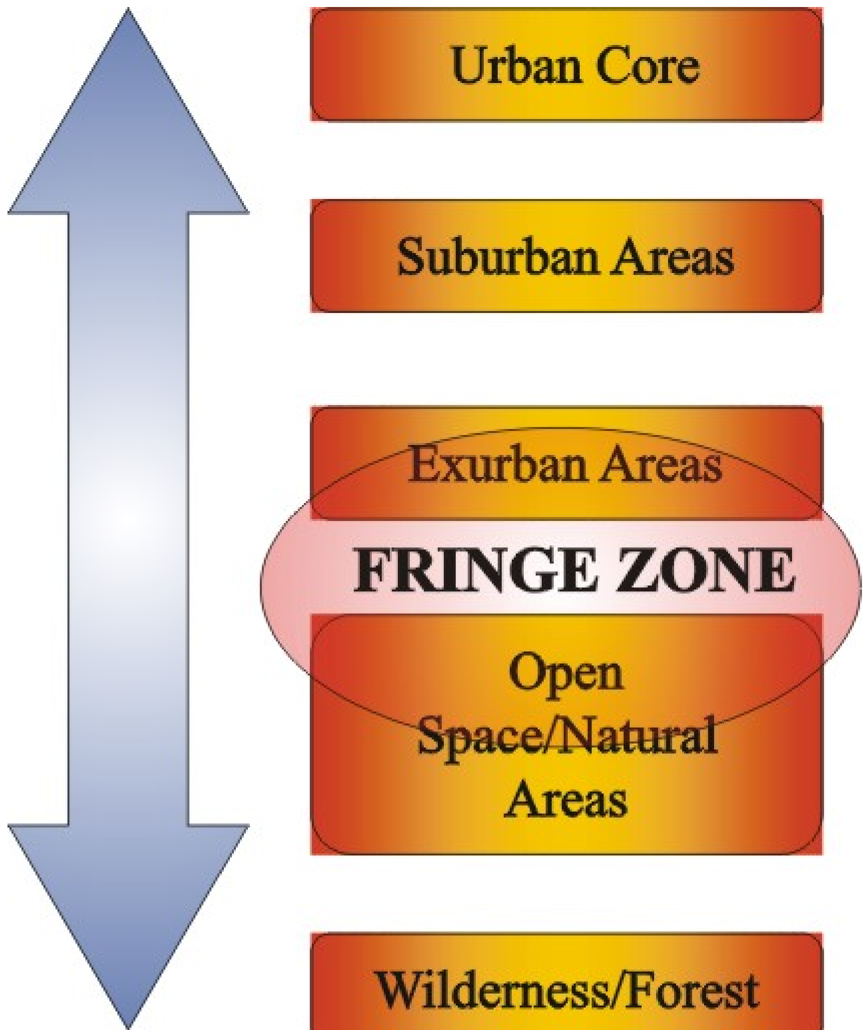
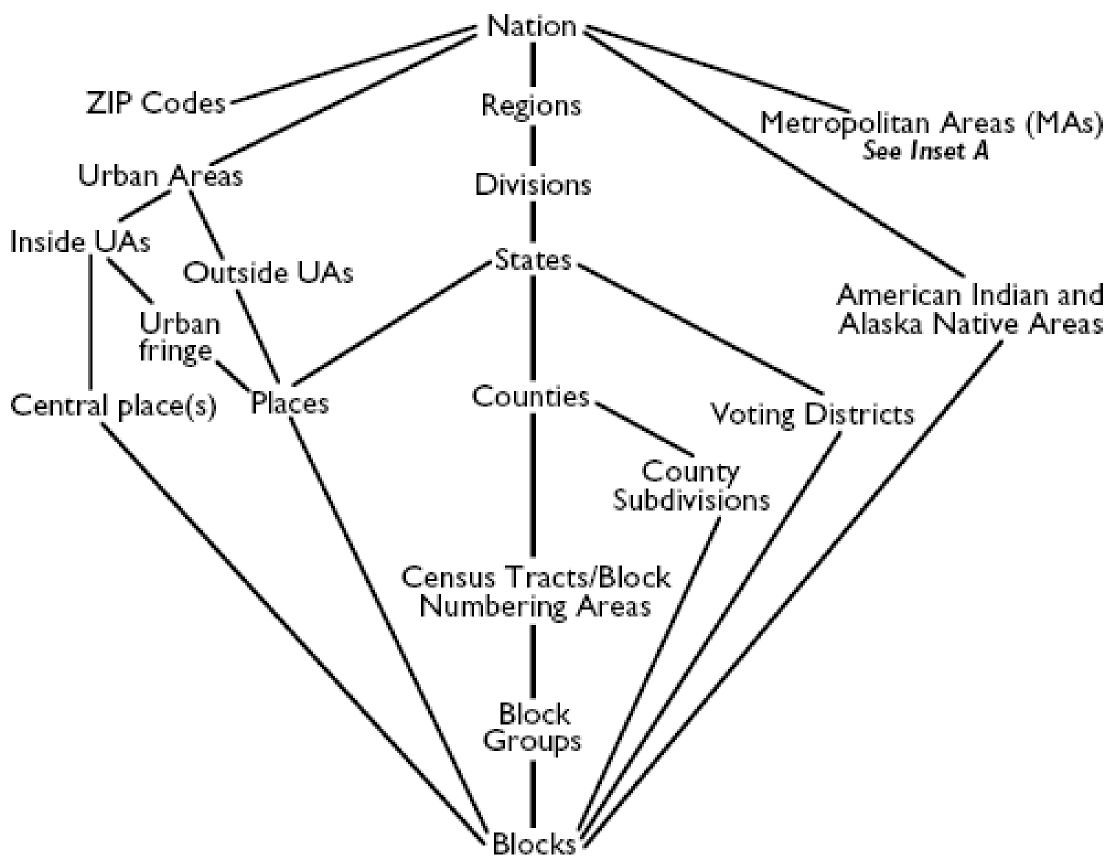


Figure 1.3: Hierarchy of Geographical Entities in the U.S. Census



Source: http://www.census.gov/geo/www/GARM/Ch2GARM.pdf

CHAPTER 2

SCALE EFFECTS IN THE DISTRIBUTION OF SOCIO-DEMOGRAPHIC CHARACTERISTICS OF RESIDENTS IN THE CONTIGUOUS UNITED STATES: EXAMINING THE MODIFIABLE AREAL UNIT PROBLEM AND HOT SPOTS[1]

[1]Raychaudhuri, U.; Tarrant, M.A.; and Nibbelink, N.P. To be submitted to *Journal of Leisure Research*

ABSTRACT

This study examines the spatial distribution of socio-demographic characteristics of residents in the contiguous United States. Information from the U.S. census was mapped in geographic information systems and all counties and census block groups in the contiguous United States were examined for socio-demographic characteristics (race, education, occupation, and income). Descriptive statistical analysis was conducted to illustrate differences between scales of measurement in census data between the county and census block group levels. Hotspot analysis based on regional distribution (Eastern and Western United States) illustrated areas of significant change in socio-demographics (at the county level). Implications of this study address the need for understanding the modifiable areal unit problem when evaluating spatially referenced data. Understanding the scale effects of spatial data and identifying the hotspots of change will aid future planning and management by delineating suitable geographic units.

INDEX WORDS: Geographic information systems, census data, modifiable areal unit problem, and hot spot analysis.

CHAPTER 2

On Tuesday, October 17th 2006, the U.S. population crossed the 300 million mark (Moscoso, 2006). With a net gain of one person every 11 seconds (Popclock, 2006), the population of the U.S. is expected to reach 400 million by 2043. In tandem with this burgeoning population there is constant evaluation of demographic characteristics by various agencies as they try to gauge impacts of population growth. This evaluation is primarily done by social scientists with the use of socio-demographic data. Distribution of population across the nation is not uniform and to understand socio-demographic data it is critical to understand characteristics of this distribution. Patterns can be clustered, dispersed or random. Characterizing patterns in socio-demographic data can not only provide valuable information on status of the human population, but can suggest underlying phenomena responsible for patterns that can be useful for policy makers and planners.

The purpose of this study was to examine the spatial distribution of socio-demographic characteristics of residents in the contiguous U.S. and test the effects of scale on data aggregation. This study also identified areas of significant change (hotspots) using a temporal analysis.

Framework for this Study

The framework for this study is based on a scale characterization of socio-demographic data. This study explores principle 8 of the guidelines for conducting social assessment from the Human Dimensions Framework (HDF) which addresses the need for assimilating and synthesizing socio-demographic information on multiple scales (spatially and temporally) (see

Bright, Cordell, Hoover and Tarrant, 2003). Enumeration of socio-demographic data needs to occur over scales to standardize and stabilize spatial systems. According to Levin (1992),

> The problem of pattern and scale is the central problem in ecology, unifying population biology and ecosystems science, and marrying basic and applied ecology. Applied challenges ... require the interfacing of phenomena that occur on very different scales of space, time, and ecological organization. Furthermore, there is no single natural scale at which ecological phenomena should be studied; systems generally show characteristic variability on a range of spatial, temporal, and organizational scales.

Apart from spatial scales the need for temporal analysis is also critical to establish trends and locations of significant change through hotspot analysis (Cordell and Overdevest, 2001).

Research Question

Based on the HDF principle of synthesizing multi-scale data for social assessment the research question is: How does the use of spatial and temporal scale influence the measurement of socio-demographics of residents in the contiguous U.S.?

Census Data

Socio-demographic data from the census bureau was used for this research. A nation as large as the U.S. has varied population settlement patterns and the enumeration of this socio-demographic data is assimilated and distributed by the U.S. census bureau. The census bureau collects data on all entities (person, household, housing units etc.) and then geo-codes (i.e. spatially references) the data. All geographic entities are classified into two categories – a) legal and administrative entities and b) statistical entities. The nation, states, and counties are examples of legal and administrative entities. Regions and CBG are examples of statistical entities. The use and application of data governs the category of entities (administrative and legal, statistical or both). Administrative and legal entities have static/stable boundaries and enable historical comparisons. In tabulating socio-demographic data for statistical units, the census bureau is mandated by Federal law (Title 13, U.S. Code) to protect an individual's right to confidentiality and therefore the census bureau devises geographic entities (example CBG) that serve the statistical equivalent of legal entities (or their hierarchical parts) based on appropriate/meaningful population size thresholds. Therefore individual socio-demographic data is statistically aggregated and then geo-coded by the census bureau before being released to the general public (Census, 2006).

Counties and Census Block Groups

Counties typically are active and functioning governments (political units) that provide administrative and legal services to the population and hence are classified under administrative and legal entities by the census bureau. Their boundaries, size, and shape are hence governed by the political unit and usually remain static. The smallest geographic entity for which the census bureau releases data is a 'census block.' The CBG is a statistical grouping of all census blocks whose identifying numbers begins with the same digit in a 'census tract' or 'block numbering area.' Census tracks or block numbering areas statistically combine to form counties and hence CBG never cross county boundaries. A CBG is generally an area bounded by streets, streams and boundaries of legal (e.g. county) and statistical entities (Census, 2006). Factors that govern the boundaries, size, and shape of CBG include topography, riparian features, land survey systems, and density of urban and rural development which cause regional variation in CBG sizes. For example in the Western U.S. where there is lower population density and lack of dense road network or riparian features, there are CBG as large as 250+ square miles in area. Urban CBG are generally 50 acres in size and rural CBG can reach 1000 acres. CBG usually contain 600 to 3000 people with an average population of about 800 (Zhang, 2004).

There is a need for identifying local patterns of spatial dependency (Ord and Getis, 2001) which requires that socio-demographic analysis be done at the CBG scale. However CBG presents problems such as large variations in areal configurations, zero populations, and nearly zero areas (extremely small areal units) which can confound data enumerations (Griffith, Wong and Whitfield, 2003).The Census Bureau provides information on counties and CBG via Topologically Integrated Geographic Encoding and Referencing (TIGER) system. The geo-database of TIGER files are spatially referenced and contain attributes information on socio-demographics for use in GIS.

Geographic Information Systems

GIS is a 'system for capturing, storing, checking, manipulating, analyzing and displaying data which are spatially referenced (Department of the Environment, 1987).' Since socio-demographic data is inherently spatial, GIS provides an efficient environment for the management, display and analysis of spatially referenced data. For socio-demographic data GIS provides attribute information (about individuals, households, blocks etc. depending on scale of measurement) which are linked to digital points, lines or polygon entities via a geographical reference. GIS is primarily used by computer-based applications to analyze spatial information and represent them via cartographic images, tables, and graphs. GIS technology is rooted in the science and theories of spatial dynamics which have essentially originated from the Geography discipline. The main GIS theory that this research is based on is the modifiable areal unit problem (MAUP) (Openshaw & Taylor, 1979). MAUP addresses issues of scale, location, zoning, and aggregation.

Aggregation

Social science measurements usually use aggregated data to test hypotheses about individual characteristics. Socio-demographic data from census statistics reflect aggregation into areal units. Such aggregation occurs for the protection of individual privacy (Census, 2006). The use of aggregated data to explain individual behavior makes the assumption that the socio-demographic variables are homogenous across all individuals. Aggregation can reduce heterogeneity among units. When areal units are similar to begin with, aggregation results in much less information loss than when aggregating highly dissimilar units. Zoning variations are much less pronounced when aggregation of areal units is performed in a non-contiguous or spatially random fashion (Crawford and Young, 2004).

Modifiable Areal Unit Problem

MAUP is an important feature of geo-spatial data that confounds the computation and understanding of spatial processes (Openshaw, 1983). The MAUP is based on the fact that spatial data values will vary as a result of spatial scale and in particular, their aggregation into areal units. Areal data cannot be measured at a single point but must be contained within a boundary to be meaningful. It is the selection of these artificial boundaries and their use in analysis that produces the MAUP. Since areal data is usually measured within boundaries (e.g. CBG or counties), the method in which areal data are aggregated for measurement is critical to the interpretation of analytical results. The impact of the MAUP on the analysis of census data is well established (Fotheringham and Wong, 1991; Openshaw, 1984).

The effects of MAUP can be divided into two categories – the scale effect and the zone effect (Table 2.1). Table 2.1 (Oliver, 2001) illustrates in a) and b) the scale effect where there is a difference in means (8.88 vs. 8.89) based on aggregation from n=9 to n=3. In the table, c) and d) illustrate the zoning effect where there is a difference in means (8.47 vs. 9.33) based on the manner of zoning. Scale effect is the variance in aggregated results that results from the aggregation process in the analysis. Zone effect is the variance in the manner in which areas are aggregated from smaller to larger units. MAUP therefore consists of two problems--one statistical and the other geographical, and it is difficult to isolate the effects of one from the other. Redefining boundaries of CBG zones and counties will change the value of the variables for each zone and cause potential MAUP problems and unpredictable variations in statistical analyses. To deal with the MAUP problem analyses must be conducted at multiple scales to understand potential biases inherent in the analyses.

Social science research has usually used one or the other (county or CBG) datasets and the use of a single scale has disregarded the incidence of MAUP in the data. County level data was used as the geographic unit of analysis in studies on land use change by Wear (2002), on population and socio-economic change by Tarrant, Porter and Cordell (2002); on environmental justice by Green, Tarrant, Raychaudhuri and Zhang (2005); and on landscape change by Cordell and Overdevest (2001), to name a few. Similarly an example of CBG level study is research on land cover and population density by Yuan and Smith (1998). However in the analysis of socio-economic data by Wong, Lasus and Falk (1999); Nakaya (2000); and Openshaw and Alvandies (1999), issues of MAUP were critically analyzed. According to Nakaya (2000), the use of small areal units (e.g. CBG) has a tendency to produce unstable variation because the population used to calculate variation is smaller. Larger areal units (e.g. counties) provide more stable variation but hide meaningful geographic patterns evident in smaller areal units. Large areal units also reveal broader trends that are not easy to discern using smaller areal units (Schlossberg, 2003).

Based on MAUP, in studies conducted on random data with no spatial correlation, Amrhein (1995, p.113) found that aggregation does not affect the mean, but that "populations with very high variances are more likely to generate aggregation effects related to zoning than are populations with very low variances." Studies by Fotheringham and Wong (1991) reveal that correlation coefficients for variables of absolute measurement increases when areal units are aggregated contiguously. The process involves a smoothing effect (by averaging or summing), so that the variation of a variable tends to decrease as aggregation increases.

A confounding characteristic of spatially referenced data is the problem of 'ecological fallacy.' Ecological fallacy states that ecological correlation does not equal individual correlation (Robinson, 1950). Ecological fallacy occurs when analyses based on grouped data lead to conclusions different from those based on individual data. This is one of the serious problems which follow from the MAUP. The ecological inference problem is analogous to creating estimates for small areas by applying national estimates within socio-demographic groups. It leads to false inferences about relationships at the individual level using aggregate data. Another characteristic that affects socio-demographic data is spatial autocorrelation. Spatial autocorrelation is related to MAUP as correlation coefficients of data vary between various scales and aggregation, e.g. census data aggregated at various scales (say county/CBG) have different spatial autocorrelation coefficients for similar variables.

The impact of spatially dependent phenomena on socio-demographics is critical to understanding the nature of communities. Illustrating the impact of spatial autocorrelation on social patterns of settlement, Longley and Batty (1996) say that geographical areas are not comprised of random groupings of individuals/households, but of individuals/households that tend to be similar. They identify three classes of models – a) grouping models where people with similar attributes choose to live near each other; b) group-dependent models, in which individuals/households in the same area/group are impacted by a contextual variable affecting all individuals in the area; and c) feedback models, in which a tendency for people living nearby to interact and as a result to develop common characteristics. Therefore a prominent issue in defining community is that of scale of analysis. Scale of analysis concerns both the scope of analysis, the region that the study covers, and the resolution of analysis, which generally refers to the choice of areal unit at which demographic data is represented and enumerated.

Objectives of this Study

Based on the review of literature and the study framework, this study analyzed the socio-demographic characteristics of residents living in the contiguous U.S. at the county level of aggregation and the CBG level of aggregation. Using descriptive statistics the study examined the spatial characterization and distributional differences which occurred due to aggregation and scale effects between county and CBG levels (to illustrate the MAUP). Time-series socio-demographic data from 1980-2000 was also analyzed based on regional distribution (Eastern and Western U.S.) illustrated areas of significant change in socio-demographics (at the county level) and identified hotspots. The study objectives were:

Objective 1: Examine and display the spatial distribution of socio-demographic characteristics of residents (at the county level and at the CBG level for year 2000) in the contiguous U.S.

Objective 2: Examine the differences in socio-demographic data (year 2000) distribution of residents as a result of scales of measurement.

Objective 3: Display the hotspots of change (1980-2000) in socio-demographic characteristics of residents by region (Eastern and Western) in the contiguous U.S.

Methods

The dataset consists of geo-spatial information on socio-demographic characteristics of residents in the contiguous United States. Spatial patterns that emerge from the distribution of these residents were used to map and analyze the distributional differences amongst the various socio-demographic variables. County/CBG data (shape files and attribute information) was retrieved from the Census CD Version 2.0 (GeoLytics, 2002). Geo-spatial data for County/CBG were in the form of shape files (digital vector based polygons) which are representations of geographic entities with attached tables containing attribute information including median household income, race, education, and occupation. Attributes for feature type, feature name, agency ownership, uniform resource locater (URL), State, and State FIPS codes were retained. The minimum map resolution included in the data was an area of 640 acres or one square mile.

A hotspot analysis was done to identify areas of significant change for time series census data. Hotspot analysis has been predominantly used in crime mapping and analysis for pattern recognition. Hotspots are defined based on spatial clustering of characteristics. Hot spot delineation and identification allows us to measure spatial association of socio-demographic data and thus can help determine priority areas for management. The clustering methods could be spatial or spatio-temporal. Hotspot analysis (see Getis and Ord (1992) and (1996); Ord and Getis (1995); and Anselin, 1995) uses stationarity measures (by calculating both distance statistics and indicators of spatial association) on local statistics to identify hotspots (i.e. data which shows dependence).

In this research ArcGIS was used to calculate the Getis Ord Gi* statistic which identifies spatial clusters in selected attribute values. It is measured as a ‘Z’ score where the Z score represents the statistical significance of clustering for a specified distance. $Z > 0$ indicates high values which are clustered together and Z < 0 indicates low values which are clustered together. The Z score indicates the strength of the association and the odds of the observed pattern being a result of chance. Z values close to zero indicate the lack of clustering within the data. At a significance level of 0.05, a Z score would have to be less than –1.96 or greater than 1.96 to be statistically significant. Cartographical representation of the range of scores is typically between +2.0 and -2.0. In ArcGis software using the Z renderer, Z scores below –2 standard deviations are rendered dark blue, Z scores between –2 and –1 standard deviations are light blue, Z scores between –1 and +1 standard deviations are white, Z scores between 1 and 2 standard deviations are orange, and Z scores above 2 standard deviations are red (ArcGIS, 2005). The cartographic representation helps in determining if hotspots exist in spatio-temporal patterns.

To represent the characteristics of the population, this study evaluated four socio-economic variables: race, education, occupation and income. These were in sync with previous studies by Tarrant and Cordell (1999), Porter and Tarrant (2001), and Green et al. (2005), who evaluated similar variables on environmental justice research concerning locally desirable land use studies. The variables in this research were:

a) Race: It was categorized as percent of the total population white (including white Hispanics) versus non-white (comprised of black, Native American Indian, and other). Race was calculated as white population divided by the total population.

b) Occupation: It was categorized as percent of the total workforce classified in blue-collar occupations (farming, construction, production, transportation, and installation) versus white collar and service occupations. Occupation was calculated as number of blue collar employees divided by total employees.

c) Education: It was classified according to percent of the population who had attended college for at least one year. Education was calculated as the total population attending some college, obtaining bachelor or higher degree (including Masters and Doctoral degree) divided by the total population older than 25 years, and

d) Income: It was measured as the median household income at a continuous level variable in dollars. Median household income was adjusted for inflation for the years 1980 and 1990. The consumer price index (CPI) was used to adjust the 1980 and 1990 values for inflation (www.bls.gov). The 1990 value was increased by a factor of 1.3175 from the actual 1990 value to obtain the 1990 adjusted value. The 1980 value was increased by a factor of 2.0898 from the actual 1980 value to obtain the 1980 adjusted value for baseline comparison with the 2000 data. Since income distribution in a population is positively skewed the appropriate measure for income used was median household income. Mean (per-capita) income reflects only the total income whereas median income reflects both the income distribution and total income (Blakely and Kawachi, 2001).

Data were spatially represented in ArcView GIS software, version 3.2 and ArcGIS 9.0 (Environmental Systems Research Institute, 1999) using the Albers equal area projection in metric units. Data from the spatial analysis was then exported to SPSS (Statistical Package for the Social Sciences, 2005) version 14.0 for statistical analysis. In SPSS the spatially referenced socio-demographic data was analyzed descriptively and was initially screened for normality by analyzing the skewness and kurtosis and a symmetric distribution in the histogram. Since the sample size was fairly large (n = 3,093 for counties and n= 206,230 for CBG), the data was assumed to represent normality. Means and variance scores were computed.

To measure the scale dependency of socio-demographic data two scales were used from which datasets were extracted – county and CBG level. County was selected as one of the units of analysis because it is the smallest consistent non-educational unit of U.S. government for which a fairly large number of the demographic variables required for this analysis are available across time periods. Also the county has a reasonable number of subdivisions of the U.S. as a whole which are represented within this designation (approximately 3111 individual sub-jurisdictions) and there are projections of major demographic variables available at this level. Thus county is a stable unit in terms of size and temporal analysis. The limitations of using the county as a basic unit of analysis relate to its variable and large size relative to the scale of actual socio-demographic patterns. The study compensated for size differences by using county subunits (CBG) to divide counties into smaller and different parts. Thus, even though the county is the basic entity across time periods for the spatio-temporal analysis, smaller entities like CBG were compared with county for the analysis of 2000 socio-demographic data to illustrate the MAUP.

Results

Objective 1:

This objective displayed the socio-demographic distribution of residents in the contiguous U.S. There were 3,093 counties and 206,230 CBG that were analyzed in SPSS for minimum, maximum, mean, and variance. Socio-demographic data at county level for 2000 (Table 2.2) shows that the percent white population has a national mean distribution of 84.86 percent and a variance of 253.48. Percent population with blue collar occupation has a national mean distribution of 30.42 percent and a variance of 62.69. Percent population with college education has a national mean distribution of 42.66 percent and a variance of 125.73. The median household income of the residents in the contiguous U.S. in 2000 was $35,298.66 with a variance of 78,105,576.94 (see Figures 2.1 – 2.4).

Socio-demographic data at CBG level for 2000 (Table 2.3) shows that the percent white population has a national mean distribution of 75.40 percent and a variance of 768.75. Percent population with blue collar occupation has a national mean distribution of 25.72 percent and a variance of 163.53. Percent population with college education has a national mean distribution of 49.41 percent and a variance of 406.45. The median household income of the residents in the contiguous U.S. in 2000 was $44,370.55 with a variance of 524,405,552.80

Objective 2:

This objective examined the socio-demographic distributional difference of residents in the contiguous U.S. (Tables 2.4 and 2.5). In table 2.4, there were 3,093 counties and 206,230 CBG that were analyzed in SPSS for mean and variance. There was difference in the means at the county and CBG level. For percent white population the mean at the county level was 84.86 and the mean was 75.40 at the CBG level. Percent population with blue collar occupation had a mean of 30.42 at the county level and a mean of 25.72 at the CBG level. Percent population with college education had a mean of 42.66 at the county level and a mean of 49.41 at the CBG level. The median household income of the residents in the contiguous U.S. in 2000 had a mean of $35,298.66 at the county level and a mean of $44,370.55 at the CBG level.

There was also a difference in the variances at the county and CBG level. For percent white population the variance at the county level was 253.48 and the variance was 768.75 at the CBG level. Percent population with blue collar occupation had a variance of 62.69 at the county level and a variance of 163.53 at the CBG level. Percent population with college education had a variance of 125.73 at the county level and a variance of 406.45 at the CBG level. The median household income of the residents in the contiguous U.S. in 2000 had a variance of 78,105,576.94 at the county level and a variance of 524,405,552.80 at the CBG level.

Comparing at the CBG level regionally there were differences in means and variances (Table 2.5). In table 2.5, there were 206,230 CBG nationally, 162,182 CBG in the Eastern U.S., and 45,314 CBG in the Western U.S. that were analyzed in SPSS for mean and variance. For percent white population the mean at the CBG level was 75.40 nationally but 76.08 in the East and 71.39 in the West. Percent population with blue collar occupation had a mean of 25.72 at the national level and a mean of 26.31 in the East and a mean of 22.90 in the West. Percent population with college education had a mean of 49.41 at the national level and a mean of 47.36 in the East and a mean of 55.65 in the West. The median household income of the residents in the contiguous U.S. in 2000 had a mean of $44,370.55, but in the East the mean was $43,456.88 and in the West the mean was $47,640.63.

There was also a regional difference in the variances at the CBG level. For percent white population the variance at the CBG level was 768.75 nationally but 845.07 in the East and 24.07 in the West. Percent population with blue collar occupation had a variance of 163.53 at the national level and a variance of 168.32 in the East and a variance of 12.27 in the West. Percent population with college education had a variance of 406.45 at the national level and a variance of 391.98 in the East and a variance of 21.19 in the West. The median household income of the residents in the contiguous U.S. in 2000 had a variance of 524,405,552.80, but in the East the variance was 503,662,377.51 and in the West the variance was 24,186.32.

The results show distributional differences in means and variances at the various scales of aggregation. Variance at the county level of measurement was less than the variance at the CBG level. Also comparing regionally the variance was different for the national level and between the East and the West. Means of the socio-demographic variables were also different between county and CBG levels.

Objective 3:

This objective displayed the change in socio-demographic characteristics of residents in the contiguous United States at the county level from 1980-2000 by region. The spatial distributions of these are displayed in Figures 2.5 – 2.9 for the Eastern and Western U.S. Getis Ord Gi* statistics indicated by the Z score rendering in the figures indicates the counties which are hotspots of change and areas of clustering for significant positive (represented by red) and negative (represented by dark blue) change.

Some of the counties which were hotspots of change in the Eastern U.S. were Dade, FL for negative change in percent white population. For change in percent population in blue collar occupation in the Eastern U.S. the counties which were hotspots of positive change were Ripley, MO; Marshall, MN; Perry, George and Greene, MS; and Kidder, ND and the counties which were hotspots of negative change were Macon, NC. For change in percent population with college education in the Eastern U.S. the counties which were hotspots of positive change were Murray, Gilmore, Fannin, Union, and Lumpkin, GA; Gallatin, Pope, Williamson, Union, and Hardin, IL; and Stoddard, Wayne, Madison, and Iron, MO and the counties which were hotspots of negative change were Dade, FL; and Grafton and Carroll, NH. For change in percent median household income in the Eastern U.S. the counties which were hotspots of positive change were Fannin, Gilmore, Rabun, Towns, Habersham, White, and Lumpkin, GA; Macon and Clay, NC; and Albemarle, VA and the counties which were hotspots of negative change were Dade, FL; Perry, George, and Greene, MS; and Cameron, LA.

For the Western U.S. the counties which were hotspots of change were Rio Arriba and Taos, NM for positive change in percent white population and Fresno, Los Angeles, and San Bernardino, CA; and Franklin, WA for negative change. For change in percent population in blue collar occupation in the Western U.S. the counties which were hotspots of positive change were Teton, Elmore, and Camas, ID; Stillwater and Petroleum, MT; and Hudspeth, TX and the counties which were hotspots of negative change were Boulder, Clear Creek, and Gilpin, CO. For change in percent population with college education in the Western U.S. the counties which were hotspots of positive change were Gila, AZ; Sierra, Torrance, Mora, and Rio Arriba, NM; and Wheeler, OR and the counties which were hotspots of negative change were La Paz, AZ; Alpine, CA; and Gunnison, Pitkin, Eagle, Summit, Gilpin, and Clear Creek, CO. For change in percent median household income in the Western U.S. the counties which were hotspots of positive change were Archuleta, Dolores, San Miguel, and Montrose, CO; Teton and Blaine, ID; Summit City, UT; and Teton, WY and the counties which were hotspots of negative change were La Paz, AZ; and Cibola, NM.

Summarizing the results of the study shows that there are distributional differences in the computation of socio-demographic characteristics of the residents of the contiguous United States. Differences in variance at the two scales (county and CBG) and difference in means shows that there are scale and zoning effects and indicates the MAUP. Trend measures by hotspot analysis illustrate the counties where there has been significant change (positive and negative) over time. Patterns of clustering in the hotspot analysis (as observed visually) are indications of spatial dependency of socio-demographic data.

Discussion and conclusions

The results of this study show that there are effects of scale on socio-demographic data aggregation. As indicated by Amrhein (1995) we see from the results and figures that high variances in income, education and race shows more aggregation and clustering effects than those exhibited by occupation which had low variances comparatively at both the county and CBG level. Also resonating with the study of Fotheringham and Wong (1991), at the county level which has a higher level of aggregation the results show lower variation than at the CBG level which has a lower aggregation and exhibited higher variances amongst all the socio-demographic variables comparatively. Even comparison at the CBG level regionally exhibited higher variances in the Eastern U.S. which has lower aggregation and smaller areal units than the Western U.S. where the CBG sizes are bigger. Regional comparison in the results show that similar areal units (as in the West) showed less variation than the aggregation of dissimilar units as in the contiguous U.S. as discussed by Crawford and Young (2004).

The time-series analysis of county data from 1980-2000 illustrated the hotspots of change and locations where there was spatio-temporal dependency in the socio-demographic data. As per Schlossberg (2003), county level data (larger areal unit) enabled historical comparison and revealed trends in socio-demographics. The geographic patterns from the hotspot analysis help in understanding data distribution and distributional differences. Identification of spatial patterns reveal underlying processes that might be impacting the data. Trend analysis information is also critical where data interpolation techniques are used to stochastically model the socio-demographic characteristics. As per Longley and Batty (1996), and as evidenced from the hotspot analysis, it is apparent that there are significant groupings in socio-demographics regionally. Social scientists might explore these patterns more critically to understand the nature of these communities (e.g. the Piedmont region of GA or around Teton County, ID)

The size, shape and orientation of the spatial units are important for geo-referenced socio-demographic data. These attributes are called the 'support' of the data. In the past spatial support (usually shape and zoning) has largely been ignored in statistical solutions to the MAUP. MAUP is a complex problem that will present itself in socio-demographic data enumeration to social scientists, ecologists, economists, etc. As evidenced from the results of this study, the consideration for the scale, grain and extent of the region being examined can play a significant role in understanding socio-demographic information. Understanding the ways in which the MAUP affects the results of statistical analysis will help choosing between the scale of zones for the particular use and requirements of the data. A simple strategy to deal with the MAUP problem is to undertake analysis at multiple scales or zones. This will avoid the ecological fallacy problem (Robinson, 1950). Being cognizant of the fact that analysis results may be dependent on the zones used to aggregate data is an important step in the data analysis process.

The purpose of analysis at multiple scales is not to find the 'best' scale of analysis but to investigate how demographic character varies across scales. Sui (1999) said that a study done at any one scale or based on a particular areal unit cannot, by definition, produce a reliable result and there is no such thing as the single 'best' or most 'appropriate' scale of analysis in research. A number of authors have suggested that GIS be used to support multi-scale analysis (McMaster, Helga and Sheppard, 1997; Sui, 1999). According to Griffith, Wong and Whitfield (2003), since statistical inferences assume stationarity of data, the presence of heterogeneous data (which shows variability of means and variances) needs to be analyzed in model-based inferential frameworks, such as in this study using the census data model for the contiguous U.S. and at multiple scales.

For researchers and policymakers who need to understand socio-demographic patterns accurately, choosing suitable geographic units to analyze is essential. As a result of data aggregation census data represents individuals within each census unit as identical. Depending on the level of aggregation and size of areal unit, this homogeneous representation limits the real variation which exists in populations and communities. To recognize this uniqueness it is important to have scale considerations while evaluating socio-demographic data. The hierarchical way that socio-demographic census data is organized provides researchers with various potential scales of analysis. While there are no best scale (as in levels of aggregation – county or CBG for example) at which analysis should be conducted, the optimum method to deal with issues of scale characterization with socio-demographic data is that social scientists realize the need for multi-scale analysis.

County level is a large aggregate to capture fine grained information inside them such as socioeconomic conditions which can be captured better by CBG level data. As evidenced by the results of this study, the county level shows more stable variances and a homogenized effect whereas the CBG level shows more data variation. However county boundaries are stable and enable temporal comparisons (whereby this study conducted a hotspot analysis) whereas CBG boundaries fluctuate based on statistical aggregations and therefore do not allow for temporal comparisons. When there is a need to address local issues and understand patterns in a small scale, data should be used at scales as small as possible (CBG or census blocks). While bigger regional measures of pattern analysis allow us to view overall patterns it is also important to analyze for local patterns (which might be lost in the bigger picture).

As the results of this study show, there are regional variations based on the size of areal units for both counties and CBG. Since, both county sizes and in turn CBG sizes vary regionally, comparisons of socio-demographic data should be regionally distributed. CBG data expresses more variation and spatial detail which are lost at the county level which however is more statistically stable for issues of spatial autocorrelation. According to Antle and Mooney (1999), the optimum scale is that at which the data exhibits the maximum inter-zonal variability and minimum intra-zonal variability. Therefore based on the nature of research the appropriate scale of analysis (preferably at least two - one legal and administrative entity and the other statistical entity in the case of census enumerations) should be used to represent socio-demographic data and account for distributional differences.

Different areal arrangements of the same data produce different results, hence the results of spatial studies are independent of the units being used and the tasks of obtaining valid generalizations or of comparable results become difficult causing an uncertainty in choosing zonal units. The literature suggests the use of disaggregate data rather than aggregate data to avoid the ecological fallacy, the scale problem, and the MAUP. However census based socio-demographic studies are comprised of aggregate data. For research with aggregate data it is best to use data with finest spatial partitioning (e.g. CBG in this study) to avoid confounding results.

Innumerable political and policy decisions are made on the basis of statistical associations obtained from the analysis of spatial data. So that data representation is valid and reliable it is required that socio-demographers understand the problems associated with data and address them appropriately by recognizing the sensitivity of the results of spatial analyses to the definition of units (Jelinski and Wu, 1996). The field of natural resource management is influenced by multiple parameters which range from ecological processes to human influenced policies, constraints, fiscal/economic models, and political mandates. Knowledge of socio-demographic characteristics will provide social scientists adequate tools to help people and communities adjust to shifting demands of resources. Ultimately communities are unique combinations of behavioral, social, political, economic and physical environments and understanding the nature of communities is a means of unraveling the socio-demographic data on them. Information from this study and about socio-demographic changes can help scientists, resource managers, and communities plan for future growth and implement plans and policies for management. Monitoring those changes over time (though hotspot analysis) can help us understand how we can sustain growth while preserving resource stewardship options for future generations to determine the sustenance of our activities, and plan for a sustainable future.

References

Antle, J. C., & Mooney, S. S. (1999, August). *Optimal spatial scale for evaluating economic and environmental tradeoffs*. Presented at the AAEA annual meeting, Nashville, TN.

ArcGis (2005). *Hotspot analysis.* Retrieved on April 24, 2006 from http://webhelp.esri.com/arcgisdesktop/9.1/index.cfm?TopicName=Hot%20Spot%20Analysis%20(Getis-Ord%20Gi*)%20(Spatial%20Statistics)

Amrhein C. (1995). Searching for the elusive aggregation effect: Evidence from statistical simulations. *Environment & Planning, 27*(1):105.

Blakely, T.A. & Kawachi, I. (2001). What is the difference between controlling for mean versus median income in analyses of income inequality? *J Epidemiol Community Health, 55*(May): 352-353.

BLS (2006). Consumer price index. Retrieved on April 24, 2006 from http://www.bls.gov/cpi/home.htm

Bright, A.D.; Cordell, H.K.; Hoover, A.P.; Tarrant, M.A. (2003). A human dimensions framework: Guidelines for conducting social assessments. *Gen. Tech. Rep. SRS-65*. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station.

Census (2006). U.S. Census Bureau. Retrieved April 24, 2006, from http://www.census.gov/

Clark, R.N., Stankey, G.H., Brown, P.J., [and others], (1999). Toward an ecological approach: integrating social, economic, cultural, biological, and physical considerations. In: W.T. Sexton, A.J. Malk, R.C. Szaro, & N.C. Johnson (Eds.), *Ecological stewardship: a common reference for ecosystem management* (pp. 297–318). Kidlington, Oxford, UK: Elsevier Sciences Ltd.

Cordell, H. K., & Overdevest, C. (2001). *Footprints on the land: An assessment of demographic trends and the Future of Natural Resources in the United States*. Champaign, Illinois: Sagamore Publishing.

Crawford, C.A.G. & Young, L.J. (2004). Combining incompatible spatial data: An introductory overview of statistical issues and methods. *Workshop for the SAMSI program on multi-scale model development and control design.* Research Triangle Park, NC.

Department of the Environment (1987). *Handling geographic information.* London: HMSO.

Driver, B.L., Manning, C.J., & Peterson, G.L. (1996). Toward better integration of the social and biophysical components of ecosystems management. In: A.W. Ewert (Ed.), *Natural resource management: the human dimension* (pp. 109-127). Boulder, CO: Westview Press.

Environmental Systems Research Institute (1999). *ArcView GIS: Using ArcView GIS.* Redlands, CA: Environmental Systems Research Institute.

Fotheringham, A.S. & Wong, D.W.S. (1991). The Modifiable Areal Unit Problem in Multivariate Statistical Analysis. *Environment and Planning, A*(23):1025-1045.

Geary, R.C. (1954). The contiguity ratio and statistical mapping. *The Incorporated statistician, 5*:115 - 145.

Geolytics, (2004). Geolytics, Inc. East Brunswick, NJ. Retrieved November 10, 2004, from http://www.geolytics.com.

Getis, A. & Ord, J.K. (1996). The analysis of spatial association by use of distance statistics. *Geographical Analysis 24,* 189-206.

Getis, A. & Ord, J.K. (1996). Local spatial statistics: An overview. In P. Longley & M. Batty (Eds.), *Spatial analysis: Modeling in a GIS environment* (pp. 261-277). Cambridge: Geo-information International.

Goodchild, M. F. (1986). *Spatial Autocorrelation*. Concepts and Techniques in Modern Geography. Geo Books: Norwich, U.K.

Green, G., Tarrant, M., Raychaudhuri, U., & Zhang, Y. (2005). Wilderness in whose backyard? *International Journal for Wilderness, 11*(3): 31-38

Griffith, D.A.; Wong, D.W.S.; & Whitfield, T. (2003). Exploring relationships between the global and regional measures of spatial autocorrelation. *Journal of Regional Science, 43*(4): 683-710

Jelinski, D.E. & Wu, J. (1996). The modifiable areal unit problem and implications for landscape ecology. *Journal of Landscape Ecology, 11*(3): 129-140

Levin, S. A. (1992). The problem of pattern and scale in ecology. *Ecology 73*(6), 1943-67.

Longley, P. & Batty, M. (1996). *Spatial analysis: Modeling in a GIS environment.* New York, NY: John Wiley & Sons.

Massey, D. S. & Denton, N. A. (1988). The dimensions of residential segregation. *Social Forces, 67*: 281-315.

McMaster, R.B., Helga, L., & Sheppard, E. (1997). GIS-based environmental equity and risk assessment: Methodological problems and prospects. *Cartography and Geographic Information Systems, 24*(3):172-189.

Moscoso, E. (2006, October 18). What's next for U.S. population? Racial lines will blur; aged will increase. *The Atlanta Journal Constitution*. Pp A1

Moran, P. A. P. (1950). Notes on continuous stochastic phenomena. Biometrika, *37*:17-23.

Nakaya, T. (2000). An information statistical approach to the modifiable areal unit problem in incidence rate maps. *Environment and Planning A 32*(1).

Oliver, L. (2001). Shifting boundaries, shifting results: The modifiable areal unit problem. Retrieved on April 24, 2006 from http://www.geog.ubc.ca/courses/geog516/talks_2001/scale_maup.html

Openshaw, S. (1984). The modifiable areal unit problem. *Concepts and Techniques in Modern Geography 38*: 41.

Openshaw, S. (1996). Developing GIS-relevant zone-based spatial analysis methods. In P. Longley & M. Batty (Eds.), *Spatial analysis: modeling in a GIS environment* (pp. 55-73). Cambridge: GeoInformation International.

Openshaw S., & Alvandies S. (1999). Applying geocomputation to the analysis of spatial distributions. In P. Longley, M. Goodchild, D. Maguire, & D. Rhind (Eds.), *Geographic Information Systems: Principles and Technical Issues*. Vol. 1, 2nd ed. New York: John Wiley and Sons Inc.

Openshaw, S., & Taylor P. (1979). A million or so correlation coefficients. In N. Wrigley (Ed.), *Statistical Methods in the Spatial Sciences* (pp. 127–144). London: Pion.

Ord, J.K., & Getis, A. (1995). Local spatial autocorrelation statistics: Distributional issues and an application. *Geographical Analysis 27*, 286-306.

Ord, J.K., & Getis, A. (2001). Testing for local spatial autocorrelation in the presence of global autocorrelation. *Journal of Regional Science, 41*: 411-432.

Popclock (2006). U.S. Population clock projection. Retrieved on October 17, 2006 from http://www.census.gov/population/www/popclockus.html

Porter, R. P. & Tarrant, M.A. (2001). A case study of environmental justice and Federal tourism sites in southern Appalachia: A GIS application. *Journal of Travel Research 40*, 27–40.

Robinson, W. S. (1950). Ecological correlations and the behavior of individuals. *American Sociological Review, 15*, 351–357.

Schlossberg, M., (2003). GIS, the US Census and neighborhood scale analysis. *Planning, Practice and Research 18*(2-3): 213-217.

SPSS, Inc. (2005). *SPSS Advanced Statistics 14.0.* SPSS, Chicago: SPSS, Inc.

Stankey, G.H., & Clark, R.N. (1992). *Social aspects of new perspectives in forestry: a problem analysis* (p. 33). Milford, PA: Grey Towers Press.

Sui, D. (1999). GIS, Environmental Equity, and the Modifiable Areal Unit Problem (MAUP). In M. Craglia and H. Onsrud (ed.), *Geographic Information Research: Transatlantic Perspectives* pp. 41-54. Taylor and Francis: London

Tarrant, M.A. & Cordell, H.K. (1999). Environmental justice and the spatial distribution of outdoor recreation sites: An application of geographic information systems. *Journal of Leisure Research, 31*(1): 18–34.

Tarrant, M. A., Porter, R., & Cordell, H. K. (2002). Socio-demographics, values, and Attitudes in Southern forest resource assessment. In D. N. Wear, & J. G. Greis (Eds.). General technical report SRS-53 (pp. 175-187). Southern research station, Asheville, NC.

Title 13, U.S. Code (2006). Title 13-Census. Retrieved on April 24, 2006 from http://www.access.gpo.gov/uscode/title13/title13.html

Tobler, W. (1969). Geographical Filters and their Inverses. *Geographical Analysis, I*(3):234-53.

Tobler, W. (1979). Smooth pycnophylactic interpolation for geographical regions (with discussion). *Journal of the American Statistical Association, 74*, 519–536.

Tobler, W. (1989). Frame independent spatial analysis. In M. Goodchild and S. Gopal (Eds.), *The Accuracy of Spatial Data Bases* (pp. 115–122). London: Taylor and Francis.

Wear, D. N. (2002). Land use in Southern forest resource assessment. In D. N. Wear, & J. G. Greis (Eds.), General technical report SRS-53 (pp. 153-173). Southern research station, Asheville, NC.

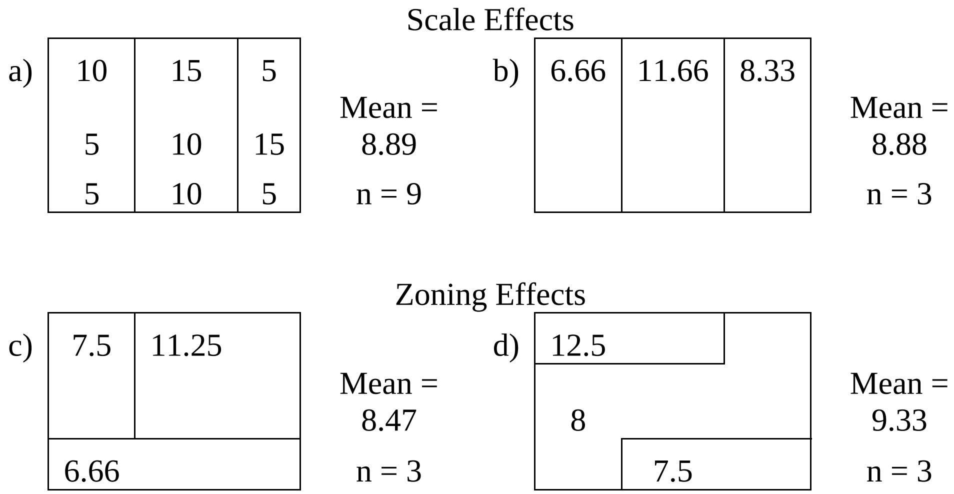
Wong, D.; Lasus, W., & Faulk (1999). Exploring the variability of segregation index D with scale and zonal systems: an analysis of... H.; *Environment & Planning A*, Vol. 31 Issue 3, p. 507

Yuan, Y., Smith, R. M., & Limp, W. F. (1998). Remodeling census population with spatial information from landsat TM imagery. *Environment and Urban Systems. 31*(3/4): 245-258.

Zhang, Y. (2004). Identification of the wild-land urban interface at regional scales. Unpublished Manuscript. University of Georgia, Athens, GA.

Table 2.1: An Example of the Modifiable Areal Unit Problem

a) and b) Scale effects and c) and d) Zoning effects



Adapted from Oliver, L. (2001). *Shifting boundaries, shifting results: The modifiable areal unit problem.* Retrieved on April 24, 2006 from http://www.geog.ubc.ca/courses/geog516/talks_2001/scale_maup.html

Table 2.2: Descriptive Statistics (at County Level) for Contiguous United States

Descriptive Statistics for 2000

	n	Minimum	Maximum	Mean	Variance
Percent white 2000	3,093	5.01	100.00	84.86	253.48
Percent blue 2000	3,093	6.30	53.83	30.42	62.69
Percent college 2000	3,093	16.91	85.39	42.66	125.73
Median Household income 2000	3,093	12,692.00	82,929.00	35,298.66	78,105,576.94

Table 2.3: Descriptive Statistics (at CBG level) for Contiguous United States

	Descriptive Statistics for 2000				
	n	Minimum	Maximum	Mean	Variance
Percent white 2000	206,559	0	100	75.40	768.75
Percent blue 2000	206,271	0	100	25.72	163.53
Percent college 2000	206,501	0	100	49.41	406.45
Median Household income 2000	207,496	0	200,001	44,370.55	524,405,552.80

Table 2.4: Socio-demographic Characteristics (County and CBG level) for the Contiguous United States

Variable	Scale			
	County		CBG	
n	3,093		206,230	
	Mean	Variance	Mean	Variance
Percent white 2000	84.86	253.48	75.40	768.75
Percent blue 2000	30.42	62.69	25.72	163.53
Percent college 2000	42.66	125.73	49.41	406.45
Median Household Income 2000	35,298.66	78,105,576.94	44,370.55	524,405,552.80

Table 2.5: Socio-demographic Characteristics (at CBG level) Comparison for the Contiguous United States and Regionally

Variable	Region					
	Contiguous U.S.		East		West	
Valid n	206,230		162,182		45314	
	Mean	Variance	Mean	Variance	Mean	Variance
Percent white 2000	75.40	768.75	76.08	845.07	71.39	24.07
Percent blue 2000	25.72	163.53	26.31	168.32	22.90	12.27
Percent college 2000	49.41	406.45	47.36	391.98	55.65	21.19
Median Household Income 2000	44,370.55	524,405,552.80	43,456.88	503,662,377.51	47,640.63	24,186.32

Figure 2.1: Distribution of Percent White Population in 2000 in the Contiguous United States (at County Level)

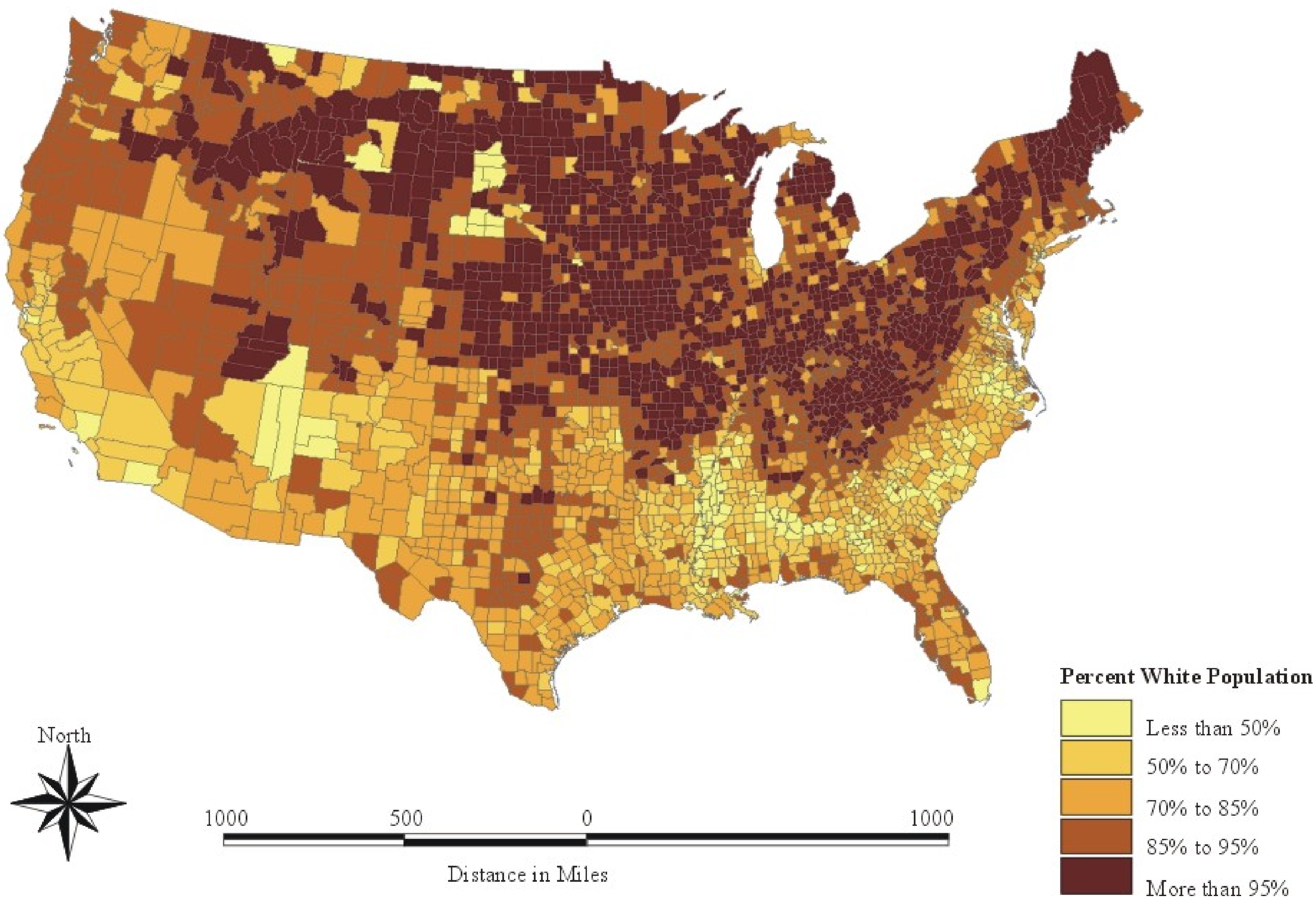


Figure 2.2: Distribution of Percent Population in Blue Collar Occupation in 2000 in the Contiguous United States (at County Level)

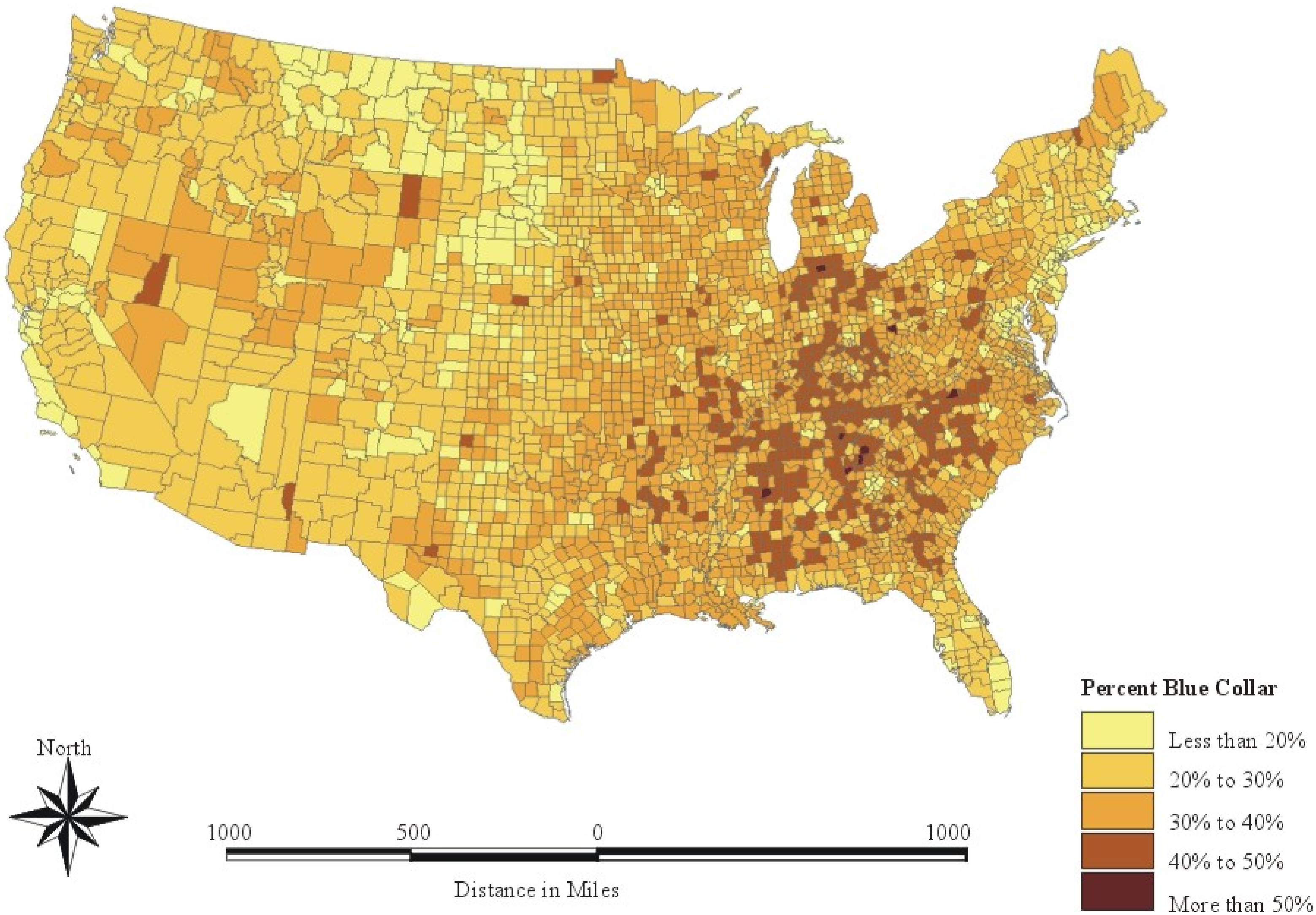


Figure 2.3: Distribution of Percent Population with College Education in 2000 in the Contiguous United States (at County Level)

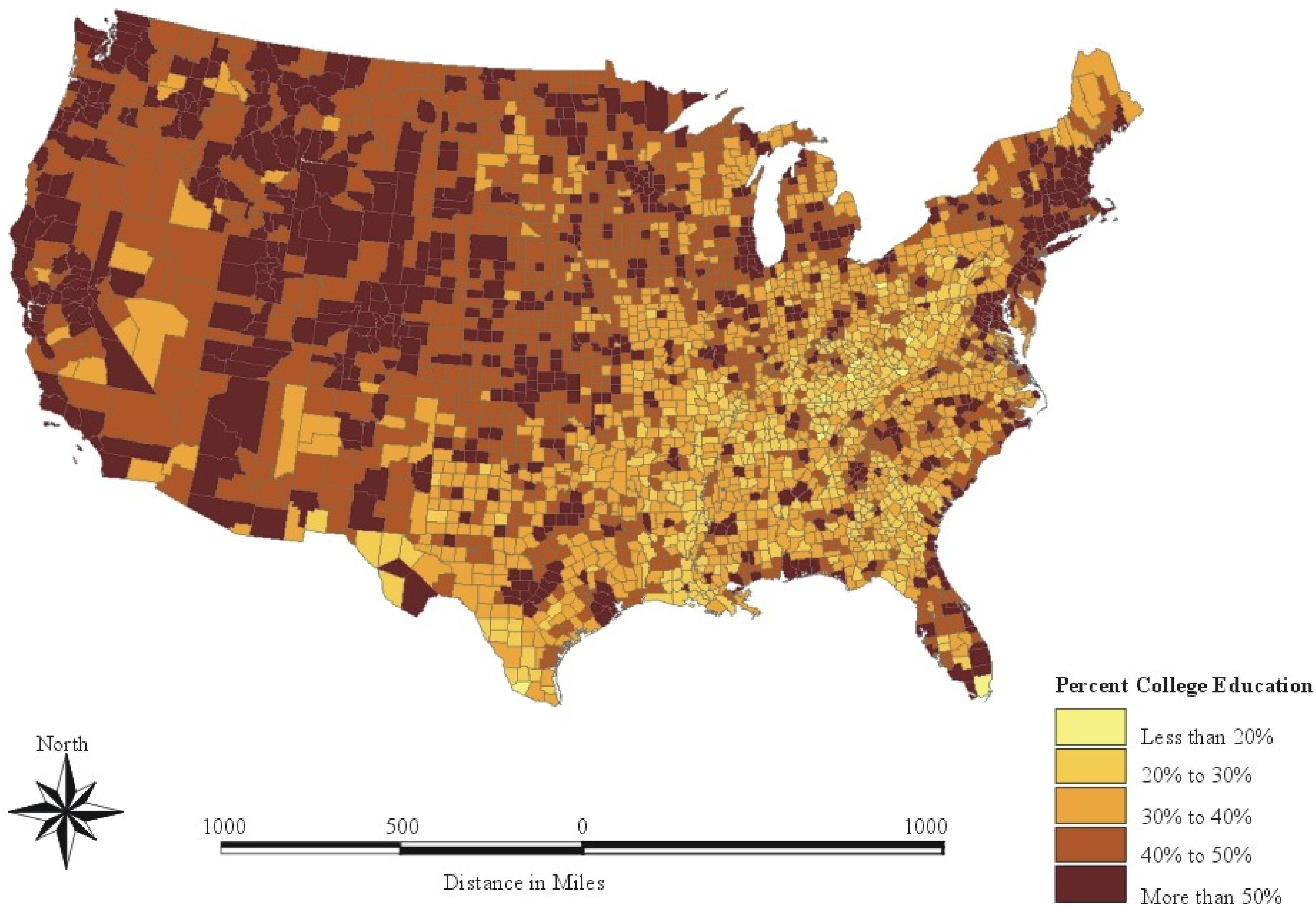


Figure 2.4: Distribution of Median Household Income in 2000 in the Contiguous United States (at County Level)

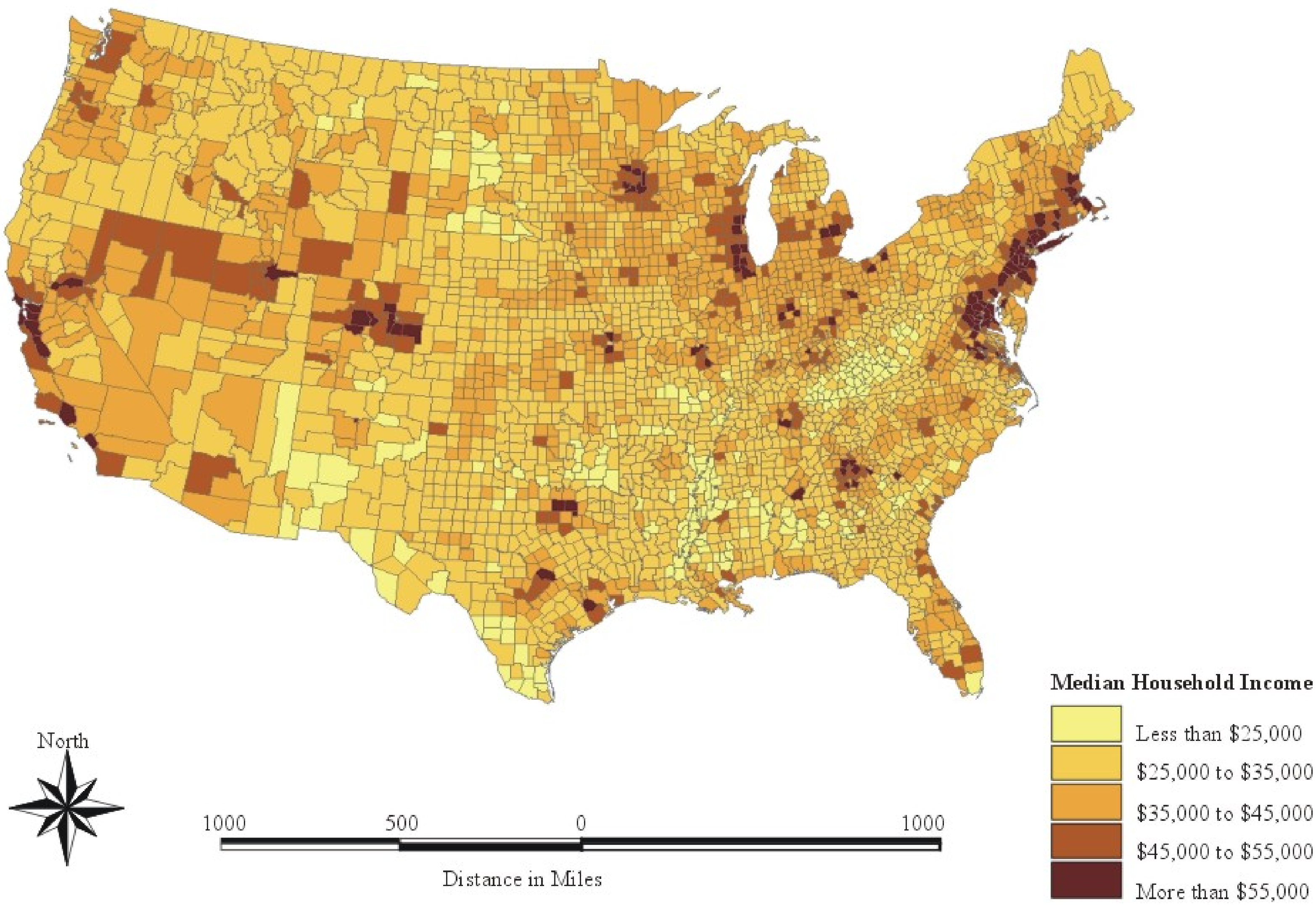


Figure 2.5: Regional Distribution of Counties between the Eastern and Western U.S (Split Along the 100th Meridian).

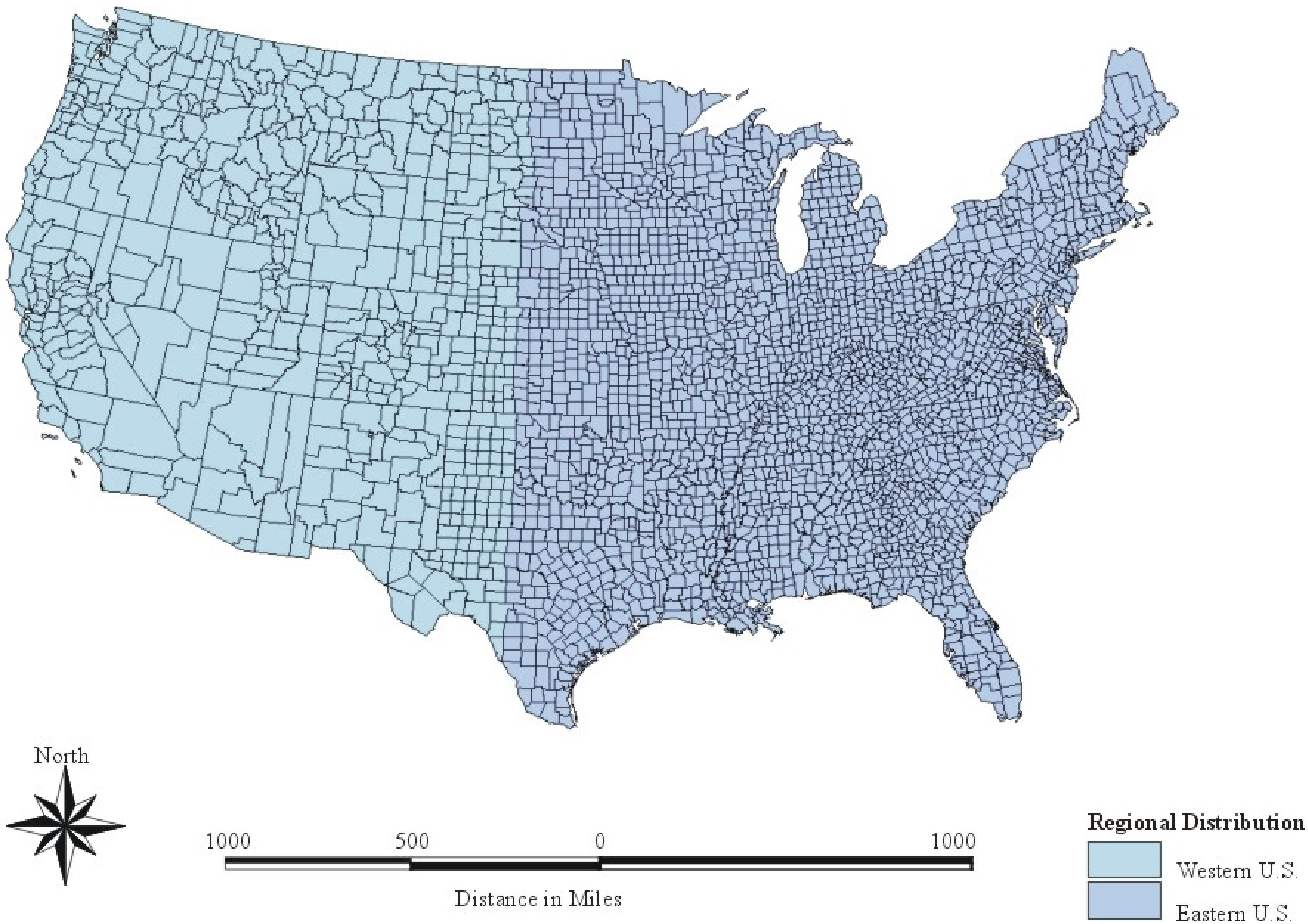


Figure 2.6: Hot spot analysis (change in percent white population from 1980-2000) in the Eastern and Western U.S.

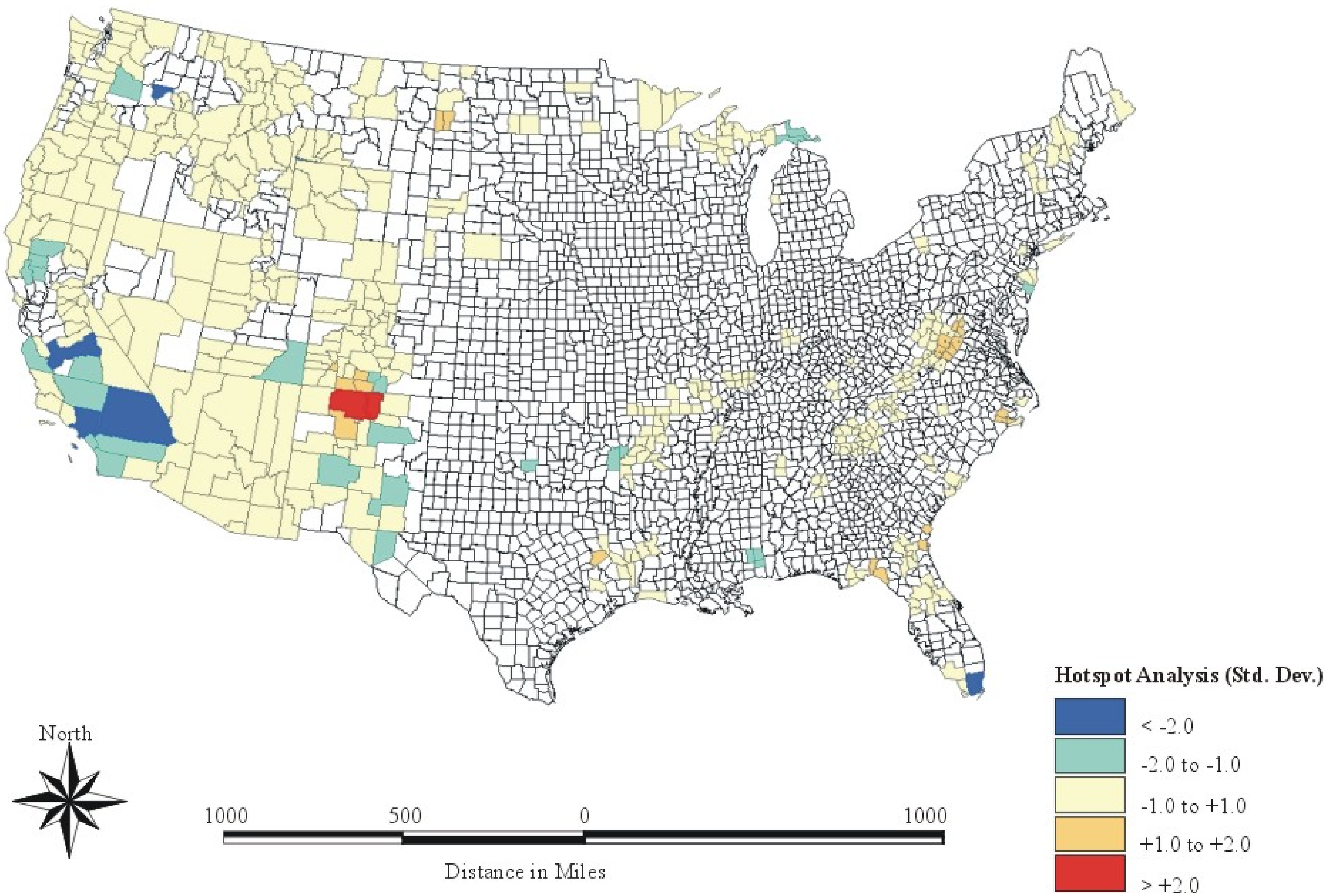


Figure 2.7: Hot spot analysis (change in percent population in blue-collar occupation from 1980-2000) in the Eastern and Western U.S.

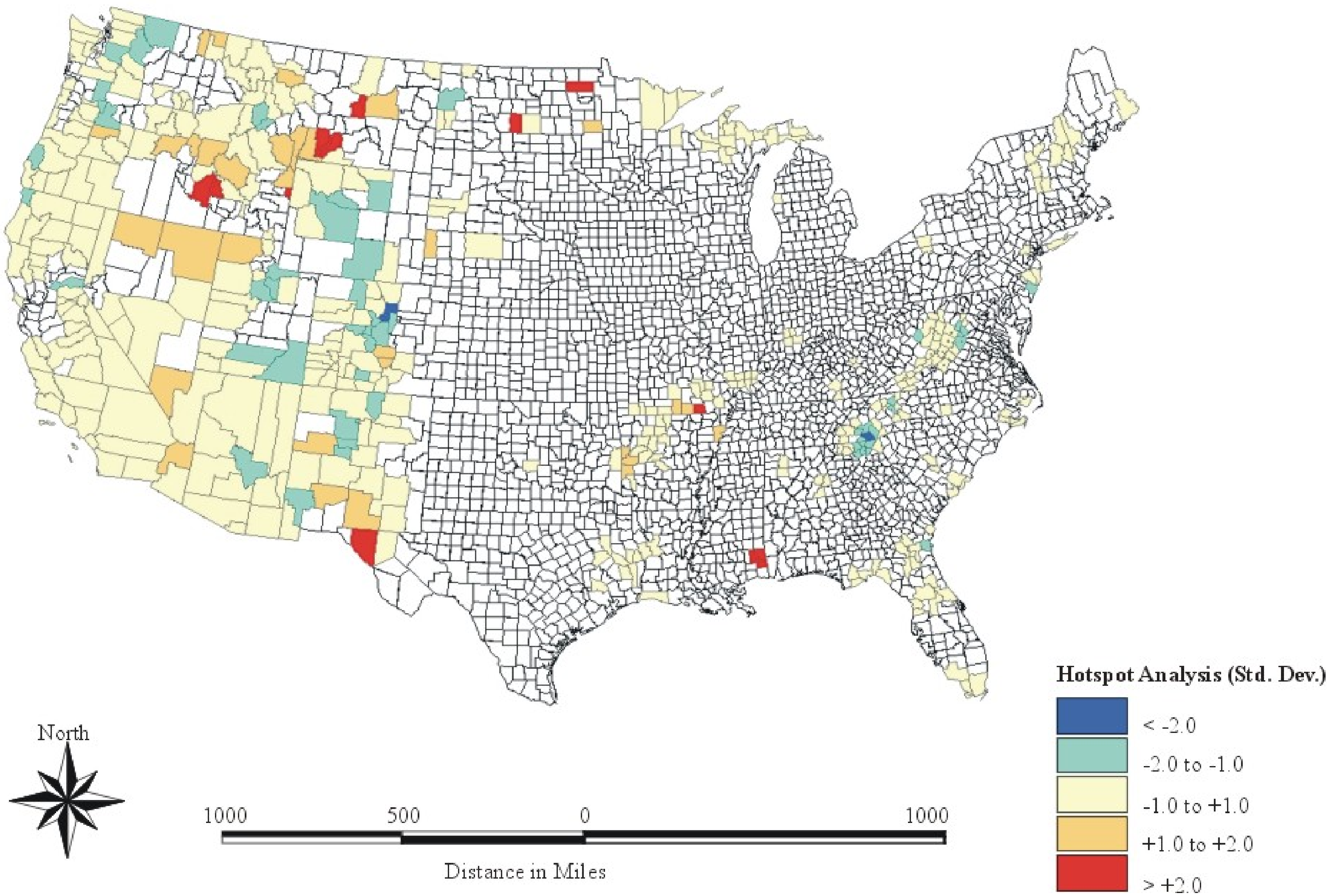


Figure 2.8: Hot spot analysis (change in percent population with college education from 1980-2000) in the Eastern and Western U.S.

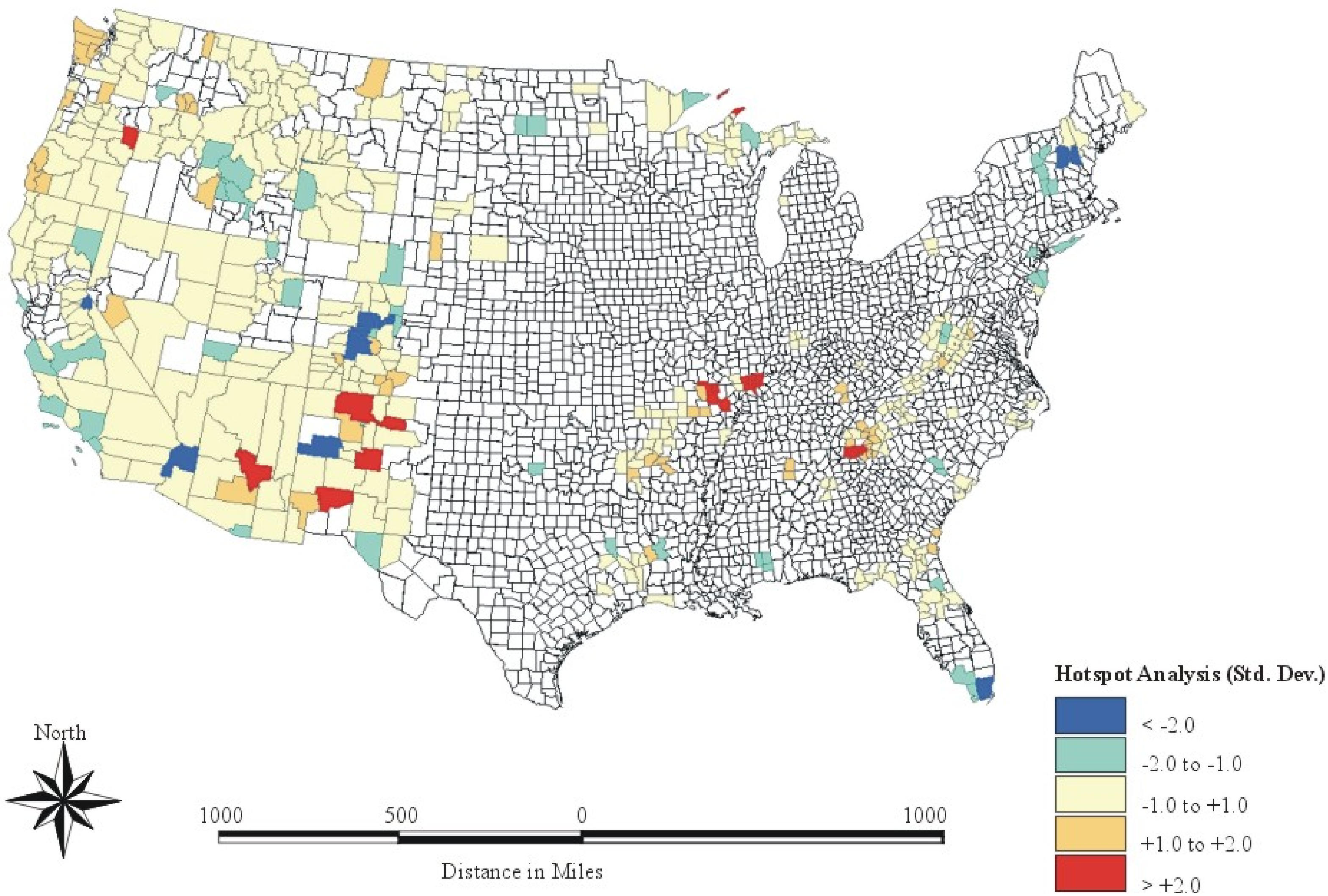
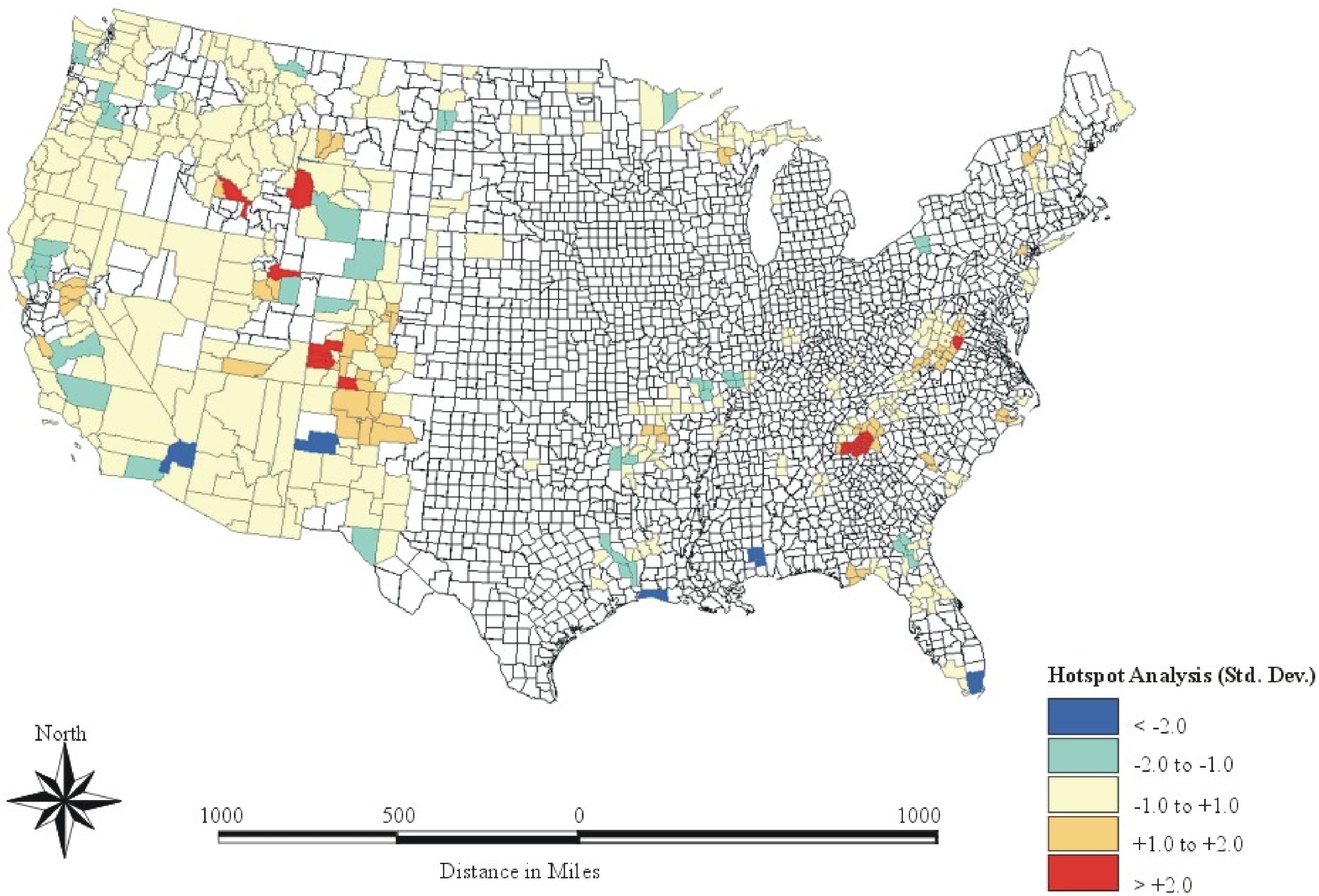


Figure 2.9: Hot spot analysis (change in median household income from 1980-2000) in the Eastern and Western U.S.



CHAPTER 3

SOCIO-DEMOGRAPHIC CHARACTERISTICS OF RESIDENTS IN THE FRINGE OF FEDERAL PROTECTED LANDS: EXAMINING DISTRIBUTIONAL DIFFERENCES FROM PROXIMITY AND REGIONAL PERSPECTIVES[1]

---

[1]Raychaudhuri, U; Tarrant, M.A.; Cordell, H.K.; Newman, D.H.; and Nibbelink, N.P. To be submitted to *Environmental Management*

ABSTRACT

This study examines the spatial distribution of Federal protected lands in the contiguous United States and the distributional differences in socio-demographic characteristics (race, education, occupation, and income) of residents in fringe areas (Counties and Census Block Groups) surrounding these protected lands. Using multivariate statistical analysis and geographic information systems, protected areas were examined as per the World Conservation Union categories and socio-demographics were analyzed in a temporal scale to illustrate change. Understanding the characterization of residents in fringe areas using the human dimensions framework will aid in future planning and policy formation concerning management surrounding protected areas.

INDEX WORDS: Federal protected lands, fringe, geographic information systems, human dimensions framework, and census data.

CHAPTER 3

In a rapidly growing and increasingly changing world, population demographics play a significantly important role in the use and demands made upon existing resources, especially natural resources. The population growth in the United States is estimated to nearly double by the turn of the century (571 million by 2100) from today's population of approximately 300 million (world population of approximately 6.5 billion) (U.S. Census Bureau, 2006). Census statistics indicate that a majority of this population growth is happening in and around expanding urban areas in the United States.

The increase in urban growth and resultant exurban settlement is a prime factor in the continued loss of natural habitats and stress on natural resources in the United States. While the availability of land (both public and private) has declined, people's demand for the products and services of public lands is expected to continue to increase in the future. For example, currently almost 95 percent of the U.S. population 16 years and older participate in some form of outdoor recreation and over 40 percent of the adult population enjoys some form of wildlife recreation. These activities generate over $100 billion in revenues (see NSRE, 2006 and Fish and Wildlife Service Strategic Plan 2000-2005, 2000).

In seeking these avenues for recreation and also better, cleaner, and pollution free habitats, people from the urban areas are rapidly moving towards the fringe of public lands (protected areas being a part of the public lands), resulting in a process of ex-urbanization (Champion, 1989; Wardwell, 1980). Primarily the development happening in the fringe of protected areas is the growing numbers of seasonal and second homes. According to Kilman and

Rose (1996) the two dominant activities driving population growth from 1990 to 1995 in rural counties were retirement (13.8 percent of growth), and recreational activities (9.7 percent of growth), as opposed to previous beliefs that commuting (6.9 percent), manufacturing (4.6 percent), and farming (3.2 percent) were the cause of such settlement patterns.

Areas on the Federal protected land-urban interface are now becoming settlement grounds for migrating populations to exurban areas. The ex-urbanization pattern and growth in settlement on lands proximate to protected area boundaries are resulting in changing economics of land use, land costs, transportation, infrastructure (sewer, water, power) and other service provisions (schools, hospitals, police) (Raychaudhuri, 2003). The distribution of protected lands as a mosaic on the land mass of the United States and the composition of inhabitants who live in the interface/fringe bordering these lands are important for the understanding of how socio-demographic changes are going to impact the future of protected areas and to provide land planners, managers, scientists and others, some management options for sustainability.

Purpose of this Study

The purpose of this study was to examine the spatial distribution of Federal protected lands in the contiguous United States and the socio-demographics in fringe areas (counties and census block groups) surrounding these protected lands.

Protected Areas

The Federal government manages nearly 30 percent of the land in the United States which accounts for approximately 650 million acres of land (National Atlas of the United States, 2005). These Federal lands are for the use of all inhabitants of the United States. The Federal agencies that manage these lands protect them for their natural resources and manage these lands for economic growth. This study however only includes public lands classified as per the World

Conservation Union (IUCN) protected area categories from the Bureau of Land Management, Forest Service, Fish and Wildlife Service, and National Park Service. This study does not include public land areas from the Bureau of Indian Affairs, Bureau of Reclamation, Department of Defense, Tennessee Valley Authority (since they have very different management objectives, policies, and guidelines), and other lands which are privately owned (even though they might have characteristics similar to protected lands) amongst others.

Protected areas as per the IUCN and the World Commission on Protected Areas (WCPA) are defined as 'areas of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means (IUCN, 1994).' The IUCN has categorized protected areas based on management objectives. IUCN has six recognized categories which are defined based on the level of gradation in human intervention (from category I to V). Category Ia/Ib has relatively no human intervention and Category V has relatively high levels of intervention. Category VI was only added to the classification system in the 1994 revision and therefore it does not follow the general pattern of categorization but is conceptually situated between Categories III and IV. The IUCN emphasizes that all categories are equally important and relevant to the conservation of biological diversity.

The Wikipedia encyclopedia reports that as per the protected area definitions, the United States had 7448 protected areas (excluding marine protected areas) as of 2002. Protected areas in the United States are managed by a variety of institutions ranging from Federal, state, and tribal to local level authorities who provide varying levels of protection. Some protected areas are managed and designated as wilderness zones while others are managed with acceptable levels of commercial exploitation of the resources. Protected areas comprise of a highly protected core area which secures critical habitats and species. These areas are surrounded by buffer zones/fringe areas which allow a broader range of uses and also insulate the core from threats to its conservation. Protected areas are often nature preserves which are isolated as islands surrounded by incompatible land uses which are development oriented. The fringe zones of protected areas have a wider range of aims for public and private benefit at local, national and global levels and span both short and long-term scales (IUCN, 1994). It is therefore important to view protected areas as part of a bigger regional approach to land management and critically examine the fringe or interface of protected areas with surrounding land uses to be able to understand the bio-regional scale for ecosystem management of these areas.

Fringe Areas

Buffer/fringe areas are like multiple-use zones where human intervention and use interact with landscapes that are hospitable to wild species. Fringe areas are a part of an integrated land-use which provides both ecological and socio-economic benefits (Miller, Chang and Johnson, 2001). Fringe areas are multiple-use landscapes managed for bio-diversity maintenance and human benefit and envisioned on the Man and Biosphere Reserve concept (MAB, 2006). Even IUCN envisioned a shift in its protected areas concepts to herald at the Durban congress a 'new paradigm' which focused on "new, more people-focused protected areas legislation" as well as "the 're-engineering' of protected areas people, the re-education of politicians and the public so they understand the new model of protected areas, and the reorientation of development assistance policies so as to integrate protected areas into poverty reduction strategies (Phillips, 2003b, pp. 20–21)." The change in paradigm emphasized the interaction between nature and humans. Promoting this shift in paradigm, IUCN president Kakabadse said, "Protected areas should include those lived in humanized landscapes where people and nature live in some kind of balance (Phillips, 2002, p. 15)."

To achieve balance in these humanized landscapes it is critical to examine these areas from a sustainability point of view. Sustainable principles integrate an understanding of planning and management processes that reduce conflict and increase compatibility within and between society and nature. Sustainable development which encompasses social theory and environmental thinking leads to better planning and conflict resolution amongst communities (Campbell, 1996). According to the World Commission on Environment and Development, sustainable development stresses generational equity, or meeting the needs of the present without compromising the ability of future generations to meet their own needs (Bruntland, 1987). In the context of generational equity, the natural, physical and human capital that is passed on to future generations includes protected areas and fringe/buffer zones around them.

It is therefore important to understand these fringe areas because they act as platforms of change in the ecological networks of the region and it is the characterization of these areas which defines the sustainable resource management practices that provide directions for development or protection of these regions. From a sustainable development perspective fringe zones can fulfill both conservation and development aims and be termed as Integrated Conservation and Development Areas (ICDA's) which are similar in philosophy to WCPA's integrated conservation and development projects (ICDP's) whose goal is to enhance biodiversity conservation through social approaches such as addressing the needs, constraints and opportunities of local people (Wells and Brandon, 1993).

Framework for this Study

This study is based on the principles of the Human Dimensions Framework (HDF) (see Bright, Cordell, Hoover and Tarrant, 2003). Three of the ten principles (namely 1, 4 and 8) of the HDF are used in this research. Human dimensions represent the primary features of the human ecosystem that affect, or are affected by, an ecological system (Bright et al, 2003).

> The HDF provides a framework for identifying and organizing human dimensions information by bringing together concepts from a variety of social science disciplines, categorizes them into basic social dimensions, and connects the concepts with measurable indicators designed to represent those concepts. It also provides guidance in use of the HDF for social assessments, (Bright et al, 2003, p.1).

Principles 1 and 4 of the HDF address the role of social sciences in land management planning, policy, and decision-making processes. By evaluating the socio-demographic and socio-economic character of the region, planners are able to characterize the composition of local stakeholders (which influences attitudes and values of stakeholders). This composition may not be stable and a time series analysis provides an insight into the historical analysis of the social environment and the nature of the change (which might provide insight into future issues). Principle 8 addresses the need for assimilating and synthesizing socio-demographic information on multiple scales (spatially and temporally). Understanding spatial variation in data is important because there are regional characteristics of socio-demographic data which exists, “e.g. in the Western States, communities or regions often are strongly affected by management of Federal lands, (Bright et al, 2003, p.30).”

Ecosystem components are influenced by shifting social values and perceptions and land management laws, policies, and management practices need to reflect changes in social, environmental, and political conditions (Cortner, Shannon, Wallace et al, 1996). The shifting values and characteristics bring to point the notion of distribution and differences in distribution that arise because of change. Distribution in this context refers to the geo-spatial and temporal distribution of communities which have their own inherent characteristics (racial, economic, occupational, and educational). A distributional difference then is a measure of the differences in community characteristics in a spatial and/or a temporal scale. Therefore to be able to understand the interactions between nature and local communities it is important to understand the human dimensions (measured by socio-demographic characteristics) in fringe areas around Federal protected lands.

Research Question

This research integrates human dimensions information in spatial, social, and temporal scales of analysis and based on this conceptual framework the research question is: Is there a difference between people who live near the fringe of Federal protected areas versus people who stay distant from protected areas?

Objectives of this Study

This study analyzes the socio-demographic characteristics of residents living on the fringe of Federal protected lands in the contiguous United States. This study examines the spatial distribution of counties and Census Block Groups (CBG) adjacent to protected areas and the socio-demographic characteristics of residents in those areas versus people who are distant or outside the fringe of protected areas (overall contiguous United States and Eastern versus Western United States). Census data was used to examine distributional differences between residents of areas proximate versus areas distant from the various categories of protected areas.

Based on data retrieved from the IUCN list of US protected lands the Federal protected lands were segregated into two categories (see Figure 3.1 – 3.4):

a) Category A (corresponding to IUCN category Ia/Ib)

b) Category B (corresponding to IUCN categories II-VI)

The study defines category A by the NWPS database and hence is also contained by the limitations of the NWPS database. The NWPS database is in a constant state of flux and new lands are designated as wilderness periodically (Meyer and Landres, 2000). The current study is consistent with the NWPS database as of January 2006. The classification of category B is also a conceptual framework comprising of IUCN categories II – VI. This classification represents a binary difference between all protected areas where the segregation has been on the basis of wilderness designation – category A representing primarily wilderness lands and category B representing non-wilderness protected lands. The areas (Federal protected lands) that comprise category B are also in a state of flux as new areas are added and appropriated to the database.

The study objectives are:

Objective 1: Examine and display the socio-demographic characteristics of residents in the contiguous United States at the county level by category A and B and across time, analyzing for proximity (adjacent vs. distant) to Federal protected lands.

Objective 2: Examine the socio-demographic characteristics of residents in the contiguous United States at the CBG level by category A and B, and regional variation, analyzing for proximity (adjacent vs. distant) to Federal protected lands.

<u>Methods</u>

The data set consists of geo-spatial information on Federal protected lands in the contiguous United States. Spatial patterns that emerge from the distribution of Federal protected lands in the contiguous United States and the associated socio-demographic characteristics of residents which live proximate to these areas are useful tools in land planning, land management, and decision making. Geographic information systems (GIS), was used to map and analyze these distributional differences amongst the various socio-demographic variables.

Category A Federal protected areas corresponding to IUCN categories Ia and Ib as zones with maximum protection and preservation areas included the National Wilderness Preservation System (NWPS) areas of the United States as outlined in the Public law 88-577. The data set was created by extracting wilderness areas from the National Atlas map layer, Federal Lands of the United States. Wilderness area shape files were downloaded from the National Atlas of the United States web-site (2006) and county/CBG data (shape files and attribute information) were retrieved from the Census CD Version 2.0 (GeoLytics, 2002). Wilderness areas (n = 993) within the contiguous United States were included in the analysis.

Category B Federal protected areas corresponding to IUCN categories II to VI as zones with decreasing levels of protection and multi-use zones/conservation areas included lands under the Bureau of Land Management, National Park Service, National Forest Service, and National Fish and Wildlife Service. The data set was created by extracting public land data from the National Atlas map layer, Federal Lands of the United States. Protected public land shape files were downloaded from the National Atlas of the United States web-site (2006) and county/CBG data (shape files and attribute information) were retrieved from the Census CD Version 2.0 (GeoLytics, 2002). Public lands and protected areas (n = 23622 – 310 National Parks, 1730 National Forests, 20,582 Bureau of Land Management lands, and 1000 Fish and Wildlife Service National Refuges) within the contiguous United States were included in the analysis.

Geo-spatial data downloaded from National Atlas of the United States website were in the form of shape files (digital vector based polygons) which are representations of geographic entities with attached tables containing attribute information. In the case of public land/protected area shape files, only limited attribute information was available (e.g., name and geographic coordinates). For county/CBG shape files, attribute information included per-capita income, race, education, and occupation. Attributes for feature type, feature name, agency ownership, uniform resource locater (URL), State, and State FIPS codes were retained. The minimum map resolution included in the data was an area of 640 acres or one square mile.

To represent the characteristics of the population, this study evaluated four socio-economic variables: race, education, occupation and income. These were synchronous with previous studies by Tarrant and Cordell (1999), Porter and Tarrant (2001), and Green, Tarrant, Raychaudhuri and Zhang (2005), who evaluated these variables on environmental justice research concerning locally desirable land use studies. The dependent variables in this research were:

a) Race: It was categorized as percent of the total population white (including white Hispanics) versus non-white (comprised of black, Native American Indian, and other). It was calculated as white population divided by the total population

b) Occupation: It was categorized as percent of the total workforce classified in blue-collar occupations (farming, construction, production, transportation, and installation) versus white collar and service occupations. It was calculated as number of blue collar employees divided by total employees

c) Education: It was classified according to percent of the population who had attended college for at least one year. It was calculated as the total population attending some college, obtaining bachelor or higher degree (including Masters and Doctoral degree) divided by the total population older than 25 years, and

d) Per-capita income: It was measured as a continuous level variable in dollars. Per-capita income was adjusted for inflation for the years 1980 and 1990. The consumer price index (CPI) was used to adjust the 1980 and 1990 values for inflation (www.bls.gov). The 1990 value was increased by a factor of 1.3175 from the actual 1990 value to obtain the 1990 adjusted value. The 1980 value was increased by a factor of 2.0898 from the actual 1980 value to obtain the 1980 adjusted value for baseline comparison with the 2000 data.

The independent variable in this study was dichotomous i.e., 0 representing counties outside of the fringe and 1 representing counties adjacent to the protected area boundaries (fringe) of protected lands. To define fringe boundaries the study was consistent with previous studies by Glickman, 1994; Hamilton, 1995; Kriesel, Centner, and Keeler, 1996; U.S. General Accounting Office, 1995; and Green et al, 2005; who used a 1500 meter (approximately 1 mile) cut-off to define the boundaries of fringe zones. Areas which were outside the boundaries of 1500 meters were considered distant (as opposed to adjacent) from Federal protected lands. Using the 1500 meter buffer demarcation makes the study consistent with other studies to be able to compare and evaluate. However the benefits and values of Federal protected lands is fluid in nature and not contained in definite physical boundaries and hence areas outside the buffer may also be influenced by their proximity/distance to Federal protected lands.

Data were spatially represented in ArcView GIS software, version 3.3 and ArcGIS 9.0 (Environmental Systems Research Institute, 1999) using the Albers Equal Area projection in metric units. The buffer analysis capability of ArcView GIS was used to delineate new shape files for assessment of proximate areas and all counties/CBG which touched or intersected a protected land boundary were selected to be in the fringe zone. Data from the spatial analysis was then exported to SPSS (Statistical Package for the Social Sciences, 2005) version 14.0 for statistical analysis.

In SPSS, the spatially referenced socio-demographic data was analyzed descriptively and was initially screened for normality using skewness and kurtosis measures. Since the sample size was fairly large (n = 3111 for counties and n= 207496 for CBG), the data was assumed to represent normality. Characters of communities inside the buffer were compared to those outside the buffer. Evidence of differences in socio-demographics was then defined as when communities in the buffer are significantly different from those outside the buffer. A multivariate model was created represented by: $Y_{ij} = \mu_{..} + \alpha_{.j} + \varepsilon_{ij}$, where $\alpha_{.j}$ represents group effects, ε_{ij} represents a measure of differences, and $\mu_{..}$ represents the group mean.

An analysis of main effects was used to test the hypothesis of interaction between the factors (variables) and marginal means. A measure of significance on how much percent variation exists in the system was explained by the grouping variable and indicated by the Wilk's Λ statistic. Since the study used census data and not sample data therefore instead of measuring significance tests the study evaluated Eigen values which computed the effect size measures to see if meaningful dimensions existed between the variables. To define the constructs which represented differences amongst the variable the measure of Structure r's was used. Canonical correlation values and Dimension Reduction Analysis also indicated significance amongst the variables.

Results

Objective 1:

Descriptive statistics (at the county level) of the socio-demographic characteristics for the contiguous United States is displayed in Table 3.1. The socio-demographic characteristics and comparison across time (from 1980 to 2000) are presented in Table 3.2 – 3.4 and represent the change across time for the socio-demographics characteristics across the contiguous United States. A descriptive analysis of temporal comparisons of the socio-demographic characteristics by protected area categories are provided in Tables 3.5 – 3.10. Analyzing the data from the tables we see that at the county scale of measurement, adjacency to protected areas for category A had a higher percent white population with lower rate of decrease, lower percent population in blue collar occupation with a higher rate of decrease, higher percent population with college education with a lower rate of increase, and higher per-capita income for population with a higher rate of increase versus category B protected areas.

At the county scale of measurement, being distant to protected areas for category A had a nearly equal or lower percent white population with a higher rate of decrease, nearly equal percent population in blue collar occupation with a nearly equal rate of decrease, nearly equal percent population with college education with a nearly equal rate of increase, and lower per-capita income for population with a nearly equal rate of increase versus category B protected areas.

Counties adjacent to category A protected areas had a higher percent white population with a lower rate of decrease, lower percent population in blue collar occupation with a higher rate of decrease, higher percent population with college education with a lower rate of increase, and higher per-capita income with a higher rate of increase for population versus those distant from category A protected areas from 1980 to 2000. Counties adjacent to category B protected areas had nearly equal or lower percent white population with a higher rate of decrease, nearly equal or lower percent population in blue collar occupation with a higher rate of decrease, higher percent population with college education with a lower rate of increase, and lower per-capita income for population with a nearly equal rate of increase versus those distant from category B protected areas from 1980 to 2000. These results are visually represented in Figures 3.5 – 3.16.

Tables 3.11 – 3.18 represent the multivariate statistical analysis of the socio-demographic data both spatially and temporally. Analyzing the statistical data from the tables, we see that testing for differences in socio-demographic characteristics (at county level) for category A and B protected areas (1980 to 2000) across contiguous United States we find that multivariate significance, as indicated by Pillai's test, is evidence that the centroids are significantly different and that the two groups (populations adjacent to protected areas vs. populations distant from protected areas) are different on at least one construct. The effect size variation is very small and the proportion of relationship or variation between the grouping variable and underlying constructs is less than 1 percent. The structure r's indicate that the main source of difference (construct) in the groups is from percent of population who have college education. Additionally Category B also had per-capita income as a significant construct.

Objective 2:

While objective 1 represented county level data across time periods (1980 – 2000), objective 2 represents data at the CBG scale and regionally for the year 2000. Descriptive analysis of CBG data is represented in Tables 3.19 – 3.23. Analyzing the data in the tables we see that in the Eastern United States CBG adjacent to category A protected areas had a higher percent white population, higher percent population in blue collar occupation, lower percent population with college education, and lower per-capita income for population versus those distant from protected areas. For category B protected areas those adjacent to protected areas had higher percent white population, higher percent population in blue collar occupation, lower percent population with college education, and lower per-capita income for population versus those distant from protected areas.

At the CBG scale of measurement, adjacency to protected areas for category A had higher percent white population, lower percent population in blue collar occupation, nearly equal percent population with college education, and higher per-capita income for population versus those adjacent to category B protected areas. At the CBG scale of measurement being distant to protected areas for category A had a higher percent white population, nearly equal percent population in blue collar occupation, nearly equal percent population with college education, nearly equal per-capita income for population versus those distant from category B protected areas.

Comparing for regional differences in the United States at the CBG level, areas adjacent to protected areas in the Eastern United States had a higher percent white population, higher percent population in blue collar occupation, lower percent population with college education, and lower per-capita income for population than those in the West. Areas distant from protected areas in the East had higher percent white population, higher percent population in blue collar occupation, lower percent population with college education, and lower per-capita income for population versus those in the West.

Tables 3.24 – 3.26 represent the multivariate statistical analysis of the socio-demographic data both spatially and temporally. Analyzing the statistical data from the tables we see that testing for differences in socio-demographic characteristics (at CBG level) for category A protected areas (in year 2000) across contiguous United States we find that multivariate significance, as indicated by Pillai's test, is evidence that the centroids are significantly different and that the two groups (populations adjacent to protected areas vs. populations distant from protected areas) are different on at least one construct. The effect size variation is very small and the proportion of relationship or variation between the grouping variable and underlying constructs is less than 1 percent. The structure r's indicate that the main source of difference (construct) in the groups is race (percent of population who are white).

Testing for differences in socio-demographic characteristics (at CBG level) for protected areas (in year 2000) in the Eastern and Western United States shows that multivariate significance, as indicated by Pillai's test, is evidence that the centroids are significantly different and that the two groups (populations adjacent to protected areas vs. populations distant from protected areas) are different on at least one construct. The effect size variation is very small and the proportion of relationship or variation between the grouping variable and underlying constructs is less than 1 percent. The structure r's indicate that the main source of difference (construct) in the groups (between adjacent/distant) is from percent of population with blue collar occupation in the Eastern United States and race (percent of population white) in the Western United States. The main source of difference (construct) in the groups (between categories A & B) is from per-capita income.

Summarizing the results of the study shows that areas adjacent to protected lands are comprised of higher percent white population, lower percent blue collar workers, higher percent college educated people and higher per-capita income. The effect is more pronounced in fringe of category A protected areas than in category B protected areas which are more homogenized. Also, the Western United States exhibits larger effects as a result of proximity to Federal protected lands than the Eastern United States. At the county level, results show that the main source of distributional difference between communities is because of education and per-capita income. At the CBG level, results show that the main source of distributional difference between communities is because of racial differences at the national level but both racial and per-capita income at the regional scale. Examining for change and trends the results show that at both scales of measurement (counties and CBG) the primary distributional differences in communities temporally has been caused by education. Results also show that distributional differences between communities in the United States are however narrowing over time (more so in the category B fringe areas than in category A fringe areas).

<u>Discussion and conclusions</u>

Based on the study results it is important to understand the characterization of the fringe of protected areas and the nature of change which is occurring there because it constitutes an integral part of ecosystem management. As represented in Table 3.27 we see that there is high correlation between income, occupation and education. Changes in education levels as represented in the results affect the other socio-demographic variables, thus altering the overall characterization of communities. As managers, planners, and policy makers make decisions both at community and larger (national, state or landscape) scales, an understanding of both the ecological and social processes operating in the ecosystem will make it easier to provide an informed policy. Many environmentalists have advocated participatory and community-based natural resource management (CBNRM) to address the differences in results the study found at the county and CBG level. By understanding the nature of the communities, representative and accountable local institutions provide keys to equity, justice, and efficiency in local decision making (Ribot, 2002).

The implication of human dimensions research on the socio-demographic characteristics of residents in the fringe of Federal protected lands provides management options towards sustainable development. According to Murray Bookchin (2001), “nearly all our present ecological problems arise from deep-seated social problems. Conversely, present ecological problems cannot be clearly understood, much less resolved, without resolutely dealing with problems within society (p. 436).” Therefore it is very important that we understand the demographic characteristics and composition of society.

Communities which live adjacent to Federal protected lands have established bonds, understanding, familiarity and relationships with these areas. These social structures have been a result of, and are influenced by, their cultural identities and subsistence practices. As evident from the study, the changing structure of these communities is fracturing these bonds and exerting pressure on the ecosystem. Understanding the distributional differences between communities and the trends of the differences has important implications not only in the social and political realm, but also in understanding the process used to develop management goals and plans. Change in community characteristics can also result in difference in values and attitudes that residents bring with them. Studies on the National Survey of Recreation and the Environment (see NSRE, 2006) have shown that there is a growing shift towards more demands and access for recreational opportunities which are provided by Federal protected lands. The social and psychological parameters that influence such change stem from differences between perceptions by new migrants to the fringe as opposed to long term residents. Alm & Witt (1996, p. 26) summarize this potential, “. . . there exists a deep historical conflict among competing values that has resulted in an ‘us against them,’ orientation where farmers, ranchers, loggers and miners view themselves as under siege from the new urban driven environmentalists.” The major difference between new migrants and existing rural dwellers is based on quality-of-life issues. In high-amenity areas (such as the Federal protected land fringe), quality of life deals directly with amenities such as clean air, pure water, forests, scenic vistas, and wildlife based recreation. In these fringe areas the newer residents and visitors place greater values towards recreation while perhaps lacking the historical and cultural connection to the land that previous rural dwellers had. Therefore for effective management of these ecosystems it is required that protected area managers, planners and policy makers recognize the stratified nature of these communities and provide/develop suitable sustainable options of development.

This study has represented both the macro (national and regional) grain and micro (county and CBG) grain of socio-demographic characteristics. However there are differences which exist at landscape levels, topological levels and individual levels. Directions for further research with distributional differences should focus on assimilating these studies to compare and enhance the current findings. There is increasing acknowledgement of the fact that there are very few areas on this planet that have been spared the human footprint and impact (Cordell and Overdevest, 2001). As development spreads far and wide and into the fringe of Federal protected lands it is required, therefore, to have an approach that is aligned with one where, "conservation thought is characterized by an enthusiasm for environmental intervention and manipulation" that will "maintain the conservation ideal in a steady state of human intervention designed to maintain a given habitat at a particular successional stage in perpetuity (Henderson, 1992, p. 397)." The HDF which acknowledges the new paradigm of development and is based on principles of sustainability would provide an integrated multi-purpose viable management option for the future of fringe areas surrounding Federal protected lands.

References

Alm, L.R. & Witt, S. (1996). The rural-urban environmental conflict in the American West: A four-state study. *Spectrum, Fall*: 26–36.

BLS (2006). Bureau of labor statistics. Retrieved April, 24, 2006 from http://www.bls.gov/

Bookchin, M. (2001). What is social ecology? In M.E. Zimmerman, J.B. Callicott, G. Sessions, K.J. Warren and J. Clark (Eds.), *Environmental philosophy* (3rd ed., pp. 436-454). Upper Saddle River, NJ: Prentice Hall.

Bright, A.D.; Cordell, H.K.; Hoover, A.P.; Tarrant, M.A. (2003). A human dimensions framework: Guidelines for conducting social assessments. *Gen. Tech. Rep. SRS-65*. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station.

Bruntland, G. (1987). *Our common future: The World Commission on Environment and Development.* Oxford University Press: Oxford, UK

Campbell, S. (1996). Green cities, growing cities, just cities? Urban planning and the contradictions of sustainable development. *Journal of the American Planning Association, 62*(3), 296-312.

Champion, A. (1989). Counter urbanization: The conceptual and methodological challenge. In A. Champion (Ed.), *Counter urbanization: The changing pace and nature of population deconcentration*. London: Edward Arnold.

Cordell, H. K. & Overdevest, C. (2001). *Footprints on the land: An assessment of demographic trends and the future of natural lands in the United States.* Champaign, IL: Sagamore Publishing.

Cortner, H.J.; Shannon, M.A.; Wallace, M.G. [and others]. (1996). Institutional barriers and incentives for ecosystem management: A problem analysis. *Gen. Tech. Rep. PNW-GTR-354.* Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.

Environmental Systems Research Institute (1999). *ArcView GIS: Using ArcView GIS.* Redlands, CA: Environmental Systems Research Institute.

Fish and Wildlife Service Strategic Plan 2000-2005. (2000). Retrieved April 24, 2006, from http://www.fws.gov/planning/USFWStrategicPlanv3.pdf

GeoLytics, (2002). Census CD+ maps. East Brunswick, NJ: GeoLytics, Inc.

Glickman, T. S. (1994). Measuring environmental equity with geographic information systems. *Resources, 116:* 2-6.

Green, G., Tarrant, M., Raychaudhuri, U., & Zhang, Y. (2005). Wilderness in whose backyard? *International Journal for Wilderness, 11*(3): 31-38

Hamilton, J. T. (1995). Testing for environmental racism: Prejudice, profits, political power? *Journal of Policy Analysis and Management, 14*, 107-132.

Henderson, N. (1992). Wilderness and the nature conservation ideal: Britain, Canada, and the US contrasted. *Ambio (21)*, 394–399.

IUCN (1994). *Guidelines for Protected Areas Management Categories.* IUCN, Cambridge, UK and Gland, Switzerland.

Kilman, S., & Rose, R.L. (1996). Population of Rural America is Swelling. *Wall Street Journal* June 21, 1996, B1.

Kriesel, W., Centner, T. J., & Keeler, A. G. (1996). Neighborhood exposure to toxic releases: Are there racial inequities? *Growth and Change, 27*, 479-499.

MAB (2006). The man and biosphere reserve program. Retrieved April 24, 2006, http://www.unesco.org/mab/mabProg.shtml

Meyer, S., & Landres, P. (2000). A national wilderness preservation system database: benefits, limitations and future needs. *International Journal of Wilderness, 6*(1), 13-18.

Miller, K., Chang, C. & Johnson, N. (2001). *Defining common ground for the Meso-American biological corridor.* World Resources Institute, Washington DC, USA

National Atlas of the United States. (2005). Retrieved November 10, 2005, from http://nationalatlas.gov/atlasftp.html

NSRE (2006). National survey on recreation and the environment. Retrieved on April 24, 2006, from http://www.srs.fs.usda.gov/trends/Nsre/nsre2.html

Phillips, A. (2002). M*anagement guidelines for IUCN category V protected areas: Protected landscapes/seascapes.* Best Practice Protected Area Guidelines Series. IUCN, Gland, Switzerland and Cambridge, UK.

Phillips, A (2003). A modern paradigm. *World Conservation Bulletin (2),* 6–7.

Porter, R. P. & Tarrant, M.A. (2001). A case study of environmental justice and Federal tourism sites in southern Appalachia: A GIS application. *Journal of Travel Research 40*, 27–40.

Raychaudhuri, U. (2003). *Environmental justice on the wilderness fringe: A GIS based analysis.* Unpublished Manuscript. University of Georgia, Athens, GA.

Ribot, J.C. (2002). *Democratic decentralization of natural resources: Institutionalizing popular participation.* World Resources Institute: Washington DC

SPSS, Inc. (2005). *SPSS Advanced Statistics 14.0.* SPSS, Chicago: SPSS, Inc.

Tarrant, M.A.; Bright, A.D.; Cordell, H. K. (1999). A world wide web human dimensions framework and database for wildlife and forest planning. *Human Dimensions of Wildlife, 3*(4), Winter, 18-43.

Tarrant, M. A., & Cordell, H.K. (1999). Environmental justice and the spatial distribution of outdoor recreation sites: An application of geographic information systems. *Journal of Leisure Research, 31*(1): 18–34.

U.S. Census Bureau (2006). Retrieved April 24, 2006, from http://www.census.gov/

U.S. General Accounting Office (1995). *Hazardous and non-hazardous waste: Demographics of people living near waste facilities* (No. GAO/RCED-95-84): U.S. Government Printing Office.

Wardwell, J. (1980). Toward a theory of urban-rural migration in the developed world. In D. Brown & J. Wardwell (Eds.), *New directions in urban-rural migration* (pp. 71-114). New York, NY: Academic. Wells & Brandon, 1993.

Wells, M.P. & Brandon, K.E. (1993). The principles and practice of buffer zones and local participation in biodiversity conservation. *Ambio, 22*(2-3), 157-162.

Table 3.1: Descriptive Statistics (at County Level) for Contiguous United States

Descriptive Statistics

	n	Minimum Statistic	Maximum Statistic	Mean Statistic	Std. Deviation Statistic
Percent white 1980	3101.00	6.05	100.00	88.54	15.07
Percent white 1990	3111.00	5.10	100.00	87.46	15.38
Percent white 2000	3108.00	5.01	100.00	84.75	16.04
Percent blue 1980	3099.00	0.00	65.52	35.86	9.83
Percent blue 1990	3111.00	8.14	60.03	32.44	8.95
Percent blue 2000	3108.00	6.30	53.83	30.45	7.93
Percent college 1980	3099.00	0.00	78.14	24.52	9.22
Percent college 1990	3109.00	11.70	100.00	35.27	11.06
Percent college 2000	3108.00	16.91	85.39	42.63	11.21
Per-capita income 1980	3111.00	0.00	45292.24	12595.05	2707.73
Per-capita income 1990	3111.00	0.00	37391.97	14647.62	3551.06
Per-capita income 2000	3108.00	5213.00	44962.00	17487.99	3932.88
valid n (listwise)	3093.00				

Table 3.2: Socio-demographic Characteristics (at County Level) Comparison Across Time for Contiguous United States

		Year					
		1980		1990		2000	
Variable	n	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
Percent white	3093	88.54	15.07	87.46	15.38	84.75	16.04
Percent blue	3093	35.86	9.83	32.44	8.95	30.45	7.93
Percent college	3093	24.52	9.22	35.27	11.06	42.63	11.21
Per-capita Income	3093	12,595.05	2,707.73	14,647.62	3,551.06	17,487.99	3,932.88

Table 3.3: Descriptive Statistics of Change Across Time (at County Level) for Contiguous United States

Descriptive Statistics

	n	Minimum Statistic	Maximum Statistic	Mean Statistic	Std. Deviation Statistic
Percent white 1980-1990	3101.00	-74.90	523.33	-0.73	15.31
Percent white 1980-2000	3101.00	-100.00	545.89	-4.04	16.51
Percent white 1990-2000	3111.00	-100.00	42.13	-3.41	5.75
Percent blue 1980-1990	3096.00	-54.90	220.22	-8.77	13.90
Percent blue 1980-2000	3093.00	-63.21	194.45	-13.60	16.49
Percent blue 1990-2000	3108.00	-44.40	85.14	-5.25	10.92
Percent college 1980-1990	3097.00	-44.08	477.73	47.43	19.48
Percent college 1980-2000	3094.00	-32.00	603.36	81.97	32.08
Percent college 1990-2000	3106.00	-12.70	102.36	23.17	11.95
Per-capita income 1980-1990	3109.00	-100.00	89.06	20.02	10.78
Per-capita income 1980-2000	3108.00	-88.06	100.00	27.23	10.92
Per-capita income 1990-2000	3108.00	-29.62	100.00	16.24	7.31
valid n (listwise)	3093.00				

Table 3.4: Socio-demographic Characteristics (at County Level) Comparison Across Time for Contiguous United States

Variable		Percent change over time					
		1980 - 1990		1990 - 2000		1980 - 2000	
	n	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
Percent white	3093	-0.73	15.31	-3.41	5.75	-4.04	16.51
Percent blue	3093	-8.77	13.90	-5.25	10.92	-13.60	16.49
Percent college	3093	47.43	19.48	23.17	11.95	81.97	32.08
Per-capita Income	3093	20.02	10.78	16.24	7.31	27.23	10.92

Table 3.5: Socio-demographic Characteristics (at County Level) Comparison (for 1980) Across Contiguous United States

Variable	Year 1980											
	Category A Protected Area						Category B Protected Area					
	Adjacent			Distant			Adjacent			Distant		
	n	Mean	Std. Deviation	n	Mean	Std. Deviation	n	Mean	Std. Deviation	n	Mean	Std. Deviation
Percent white	432	91.13	11.12	2664	88.13	15.57	1223	88.19	15.58	1883	88.78	14.72
Percent blue	432	34.45	9.65	2664	36.09	9.84	1223	35.72	10.21	1883	35.95	9.58
Percent college	432	29.03	11.61	2664	23.78	8.55	1223	25.99	10.47	1883	23.57	8.17
Per-capita Income	432	12,739.54	2,745.60	2664	12,628.23	2,571.95	1223	12,403.07	2,817.81	1883	12,799.08	2,431.84

Total n = 3096

Table 3.6: Socio-demographic Characteristics (at County Level) Comparison (for 1990) Across Contiguous United States

Variable	Year 1990											
	Category A Protected Area						Category B Protected Area					
	Adjacent			Distant			Adjacent			Distant		
	n	Mean	Std. Deviation	n	Mean	Std. Deviation	n	Mean	Std. Deviation	n	Mean	Std. Deviation
Percent white	432	90.32	11.06	2664	87.01	15.92	1223	87.05	15.87	1883	87.75	15.04
Percent blue	432	30.93	8.86	2664	32.69	8.94	1223	32.25	9.27	1883	32.57	8.73
Percent college	432	39.61	12.83	2664	34.56	10.58	1223	36.41	12.16	1883	34.52	10.21
Per-capita Income	432	14,858.27	3,730.90	2664	14,624.39	3,499.13	1223	14,295.94	3,636.72	1883	14,891.52	3,444.24

Table 3.7: Socio-demographic Characteristics (at County level) Comparison (for 2000) Across Contiguous United States

Variable	Year 2000											
	Category A Protected Area						Category B Protected Area					
	Adjacent			Distant			Adjacent			Distant		
	n	Mean	Std. Deviation	n	Mean	Std. Deviation	n	Mean	Std. Deviation	n	Mean	Std. Deviation
Percent white	432	86.54	12.42	2664	84.46	16.54	1223	83.94	16.61	1883	85.27	15.64
Percent blue	432	28.39	7.75	2664	30.78	7.91	1223	29.98	8.15	1883	30.75	7.77
Percent college	432	46.95	12.48	2664	41.93	10.83	1223	43.57	12.11	1883	42.02	10.54
Per-capita Income	432	17,809.94	4,436.21	2664	17,435.73	3,843.35	1223	17,121.95	4,121.34	1883	17,725.70	3,787.63

Table 3.8: Change in Socio-demographic Characteristics (at County level) Comparison (1980-1990) Across Contiguous United States

Variable	Percent change across time 1980 - 1990											
	Category A Protected Area						Category B Protected Area					
	Adjacent			Distant			Adjacent			Distant		
	n	Mean	Std. Deviation	n	Mean	Std. Deviation	n	Mean	Std. Deviation	n	Mean	Std. Deviation
Percent white	432	-0.74	5.97	2661	-0.71	16.25	1212	-0.41	18.06	1881	-0.91	13.10
Percent blue	432	-9.54	15.83	2661	-8.73	12.95	1212	-8.85	15.89	1881	-8.84	11.50
Percent college	432	41.29	18.57	2661	48.43	19.44	1212	44.93	22.82	1881	49.05	16.77
Per-capita Income	432	20.72	11.81	2661	20.02	9.83	1212	20.65	10.78	1881	19.78	9.68

total n = 3093

Table 3.9: Change in Socio-demographic Characteristics (at County level) Comparison (1990-2000) Across Contiguous United States

Variable	1990 - 2000											
	Category A Protected Area						Category B Protected Area					
	Adjacent			Distant			Adjacent			Distant		
	n	Mean	Std. Deviation	n	Mean	Std. Deviation	n	Mean	Std. Deviation	n	Mean	Std. Deviation
Percent white	432	-4.21	4.41	2661	-3.15	4.91	1212	-3.72	4.94	1881	-3.02	4.78
Percent blue	432	-7.3	10.59	2661	-4.91	10.95	1212	-6.09	11.02	1881	-4.70	10.84
Percent college	432	21.56	12.41	2661	23.47	11.87	1212	22.47	12.62	1881	23.67	11.50
Per-capita Income	432	16.38	8.15	2661	16.14	6.81	1212	16.46	7.41	1881	15.98	6.73

total n = 3093

Table 3.10: Change in Socio-demographic Characteristics (at County level) Comparison (1980-2000) Across Contiguous United States

Variable	1980 - 2000											
	Category A Protected Area						Category B Protected Area					
	Adjacent			Distant			Adjacent			Distant		
	n	Mean	Std. Deviation	n	Mean	Std. Deviation	n	Mean	Std. Deviation	n	Mean	Std. Deviation
Percent white	432	-3.76	17.21	2661	-4.93	6.53	1212	-4.06	18.36	1881	-3.84	14.56
Percent blue	432	-16.43	15.78	2661	-13.15	16.56	1212	-14.51	17.96	1881	-13.02	15.46
Percent college	432	72.29	32.21	2661	83.55	31.79	1212	77.99	36.51	1881	84.54	28.59
Per-capita Income	432	27.61	10.8	2661	26.82	9.73	1212	26.86	10.83	1881	26.97	9.24

total n = 3093

Table 3.11: Test of Differences in Socio-demographic Characteristics (at County level) for Category A Protected Areas (for 1980) Across Contiguous United States

Variable	Category A Protected Area					
	Adjacent			Distant		
	n	Mean	Std. Deviation	n	Mean	Std. Deviation
Percent white	434	91.13	11.12	2665	88.13	15.57
Percent blue	434	34.45	9.65	2665	36.09	9.84
Percent college	434	29.03	11.61	2665	23.78	8.55
Per-capita Income	434	12,739.54	2,745.60	2665	12,628.23	2,571.95

Total n = 3099

Multivariate test for Homogeneity of Dispersion matrices:
Box's M = 220.47772; F with (10,2580912) DF = 21.97304, P = 0.000 (Approx.)
Chi-Square with 10 DF = 219.73130, P = 0.000 (Approx.)
Multivariate Tests of Significance (S = 1, M = 1, N = 1546)

Test Name	Value	Exact F	Hypoth. DF	Error DF	Sig. of F
Pillais	0.08226	69.33099	4.00	3094.00	<0.000

Multivariate Effect Size: 0.082
Eigen values and Canonical Correlations:

Root No.	Eigen value	Pct.	Cum. Pct.	Canon Cor.	Sq. Canon Cor.
1	.090	100.000	100.000	0.287	0.082

Correlations between DEPENDENT and canonical variables

Variable	Canonical Variable 1
Percent white 1980	-0.231
Percent blue 1980	0.194
Percent college 1980	-0.674
Per-capita income 1980	-0.050

Table 3.12: Test of Differences in Socio-demographic Characteristics (at County level) for Category B Protected Areas (for 1980) Across Contiguous United States

Variable	Category B Protected Area					
	Adjacent			Distant		
	n	Mean	Std. Deviation	n	Mean	Std. Deviation
Percent white	1215	88.19	15.58	1884	88.78	14.72
Percent blue	1215	35.72	10.21	1884	35.95	9.58
Percent college	1215	25.99	10.47	1884	23.57	8.17
Per-capita Income	1215	12,403.07	2,817.81	1884	12,799.08	2,431.84

Total n = 3099

Multivariate test for Homogeneity of Dispersion matrices
Boxs M = 267.08539 F WITH (10,31472964) DF = 26.66903, P = 0.000 (Approx.)
Chi-Square with 10 DF = 266.69036, P = 0.000 (Approx.)
Multivariate Tests of Significance (S = 1, M = 1 , N = 1546)

Test Name	Value	Exact F	Hypoth. DF	Error DF	Sig. of F
Pillais	.07386	61.68802	4.00	3094.00	<0.000

Multivariate Effect Size: 0.074
Eigen values and Canonical Correlations:

Root No.	Eigen value	Pct.	Cum. Pct.	Canon Cor.	Sq. Canon Cor.
1	0.080	100.000	100.000	0.272	0.073

Correlations between DEPENDENT and canonical variables

Variable	Canonical Variable 1
PERCENT WHITE 1980	0.067
PERCENT BLUE 1980	0.041
PERCENT COLLEGE 1980	-0.460
PER-CAPITA INCOME 1980	0.264

Table 3.13: Test of Differences in Socio-demographic Characteristics (at County level) for Category A Protected Areas (for 1990) Across Contiguous United States

Variable	Category A Protected Area					
	Adjacent			Distant		
	n	Mean	Std. Deviation	n	Mean	Std. Deviation
Percent white	434	90.32	11.06	2675	87.01	15.92
Percent blue	434	30.93	8.86	2675	32.69	8.94
Percent college	434	39.61	12.83	2675	34.56	10.58
Per-capita Income	434	14,858.27	3,730.90	2675	14,624.39	3,499.13

Total n = 3109

Multivariate test for Homogeneity of Dispersion matrices:
Box's M = 219.41313; F with (10, 2579585) DF = 21.86696, P = 0.000 (Approx.)
Chi-Square with 10 DF = 218.67043, P = 0.000 (Approx.)
Multivariate Tests of Significance (S = 1, M = 1, N = 1546)

Test Name	Value	Exact F	Hypoth. DF	Error DF	Sig. of F
Pillais	.05423	44.49476	4.00	3104.00	.000

Multivariate Effect Size: 0.054
Eigen values and Canonical Correlations:

Root No.	Eigen value	Pct.	Cum. Pct.	Canon Cor.	Sq. Canon Cor.
1	.057	100.000	100.000	.233	.054

Correlations between DEPENDENT and canonical variables

Variable	Canonical Variable 1
PERCENT WHITE90	-.312
PERCENT BLUE90	.285
PERCENT COLLEGE90	-.670
PER-CAPITA INCOME90	-.096

Table 3.14: Test of Differences in Socio-demographic Characteristics (at County level) for Category B Protected Areas (for 1990) Across Contiguous United States

Variable	Category B Protected Area					
	Adjacent			Outside		
	n	Mean	Std. Deviation	n	Mean	Std. Deviation
Percent white	1223	87.05	15.87	1883	87.75	15.04
Percent blue	1223	32.25	9.27	1883	32.57	8.73
Percent college	1223	36.41	12.16	1883	34.52	10.21
Per-capita Income	1223	14,295.94	3,636.72	1883	14,891.52	3,444.24

Total n = 3109

Multivariate test for Homogeneity of Dispersion matrices
Boxs M = 129.51075 F WITH (10, 32002101) DF = 12.93201, P = .000 (Approx.)
Chi-Square with 10 DF = 129.32018, P = .000 (Approx.)
Multivariate Tests of Significance (S = 1, M = 1, N = 1546)

Test Name	Value	Exact F	Hypoth. DF	Error DF	Sig. of F
Pillais	.05495	45.12297	4.00	3104.00	.000

Multivariate Effect Size: 0.055
Eigen values and Canonical Correlations:

Root No.	Eigen value	Pct.	Cum. Pct.	Canon Cor.	Sq. Canon Cor.
1	.058	100.000	100.000	.234	.054

Correlations between DEPENDENT and canonical variables

Variable	Canonical Variable 1
PERCENT WHITE90	.092
PERCENT BLUE90	.073
PERCENT COLLEGE90	-.348
PER-CAPITA INCOME90	.343

Table 3.15: Test of Differences in Socio-demographic Characteristics (at County level) for Category A Protected Areas (for 2000) Across Contiguous United States

Variable	Category A Protected Area					
	Adjacent			Outside		
	n	Mean	Std. Deviation	n	Mean	Std. Deviation
Percent white	434	86.54	12.42	2674	84.46	16.54
Percent blue	434	28.39	7.75	2674	30.78	7.91
Percent college	434	46.95	12.48	2674	41.93	10.83
Per-capita Income	434	17,809.94	4,436.21	2674	17,435.73	3,843.35

Total n = 3108

Multivariate test for Homogeneity of Dispersion matrices:
Box's M = 140.05822; F with (10, 2579717) DF = 13.95836, P = 0.000 (Approx.)
Chi-Square with 10 DF = 139.58412, P = 0.000 (Approx.)
Multivariate Tests of Significance (S = 1, M = 1, N = 1550 1/2)

Test Name	Value	Exact F	Hypoth. DF	Error DF	Sig. of F
Pillais	.03833	30.91956	4.00	3103.00	.000

Multivariate Effect Size: 0.038
Eigen values and Canonical Correlations:

Root No.	Eigen value	Pct.	Cum. Pct.	Canon Cor.	Sq. Canon Cor.
1	.040	100.000	100.000	.196	.038

Correlations between DEPENDENT and canonical variables

Variable	Canonical Variable 1
PERCENT WHITE00	-.226
PERCENT BLUE00	.527
PERCENT COLLEGE00	-.788
PER-CAPITA INCOME00	-.165

Table 3.16: Test of Differences in Socio-demographic Characteristics (at County level) for Category B Protected Areas (for 2000) Across Contiguous United States

Variable	Category B Protected Area					
	Adjacent			Outside		
	n	Mean	Std. Deviation	n	Mean	Std. Deviation
Percent white	1223	83.94	16.61	1883	85.27	15.64
Percent blue	1223	29.98	8.15	1883	30.75	7.77
Percent college	1223	43.57	12.11	1883	42.02	10.54
Per-capita Income	1223	17,121.95	4,121.34	1883	17,725.70	3,787.63

Total n = 3108

Multivariate test for Homogeneity of Dispersion matrices
Box's M = 85.83499 F WITH (10, 32006725) DF = 8.57086, P = .000 (Approx.)
Chi-Square with 10 DF = 85.70867, P = .000 (Approx.)
Multivariate Tests of Significance (S = 1, M = 1, N = 1550 1/2)

Test Name	Value	Exact F	Hypoth. DF	Error DF	Sig. of F
Pillais	.03618	29.12188	4.00	3103.00	.000

Multivariate Effect Size: 0.036
Eigen values and Canonical Correlations:

Root No.	Eigen value	Pct.	Cum. Pct.	Canon Cor.	Sq. Canon Cor.
1	.038	100.000	100.000	.190	.036

Correlations between DEPENDENT and canonical variables

Variable	Canonical Variable 1
PERCENT WHITE00	.210
PERCENT BLUE00	.247
PERCENT COLLEGE00	-.350
PER-CAPITA INCOME00	.388

Table 3.17: Test of change in Differences in Socio-demographic Characteristics (at County level) for Category A Protected Areas (1980 -2000) Across Contiguous United States

Variable	Category A Protected Area					
	Adjacent			Outside		
	n	Mean	Std. Deviation	n	Mean	Std. Deviation
Percent white	432	-3.76	17.21	2661	-4.93	6.53
Percent blue	432	-16.43	15.78	2661	-13.15	16.56
Percent college	432	72.29	32.21	2661	83.55	31.79
Per-capita Income	432	27.61	10.8	2661	26.82	9.73

total n = 3093

Multivariate test for Homogeneity of Dispersion matrices:
Box's M = 527.22594; F with (10, 2556027) DF = 52.54309, P = 0.000 (Approx.)
Chi-Square with 10 DF = 525.43298, P = 0.000 (Approx.)
Multivariate Tests of Significance (S = 1, M = 1, N = 1543)

Test Name	Value	Exact F	Hypoth. DF	Error DF	Sig. of F
Pillais	.02355	18.62015	4.00	3088.00	.000

Multivariate Effect Size: 0.024
Eigen values and Canonical Correlations:

Root No.	Eigen value	Pct.	Cum. Pct.	Canon Cor.	Sq. Canon Cor.
1	.024	100.000	100.000	.153	.023

Correlations between DEPENDENT and canonical variables

Variable	Canonical Variable 1
PERCENT WHITE1980-2000	-.161
PERCENT BLUE1980-2000	-.445
PERCENT COLLEGE1980-2000	-.789
PER-CAPITA INCOME1980-2000	.179

Table 3.18: Test of change in Differences in Socio-demographic Characteristics (at County level) for Category B Protected Areas (1980 -2000) Across Contiguous United States

Variable	Category B Protected Area					
	Adjacent			Outside		
	n	Mean	Std. Deviation	n	Mean	Std. Deviation
Percent white	1212	-4.06	18.36	1881	-3.84	14.56
Percent blue	1212	-14.51	17.96	1881	-13.02	15.46
Percent college	1212	77.99	36.51	1881	84.54	28.59
Per-capita Income	1212	26.86	10.83	1881	26.97	9.24

total n = 3093

Multivariate test for Homogeneity of Dispersion matrices:
Box's M = 235.36713; F with (10, 31309826) DF = 23.50182, P = 0.000 (Approx.)
Chi-Square with 10 DF = 235.01824, P = 0.000 (Approx.)
Multivariate Tests of Significance (S = 1, M = 1, N = 1543)

Test Name	Value	Exact F	Hypoth. DF	Error DF	Sig. of F
Pillais	.01303	10.18827	4.00	3088.00	.000

Multivariate Effect Size: 0.013
Eigen values and Canonical Correlations:

Root No.	Eigen value	Pct.	Cum. Pct.	Canon Cor.	Sq. Canon Cor.
1	.013	100.000	100.000	.114	.012

Correlations between DEPENDENT and canonical variables

Variable	Canonical Variable 1
PERCENT WHITE1980-2000	-.059
PERCENT BLUE1980-2000	-.384
PERCENT COLLEGE1980-2000	-.871
PER-CAPITA INCOME1980-2000	-.047

Table 3.19: Socio-demographic Characteristics (at Census Block Group level) Comparison (for 2000) Across Contiguous United States

Variable	Region					
	Contiguous U.S.					
	Category A Protected Area					
	Adjacent			Distant		
	n	Mean	Std. Deviation	n	Mean	Std. Deviation
Percent white 2000	1525	87.64	17.96	204705	75.34	27.73
Percent blue 2000	1525	26.44	12.31	204705	25.71	12.77
Percent college 2000	1525	52.04	19.42	204705	49.41	20.14
Per-capita Income 2000	1525	21,492.56	11,318.94	204705	21,288.10	11,867.39

Table 3.20: Socio-demographic Characteristics (at Census Block Group level) Comparison (for 2000) Across Eastern United States

Variable	Region Eastern U.S.											
	Category A Protected Area						Category B Protected Area					
	Adjacent			Distant			Adjacent			Distant		
	n	Mean	Std. Deviation	n	Mean	Std. Deviation	n	Mean	Std. Deviation	n	Mean	Std. Deviation
Percent white 2000	527	89.19	20.41	161655	76.04	29.08	4842	86.76	20.45	157340	75.71	29.25
Percent blue 2000	527	31.77	13.62	161655	26.29	12.97	4842	33.09	11.99	157340	26.08	12.94
Percent college 2000	527	39.62	18.27	161655	47.38	19.80	4842	39.41	16.08	157340	47.63	19.85
Per-capita Income 2000	527	19837.49	12646.99	161655	20,937.05	11,521.34	4842	17,932.50	8,067.89	157340	21,029.83	11,599.29

Table 3.21: Socio-demographic Characteristics (at Census Block Group level) Comparison (for 2000) Across Western United States

Variable	Region Western U.S.											
	Category A Protected Area						Category B Protected Area					
	Adjacent			Distant			Adjacent			Distant		
	n	Mean	Std. Deviation	n	Mean	Std. Deviation	n	Mean	Std. Deviation	n	Mean	Std. Deviation
Percent white 2000	1029	84.49	21.39	44285	71.09	24.05	5526	81.24	21.77	39788	69.64	24.00
Percent blue 2000	1029	22.92	11.13	44285	22.90	12.30	5526	23.47	10.72	39788	22.82	12.51
Percent college 2000	1029	57.04	18.91	44285	55.61	21.24	5526	55.13	17.92	39788	55.68	21.67
Per-capita Income 2000	1029	22062.47	13428.51	44285	22,069.85	13,481.42	5526	20,603.67	10,824.60	39788	22,278.89	13,806.11

Table 3.22: Socio-demographic Characteristics (at Census Block Group level) Comparison (for 2000) Across Eastern & Western United States for Category A Protected Areas

Variable	Region							
	Overall U.S. Protected Area Category A							
	Overall Eastern U.S.				Overall Western U.S.			
	Adjacent		Distant		Adjacent		Distant	
	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
Percent white 2000	89.19	20.41	76.04	29.08	84.49	21.39	71.09	24.05
Percent blue 2000	31.77	13.62	26.29	12.97	22.92	11.13	22.90	12.30
Percent college 2000	39.62	18.27	47.38	19.80	57.04	18.91	55.61	21.24
Per-capita Income 2000	19837.49	12646.99	20,937.05	11,521.34	22062.47	13428.51	22,069.85	13,481.42

Table 3.23: Socio-demographic Characteristics (at Census Block Group level) Comparison (for 2000) Across Eastern & Western United States for Category B Protected Areas

Variable	Region							
	Overall U.S. Protected Area Category B							
	Overall Eastern U.S.				Overall Western U.S.			
	Adjacent		Distant		Adjacent		Distant	
	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
Percent white 2000	86.76	20.45	75.71	29.25	81.24	21.77	69.64	24.00
Percent blue 2000	33.09	11.99	26.08	12.94	23.47	10.72	22.82	12.51
Percent college 2000	39.41	16.08	47.63	19.85	55.13	17.92	55.68	21.67
Per-capita Income 2000	17,932.50	8,067.89	21,029.83	11,599.29	20,603.67	10,824.60	22,278.89	13,806.11

Table 3.24: Test of Differences in Socio-demographic Characteristics (at Census Block Group level) for Category A Protected Areas (for 2000) Across Contiguous United States

Variable	Region					
	Contiguous U.S.					
N=206230	Category A Protected Area					
	Adjacent			Outside		
	n	Mean	Std. Deviation	n	Mean	Std. Deviation
Percent white 2000	1525	87.64	17.96	204705	75.34	27.73
Percent blue 2000	1525	26.44	12.31	204705	25.71	12.77
Percent college 2000	1525	52.04	19.42	204705	49.41	20.14
Per-capita Income 2000	1525	21,492.56	11,318.94	204705	21,288.10	11,867.39

Multivariate test for Homogeneity of Dispersion matrices:
Box's M = 2255.35266; F with (15, 26220636) DF = 150.18135, P = 0.000 (Approx.)
Chi-Square with 15 DF = 2252.72160, P = 0.000 (Approx.)
Multivariate Tests of Significance (S = 1, M = 1 1/2, N = 103111)

Test Name	Value	Exact F	Hypoth. DF	Error DF	Sig. of F
Pillais	.00194	80.25444	5.00	206224.00	.000

Multivariate Effect Size: 0.002
Eigen values and Canonical Correlations:

Root No.	Eigen value	Pct.	Cum. Pct.	Canon Cor.	Sq. Canon Cor.
1	.002	100.000	100.000	.044	.001

Correlations between DEPENDENT and canonical variables

Variable	Canonical Variable 1
Percent white00	-.863
Percent blue00	-.110
Percent college00	-.253
Per-capita income00	-.033

Table 3.25: Test of Differences in Socio-demographic Characteristics (at Census Block Group level) for Category A and Category B Protected Areas (for 2000) Across Eastern United States

Variable	Eastern U.S.											
	Category A Protected Area						Category B Protected Area					
	Adjacent			Outside			Adjacent			Outside		
	n	Mean	Std. Deviation	n	Mean	Std. Deviation	n	Mean	Std. Deviation	n	Mean	Std. Deviation
Percent white 2000	527	89.19	20.41	161655	76.04	29.08	4842	86.76	20.45	157340	75.71	29.25
Percent blue 2000	527	31.77	13.62	161655	26.29	12.97	4842	33.09	11.99	157340	26.08	12.94
Percent college 2000	527	39.62	18.27	161655	47.38	19.80	4842	39.41	16.08	157340	47.63	19.85
Per-capita Income 2000	527	19837.49	12646.99	161655	20,937.05	11,521.34	4842	17,932.50	8,067.89	157340	21,029.83	11,599.29

Multivariate test for Homogeneity of Dispersion matrices:
Box's M = 2680.31109; F with (20, 6867766) DF = 133.81271, P = 0.000 (Approx.)
Chi-Square with 20 DF = 2676.26201, P = 0.000 (Approx.)
Multivariate Tests of Significance (S = 2, M = 1/2, N = 81087)

Test Name	Value	Exact F	Hypoth. DF	Error DF	Sig. of F
Pillais	.01611	329.25538	8.00	324354.00	.000

F statistic for WILKS' Lambda is exact.
Multivariate Effect Size: Pillais 0.008
Eigen values and Canonical Correlations:

Root No.	Eigen value	Pct.	Cum. Pct.	Canon Cor.	Sq. Canon Cor.
1	.016	98.735	98.735	.126	.015
2	.000	1.265	100.000	.014	.0001

Correlations between DEPENDENT and canonical variables

Variable	Canonical Variable 1	Canonical Variable 1
Percent white00	.548	.307
Percent blue00	.750	-.397
Percent college00	-.584	.047
Per-capita income00	-.356	.627

Table 3.26: Test of Differences in Socio-demographic Characteristics (at Census Block Group level) for Category A and Category B Protected Areas (for 2000) Across Western United States

Variable	Western U.S.											
	Category A Protected Area						Category B Protected Area					
	Adjacent			Outside			Adjacent			Outside		
	n	Mean	Std. Deviation	n	Mean	Std. Deviation	n	Mean	Std. Deviation	n	Mean	Std. Deviation
Percent white 2000	1029	84.49	21.39	44285	71.09	24.05	5526	81.24	21.77	39788	69.64	24.00
Percent blue 2000	1029	22.92	11.13	44285	22.90	12.30	5526	23.47	10.72	39788	22.82	12.51
Percent college 2000	1029	57.04	18.91	44285	55.61	21.24	5526	55.13	17.92	39788	55.68	21.67
Per-capita Income 2000	1029	22062.47	13428.51	44285	22,069.85	13,481.42	5526	20,603.67	10,824.60	39788	22,278.89	13,806.11

Multivariate test for Homogeneity of Dispersion matrices:
Box's M = 1842.99290; F with (20, 28180532) DF = 92.07314, P = 0.000 (Approx.)
Chi-Square with 20 DF = 1841.46407, P = 0.000 (Approx.)
Multivariate Tests of Significance (S = 2, M = 1/2, N = 22653)

Test Name	Value	Exact F	Hypoth. DF	Error DF	Sig. of F
Pillais	.04741	275.04695	8.00	90618.00	.000

F statistic for WILKS' Lambda is exact.
Multivariate Effect Size: Pillais 0.024
Eigen values and Canonical Correlations:

Root No.	Eigen value	Pct.	Cum. Pct.	Canon Cor.	Sq. Canon Cor.
1	.050	99.545	99.545	.217	.047
2	.000	.455	100.000	.015	.0001

Correlations between DEPENDENT and canonical variables

Variable	Canonical Variable 1	Canonical Variable 1
Percent white00	.812	.577
Percent blue00	.070	-.474
Percent college00	-.016	.844
Per-capita income00	-.173	.930

Table 3.27: Correlation Matrix for Socio-demographic Variables (at County level) for the Contiguous United States.

	WHIT80	WHIT90	WHIT00	BLUE80	BLUE90	BLUE00
WHIT80	15.566					
WHIT90	.953	15.836				
WHIT00	.928	.978	16.452			
BLUE80	-.131	-.092	-.043	9.846		
BLUE90	-.141	-.098	-.044	.898	8.929	
BLUE00	-.055	-.013	.037	.815	.924	7.898
COLL80	.114	.071	.005	-.645	-.733	-.739
COLL90	.146	.113	.048	-.634	-.738	-.747
COLL00	.181	.163	.107	-.627	-.723	-.749
PINC80	.304	.272	.209	-.280	-.403	-.412
pinc1990	.188	.188	.130	-.274	-.392	-.447
pinc2000	.208	.221	.182	-.249	-.359	-.409

	COLL80	COLL90	COLL00	PINC80	pinc1990	pinc2000
COLL80	8.547					
COLL90	.950	10.587				
COLL00	.904	.963	10.833			
PINC80	.622	.656	.654	1230.945		
pinc1990	.627	.699	.702	.827	1673.257	
pinc2000	.583	.662	.702	.785	.944	1844.755

Figure 3.1: Distribution of Category A Federal Protected Lands (IUCN Categories Ia/Ib)

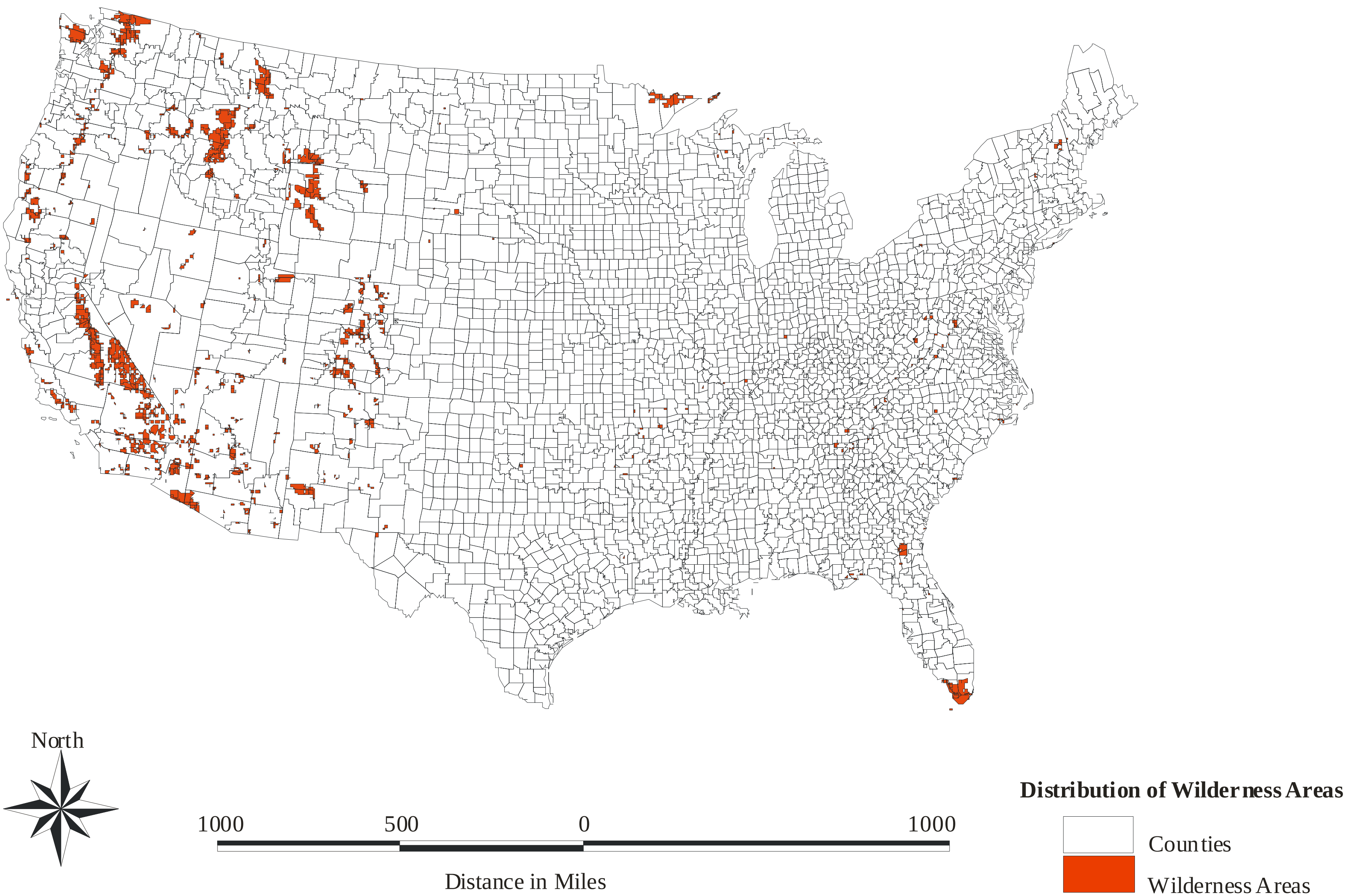


Figure 3.2: Distribution of Counties on the Fringe of Category A Federal Protected Lands (IUCN Categories Ia/Ib)

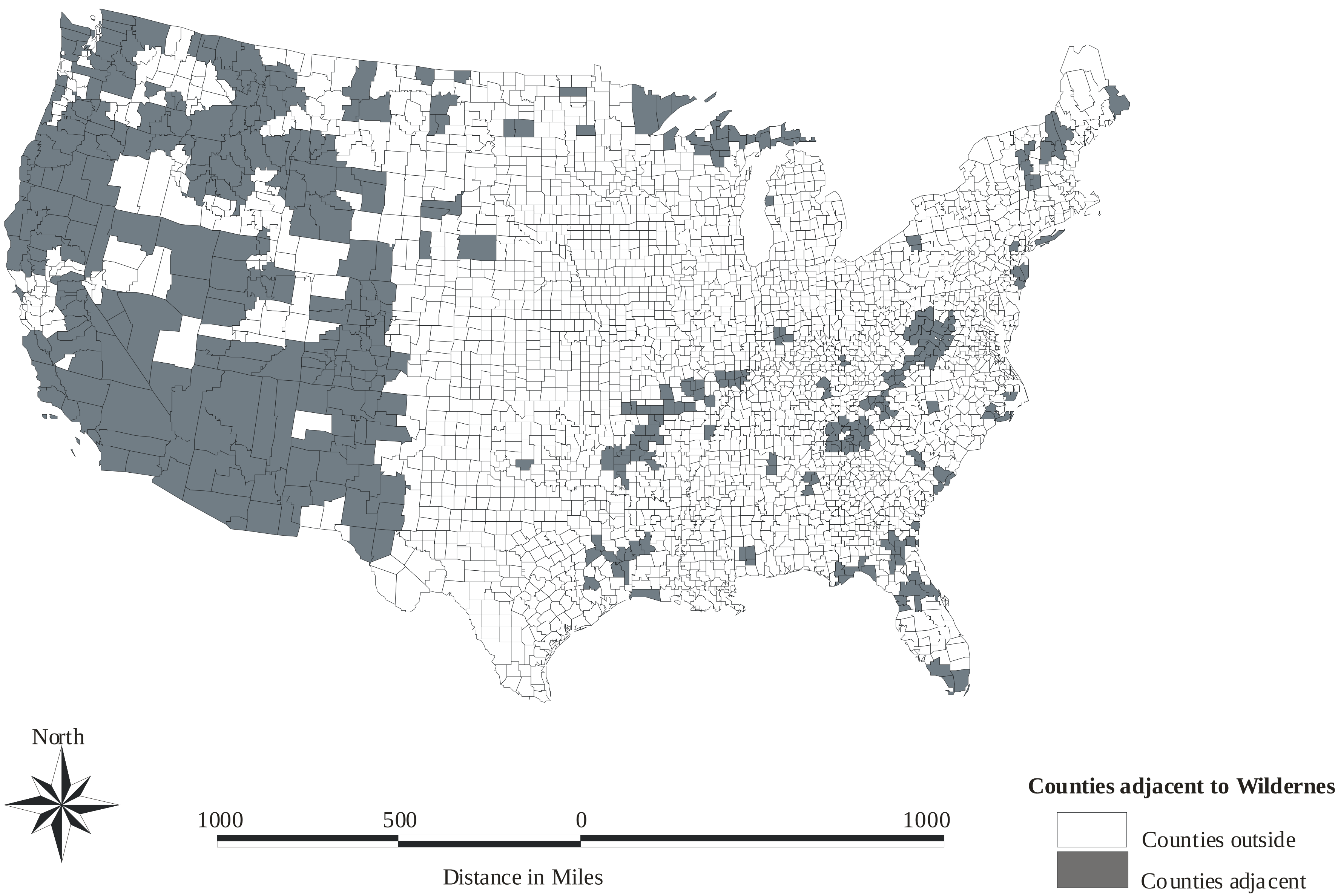


Figure 3.3: Distribution of Category B Federal Protected Lands (IUCN Categories II-VI)

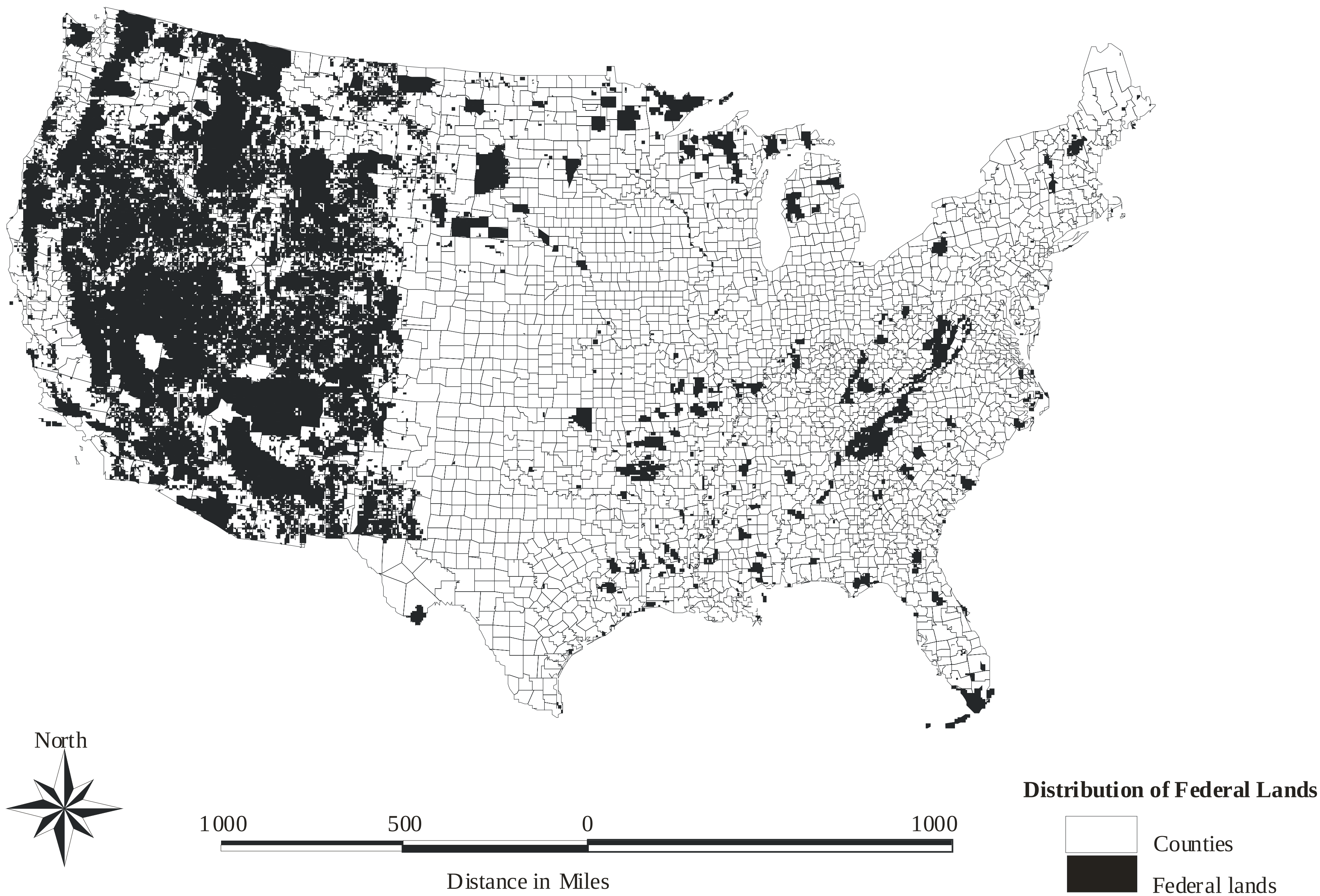


Figure 3.4: Distribution of Counties on the Fringe of Category B Federal Protected Lands (IUCN Categories II - VI)

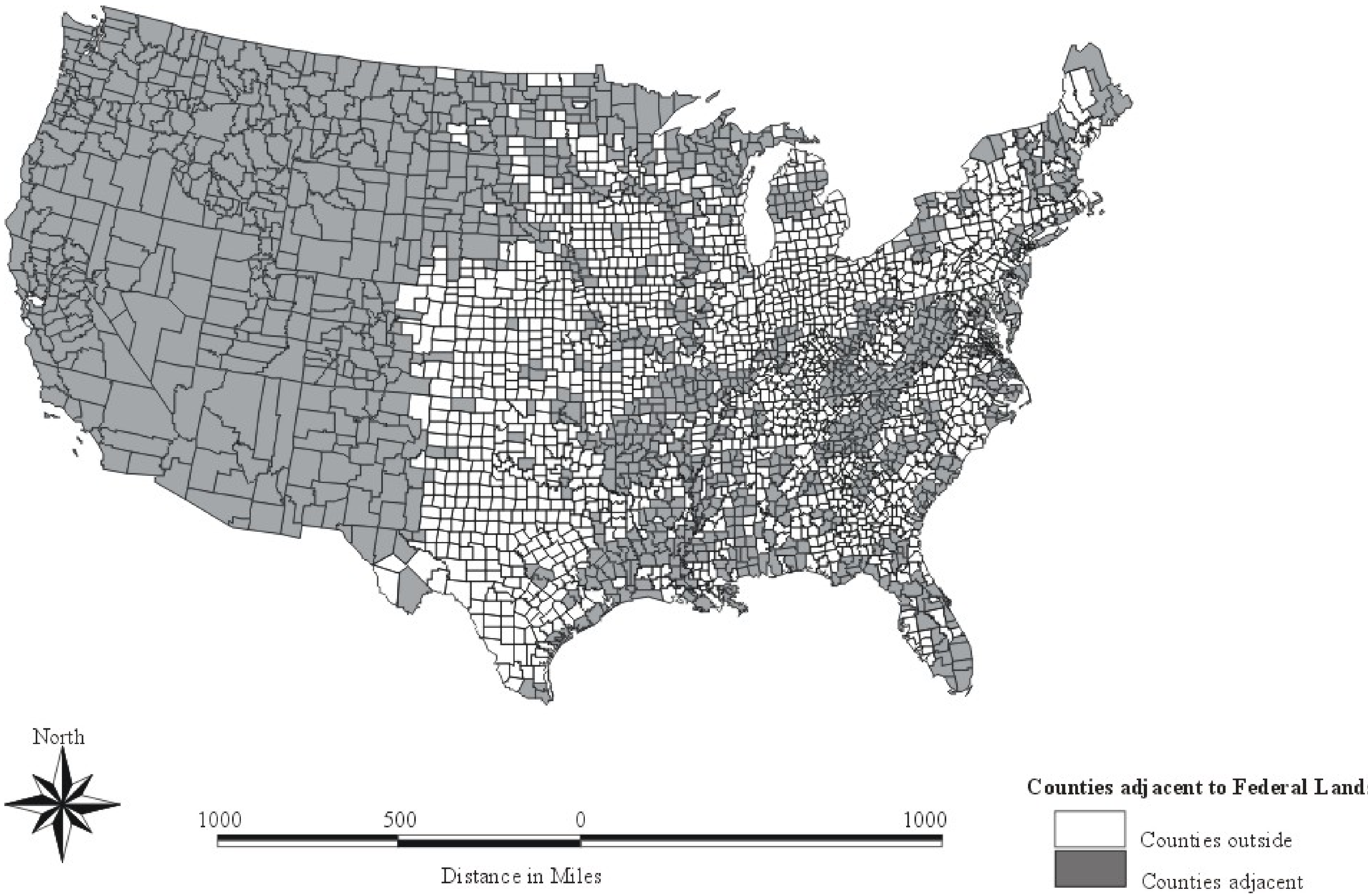


Figure 3.5: Distribution of Percent White Population in the Contiguous U.S. Counties (1980)

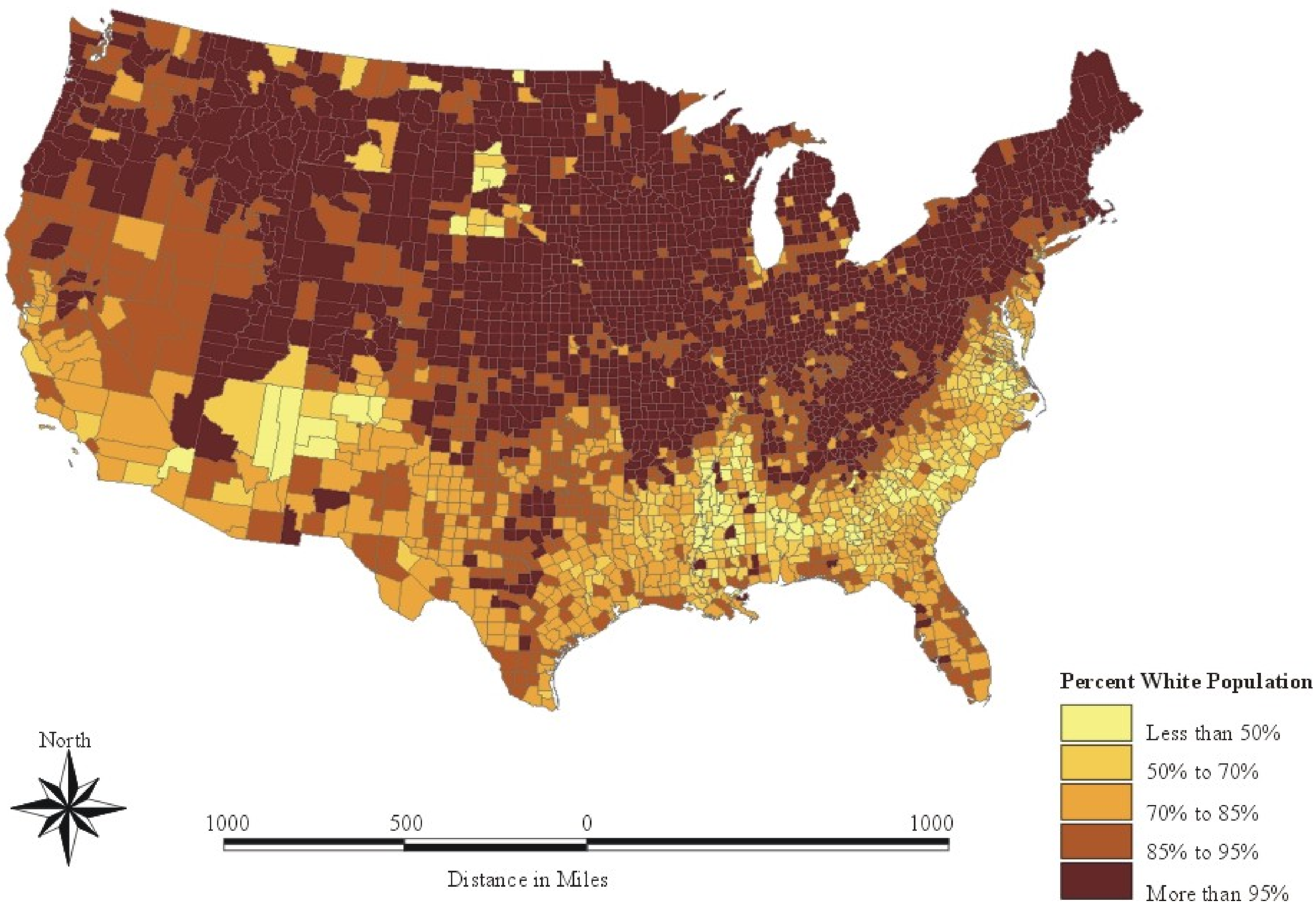


Figure 3.6: Distribution of Percent White Population in the Contiguous U.S. Counties (1990)

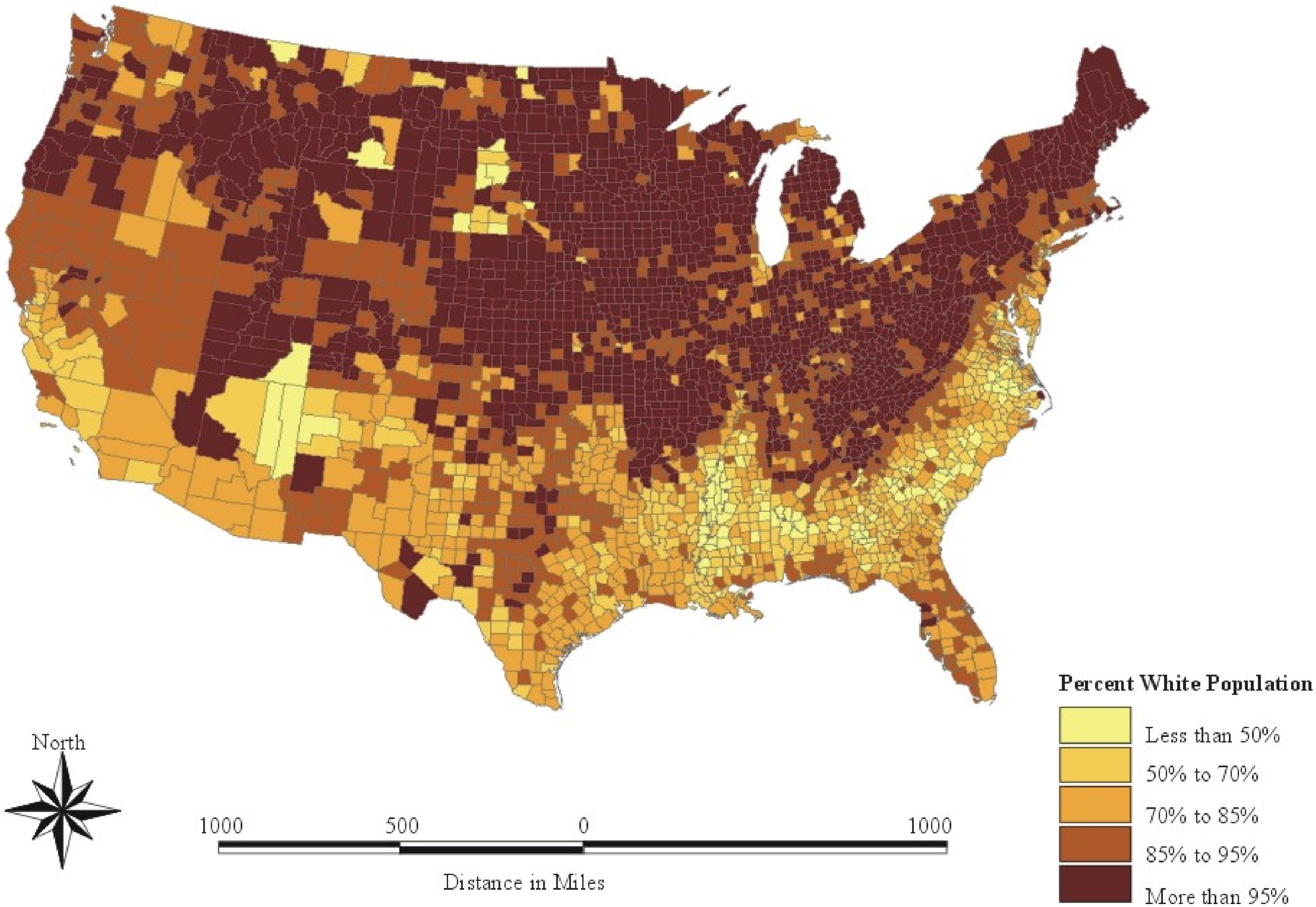


Figure 3.7: Distribution of Percent White Population in the Contiguous U.S. Counties (2000)

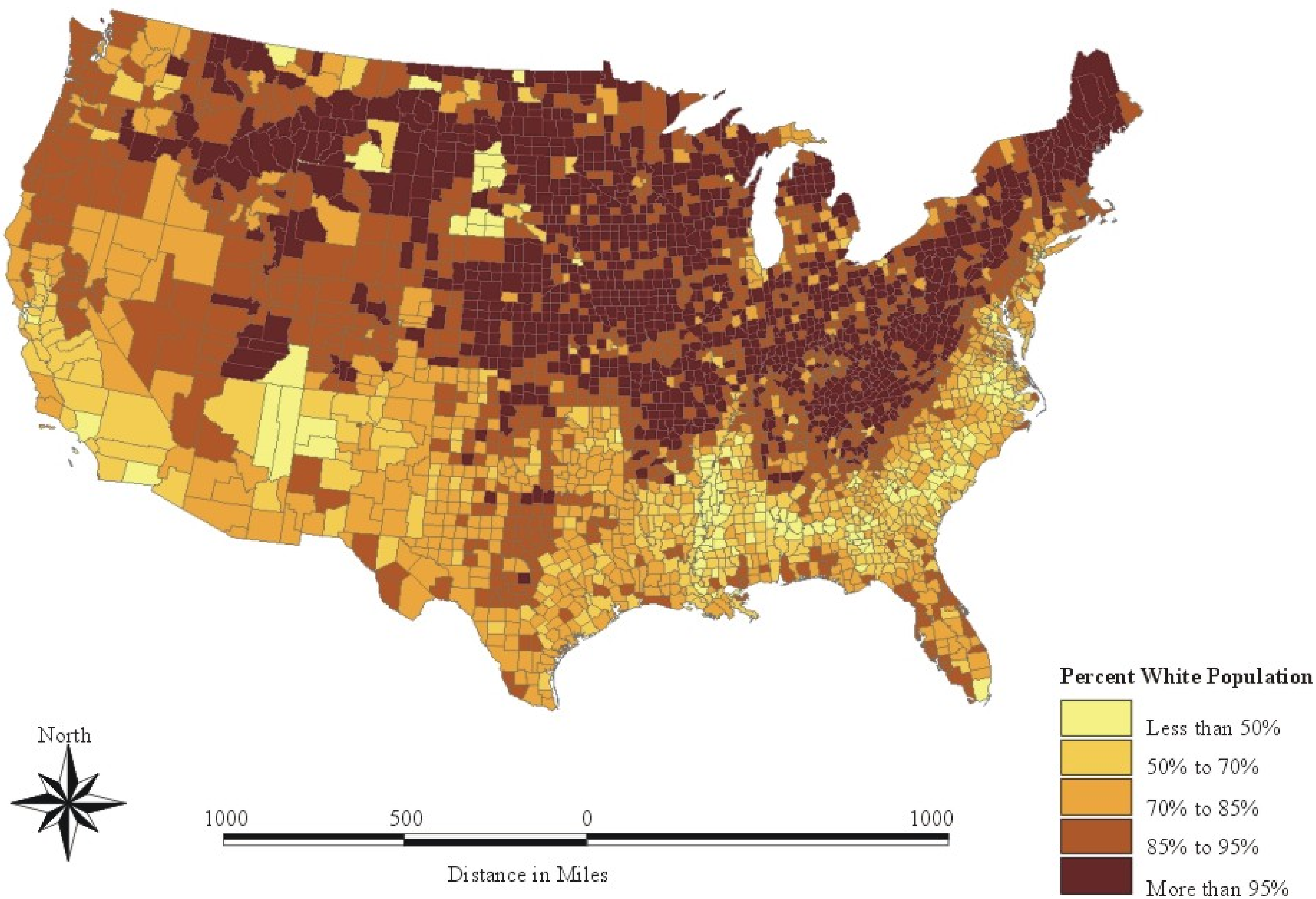


Figure 3.8: Distribution of Percent Population with Blue Collar Occupation in the Contiguous U.S. Counties (1980)

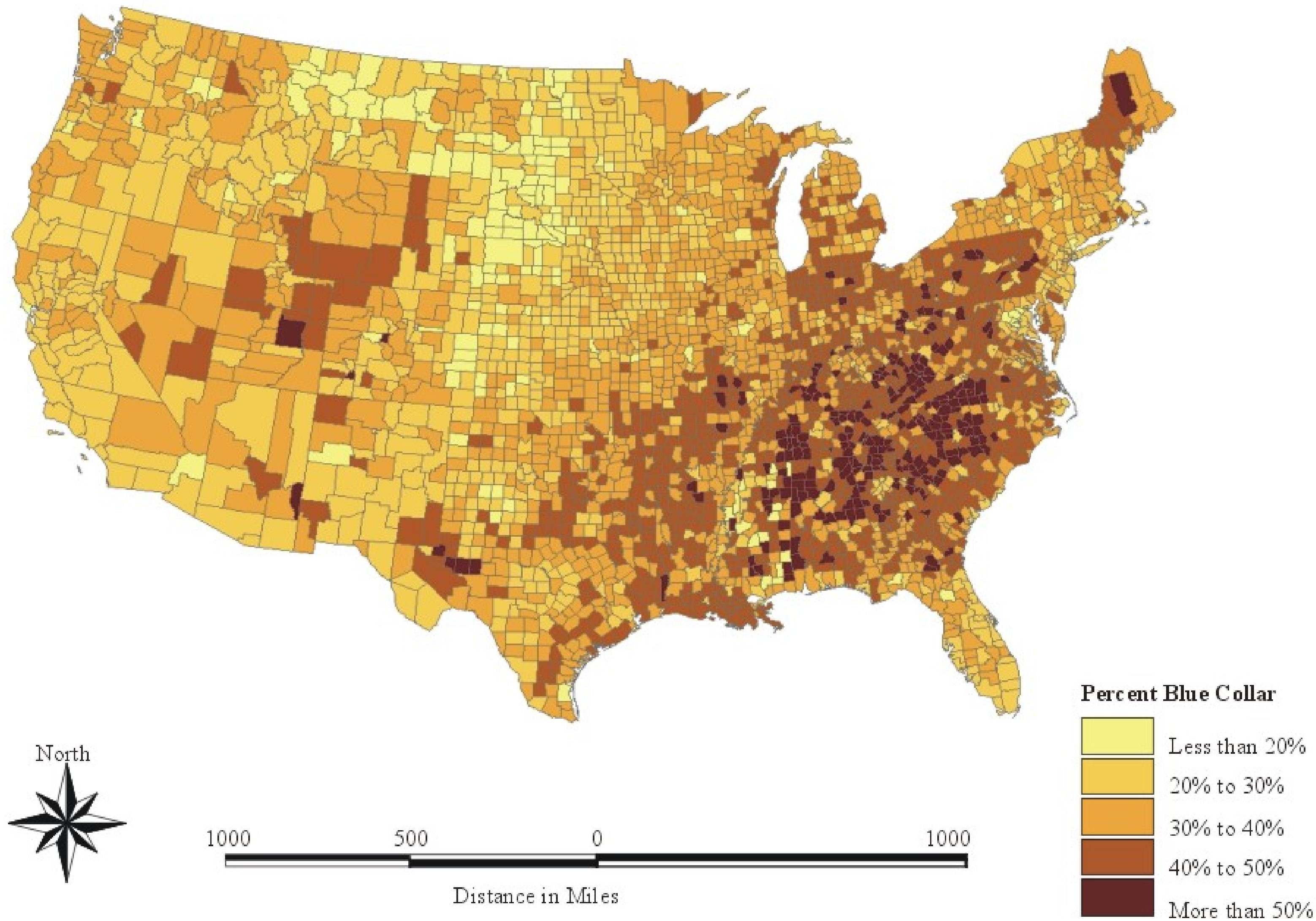


Figure 3.9: Distribution of Percent Population with Blue Collar Occupation in the Contiguous U.S. Counties (1990)

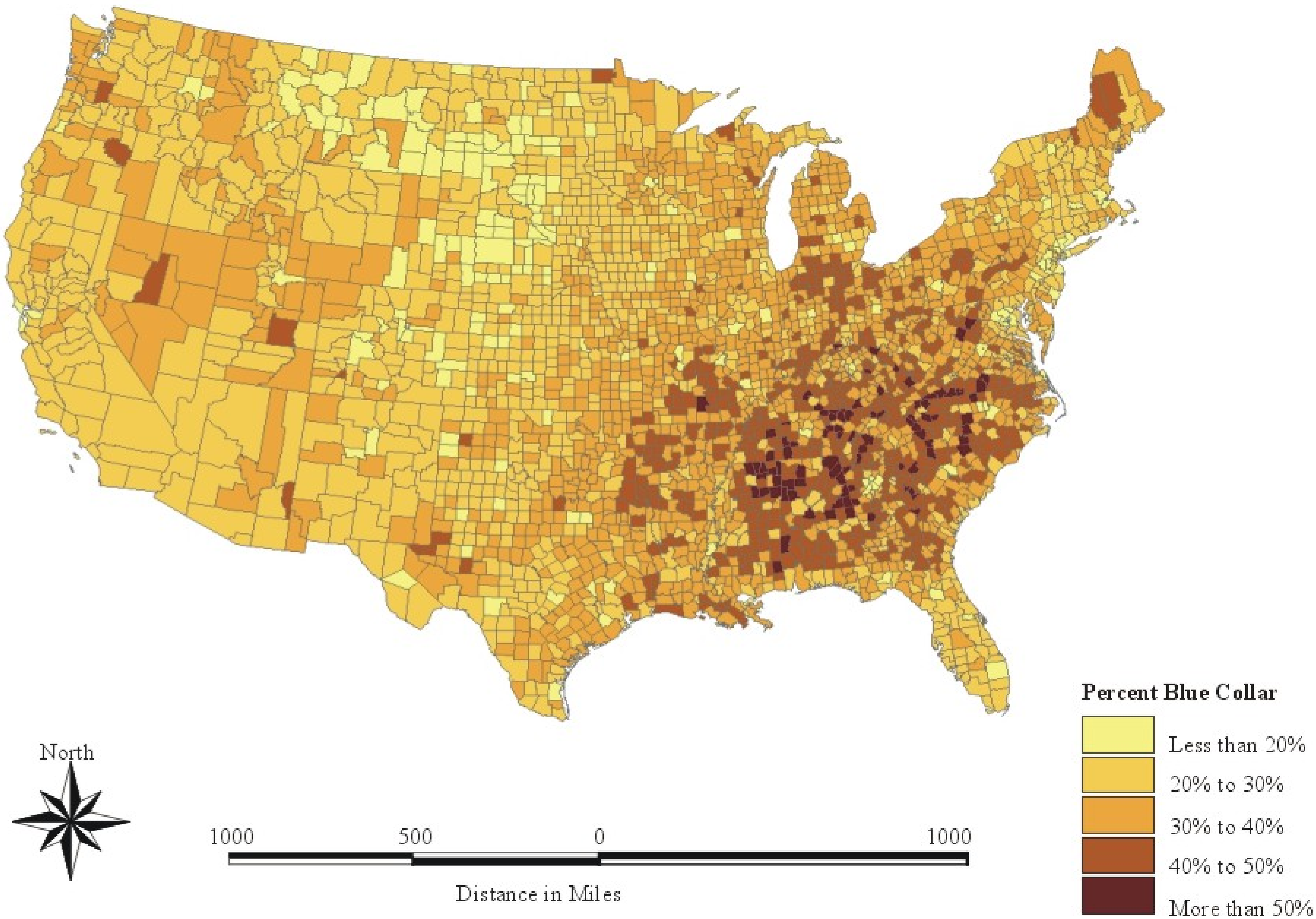


Figure 3.10: Distribution of Percent Population with Blue Collar Occupation in the Contiguous U.S. Counties (2000)

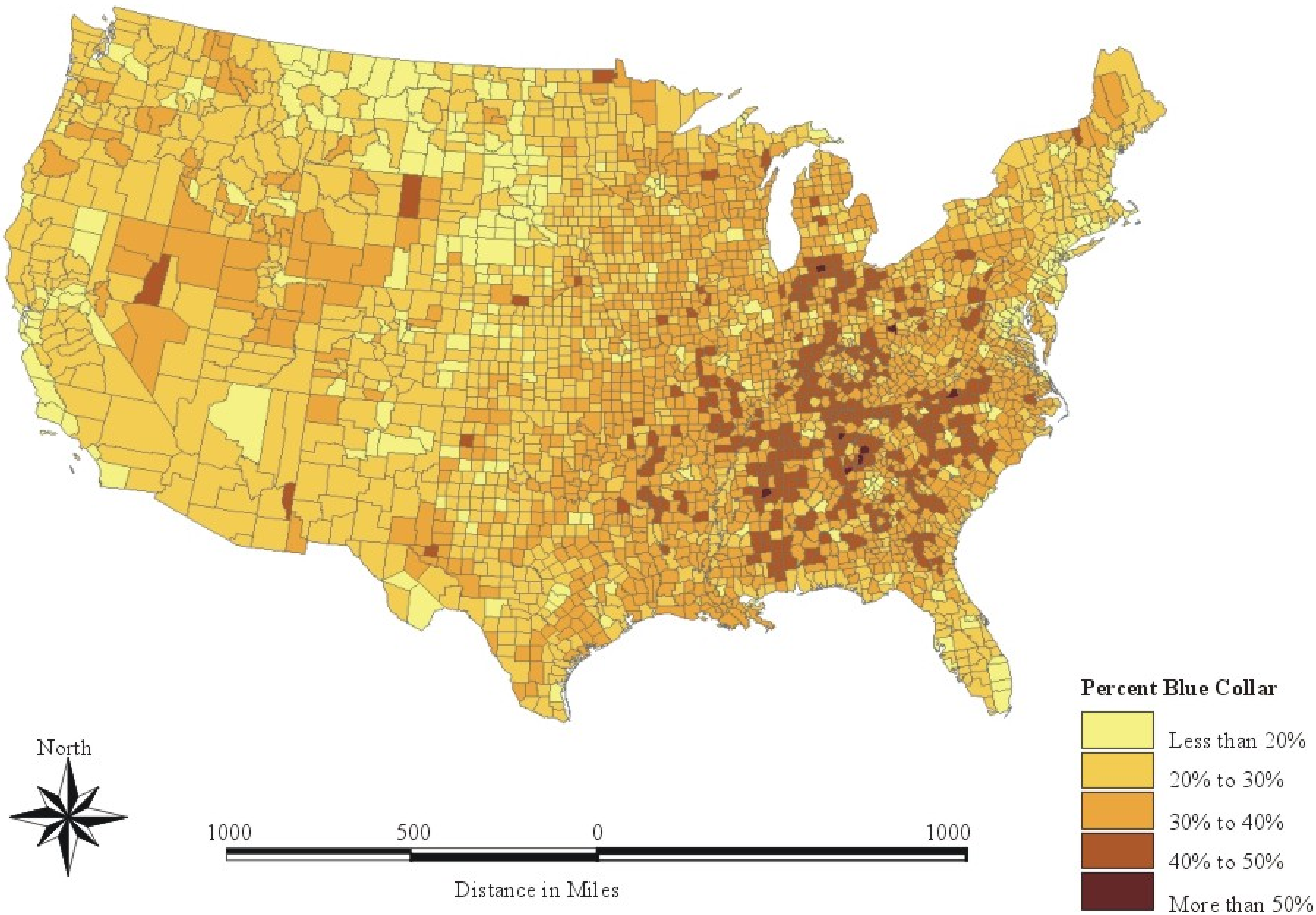


Figure 3.11: Distribution of Percent Population with College Education in the Contiguous U.S. Counties (1980)

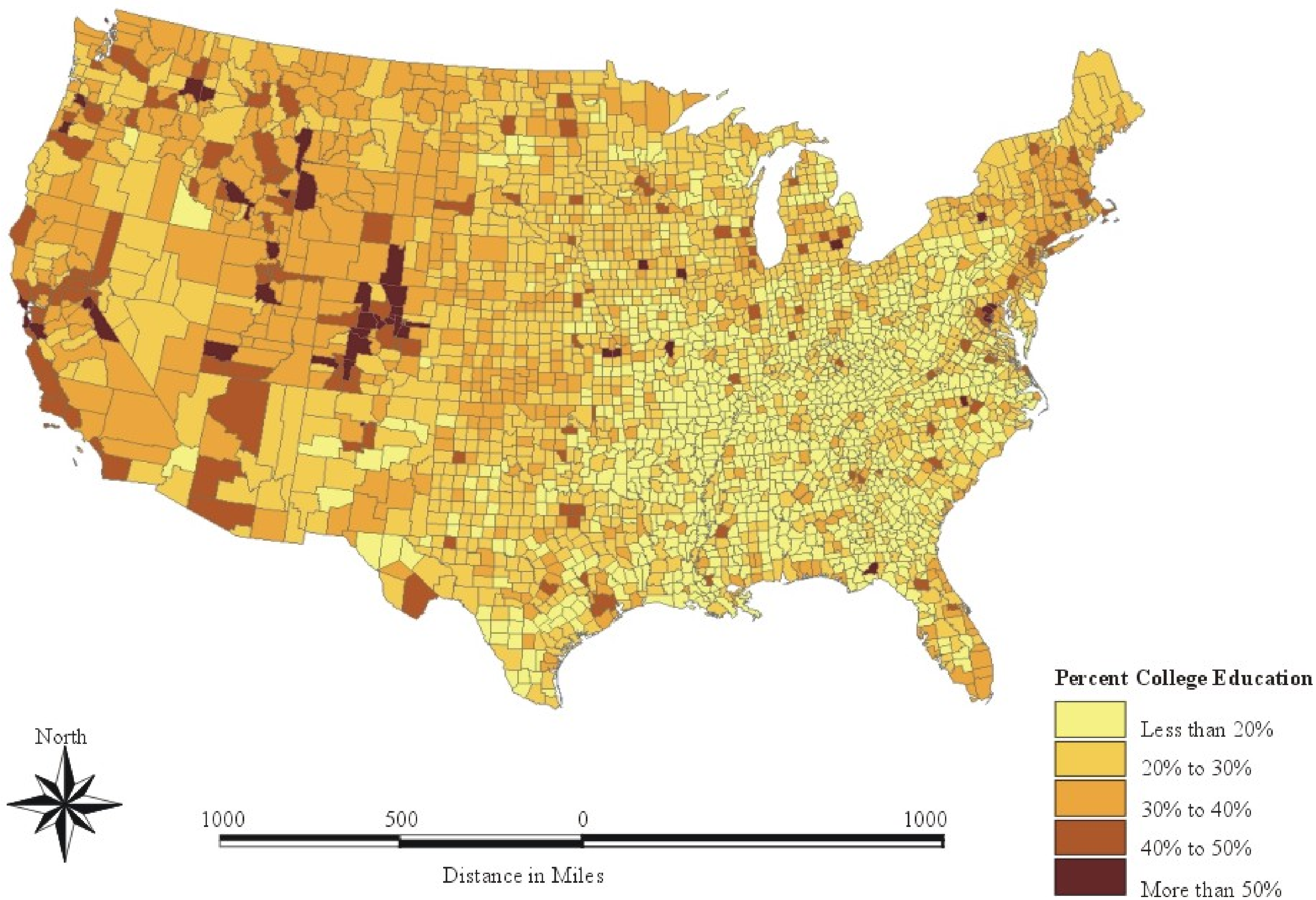


Figure 3.12: Distribution of Percent Population with College Education in the Contiguous U.S. Counties (1990)

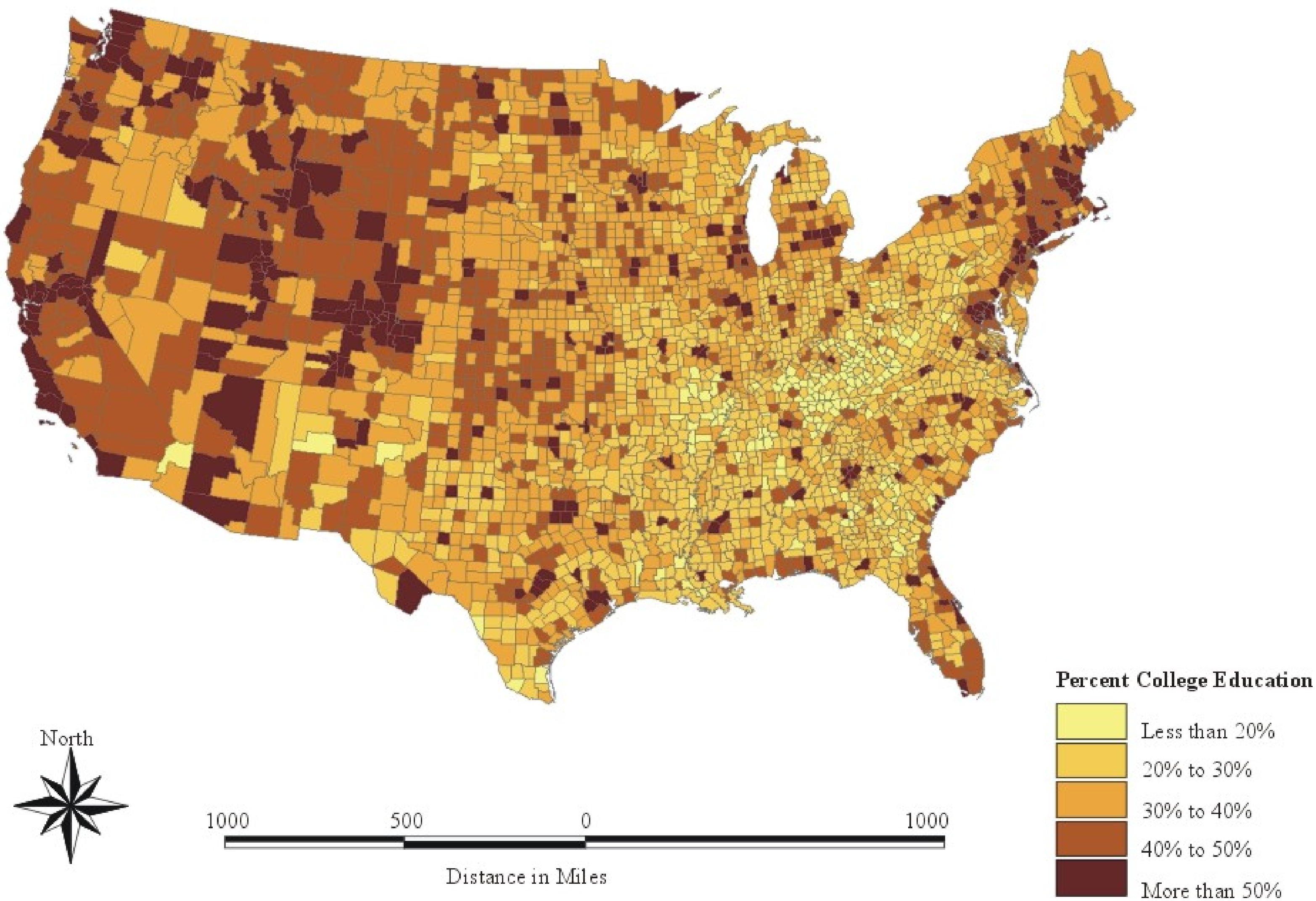


Figure 3.13: Distribution of Percent Population with College Education in the Contiguous U.S. Counties (2000)

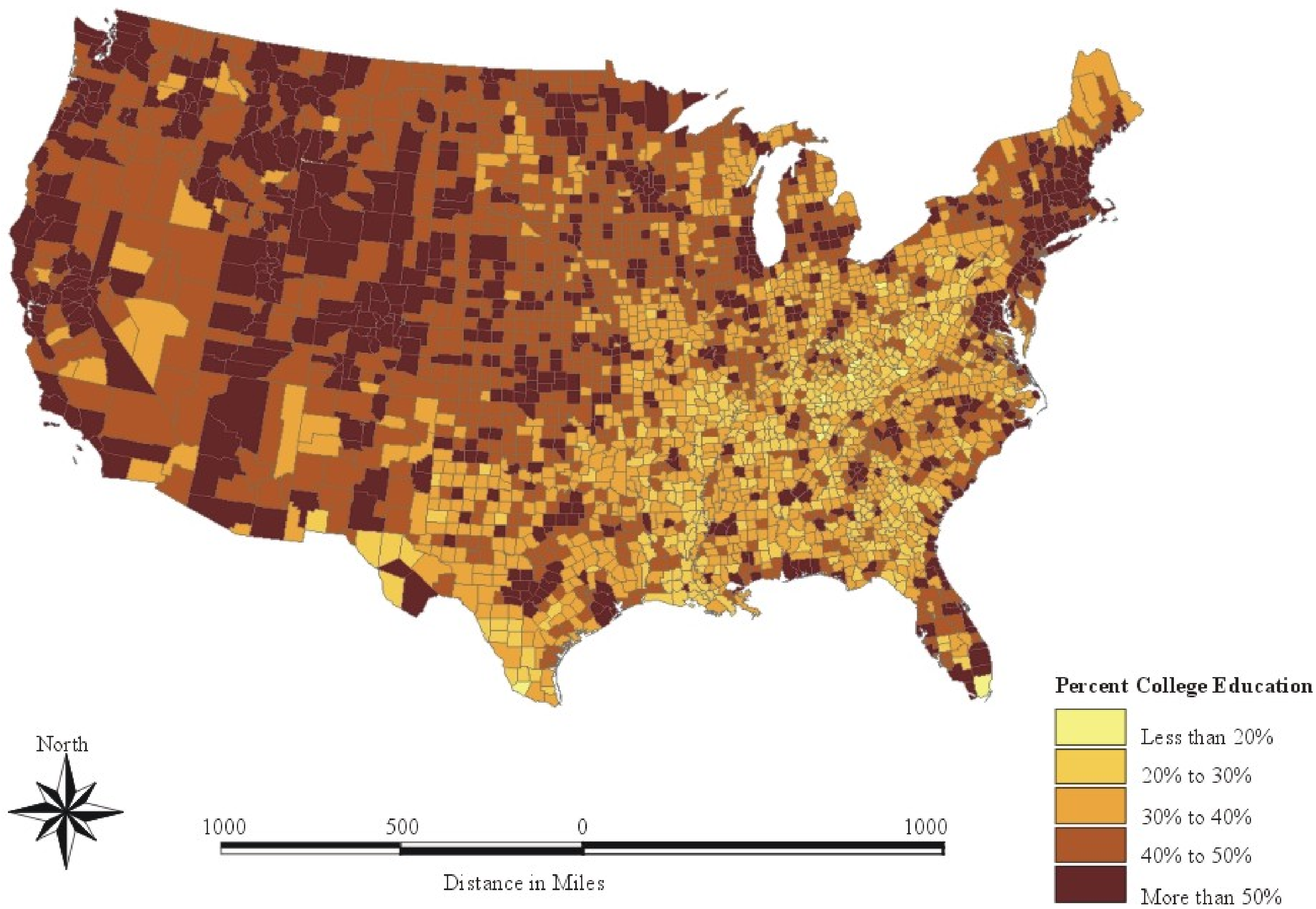


Figure 3.14: Distribution of Per-capita Income in the Contiguous U.S. Counties (1980)

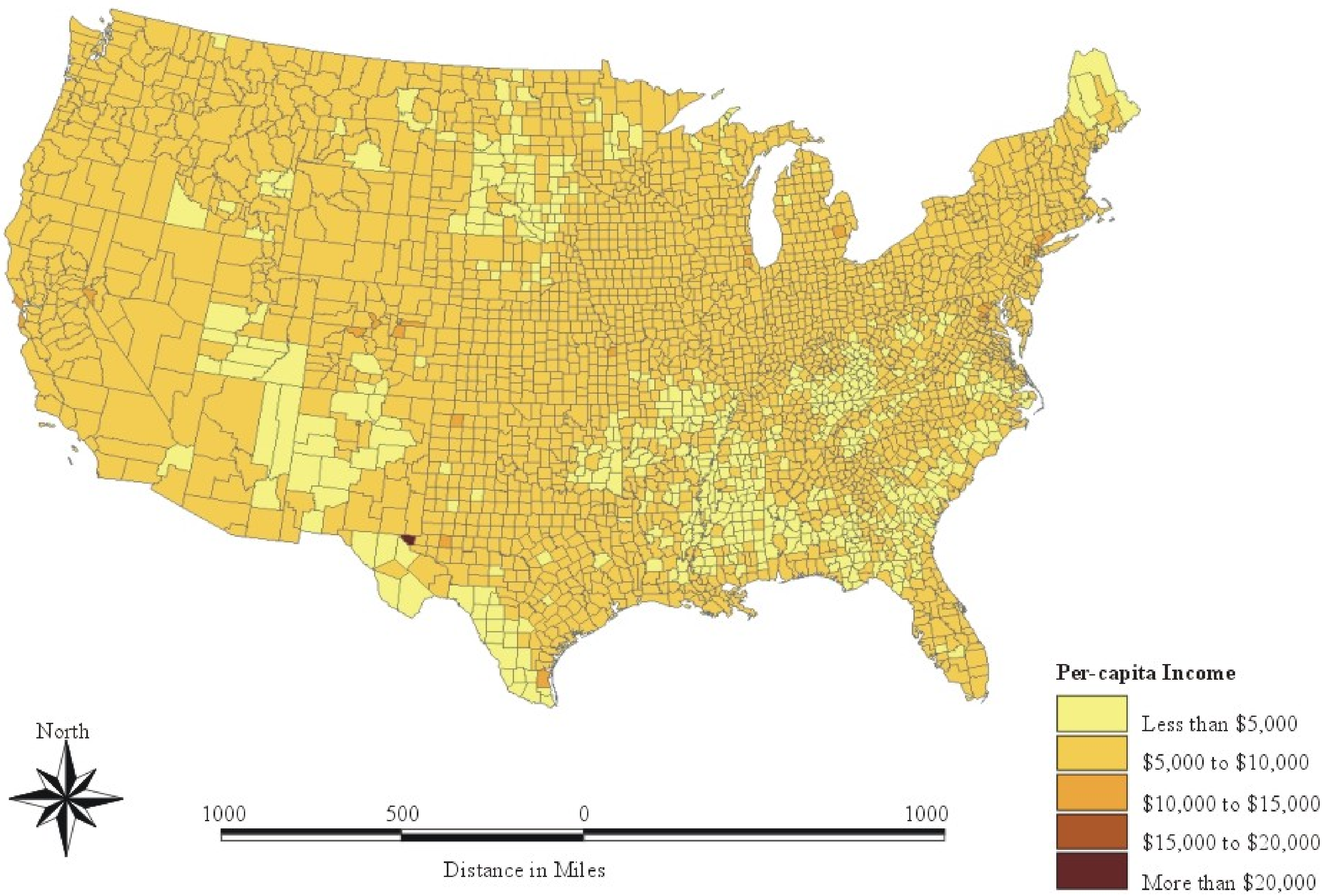


Figure 3.15: Distribution of Per-capita Income in the Contiguous U.S. Counties (1990)

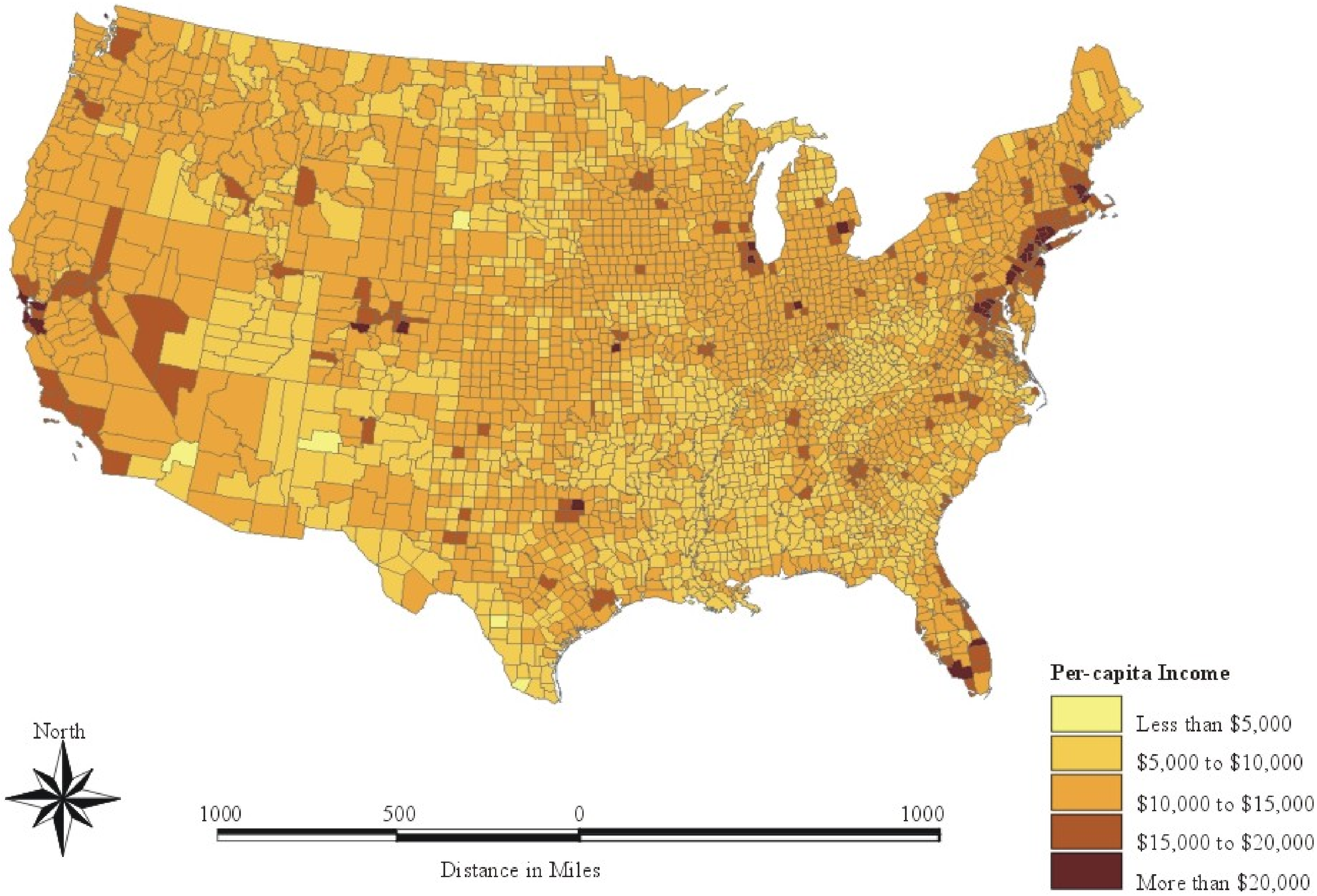
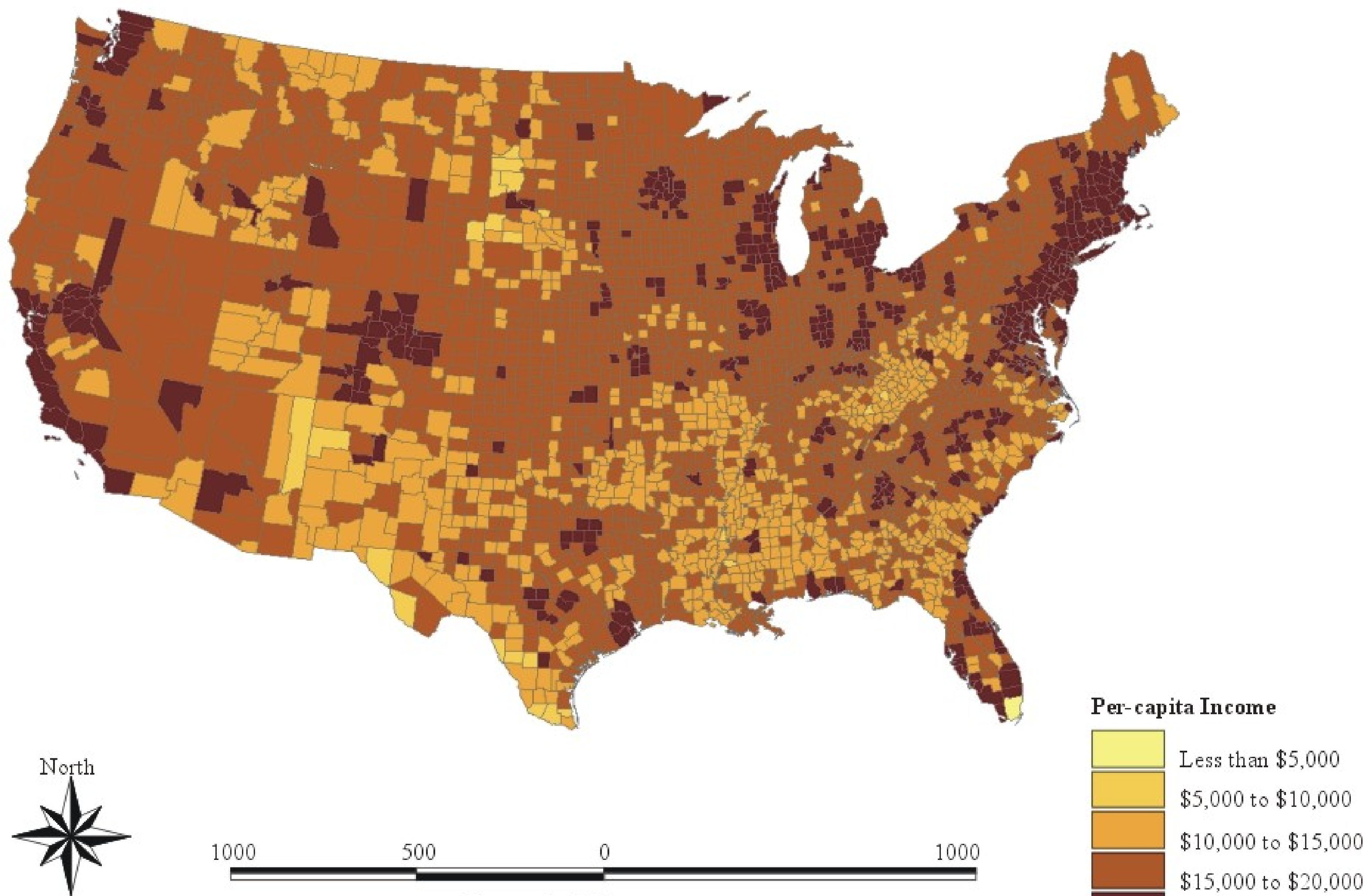


Figure 3.16: Distribution of Per-capita Income in the Contiguous U.S. Counties (2000)



CHAPTER 4

DISCUSSION AND CONCLUSIONS

Results and Interpretation

Summarizing the results of the study shows that there are distributional differences in the computation of socio-demographic characteristics of the residents of the contiguous United States. Differences in variance at the two scales (county and CBG) and difference in means shows that there are scale and zoning effects and indicates the modifiable areal unit problem (MAUP). Trend measures by hotspot analysis illustrate the counties where there has been significant change (positive and negative) over time. Patterns of clustering in the hotspot analysis (as observed visually) are indications of spatial dependency of socio-demographic data.

The study further shows that areas adjacent to protected lands are comprised of higher percent white population, lower percent blue collar workers, higher percent college educated people, and higher per-capita income. The effect is more pronounced in fringe of category A protected areas than in category B protected areas which are more homogenized. Also, the Western United States exhibits larger effects as a result of proximity to Federal protected lands than the Eastern United States. At the county level results show that the main source of distributional difference between communities is because of education and per-capita income. At the CBG level results show that the main source of distributional difference between communities is because of racial differences at the national level but both racial and per-capita income at the regional scale. Examining for change and trends the results show that at both scales of measurement (counties and CBG) the primary distributional differences in communities temporally has been education. Results also show that distributional differences between communities in the United States are however narrowing over time (more so in the category B fringe areas than category A fringe areas).

Discussion and Implications

The findings and implications described here are not exhaustive; however, they represent the tenor of discussions about what is necessary in developing an effective understanding of the human dimensions framework for evaluating socio-demographic data. Information from this study and about socio-demographic changes can help scientists, resource managers, and communities plan for future growth and implement plans and policies that conserve our natural resources. Land management is influenced by multiple parameters which range from ecological processes to human influenced policies, constraints, fiscal/economic models, and political mandates. As increasing numbers of people move to undeveloped parts of the country (primarily fringes of natural areas), the nature of local communities and the corresponding land use decisions shaped by grassroots community voices needs to be understood (Dennis, 2001).

Protected areas do not exist in isolation from the communities adjacent to them. They are impacted by shifts in local population and must be responsive to local community needs. Understanding the needs and dynamics of change can lead to policies that more adequately integrate these interests. In-migrants to fringe/buffer zones bring not only impacts directly related to the magnitude of population growth, but also consequences that grow out of different value associations. The buffer zones of protected areas are usually there to provide support and protection to the core of the protected areas. They buffer the protected areas from the negative impacts of neighboring settlements/communities and also protect the neighboring settlements/communities from wild animals leaving the protected areas.

Protected areas are for the protection and maintenance of all forms of biodiversity and cultural landscapes. Fringe areas around protected lands being buffers and transition zones for protection, conservation, and development it is imperative to note the characterization of those spaces. It should be understood that there is no 'one size fits all' solution and management goals must incorporate site-specific situations. This encourages a system of conservation and development in which decisions about who manages the resources accounts for an understanding of the local situation and scale.

Socio-demographic data aids in planning and policy development by synthesizing human dimensions analysis for natural resource management and promoting stewardship. By linking this data to biological and physical science information (i.e. with spatially referenced public protected lands database in this case) the planner is able to recognize the complex, interactive role that humans play in natural systems. Planners are also able to evaluate how the characteristics (which shape values, see Tarrant and Cordell, 2002; Tarrant, Cordell and Green, 2003; Cordell and Tarrant, 2003; Cordell, Tarrant and Green, 2003; Tarrant and Hull, 2005) of different stakeholder groups are continuously changing. This information may help the managers to identify policy directions that benefit both natural resources and humans.

By studying the population characteristics, planners and managers can address the racial diversity of the communities (and in turn have a frame of reference for values). Values and attitudes are also indicated by the educational achievement of the community, their income levels and occupation. Increasing human numbers which impacts resource consumption provide a familiar backdrop to the debate on how sustainable development needs to be or can be achieved. Development must be people-centered, but conservation-based that involves multi-purpose management of the environment. Planning has to be based on critical analysis (and extrapolation) of current trends by creating improved models of socio-environmental systems.

Campbell's model of planner's triangle has three basic nodes of planning: economic development, environmental protection, and social equity which resonates the sustainable development principles. All mainstream definitions of sustainable development share three characteristics: First, achieving sustainable development requires integrating policies related to social justice, environmental protection, and economic development. Second, the interests of future generations must be taken into account. And third, transparency and public participation at all levels of decision-making, from local to global, are essential to achieving sustainable development (Chaudhry, Lynch and Magraw, 2002).

In areas of population growth, immigration, and influx into the local settlement are important issues to address as part of the management options which combine equitable cost and benefit sharing, look at conflict resolution, and develop partnerships with local communities for co-management in buffer zones. According to Bright, Cordell, Hoover and Tarrant (p. 6, 2003), "over time, human values are continually changing as demographics shift both within and among regions. The social assessment can be an effective tool for tracking such changes and ensuring that decisions consider current social conditions. In addition, long-term data collection will allow ongoing analysis of a region's changing social environment."

Understanding the scale characterization of spatial data and identifying the hotspots of change will aid future planning and policy formation by delineating suitable geographic units and recognizing the management zones. Understanding the characterization of residents in fringe areas using the human dimensions framework will aid in future planning and policy formation concerning sustainable development and management surrounding protected areas.

References

Bright, A.D.; Cordell, H.K.; Hoover, A.P.; Tarrant, M.A. (2003). A human dimensions framework: Guidelines for conducting social assessments. *Gen. Tech. Rep. SRS-65*. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station.

Chaudhry, S., Lynch, O.J. & Magraw, D.B. (2002). *One species one planet.* Washington, DC: Environmental Justice and Sustainable Development Center for International Environmental Law (CIEL)

Cordell, H.K. & Tarrant, M.A. (2003). The Southern Forest Resource Assessment highlights: Changing demographics, outdoor recreation, values and attitudes. *Journal of Forestry, 100*(7), 28-33.

Cordell, H.K., Tarrant, M.A., & Green, G.T. (2003). Is the public viewpoint of wilderness shifting? International Journal of Wilderness, 9(2), 23-28.

Dennis, S. (2001). *Natural resources and the informed citizen.* Champaign, IL: Sagamore Publishing.

Tarrant, M.A. & Cordell, H.K. (2002). Amenity values of public and private forests: Examining the value-attitude relationship. *Environmental Management, 30*(5), 692-703.

Tarrant, M.A., Cordell, H.K., & Green, G.T. (2003). The Public Values of Forests Scale. *Journal of Forestry, 101*(6), 24-30.

Tarrant, M.A. & Hull, R.B. (2005). Forest values and attitudes in the South: Past and future research. In H. M. Rauscher and K. Johnsen (Eds.), *Southern forest science: Past, present, and future* (pp. 231-241). USDA Forest Service, Asheville, NC.