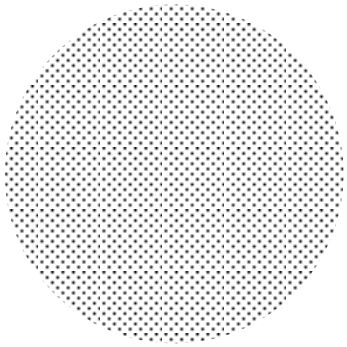
RENEWABLE RESOURCES JOURNAL
SPECIAL REPORT

VOLUME 16 NUMBER 4
WINTER 1998-1999



®

CONGRESS ON HUMAN POPULATION GROWTH: IMPACTS ON THE SUSTAINABILITY OF RENEWABLE NATURAL RESOURCES

RENEWABLE NATURAL RESOURCES FOUNDATION

RENEWABLE NATURAL RESOURCES FOUNDATION

MEMBER ORGANIZATIONS

American Congress on Surveying an Mapping

American Fisheries Society

American Geophysical Union

American Meteorological Society

American Society for Photogrammetry and Remote Sensing

American Society of Agronomy

American Society of Civil Engineers

American Society of Landscape Architects

American Water Resources Association

Association of American Geographers

The Humane Society of the United States

The Nature Conservancy

Society for Range Management

Society of Wood Science and Technology

Soil and Water Conservation Society

The Wildlife Society

Support Provided By

USDA Agricultural Research Service

USDA Forest Service

U.S. Geological Survey

Hosted By

Institute for the Environment
The George Washington University

CONGRESS PROGRAM COMMITTEE

Priscilla Reining, Committee Chair, American Anthropological Association; Virginia Abernethy, Vanderbilt University; Dale A. Bucks, USDA Agricultural Research Service; Robert D. Day, Executive Director, Renewable Natural Resources Foundation (*ex officio*); Lee De Cola, American Society for Photogrammetry and Remote Sensing; Jonathan P. Deason, The George Washington University, Public Interest Member of the RNRF Board; Richard L. Duesterhaus, RNRF Chairman, Soil and Water Conservation Society (*ex officio*); Thomas M. Franklin, The Wildlife Society; Hardin R. Glascock, Jr., Public Interest Member of the RNRF Board; Albert A. Grant, former president, American Society of Civil Engineers, Public Interest Member of the RNRF Board; Michael Hewitt, American Society of Civil Engineers; Laurent R. Hourclé, The George Washington University; Clare W. Hendee, Public Interest Member of the RNRF Board; David E. Kissel, American Society of Agronomy; David W. Moody, American Water Resources Association; Howard N. Rosen, Society of Wood Science and Technology; David L. Trauger, U.S. Geological Survey; Robert S. Unnasch, The Nature Conservancy; J.C. "Craig" Whittekiend, Society for Range Management; Staff Liaison: Kristen L. Krapf, Director of Programs, Renewable Natural Resources Foundation

SPECIAL REPORT:
CONGRESS ON HUMAN POPULATION GROWTH:
IMPACTS ON THE SUSTAINABILITY
OF RENEWABLE NATURAL RESOURCES

CONTENTS

Acknowledgments

The Renewable Natural Resources Foundation's third congress and this report were made possible by funding from the **USDA Agricultural Research Service**, **USDA Forest Service**, and **U.S. Geological Survey**.

Four distinguished plenary-session speakers provided valuable background information and thoughtful insight: **Dale Bumpers**, United States Senate; **Herman Daly**, University of Maryland; **Carl Haub**, Population Reference Bureau; and **David Rejeski**, Council on Environmental Quality. **Albert A. Bartlett**, University of Colorado, presented an informative dinner address.

The Institute for the Environment of The George Washington University served as host. J.P. Blackford coordinated use of the university's facilities.

Leadership and planning for the congress were provided by Priscilla Reining, chair of the Congress Program Committee, and the 19 dedicated volunteers who served on the committee with her (see list on page 3).

Conduct of the meeting and preparation of this report would not have been possible without the volunteered assistance of working group chairs, facilitators and note takers (see list on page 28).

A special thank you goes to RNRF Program Director Kristen L. Krapf, who assembled this report from working group reports, notes, flip chart sheets and delegate comments.

Finally, a heartfelt thanks to the congress delegates who shared their education, experience, passion and ideas in support of this important endeavor. They made this meeting happen! (A list of delegates appears in the appendix.)

R.D.D.

RENEWABLE RESOURCES JOURNAL

The Renewable Resources Journal (ISSN 0738-6532) is published quarterly by the Renewable Natural Resources Foundation.
5430 Grosvenor Lane, Bethesda, Maryland 20814-2193 USA. Telephone: (301) 493-9101
Robert D. Day, editor; Kristen L. Krapf, assistant editor

EXECUTIVE SUMMARY: CONGRESS ON HUMAN POPULATION GROWTH: IMPACTS ON THE SUSTAINABILITY OF RENEWABLE NATURAL RESOURCES

The Renewable Natural Resources Foundation (RNRF) was incorporated in Washington, D.C. in 1972. It is a consortium of 16 scientific, professional, and educational organizations interested in natural resources and interdisciplinary science. RNRF was established to: advance sciences and public education in renewable natural resources; promote the application of sound scientific practices in managing and conserving renewable natural resources; foster coordination and cooperation among organizations having leadership responsibilities for renewable natural resources; and develop a Renewable Natural Resources Center.

RNRF's most recent national meeting was convened on September 16-19, 1998, at the George Washington University in Washington, D.C. The RNRF Board of Directors—comprised of representatives of each member organization, and several "public interest" members—voted unanimously to examine the impacts of human population growth on the sustainability of renewable natural resources in the United States (U.S.). This vote was significant because it was the first formal action by the disciplines represented by RNRF members to address the impacts of human population growth. However, prior to the meeting the RNRF Board of Directors unanimously had approved statements of policy on "sustainability" and "human populations."

Approximately 65 delegates from among RNRF's member organizations and other institutions participated in deliberations. They identified information gaps and formulated recommendations and alternative solutions (Table 1). Delegates were assigned to three of four working groups: 1) urbanization and settlement patterns, 2) terrestrial systems, 3) aquatic systems, and 4) utilization and consumption of resources.

The report of the Congress presents the content and spirit of discussions that took place within the working-group sessions. Each working group had its own dynamic and incorporated different approaches for structuring discussions and reaching conclusions. There also were variations from session-to-session within working groups. Although there were no formal votes among delegates regarding population impacts or alternative solutions, consensus was noted informally and recorded by working-group chairs and note takers. Also, each delegate was given an opportunity to comment on the draft report.

Discussion of alternative solutions for sustaining renewable natural resources inevitably leads to considerations beyond the purview of science. Scientists can identify natural resource conditions and trends reasonably well. However, the decision of what can or should be done in response to scientific information ultimately depends in large measure on the value society assigns to these resources. Thus, it should come as no surprise that many of the alternative solutions favored by congress delegates reflected their personal values. A group of scientists with different values related to our natural heritage likely would have formulated different alternative solutions. Readers should appreciate the fact that discussion of sustainability will include consideration of values.

The findings, recommendations and alternative solutions represent the opinions and ideas of the congress delegates and not necessarily those of RNRF, its member organizations, and the sponsoring agencies.

STABILIZING HUMAN POPULATION AND REDUCING CONSUMPTION

U.S. population presently is increasing at a rate of one percent per annum—the highest of any industrialized country. Delegates agreed that continued

growth at the current rate will lead to fragmented and destroyed aquatic and terrestrial habitats, continued degradation and loss of arable land, continued loss of plant and animal species, and demands for fresh water that will exceed supply. There was a consensus among delegates that the U.S. should take appropriate measures to stabilize its human population.

The most important suggestion was to adopt a policy to stabilize U.S. population and increase economic and political support for developing countries. Delegates noted the importance of promoting economic stability in foreign countries to lessen pressures for immigrating to the U.S. Although advocating a population policy currently is seen as politically difficult, delegates believed it is a necessary measure to stop population growth and the degradation of natural resources.

Increasing education and public awareness was identified as another important strategy. Much needs to be done currently to promote understanding of the values and uses of natural resources, the impacts and costs of urban sprawl, and how increasing per-capita consumption is adversely affecting the sustainability of renewable natural resources. Delegates recommended the use of "focus groups" to aid in determining educational needs and priorities relating to population growth.

Delegates supported development of an "Alternative Futures Report." It should include information on population forecasts, and projections of future resource-use trends. Compiling this report would require research to identify the impacts of different population growth rates on natural resources. These projections would help communities make more informed land-use planning and resource-management decisions.

Delegates also recommended development of a national research agenda to identify the information necessary to facilitate stabilization of the U.S. population. Delegates also agreed that the professional, scientific and educational organizations of RNRF, and other organizations, should place the issue of population growth on their public policy agendas.

BUILDING SUSTAINABLE COMMUNITIES

Delegates agreed on the need to develop models and descriptions of how communities can become sustainable. Delegates described "sustainable communities" as people living in a compact space, using public transportation, minimizing energy use and the consumption of other resources, and reducing and recycling waste. The goal of building such communities is to limit sprawl, preserve the environment, and use natural resources more efficiently. Developing models will require research on case studies of successfully planned elements of existing communities and metropolitan regions.

Delegates believed that the U.S. needs additional information on how to improve resource data collection methods and the quality of geographic information systems (GIS). This information would help improve land-use descriptions and the accuracy of natural resource inventories. Delegates also noted that much of the data already collected on land use by the government are not readily available to either policymakers or the public. Converting the data into a usable form for people who do not have technical training is another important objective.

Delegates also agreed that it is important to develop local initiatives and goals to increase citizen participation in the decision-making process. The purpose is to instill community appreciation of the local environment and natural resources. Local initiatives should include projects directed towards improving land-use planning, reducing demands on resources, and protecting the environment.

PROMOTING SUSTAINABLE ECONOMIC PROGRAMS AND POLICIES

Delegates agreed that economic programs and policies that promote unsustainable development should be reformed. For example, many delegates suggested that estate-tax laws could be changed to preserve undeveloped land and prevent the conversion of farmland to other commercial uses. Delegates also supported implementing a tax shift from payrolls, incomes and investments, to goods and services that diminish the natural-resources base, harm the environment, and cause pollution (consumption tax). Delegates also recognized the need for developing economic incentives to encourage small families.

Delegates encouraged pricing energy, water, and agricultural products to reflect true costs. Prices should include fees for ameliorating future environmental impacts. If more realistic prices are imposed, consumers may be encouraged to reduce their current resource consumption.

Economists, political scientists, and other specialists should research a "zero-growth economy." A model should be created to answer questions such as, "What would a zero-growth economy look like?" and "Would it work?" The U.S. also needs to set standards and goals for businesses such as "zero waste" and near "100-percent efficiency" in production. Delegates believe that economic growth with less natural resource consumption is an attainable goal.

Delegates observed that many existing policies and programs seem to encourage growth and the waste and overutilization of natural resources. Delegates recognized that amending such policies and programs may not be possible before campaign finance reform is instituted. Campaign finance reform is an important strategy because politicians may be less beholden to special interests that do not support population stabilization and sustainable development.

CONCLUSION

Moving towards a sustainable society will be a complex, long-term and daunting task. It will require human population stabilization, reduction of per-capita consumption, and wiser use of land, air, and water resources. In the absence of progress, our renewable natural resources base will be in jeopardy.

A sustainable society also will require a new economic blue print; one that does not rely on perpetual growth. Success will be achieved only through national resolve and persistence. Public education and new decision-making tools also will be important components. In the U.S. today, there are a thousand pieces of the sustainability puzzle and 270 million people are at the table.

Finally, a sustainable society will require recognition of the important roles of values and science. We must value our natural resources heritage enough to save it. The cost of rescue will be significant. At the same time, our biological, physical and social scientists must cooperate as never before to develop the necessary interdisciplinary science and solutions.

There is reason for optimism in the fact that representatives of the scientific disciplines represented by RNRF came together for the first time to examine the impacts of human population growth on renewable natural resources. Through numerous recommendations and alternative solutions, these representatives have demonstrated that they highly value our natural resources heritage. They also have identified many of the necessary first steps to sustain them.«

Table 1. Principal Recommendations and Alternative Solutions

Goal	Recommendations and Alternative Solutions
Stabilize human population and reduce per-capita consumption	• Adopt a U.S. population policy aimed at stabilizing U.S. population and increasing support for developing countries
	• Increase education and awareness on population and resource issues
	• Create focus groups to gauge public understanding and educational needs on population and resource issues
	• Place population on the public policy agendas of professional, scientific, and educational organizations
	• Develop an "Alternative Futures Report" to identify the impacts of different population growth rates on resources
	• Develop a national research agenda identifying knowledge gaps and practical research that will reduce population growth and consumption
Build sustainable communities	• Develop sustainable community models
	• Increase citizen participation in the decision-making process
	• Improve resource data collection and distribution methods
	• Improve the quality of GIS
	• Improve public transportation and encourage ride-sharing
Promote sustainable economic programs and policies	• Create economic incentives for small families
	• Shift tax burden from labor and investments to goods and services that diminish the natural resource base (consumption tax)
	• Encourage campaign finance reform so politicians may be less beholden to special interests promoting growth and unsustainable development
	• Resource pricing should reflect true costs by including fees for ameliorating future environmental impacts
	• Encourage "zero waste" and near "100-percent efficiency" in production
	• Research a "zero-growth" economy
	• Change estate-tax laws so they encourage the preservation of undeveloped land

Introduction

Kristen L. Krapf

BACKGROUND

With a population of more than 270 million, the United States is the third most populous country in the world. The U.S. also has the highest annual growth rate of any industrialized country (1.0 percent or approximately three million people per year). According to Steven A. Camarota, resident scholar at the Center for Immigration Studies in Washington, D.C., immigration and births to immigrant women account for 70 percent of the increase in the U.S. population in the 1990's. Thirty percent of the increase is attributed to native births.

Population growth, coupled with increasing consumption, is placing unprecedented demands on the nation's environment and natural resources. In recognition of this problem, the Renewable Natural Resources Foundation (RNRF) convened a national meeting of resource professionals and educators to explore the impacts of population growth, urban development, and consumption patterns on the sustainability, management, and conservation of natural resources. Delegates also proposed strategies and recommendations to mitigate the impacts of population growth on natural resources. Although the scope of the congress was limited to the U.S., global linkages and problems also were considered.

The congress, entitled "Human Population Growth: Impacts on the Sustainability of Renewable Natural Resources," was hosted by the Institute for the Environment at The George Washington University, Washington, D.C., September 16-19, 1998.

The congress was a significant event because it was the first time that the disciplines represented by RNRF had gathered to discuss the issue of population growth in the U.S. The purpose of the meeting was to provide an interdisciplinary forum to explore current and future impacts of human population growth and increasing consumption on natural resources. Identifying the linkages among population growth, sustainability, and conservation was, therefore, critical to the discussions.

The delegates also identified strategies and recommended methods of implementation for government agencies, businesses, industries, and communities to help mitigate the impacts associated with further population growth. Many of the strategies and recommendations offered by each of the four working groups overlapped, confirming that the four resource issues discussed—urbanization and settlement patterns, terrestrial systems, aquatic systems, and utilization and consumption—are interrelated. Results of the congress will better equip RNRF's member organizations to engage in the public policy debate about human population growth in the U.S.

Nearly all delegates were members of one or more of RNRF's 16 member organizations and represented a wide spectrum of disciplines. Among them were prominent natural resources professionals from federal and state resource management agencies, academic institutions, non-governmental organizations, and research institutes and agencies. (A complete list of delegates appears in the Appendix on page 28).

Delegates were assigned to working groups based upon their preferences. RNRF made every effort to create a diverse and balanced group of disciplines and perspectives in each working group. The congress operated according to a model first used at the 1992 congress in Vail, Colorado, and again at the 1996 congress in Grand Teton National Park, Wyoming. Delegates rotated among different working groups with only the chairs and facilitators remaining the

The author of this report, Kristen L. Krapf is the program director at the Renewable Natural Resources Foundation. Krapf earned her Bachelor of Arts and Sciences and Master of Science in environmental sciences from the University of Virginia.

same for each working group session. Working group chairs were resource professionals and educators representing RNRF member organizations. Facilitators were professors and graduate students from The George Washington University. Students from George Washington also assisted as note takers.

This model of rotating delegates among three of the four groups allowed the delegates to be exposed to and comment on an array of topics and issues. Working group questions were distributed prior to discussions and were addressed at each session. The questions, developed by the RNRF Congress Program Committee, were intended to aid in the working group discussions. The report is structured around the four working group topics and based upon the notes and summaries prepared by the chairs, facilitators, and note takers. This report would not have been possible without their dedication and hard work.

PLENARY SESSIONS

The congress opened with an evening reception on September 16. RNRF Chairman Richard L. Duesterhaus welcomed delegates to the congress.

The first full day of the meeting (September 17) was filled with working group sessions and a diverse group of speakers. Carl Haub, senior demographer and information and education director at the Population Reference Bureau, was the first plenary speaker. Haub gave a broad overview of current world population trends and prospects for future growth. He compared projected growth patterns in developed countries with those of less developed countries. Finally, he offered perspectives regarding the recent trend of declining population growth of several developed countries.

David Rejeski, executive director, Environmental Technology Task Force of the Council on Environmental Quality, was the second plenary speaker. Rejeski spoke about prerequisites for developing a U.S. population policy. He emphasized the importance of educating Americans about population and resource related issues, developing accurate quantitative models describing demographic change, conducting research, finding champions, and generating foresight to deal with uncertain and highly complex futures. In order to lay the foundation for a sustainable society, Rejeski believes that these strategies must be pursued by the public and private sector together. (An adaptation of his presentation appeared in Volume 16, Number 3 of the *Renewable Resources Journal*.)

Herman Daly, a professor at the School of Public Affairs of the University of Maryland, College Park, was the third and final plenary speaker. Daly, an advocate for a "steady-state economy," emphasized minimizing, rather than maximizing, both production and consumption. He spoke about issues of sustainability and how they relate to theories of "green economics." (Green economics describes a model that imitates nature's cycle of recycling materials within a closed-loop system.) Furthermore, Daly believes that until the economy and the environment are viewed as a single system—instead of two independent subsystems—it will be difficult to work towards developing a sustainable society.

U.S. Senator Dale Bumpers (Ark.) delivered the keynote address. He spoke of his role in protecting America's natural heritage, and of his belief that the fate of the nation hinges on conserving its natural resources. Bumpers views population growth as one of the most important issues facing the U.S. and the world. He observed that many policy makers associate population stabilization with abortion, and use that association to avoid discussing the issue. Bumpers concluded that meaningful dialogue on population will not occur until policy makers are able to separate birth control from the many other issues related to population growth.

The first day of the congress was capped off with a dinner presentation by Albert A. Bartlett, professor emeritus, Department of Physics, University of Colorado, Boulder. (An article by Bartlett, "Reflections on Sustainability, Population Growth, and the Environment—Revisited," was featured in Volume 15, Number 4 of the *Renewable Resources Journal*.)

In his talk, Bartlett explained that our world's technical societies have operated on the assumption of continued steady growth of populations, resource consumption and the gross national product. Bartlett illustrated the irrational consequences of steady growth in examples such as inflation, investments, and the growth of our communities. He observed that even small annual growth rates result in unsustainable development and consumption.

WORKING GROUPS

Working group debates and discussions addressed four topics or resource issues from a national perspective. Working groups, which met for part of the first day and all of the second, were organized around four topics. The following topics were identified by the congress program committee as key natural resource issues:

1. Urbanization and Settlement Patterns

Historically, human population throughout the U.S. has been unevenly distributed with concentrations around major industrial, transportation, and port areas. As population has increased, cities have expanded into formerly rural areas. Urban sprawl causes air, land, and water pollution, wildlife habitat loss and fragmentation, loss of open space, and the degradation of natural resources. Members of this working group focused on issues associated with current urbanization and settlement patterns in the U.S., and examined the extent to which

the effectiveness of management options and mitigating actions are limited or compromised by continued population growth. The delegates identified strengths and weaknesses of alternative strategies and made recommendations. This working group also identified critical knowledge gaps that would benefit from research.

2. Terrestrial Systems

The nation's forests, rangelands, and agricultural lands are sources of food, fiber, and ecological services to humans and wildlife. This working group examined how population growth and land conversion have and will continue to affect land resources and plant and wildlife species. Alternative strategies for mitigating the adverse impacts of population growth patterns and consumption on terrestrial systems were identified. Delegates noted the strengths and weaknesses of each recommendation. Discussions also focused on critical knowledge gaps and research required to protect forests and rangelands, and implementing sustainable resource management under population pressures.

3. Aquatic Systems

Identifying how U.S. population growth impacts coastal, lake, and estuarine resources, including impacts on fresh water and coastal marine life, was the focus of this working group. Delegates formulated strategies and actions to conserve, protect, and restore aquatic resources, and identified the strengths and weaknesses of each approach. Delegates identified critical knowledge gaps and essential research that should be conducted to ensure that the U.S. will meet long-term demands for fresh water supplies and aquatic resources.

4. Utilization and Consumption of Resources

United States consumption of goods, services, and raw materials—and the associated production of waste—are unparalleled in the world. Therefore, this working group identified ways in which current utilization and consumption patterns are impacting renewable natural resources. Delegates recommended alternative strategies to reduce per capita resource consumption to a level that is sustainable for future generations. Delegates also discussed critical knowledge gaps and essential research.

This report presents the content and spirit of discussions that took place within the working-group sessions. Each working group had its own dynamic and incorporated different approaches for structuring discussions and reaching conclusions. There also were variations from session-to-session within working groups. Although there were no formal votes among delegates regarding population impacts or proposed actions, consensus was noted informally and recorded by working-group chairs and note takers. Also, each delegate was given an opportunity to comment on the draft report.

Discussion of alternative strategies for sustaining renewable natural resources inevitably leads to considerations beyond the purview of science. Scientists can identify natural resource conditions and trends reasonably well. However, the decision of what can or should be done in response to scientific information ultimately depends in large measure on the value society attaches to these resources. Thus, it should come as no surprise that many of the alternative strategies favored by congress delegates reflected their personal values. A group of scientists with different values related to our natural heritage would likely have formulated different alternative strategies. Readers should appreciate the fact that discussion of sustainability will include consideration of values.

The findings, recommendations, conclusions and strategies identified represent the opinions and ideas of the delegates attending the congress and not necessarily those of RNRF, its member organizations, and the sponsoring agencies.«

Urbanization and Settlement Patterns

Delegates from this working group examined the link between urbanization and settlement patterns, and demands on renewable and non-renewable natural resources. They also identified alternative strategies to current approaches to addressing these issues. Delegates concluded that urbanization and settlement patterns associated with population growth in the United States are impacting natural resources and will continue to do so in the future. The following four questions were provided by the congress program committee as a basis for this discussion:

1. What are the current urbanization and settlement patterns in the U.S.?
2. To what extent are the effectiveness of management options and mitigating actions in the U.S. limited or compromised by continued population growth?
3. What are alternative strategies for mitigating adverse impacts of this growth on renewable natural resources (such as changes in policy related to transportation, taxes, environmental compliance, development, and land use)? What are the strengths and weaknesses of each alternative strategy?
4. Are there critical knowledge gaps that need to be filled, and if so, what essential research is required?

Prior to discussions, the urbanization and settlement patterns working group proposed that delegates bear in mind that the U.S. population grows at one percent per annum, with 70 percent reflecting immigration and 30 percent reflecting natural increases. At the present rate, the population will double in 70 years. With these statistics, delegates considered whether proposed strategies should work to manage population growth, slow, or stop it. Given the current extent of resource degradation and consumption in the U.S., delegates recognized that simply working to manage population growth (in contrast to halting it) is not an adequate solution.

CURRENT URBANIZATION AND SETTLEMENT PATTERNS IN THE U.S.

National Patterns

Delegates noted that settlement patterns in the U.S. are oriented around water, with the nation's largest cities concentrated along the two ocean shorelines, the Gulf of Mexico, or the Great Lakes. The east and west coasts are most densely populated, with comparatively fewer people occupying the interior of the country, especially in the West. (The interior West generally is designated as the area ranging from the Great Plains to the Cascade Mountains.) However, much recent growth has occurred in the nation's relatively dry interior, often termed "in-filling." The phenomenal growth of Las Vegas, Denver, and Phoenix best illustrates this new settlement pattern. With land relatively cheap and available in these new growth areas, much of the development has been sprawling and only loosely concentrated around an urban core.

Regional and Local Patterns

Suburban sprawl is a phenomenon that is being observed on regional and local levels as people continue to move from urban areas to their outlying suburbs. Development along city limits has created edge cities. Urban corridors have resulted from large cities expanding and then combining along highways.

The movement of people from the cities to the suburbs has led to the reconfiguration of rural-urban patterns. As people leave the cities, lucrative businesses are displaced from the cities into the suburbs. As employment sources move into suburban areas, commuting distances often are increased and people can both live and work in distant parts of these outlying regions. Meanwhile, the inner cities suffer from a reduced tax-base. The problems of a dying urban core are many and well known: increased crime, abandoned industrial lots, degraded schools and community services. This situation is often termed the "donut-effect" or "rotten-core-effect."

Efforts are being made to change current urbanization and settlement patterns that promote sprawl at the expense of the urban core. For example, the devel-

opment of self-contained suburban communities such as Reston, Virginia, are a popular solution that attempts to minimize suburban sprawl. There also has been a movement to bring people back into cities such as Portland, Oregon, and Chattanooga, Tennessee. These efforts have attracted businesses back to urban areas, leading to the revitalization of inner cities and industrial sectors.

EFFECTIVENESS OF MANAGEMENT OPTIONS AND MITIGATING ACTIONS

Continued population growth will compromise the effectiveness of management options and mitigating actions aimed at addressing the deleterious impacts of that growth. In other words, the bigger the problem, the harder it is to address effectively. Delegates noted that U.S. population growth may weaken the ability of government to manage and protect natural resources.

Population increases also may reduce the ability of citizens to influence legislation. With population growth, local leaders often represent greater numbers of citizens, diminishing the influence of the individual voter. Democracy is diluted as population growth continues.

Legislative and Policy Tools

Delegates cited examples of legislation that currently exists to protect and manage natural resources. Among those cited were the Endangered Species Act, Fish and Wildlife Conservation Act, and Migratory Bird Treaty Act. Infrastructure related mandates about solid-waste management, highway construction, water use, and public utilities also exist to protect the environment. Command and control mechanisms, such as statutes, regulations, and ordinances, include the National Pollutant Discharge Elimination System and the Clean Air and Water Acts. All of these laws and policies have been made necessary by population growth.

Management of infrastructure, solid waste, water projects and uses, public utilities, and highways probably will be at the forefront of the nation's agenda in the future. Delegates reached this conclusion because government agencies currently are not effective at creating disincentives for population growth. Highways are being built based upon data collected several years prior to construction. This leads to outdated construction for present and future traffic conditions and patterns. Alternative modes of transportation are given inadequate attention.

Delegates also discussed how the desire for special wildland products is placing demands on resources and resource management. Large-scale immigration into the U.S. has contributed to the increasing demand for particular flowers, ferns, and mushrooms which, historically, have been gathered in small quantities. Creating more specialized farms is a viable alternative that already has helped reduce the collection of these products on public and private lands.

Delegates also noted that developing a comprehensive and responsible immigration policy that works to reduce immigration levels is another important strategy in working towards resource sustainability in the U.S.

Delegates observed socioeconomic dimensions that impact natural resources. For example, high standards of living often are associated with extravagant lifestyles, the accumulation of material goods, and high levels of consumption. These attributes adversely affect the environment. In contrast, many new immigrants and the disadvantaged may have more modest consumption patterns, but also often have larger families which contribute to the population increase and adverse environmental effects. Delegates agreed that strategies aimed at curbing population growth and resource consumption should be sensitive to socioeconomic differences, including resource use, distribution, and the production of waste.

Population growth will make it increasingly difficult for society to avoid further habitat destruction and fragmentation, detrimental land-uses, and encroachment on protected areas. Management options and mitigating actions also may be compromised by local governments that are unable or unwilling to manage growth patterns through progressive land-use and zoning regulations. Population growth coupled with poor management leads to increased land conversion and a reduction in available agricultural lands, forests, and rangelands—and degraded watersheds.

ALTERNATIVE STRATEGIES

Education

Delegates suggested that one of the most important strategies for mitigating the adverse impacts of population expansion on renewable natural resources is public education. Delegates agreed that people should be educated on the impacts of population growth on food production, waste disposal, water treatment, and energy sources. Focus groups should be developed to gauge public understanding and educational needs concerning these issues.

Programs also should be developed to educate government officials, developers, and communities about the costs of population growth and sprawl. The goal of these programs would be to expand public understanding about how human behavior impacts natural resources.

Delegates also stressed the importance of educating stakeholders about federal, state, and local planning processes so they are better informed about compliance issues (such as NEPA requirements), the language of planning, and development issues.

Alternative Lifestyles

The adoption of less resource consumptive lifestyles is another important

strategy for mitigating the adverse effects of U.S. population growth. This strategy includes increased public involvement in the decision-making process and participation in programs or projects aimed at instilling community appreciation of consumption patterns and the life cycle of natural resources. These strategies would equip the public with tools to work to protect the environment and reduce demands on resources. Re-using housing stock, improving recycling programs, and renovating existing buildings are three possible courses of action to reduce resource demand. Halting the building of second homes in sensitive areas also was suggested as a way to protect fragile natural systems.

Community appreciation also may reduce urban blight and the creation of brownfields. Building bike commuting trails, encouraging environmentally friendly business practices through tax-breaks and other incentives, and increasing grant money from foundations for "green" ideas (e.g., compatible with nature and natural systems) could further promote sustainable lifestyles and products.

Land-Use Planning and Cooperative Relationships

Delegates stated that land-use planning should draw upon local expertise, be locally supported, and rely less on top-down strategies. In particular, delegates noted that bottom-up strategies may reduce feelings of government interference, infringement, and the manipulation of personal property rights—all problems associated with top-down strategies. By involving stakeholders in the community, localities can draw upon their education and understanding. Delegates noted that such measures may help improve the enforcement of existing zoning restrictions affecting fragile habitats, and increase local interest in habitat conservation and sustainable community planning.

Delegates also concluded that an analysis of potential land-use impacts should be prepared prior to the development of undisturbed land. In other words, developers should be asked to prove that the benefit to the community from their construction will outweigh negative impacts on land and water resources. As a disincentive to development, delegates suggested making developers pay the school, water, sewer, and road costs in new developments. Traditionally, these costs have been absorbed by local governments as incentives for construction. Meanwhile, incentives for better planning could promote the development of more sustainable communities and buildings. Local governments also could provide incentives for developers to refurbish existing houses, buildings, and shopping malls.

In coordination with improved planning practices, delegates also stressed the importance of expanding the application of Best Management Practices (BMPs) across larger landscapes that encompass different political jurisdictions and land-use patterns. The goal of this ecosystem-approach is to promote the preservation of resources on public and private lands through effective partnerships and cooperative relationships between public, private, and tribal entities.

Delegates suggested implementing more innovative uses of land trusts that use conservation easements to protect public values on private lands. The purpose of a land trust is to protect lands and public interests by placing an easement or development restriction on property in exchange for incentive payments and/or reduced taxes. Recent increased support for land trusts and private resource protection groups such as The Nature Conservancy demonstrates the growing appeal of the strategy.

Economic Strategies

Delegates suggested that there are market-based solutions to mitigating the adverse impacts of population growth such as banking and trading carbon credits or wetlands mitigation. Creating incentives such as market subsidies also was suggested as an option.

Delegates proposed that the government consider taking controversial steps to protect and preserve natural resources. For example, by increasing user fees for activities such as mining and grazing on public lands, the government would be compensated for costs it incurs in rehabilitating damaged resources. Furthermore, delegates agreed that increased fees may deter certain commercial users from conducting practices that adversely affect resources.

Taxes (federal, state, and local) could be decreased as an incentive for people to manage their lands in an ecologically friendly manner. Delegates suggested that estate-tax laws be changed to reduce inheritance taxes in cases where such a reduction is necessary to preserve the land as undeveloped and to prevent the conversion of farmland to other commercial uses. Some delegates also proposed raising gasoline taxes or prices to reflect the true costs of energy consumption and emissions pollution.

CRITICAL KNOWLEDGE GAPS AND REQUIRED RESEARCH

Inventories, Socioeconomic Factors, and Planning Successes

Delegates identified the need for research on the impacts of human population growth on natural resources. A first step is to involve communities, governments, and resource professionals in an effort to take more detailed inventories of existing renewable natural resources. Delegates noted that this will require further research on how to improve data collection methods and the quality of geographic information systems. Such research will create a connection between local governments and natural resource professionals, and raise awareness about the link between envi-

ronmental heath and the quality of life in the community.

A critical knowledge gap that delegates identified was understanding the impact of socioeconomic factors on U.S. population growth. Delegates noted that economics, family organization, and family size have varied impacts on natural resources and land-use. Research is needed to answer questions such as: 1) Do "welfare-to-work" programs affect family size and fertility rate?; 2) How do different urban groups determine the size of their families?; 3) What relationship, if any, exists between birthrate and higher education for immigrants and women?

Other required research includes collecting case studies of successfully planned communities and metropolitan regions (Minneapolis, Minnesota and Toronto, Canada are good examples), identifying sustainable resource uses, and developing politically feasibly and economically viable ways to improve land-use planning. There also is a need for better understanding of the dynamics behind migration from core urban areas, how to combat this trend, and how to develop more habitable cities. Improved population forecasting and more accurate projections of future trends would aid in planning.

Effective Planning

Delegates recommended that natural resource organizations collaborate on research to define resource-use issues and develop accurate predictive models which describe future impacts of population growth on natural resource consumption. Such modeling would help resource managers plan for potential future impacts.

Delegates also suggested that organizations produce an "Alternative Futures Report" for local areas. This report would require research to identify the impacts of different population growth rates on natural resources. Communities could use these projections to make more effective management and planning decisions. Moreover, as communities better understand that decisions made today impact the quality of the community tomorrow, it is hoped they will work harder to create more sustainably attractive futures.

Resource organizations also should collaborate with social scientists on examining questions such as: 1) What are the cultural uses and perceptions of natural resources?; 2) How do people define, use, value, and manage natural resources?; 3) What is the cost-effectiveness of renewable energy sources?; 3) How does resource use affect natural systems and associated life cycles?; and 4) How do immigrants alter local economies and impact resource supplies? Understanding the connections between population growth and resource use, availability, and consumption, will result in more effective planning for a sustainable future.«

Terrestrial Systems

Delegates from the terrestrial systems working groups considered how an increasing human population and trends in land use and land conversion will affect renewable natural resources. Population growth and continued resource use places demands on available forests, rangelands, and agricultural lands. Delegates discussed current and potential impacts of this growth that make powerful cases for stopping U.S. population growth, conserving land, and easing the increasingly intense demand for resources. Delegates considered five questions:

1. How does population growth and land conversion affect U.S. forests and rangelands?
2. How does population growth and migration affect plants and wildlife?
3. How does population growth and land conversion impact agricultural resources?
4. What are alternative strategies for mitigating adverse impacts of this growth on terrestrial systems (such as changes in policy related to transportation, taxes, environmental compliance, development, and land use)? What are the strengths and weaknesses of each alternative strategy?
5. Are there critical knowledge gaps that need to be filled, and if so, what essential research is required?

Delegates participating in this working group noted that discussion on questions one and two overlapped. As habitat, plants, and wildlife are fundamentally linked, the negative impacts of population growth and expansion on these resources are similar. Therefore, this report will examine questions one and two together.

IMPACT OF POPULATION GROWTH AND LAND CONVERSION ON U.S. FORESTS, RANGELANDS, PLANTS, AND WILDLIFE

A large number of delegates identified the degradation and loss of forests, rangelands, wetlands, and agricultural lands resulting from urban and suburban development as being the most profound impact of population growth. Until recently, the overriding limit to human expansion was the lack of labor and capital to clear forests, irrigate lands, and drain wetlands. Today, human activities are placing increasingly intense pressure on available resources and the food supply.

In addition to population growth, increased U.S. per capita use of land and other natural resources has accelerated and heightened the impact of population growth. Delegates recommended that we adopt sound agricultural, land-use, and population policies in order to secure a future for the resources and the people that depend on them.

Fragmentation of forests, rangelands, and agricultural lands at the outer edges of suburban expansion was recognized as a serious problem. This fragmentation leads to smaller management units of forest and agricultural fields, which interferes with or reduces the efficiency of forest, crop, and livestock management.

Urban development and sprawl also have resulted in overharvesting of forests, destroyed wetlands, and degraded coastal habitats—all of which are vital to numerous plant and animal species. Conservation biologists believe that an increasing number of plant and animal species will disappear each year because of habitat destruction and fragmentation.

Virtually all wild plant and animal populations require some minimum area of "undeveloped" land to thrive and survive. If land development and degradation continues at its current rate, delegates agreed that species diversity will be reduced, gene pool resources will be lost, food availability will decrease, competition for habitat will increase, human/wildlife conflicts will heighten, and health problems will increase. Ultimately, population growth will lead to a reduced quality of life for humans and the degradation of many plant and wildlife populations.

The conversion of terrestrial systems from natural to altered states can cause climate changes at the micro- and macro-scale because vegetation influences water availability, carbon dioxide concentrations, and temperatures. Delegates pointed to reduced economic productivity of the land, aesthetic losses,

and degraded water quality as other impacts associated with land conversion. The removal of vegetation also leads to unstable soils, increased erosion, and a loss of soil nutrients.

Increased travel and international trade (especially in agricultural and forest products) have led to the introduction of invasive and exotic species. Unlike native species, introduced species usually have few natural regulating factors, and therefore, can cause irreversible changes to natural systems and widespread damage to forests, rangelands, and wildlands.

Likewise, wildfire suppression (the reduction of natural fires) has had a profound impact on terrestrial ecosystems. Fire is an essential ecological process and change agent that plays a fundamental role in natural systems. The suppression of wildfires reduces forest and wildland health, and also increases the likelihood of catastrophic burns because of the build-up of fuel.

IMPACT OF POPULATION GROWTH AND LAND CONVERSION ON AGRICULTURAL RESOURCES

Delegates proposed that reductions in the agricultural land base, including decreased food production, coupled with resource scarcity could reduce U.S. national security. Delegates discussed how a deficiency of critical natural resources such as fresh water and arable land creates domestic and international conflicts. Scientists estimate that the U.S. loses 1-1.5 million acres of farmland each year to land conversion. Although agricultural production historically has kept pace with population growth, the reality is that less arable land is available to feed increasing numbers of people.

For regions with minimal natural resources reserves, population growth undoubtedly is a factor complicating sustainable land use. Poor resource management, however, also contributes to this problem. For example, topsoil erosion and nutrient depletion, due in most part to unsustainable farming practices, degrades agricultural lands. Farmers have relied upon nutrient-poor lands, fertilizers, and other inputs to maintain yields. Only within the past ten to fifteen years have agricultural inputs leveled or declined relative to outputs.

Delegates observed that farming low quality lands can degrade the areas beyond restoration. There is very little land available that can be converted to agricultural use and farmed productively and sustainably. Increasing irrigated farmland acreage is not a likely alternative because water resources generally have been developed to their limits in the U.S. Delegates agreed that a shortage of productive lands could reduce management options and make conserving and protecting resources even more difficult.

Modernization and industrialization of the nation's farming practices — such as the increased use of pesticides and fertilizers and expanded water diversion and irrigation projects — have helped increase agricultural production. Agricultural intensification (the process of increasing the inputs and yields) and factory farms (the intense production of livestock) also have helped farmers maintain food production for the growing U.S. population. Delegates concluded, however, that the benefit of many technological advances are offset by a host of adverse environmental impacts. Factory farms, for example, often produce massive pollution problems. Many delegates agreed that the only real solution to achieving long-term sustainable food production is to stop population growth. Realizing the difficulty of achieving this objective, delegates also considered alternative strategies for a sustainable future.

ALTERNATIVE STRATEGIES

Education

Delegates agreed that education can make a dramatic difference in mitigating the adverse impacts of population growth patterns on terrestrial systems. Due to the large amount of material covered in our general educational systems, limited amounts of information on natural resource use and consumption are provided. As a result, most people understand very little about the importance of preserving and managing terrestrial systems or the critical role of forests, rangelands, and wetlands. People also lack knowledge about the economics of resource-based enterprises and the impacts of resource consumption. If Americans were taught about the environmental, economic, and social impacts of their actions, delegates believed they would be more eager to make wise decisions regarding resource use and consumption.

Education on population and resources should be available in both formal and informal settings — from school curricula to continuing education classes. Delegates recommended that teachers be trained to educate students about topics such as population growth, conservation, and sustainability.

Because increasing numbers of students have access to the Internet, educating students and teachers about accessing environmental information should be a high priority. Delegates also suggested that community-based organizations develop strategies to enhance and expand public education opportunities. Focus groups could be used to identify existing knowledge gaps and educational needs.

Locally Oriented Goals

Locally oriented solutions aimed at reducing per capita resource consumption and increasing conservation practices are crucial to implementing lasting change. More efficient transportation modes, economic incentives for sustainable practices, and innovative recycling strategies should be on the agenda of every community. Local land-use zoning laws should be modified to

reduce urban sprawl and contribute to developing sustainable communities.

Delegates are optimistic that by involving local community members in decisions that encompass the planning and managing of natural resources, the nation will move towards developing cities and towns in a manner that is responsible and compatible with the available resources. Rewarding local communities for innovative land-use planning and sustainable technologies were other strategies delegates suggested.

Delegates would like to see RNRF and other resource organizations host sessions on collaborative approaches to conducting local land-use studies and analyses. These sessions would help increase localities' understanding and ability to predict the impacts of population growth on the community. New policies and regulations regarding land use and the management of invasive and exotic species also could be drafted and implemented based upon this enhanced information.

State and National Strategies

Delegates explored numerous state and national strategies to reduce the impacts on terrestrial resources of population growth and consumption. The suggested alternatives or actions present substantial logistical challenges but are imperative to reducing the impact of human activity on the environment. One of the biggest challenges is developing and adopting a U.S. population policy. Delegates stated that such a policy should include measures aimed at stabilizing U.S. population. A related policy would increase economic and political support for developing countries. Delegates agreed that this policy can be implemented if the U.S. government acknowledges and communicates the detrimental impacts associated with growth.

Achieving such a policy will be extremely difficult. Delegates understand that promoting growth, regardless of environmental consequences, is a national obsession.

Numerous state and federal tax provisions discourage environmentally beneficial activities. Delegates suggested changing tax laws and policies to shift incentives from highway construction to public transportation and ride-sharing. Delegates advised that government officials should direct money to mass transit projects and other improvements in urban areas and away from road construction in undeveloped areas.

A consumption tax that would supplement the federal income tax also was viewed as a possible action to reduce consumption. Delegates supported implementing a tax shift from labor and investment to the consumption of goods. This change may increase natural resources conservation and reduce waste production. Eliminating the mortgage interest tax deduction also may reduced resource consumption. Finally, delegates suggested limiting or reforming federal tax deductions for dependents as a way to discourage large families.

Delegates suggested that state and federal governments enact laws and develop a comprehensive federal policy to protect farms, forests, rangelands, wetlands and other important lands. Delegates also recommended that the government provide incentives for environmentally sound land use and agricultural practices, encourage the preservation of open space, and standardize best management practices (BMPs) so that they are more consistent across wide landscapes and varied land uses.

Estate-tax laws should be modified to stop forced development on recently willed property. Policies and programs should encourage people to capitalize on opportunities that protect natural habitats and resources, preserve viewscapes, and improve the sustainable utilization of forest products. Delegates also suggested that government agencies provide funding for land trusts which stop the loss of prime agricultural farmland, forests, and wetlands.

Delegates emphasized the need for managing and coordinating resource data on a state and national scale. Improving technology, such as geographical information systems, and converting the data into a usable form for people who do not have technical training are other important objectives. Delegates noted that much of the data already collected by the government on land use are not readily available to either policymakers or the public. This shortfall in information exchange must be addressed.

Many delegates agreed that U.S. immigration can be reduced by decreasing incentives for people to immigrate to the U.S. Steps must be taken to encourage sustainable and widely shared economic development in foreign countries. Delegates noted that it is important to promote economic stability in foreign countries to lessen pressures to immigrate to the U.S.

Delegates proposed that there is a critical link between campaign finance reform and curbing population growth. Campaign finance reform is an important strategy because politicians would be less beholden to special interests that do not support population stabilization and improving resource efficiency and conservation. Many existing policies seem to encourage growth and the waste and overutilization of natural resources.

Delegates encouraged pricing energy, water, and agricultural products to reflect true costs by including fees for related services, environmental impacts, and efficient management practices. If more realistic prices are imposed, consumers may be encouraged to reduce their current resource consumption. Lastly, delegates suggested making information on environmental permits, especially those that encourage sustainable land-use practices, readily available and understandable so that compliance is desired and easily achieved.

Targeting Businesses and Products

Delegates suggested implementing manufacturing arrangements which fos-

ter resource conservation, waste reduction, cleaner products and technologies, and responsible consumer choices. Delegates cited two examples: 1) the Ford Motor Company recycles and uses recycled-content materials in the manufacturing process and 2) the German Program requires manufacturers to either reuse packaging or pay to recycle it. Delegates noted that changes in manufacturing begin with educating industries, businesses, and consumers on industrial ecology. Industrial ecology describes a closed loop system where resources and energy used in production processes remain in that system so that minimal waste is generated. Industrial ecology is rooted in the principle of treating industrial systems in a manner that parallels ecological systems.

The U.S. also needs to set standards and goals for businesses such as "zero waste" and near "100-percent efficiency" in production. Delegates proposed that economic growth and reduced natural resource consumption is possible if solutions to these goals are explored.

CRITICAL KNOWLEDGE GAPS AND ESSENTIAL RESEARCH

Delegates identified several areas for further research. For example, the environmental costs and benefits of industrial agricultural and forestry practices should be evaluated. Delegates agreed that research is needed on how to effectively regulate the development of urban lands adjacent to agricultural lands. Research also should be conducted on developing sustainable communities.

Economists, political scientists, and other specialists should research a "zero-growth economy" and create a model to answer questions such as, "What would a zero-growth economy look like?" and "Would it work?"«

Aquatic Systems

Water is a renewable natural resource that is vital to the survival of all living things. As human population increases, the proportion of fresh water available to each living thing declines because available fresh water, although renewable, is finite. (Available fresh water often is defined as salt-free water that is fully replaced in any given year through precipitation that falls on continents and islands. It does not include water trapped in the polar ice-caps as that is not readily available for human use.) Delegates observed that if the human population continues to rise, demands for fresh water supplies eventually will exceed supply, causing water scarcity on a large scale.

Global climate changes could redistribute and further reduce localized water supplies. Uncertainties of future climatic conditions adds to the current challenge of managing the U.S. water supply. Delegates recognized that the finite nature of this natural resource makes it an important topic to discuss in the context of human population growth. The aquatic systems working group addressed four main questions:

1. How does population growth impact coastal, lake, and estuarine resources?
2. How does population growth impact freshwater ecosystems and coastal marine life?
3. What are possible alternative strategies for mitigating adverse impacts of this growth on aquatic systems (such as changes in policy related to transportation, taxes, environmental compliance, development, and land use)? What are the strengths and weaknesses of each alternative strategy?
4. Are there critical knowledge gaps that need to be filled, and if so, what essential research is required?

Although this working group considered all four questions, discussions tended to focus on the topics of water quality and the impacts of urban development on water resources. There was less discussion of the overall health of aquatic ecosystems. This report combines the analyses of questions one and two because discussions on these questions frequently overlapped.

IMPACT OF POPULATION GROWTH ON COASTAL, LAKE, AND ESTUARINE RESOURCES, AND FRESHWATER AND COASTAL MARINE LIFE

Directly or indirectly, delegates noted that the major threats to aquatic resources and marine life are the pressures of population growth and urban development. Direct impacts of population growth in the U.S. include water depletion, over-harvested fish stocks, and point and non-point source water pollution. Non-point source water pollution describes widespread and often diffuse pollution from urban and agricultural runoff. The Chesapeake Bay was cited as an example of an aquatic system that is being degraded by increased agricultural runoff from fertilizers, manure, and pesticides. Although more easily quantified, monitored, and controlled with regulations, point-source discharge from sewage treatment plants and industrial plants also pollutes the water supply.

Dense population along the nation's coasts puts enormous pressure on water resources. Coastal systems, which include the ocean, shoreline, and estuarine and riparian wetlands, are particularly vulnerable to population impacts. This vulnerability exists because aquatic ecosystems function as an entire hydrologic unit—river water, upland runoff, and local rainfall all flow seaward through the system. Furthermore, because water behaves as a single entity, and thus serves as an environmental integrator, habitat destruction and losses in biological diversity are generally greater for aquatic systems than terrestrial systems.

Construction of housing developments and industries adjacent to aquatic ecosystems often leads to water pollution, flooding, and increased soil erosion. Urban development destroys wetland habitats, diminishes biological diversity, and threatens marine life. The construction of docks and marinas, harbor related dredging operations, and commercial fishing, crabbing, and clam-dredging all are detrimental to sensitive bay areas. Along many coastal fringes, the increasing use of groundwater to support new development has led to high levels of saltwater intrusion.

Freshwater systems, particularly rivers, increasingly are used or altered to meet hydropower, manufacturing, and transportation needs. Implications of such activities include reduced water quality and diminished plant and animal productivity. Water flow modifications, such as dams, levees, and channelization also have detrimental impacts on the environment. These activities change flooding regimes and reduce the amount of water, sediment, and nutrients supplied to estuaries and coastal marshes. These activities also are detrimental to many native species. For example, water barriers alter wildlife habitats, contribute to insufficient stream flow, and block fish from reaching historic spawning and rearing grounds.

Impacts associated with watercraft pollution have been a growing concern for aquatic researchers. As the number of engine-powered boats and jet skis increases, so does the amount of oil and gasoline spilled into the water. When multiplied many times or in combination with other chemicals, discharges may form significant concentrations that have detrimental biological effects. Scientists believe that these spills are partly responsible for the declining manatee population in Florida.

ALTERNATIVE STRATEGIES

Education and Community Awareness

Increasing education and community awareness are important mitigating measures to reduce adverse impacts of population growth patterns on aquatic systems. In recognition of this goal, delegates offered three issues that should be guideposts for educating local communities and coastal area inhabitants: 1) the natural hydrologic cycle, 2) the value and uses of water resources, and 3) the impacts of population growth on aquatic systems. Delegates suggested that if citizens are informed on these issues, they will show a strong interest in preserving water resources.

Increased awareness about population growth and related water issues could be fostered through features on the front pages of local newspapers, continuing education classes, and community-sponsored activities. Local initiatives should be designed to promote sustainable development and water conservation in order to help offset current shortages and meet future demands. Delegates agreed that an informed public is a long-term solution to managing population growth and water resources.

Delegates also emphasized educating children so that they can assist in educating parents and other adults. Delegates recommended increasing classroom discussions on population and resource issues in order to foster environmentally sensitive students. Another educational tool is to develop innovative elementary school projects (such as "Project Wet") that teach children fundamental concepts of conservation, recycling, restoration, and population control.

Incentives and viable alternatives should be available for people to make informed choices and conduct their daily activities in such a way that is not detrimental to the environment. Delegates also proposed that individuals and communities assume greater roles in stewardship projects such as "Adopt a Watershed." Stewardship projects are important because volunteers offer numerous environmental benefits by monitoring water quality, restoring fish habitats, and managing water resources.

State and National Strategies

Delegates discussed several state and national strategies that target the management, conservation, and protection of aquatic systems. Suggested strategies included restoring and protecting wetlands, coastal waters, and high-priority watersheds (termed "problem sheds" by the delegates). Existing policies such as the Coastal Zone Management Act (CZMA) and Section 404 of the Clean Water Act (cornerstone of the federal effort to regulate wetlands), coupled with new technologies, could be used to develop water-use alternatives and encourage conservation. National professional standards and guidelines also need to be developed to protect and preserve aquatic systems.

Incentive based programs could encourage the development of geographical information systems and remote sensing to monitor, manage, and protect aquatic resources. Increasing incentives for private land stewardship could help farmers control polluted runoff, create buffers, and incorporate pollution prevention measures. (This already is occurring, to some extent, through several Farm Bill programs.) State and federal water laws also need to be revised to resolve conflicting and increasing demands on water resources, especially in the West. Recent conflicts between Georgia, Alabama, and Florida illustrates that problems occur in the East as well.

Many delegates agreed that water prices should be revised to reflect the full costs, including the cost of providing services and ameliorating future environmental problems. Making users pay the full cost would encourage water conservation, particularly through development of low-cost water saving measures.

Water prices historically have encouraged population growth and urban development. For example, revenues needed to maintain and expand water and sewer systems are dependent upon fees from new construction. Also, these costs often are hidden in the cost of buying a new home or in homeowners association fees. Delegates recommended that state and federal governments find alternative funding sources for development and infrastructure that are not tied to population growth. Delegates also suggested establishing natural resource units where a specific amount of water is allocated to each person each year. These new approaches may translate into greater water conservation.

To help conserve water supplies, any laws or policies that promote unsustainable farming practices should be modified or abandoned. Delegates also proposed the elimination of intended and unintended subsidies, especially those given to farmers. If subsidies to agriculture were eliminated, farmers would be more likely to adopt irrigation and water management practices that conserve water. Delegates suggested, for example, that farmers employ central-pivot irrigation systems which utilize less water and produce less run-off. Other practices, such as contour farming, strip cropping, and terracing also aid in reducing water loss and pollution and should be encouraged through economic incentives.

Linking water and land-use planning strategies could improve the management of both resources. For example, stormwater management is an environmentally responsible development practice that should be required. Urban renewal, including the utilization of abandoned factories and buildings, also would aid in protecting aquatic resources. Urban development reduces the amount of land, especially wetlands and fragile coastal areas, that is used for new construction.

Finally, delegates agreed that professional, scientific, and educational organizations, including member organizations of RNRF, should place the issue of population growth on their public policy agendas.

CRITICAL KNOWLEDGE GAPS AND ESSENTIAL RESEARCH

Filling Knowledge Gaps

Delegates suggested that the most critical knowledge gap concerning aquatic systems is the lack of understanding about the natural functions, uses, and distribution of water. Delegates compiled a list of important questions that should be answered if the fresh water supply is to be sustained: How much fresh water is available? How is water distributed and what are its natural functions? What are the impacts of population growth and urban development on the water supply? What are the full costs of water? Who owns the rivers? Who protects the commons? How do you protect aquatic resources and at what scale? What are potential sources of future water supplies? What are the related energy costs of a new potable water supply? Who makes decisions regarding land and water-use? How do you integrate planning and permitting with water availability?

Delegates also agreed that to protect water resources, it is important to understand how the public values water in terms of its services, products, and functions.

State and National Research

Another important research issue facing the nation is how to stop human population growth and control urban sprawl. The burden of population growth and sprawl has led to the exploitation of aquatic resources, especially in the West. To ensure the long-term health of aquatic systems, delegates agreed that population stabilization must be achieved.

Delegates also recommended that research be conducted on how to integrate water availability with land-use planning, permitting, and zoning. Should additional suburbs be built in Phoenix, for example, given the cost of supplying the residents with fresh water?

Delegates also mentioned the need for research to examine the potential impacts of population growth on: 1) climate change, 2) regional water quantity and quality, 3) sediment and contaminant transport, 4) wetlands and watersheds, and 5) groundwater recharge.«

Utilization and Consumption of Resources

Delegates pointed out that the U.S. population currently is growing faster than any other industrialized country in the world (1.0 percent or approximately three million people per year). Delegates also pointed out that the U.S. uses far more energy and natural resources than any other nation. Delegates maintain that population growth combined with increased resource consumption will place increasing pressure on the abundance and health of the nation's renewable natural resources. Population growth and consumption will make these resources difficult to allocate, manage, and protect. (Consumption includes finished products as well as the materials and energy it takes to make those products.)

Balancing future demands with resource supplies will be an enormous challenge. Delegates recognized that government agencies, natural resource organizations, academic institutions, industries, and individuals will need to work together to create communities that are sustainable, healthy, and economically prosperous. The utilization and consumption working group examined the following questions:

1. In what ways are current levels of utilization and consumption impacting renewable natural resources in the U.S.?
2. What are the alternative strategies for improving the utilization and reducing consumption of renewable natural resources in the U.S. to a level that is sustainable for future generations (such as changes in policy related to transportation, taxes, environmental compliance, development, and land use)? What are the strengths and weaknesses of each alternative strategy?
3. Are there critical knowledge gaps that need to be filled, and if so, what essential research is required?

Working group discussions mainly focused on strategies aimed at improving the utilization and reducing consumption of our natural resources.

IMPACT OF UTILIZATION AND CONSUMPTION ON THE U.S. RENEWABLE NATURAL RESOURCE BASE

Delegates noted that population growth and consumption have numerous ecological costs. Either directly or indirectly, population growth and consumption have led to soil, air, and water pollution, groundwater depletion, cropland damage, the disruption and loss of natural habitats (both aquatic and terrestrial), and the extinction of countless plant and animal species.

On a per capita basis, the U.S. consumes more than twice as much energy as Japan or western Europe and ten times as much as developing nations. Americans also are the greatest producers of waste. As a result of this combination, Americans are disproportionally impacting the environment. Many delegates believed that the U.S. should be vigorously leading the movement towards reducing consumption.

Delegates noted that differences in resource and energy consumption primarily are due to differences in history and geography as well as cultural attitudes and settlement patterns. For example, Europeans and the Japanese tend to live in densely populated cities, towns and villages. Hence they commute shorter distances and drive smaller cars compared with the U.S. Furthermore, they typically own fewer material possessions and live in smaller and older homes that use less energy for heating and cooling.

Some delegates noted that understanding how consumption is impacting the nation's resources requires an examination of economic systems and associated market theories. The free market system in the U.S. is encouraging people to maximize consumption, and thus production. Mass marketing techniques and commercialization perpetuate the desire for material possessions and thus indirectly lead to ecosystem destruction. (The advertisements for sport utility vehicles in off-road environments are an excellent example.) Moreover, economic systems define or measure economic prosperity by the production of "stuff." Delegates stated that the nation's desire to acquire material goods is deleteriously impacting our resources and the natural environment. With this con-

sumption paradigm as a backdrop for discussion, delegates explored several alternative strategies.

ALTERNATIVE STRATEGIES

Fostering Change at the Individual, Community, and National Levels

Many delegates agreed that the major obstacle to curbing resource consumption is the nation's lack of understanding about the ecological costs of producing and consuming goods. Delegates identified strategies needed to foster this cultural change.

Educating Americans about the impacts of their choices will help expose the link between consumption and resource depletion and degradation. Knowledgeable consumers have the power to make informed decisions about the products and services they choose. Teaching citizens about the importance of recycling, the impacts associated with increasing waste, and the environmental consequences of relying on non-renewable resources will help to reduce consumption and improve the sustainability of resources. Delegates also suggested forming focus groups to identify knowledge gaps and critical issues on population growth and resource consumption.

Redirecting America's utilization patterns is another important strategy. The goal is to move the nation towards more effective resource use. Purchasing and producing a reduced volume of goods, diminishing the reliance on virgin resources, and increasing the recycling of materials will help achieve this strategy. Delegates also emphasized reducing the amount of waste produced, suggesting that the nation work toward a zero-waste policy. The Amish community was identified as a nearly closed system that produces minimal waste. It is a good model to study.

Delegates discussed that the current cultural value system must be reorganized—decoupling economic prosperity and natural resource use. In other words, America needs to shift the importance from resource extraction, mass-production, and excessive consumption towards sustainable resource use and ecosystem preservation and restoration.

Developing sustainable communities can help trigger a cultural shift. Society's ability to meet human needs in a manner consistent with protecting natural resources and the environment (efficiently using resources and producing minimal wastes and environmental damage, for example) is the premise for sustainable communities. In making decisions, sustainable community members always need to consider long-term benefits to future generations alongside short-term benefits for themselves. Members also must support local initiatives and improve communication and education within the community.

Talking about population issues and, ultimately, stopping population growth were deemed essential strategies for reducing consumption and creating sustainable communities. We need to develop a method for discussing these sensitive issues without raising fear or generating anger. To participate effectively in conversations about population issues, however, Americans also need to know about the limitations of natural resources and the importance of conservation.

Economic Strategies

Delegates agreed that there are mechanisms that state and federal governments can use to curb resource use, such as tax reforms and economic incentives. Many delegates supported implementing a tax shift from payrolls, incomes, and investments to goods and services that diminish the natural resources base, harm the environment, and cause pollution (consumption tax). Tax incentives should be provided for efficient and innovative technologies that reduce energy use and promote resource conservation.

In addition, delegates agreed that any federal or state tax policy or code that discourages or prevents environmentally-friendly activities should be revised.

Targeting the Environmentalist Movement

Delegates suggested that the pessimistic tone of the environmentalist movement be modified. Presenting the future of our environment in doomsday scenarios only creates feelings of futility, fear, and anger among the public. Much of the current dialogue is oriented to finding fault or blame with human actions and does not recognize that nature is interconnected—humankind is part of the problem and solution. Moreover, dialogue on the importance of conserving and enhancing natural resources needs to include discussion of the many ancillary benefits of conservation. Today, environmental conservation and economic advancement are often presented as mutually-exclusive goals, when in fact they can coexist.

Business, Industry, and Manufacturing Strategies

Delegates mentioned several other important strategies aimed at reducing resource consumption to a sustainable level. It would be beneficial to conduct product life-cycle analyses in order to evaluate the environmental impacts associated with certain manufactured goods. Such analyses would help in planning for future demands on resources. To help ensure sustainable business practices such as the recycling of products and materials, delegates proposed developing depositing techniques that are more flexible and economically beneficial to consumers and manufacturers.

Delegates favored awarding certifications to manufacturers and advertisers for sustainable products. Labeling would help consumers identify clean

and environmentally-sound products. If people prefer these products, it would encourage manufacturers to meet the standards and requirements established for certification. Delegates also suggested recognizing projects by bestowing national and highly visible awards in order to foster the development of green ideas and technology.

Policies and programs (including many federal subsidies) that discourage business and industry from implementing environmentally friendly technologies or practices should be revised or eliminated. Such policies and programs also should be more flexible and result oriented so that businesses and industries can achieve superior environmental performance. Delegates are aware, however, that amending federal policies and programs may not be possible until campaign finance reform is instituted.

CRITICAL KNOWLEDGE GAPS AND ESSENTIAL RESEARCH

Delegates suggested that the U.S. develop an agenda identifying knowledge gaps that need to be filled, and practical research that will aid in efforts to reduce population growth and consumption. Knowledge gaps include understanding the ecological consequences of product choices, and the potential for economic development with less natural resource consumption. Other critical research items include improving natural resource inventories, conducting product life-cycle analyses, and developing economically viable alternate forms of energy. Estimating the nation's human carrying capacity and evaluating environmental impacts associated with population growth were also deemed as essential research items.«

Synthesis: Steps Toward Stopping Population Growth and Conserving Natural Resources

LIMITS TO POPULATION GROWTH AND RESOURCE CONSUMPTION

During his remarks at the Congress dinner event, Dr. Albert Bartlett, professor meritus of physics at the University of Colorado, posed two challenging questions: "If population growth continues in the U.S., will it improve the quality of citizens' lives?" and "Will society be more manageable and cities more livable?"

Upon reflection, delegates concluded that current population growth poses serious long-term threats to the ecological and societal health of the U.S. Delegates are confident that continued population growth and consumption will cause a decline in the quality of life.

A prevalent notion in modern society is that there is an unlimited supply of resources exclusively for human use and exploitation. However, as the U.S. population has increased, the nation's resources have been impacted in several ways including: groundwater contamination, surface water shortages, species extinctions, deforestation, rangeland and wetland destruction, farmland degradation, and widespread pollution. These problems serve as warning signs for more complex and serious problems ahead.

Delegates suggested that population be stabilized through public education and awareness, by building sustainable communities, and by adopting effective policies and programs. All of these approaches must be employed to maintain our social, economic, and environmental options. As the world's third most populous country and the leader in resource consumption, it is important for the U.S. to provide leadership in the development of sustainable resource use and strategies for population stabilization.

STRATEGIES FOR POPULATION STABILIZATION AND RESOURCE CONSERVATION

Delegates in all four working group sessions agreed that there is accumulating evidence that the current U.S. population growth poses risks to the management, protection, and conservation of our natural resources. With this in mind, delegates endorsed strategies that work to encourage population stabilization and resource conservation. Recommended strategies are listed under three general themes.

Education and Awareness

Delegates recognized that education is critical to altering existing attitudes and approaches to population growth and resource consumption. Education will encourage people to consider the long-term social, economic, and environmental costs of population growth and consumption. If Americans understand the consequences of their actions, and those of the government, on the environment and natural resources, they will be more supportive of laws, programs, and policies that reduce population growth and moderate consumption.

Delegates also mentioned that government officials, policy makers, and planners need to be educated on population issues and the benefits of sustainable development and resource use.

Building Sustainable Communities

Delegates agreed that good models of sustainable communities need to be developed because currently very few examples exist. Delegates described a popular notion of a sustainable community: people living in a compact space, using public transportation, minimizing energy use and the consumption of other resources, and reducing and recycling waste. The goal of building such communities is to limit sprawl, preserve the environment, and use natural resources more efficiently.

Developing sustainable communities will require improving recycling programs, rehabilitating existing buildings, and formulating innovative new building designs that are ecologically friendly. Preserving natural settings and re-developing brownfield sites will be other important activities. Land-use planning should incorporate the needs of future and current generations. Delegates suggested that sustainable communities can be achieved if local citizens are involved in the decision-making process regarding land-use planning and resource conservation.

Economic Programs and Policies

Delegates posed two important questions during their discussions, "What would a steady-state economy look like?" and "Would it work?" The wealth of the U.S. economy historically has been measured largely by the quantity of output (or the production and consumption of goods) in terms of the Gross National Product (now Gross Domestic Product). Under this assessment, Americans believe that economic growth depends on ever increasing population and resource consumption, thereby encouraging both situations. Delegates proposed that there are advantages in economic equilibrium and minimizing the production and consumption of goods. They admitted, however, that more information is needed on how such systems would operate.

Delegates suggested other economic strategies as possible actions to reduce resource consumption. These strategies included shifting taxation from labor and investments to the consumption of goods and services, and reducing or eliminating tax deductions for dependents as a way of discouraging large families. Economic incentives for sustainable development, the preservation of open space, and innovative technologies that reduce energy use and minimize the consumption of resources were among the other suggestions.

THE NEXT STEP

Delegates recommended several future activities for RNRF and other natural resource organizations. For example, it is important to produce an "Alternative Futures Report" to identify the impacts of different population growth rates on natural resources. Communities could use these projections to make effective decisions on resource management and land-use planning. Delegates also would like RNRF to host sessions on collaborative approaches for conducting land-use studies and analyses. Such an activity would increase the understanding and ability of localities to predict the impacts of population growth and resource consumption on the community.

A wealth of ideas, strategies, and recommendations were proposed at this congress. This report describes several high priority research needs. Scientists and researchers have the capability to develop these into a comprehensive research agenda.

If trends in population growth and resource consumption continue unabated, the U.S. will face increasingly difficult environmental issues and conflicts. Americans must take steps to assure a sustainable quality of life for future generations.«

Appendix: List of Delegates

Albert A. Bartlett
Professor Emeritus
Department of Physics
University of Colorado
Boulder, CO

John R. Bermingham
President
Colorado Population Council
Denver, CO

G. Ronnie Best
Chief and Supervisory Ecologist
Restoration Ecology Branch
U.S. Geological Survey
Miami, FL

Peter E. Black
Former President, American Water Resources Association
Professor
Water and Related Land Resources
SUNY ESF
Syracuse, NY

James Bowyer
Director
Forest Products Management Development Institution
University of Minnesota
St. Paul, MN

Joseph J. Breen
The Green Chemistry Institute
Rockville, MD

Cory Briggs **
Law School
The George Washington University
Washington, DC

Dale Bumpers
United States Senate
Washington, DC

Hwei-Hsien Cheng
President, American Society of Agronomy
Professor
Department of Soil, Water, and Climate
University of Minnesota
St. Paul, MN

Tommy L. Coleman
Professor
Soil Science and Remote Sensing
Alabama A&M University
Normal, AL

Francis P. Conant
Professor Emeritus (Anthropology)
Hunter College
New York, NY

C. Richard Cothern **
Professor
Law School
The George Washington University
Washington, DC

Muriel Crespi *
Chief Ethnographer
Archeology and Ethonography Program
National Park Service
Washington, DC

M. Rupert Cutler *
Executive Director
Western Virginia Land Trust
Roanoke, VA

Herman E. Daly
Professor
School of Public Affairs
University of Maryland
College Park, MD

Robert D. Day
Executive Director
Renewable Natural Resources Foundation
Bethesda, MD

Lee De Cola
Research Physical Scientist
National Mapping Division
U.S. Geological Survey
Reston, VA

Jonathan P. Deason **
Professor
School of Engineering and Applied Science
The George Washington University
Washington, DC

Richard L. Duesterhaus *
Former President, Soil and Water Conservation Society
Chairman
RNRF Board of Directors
Vienna, VA

Martha E. Geores
Assistant Professor
Department of Geography
University of Maryland
College Park, MD

Bertha Gillam
Director
Range Management Staff
USDA Forest Service
Washington, DC

Karl Glasener
Director of Science Policy
American Society of Agronomy, Crop Science Society of America, Soil Science Society of America
Washington, DC

Albert A. Grant
Former President, American Society of Civil Engineers
Consulting Engineer
Potomac, MD

David Guillet
Professor
Depart of Anthropology
Catholic University of America
Washington, DC

Ann Hanus
Assistant State Forester
Oregon Department of Forestry
Salem, OR

Carl Haub
Information and Education Director
Population Reference Bureau
Washington, DC

Victoria Herian
Executive Director
Society of Wood Science and Technology
Madison, WI

Michael Hewitt
Manager
Technical Activities
American Society of Civil Engineers
Reston, VA

Ann Marie Hobbs ***
Department of Anthropology
Catholic University of America
Washington, DC

Laurent R. Hourclé **
Co-Director
Environmental Law Program
The George Washington University Law School
Washington, DC

Michael D. Jawson
National Program Leader
USDA Agricultural Research Service
Beltsville, MD

Kelly Jones-Petska ***
Department of Anthropology
Catholic University of America
Washington, DC

Sven-Erik Kaiser
Office of Solid Waste and Emergency Response
U.S. Environmental Protection Agency
Washington, DC

Laura Kallus ***
The George Washington University
Washington, DC

Frederick A. Kamke
Former President, Society of Wood Science and Technology
Professor
Brooks Forest Products Center
Virginia Tech
Blacksburg, VA

Dennis R. Keeney
Director
Leopold Center for Sustainable Agriculture
Iowa State University
Ames, IA

David E. Kissel *
Former President, Soil Science Society of America
Professor
Department of Crop and Soil Sciences
University of Georgia
Athens, GA

Kristen L. Krapf
Director of Programs
Renewable Natural Resources Foundation
Bethesda, MD

Robert T. Lackey
Associate Director for Science
National Health and Environmental Effects Research Laboratory
Western Ecology Division
U.S. Environmental Protection Agency
Corvallis, OR

Berton L. Lamb
Research Social Scientist
U.S. Geological Survey
Fort Collins, CO

Christopher Lant
Professor
Department of Geography
Southern Illinois University
Carbondale, IL

Barbara Lenkerd *
Senior Research Associate
Project on Technology, Work and Character
Silver Spring, MD

Edward Lytwak
Senior Researcher
Negative Population Growth
Washington, DC

G. Richard Marzolf
Chief
Regional Research Branch (Water)
U.S. Geological Survey
Reston, VA

David W. Moody
Former President, American Water Resources Association
Vice-Chairman
RNRF Board of Directors
Alstead, NH

Katy Moran
Executive Director
The Healing Forest Conservancy
Washington, DC

Elvia Niebla
National Global Change Coordinator
USDA Forest Service
Washington, DC

Larry A. Nielsen
Former President, American Fisheries Society
Director
School of Forest Resources
Pennsylvania State University
University Park, PA

Mary Margaret Overbey
Director of Government Relations
American Anthropological Association
Arlington, VA

Kelly Ann Quinn
Program Assistant
Winrock International Leadership and Human Development Program
Arlington, VA

Priscilla Reining
American Anthropological Association
Chair, Congress Program Committee
Washington, DC

David W. Rejeski
Executive Director
Environmental Technology Task Force
Council on Environmental Quality
The White House
Washington, DC

Howard Rosen
Staff Specialist, Forest Products and Harvesting Staff
USDA Forest Service
Washington, DC

Maria Consuelo Sanchez ***
Department of Anthropology
Catholic University of America
Washington, DC

Elizabeth Scholl
Ecologist
Department of the Army
Fort Lee, VA

Michael Shanon
Acting Director
National Program Staff
USDA Agricultural Research Service
Beltsville, MD

Sean Sheehan
Director of Network Services and Internet Programs
Center for the New American Dream
Tacoma Park, MD

George William Sherk **
School of Engineering and Applied Sciences
The George Washington University
Washington, DC

Willis E. Sibley
Professor Emeritus (Anthropology)
Cleveland State University
Shady Side, MD

E. Lamar Smith
President, Society for Range Management
Professor
School of Renewable Resources
University of Arizona
Benson, AZ

David South
Professor
School of Forestry
Auburn University
Auburn, AL

David L. Trauger *
Biological Resources Division
U.S. Geological Survey
Reston, VA

James J. Vinch **
Law School
The George Washington University
Washington, DC

Lorie A. Wagner
Acting Chief
Minerals and Materials Analysis Section
Minerals Information Team
U.S. Geological Survey
Denver, CO

Craig Whittekiend
Executive Vice President
Society for Range Management
Denver, CO

Angela S. Williams
Director, Society for Range Management
USDA Natural Resources Conservation Service
Paoli, OK

Note Takers

Seeky Cacciatore
Silver Spring, MD

Pavitra Srinivasan ***
The George Washington University
Washington, DC

* *Working Group Chair*
** *Facilitator*
*** *Graduate Student*

Population Web Site References

Alan Guttmacher Institute
http://www.agi-usa.org

CARE
http://www.care.org

Center for Development and Population Activities (CEDPA)
http://www.cedpa.org

Global Action and Information
http://www.igc.apc.org/gain/

Horizon Communications Solutions Site
http://www.yale.edu/horizon

International Council for Local Environmental Initiatives
http://www.iclei.org/

International Institute for Sustainable Development
http://iisd1.iisd.ca/

Negative Population Growth
http://www.npg.org

PopNet (Global Population Information)
http://www.popnet.org

Population Action International
http://www.populationaction.org

Population Council
http://www.popcouncil.org

Population-Environment Balance
http://www.balance.org

Population Institute
http://www.populationinstitute.org

Population Reference Bureau
http://www.prb.org

President's Council on Sustainable Development
http://www.whitehouse.gov/PCSD

Smart Growth Network
http://www.smartgrowth.org

United Nations Environment Program
http://unep.unep.no/

United Nations Population Fund
http://www.unfpa.org

United Nations Population Information Network
http://www.undp.org/popin

Zero Population Growth
http://www.zpg.org

About RNRF

The Renewable Natural Resources Foundation (RNRF) was incorporated in Washington, D.C., in 1972 as a nonprofit, public, tax-exempt, operating foundation. It was established to: advance sciences and public education in renewable natural resources; promote the application of sound scientific practices in managing and conserving renewable natural resources; foster coordination and cooperation among professional, scientific and educational organizations having leadership responsibilities for renewable natural resources; and develop a Renewable Natural Resources Center.

The foundation represents a unique, united endeavor by outdoor scientists to cooperate in assessing our renewable resources requirements and formulating public policy alternatives.

RNRF's members are professional, scientific and educational organizations that have, among their primary purposes, the advancement of sciences and public education in renewable natural resources and/or the application of scientific knowledge to the management of renewable natural resources. Each member organization is represented on the board of directors. Also, "public interest members" may be elected to the board.

Individuals who support the foundation's purposes and programs may become "associates."

RNRF conducts conferences, symposia and congressional forums on renewable natural resources issues, and roundtable sessions for public/government affairs staffers of RNRF member organizations. RNRF also conducts biennial summits of the elected and appointed leaders of its member organizations. Current and future leaders are able to explore common interests and plan collaborative activities.

The *Renewable Resources Journal* promotes communications among RNRF's represented disciplines, and it is provided to all members of the governing bodies of RNRF member organizations. *Renewable Resources Journal* also is provided to members of the U.S. Congress, federal agencies, universities, and staff members of congressional committees with jurisdiction over natural resources.

RENEWABLE RESOURCES
JOURNAL
INDEX—VOLUME 16

AUTHORS

SUBJECTS

The subject index covers article titles, which are in italics, and general topic headings, which are in roman type.

Renewable Resources Journal **also is independently indexed in the Environmental Periodicals Bibliography. A complete list of tables of contents of all volumes can be found on the World Wide Web at http://members.aol.com/RNRF.**

RENEWABLE RESOURCES JOURNAL
Renewable Natural Resources Foundation
5430 Grosvenor Lane
Bethesda, Maryland 20814 USA

Non-Profit Organization U.S. Postage PAID Permit No. 92 Bethesda, MD

Printed on Recycled Paper