UTAH VITAL SIGNS

A Sustainability Indicators Project of the Utah Population and Environment Coalition

The Ecological Footprint of Utah

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FOREWORD

I frequently find pleasure in an image wedded strongly in my mind of the earliest human experience with philosophy. On the edge of an ancient city, perhaps Ephesus or Miletus, there is gathered under a grove of olive trees a cluster of young students eagerly engaged in inquiry with an older more experienced thinker. There the human capacity for critical reflection on the thoughts of self, of others and of the deeper aspects of nature was given a form that we would easily recognize today.

And so from these early roots we have sought to know how to live with ourselves and in community and to establish patterns of governance for the fulfillment of human needs. Yet today we stand upon a new horizon that presents us, perhaps for the first time, with the possibility of living integrally within a larger earth community.

History teaches that human progress holds a dark side. Of course this is to be expected for we are a predacious species. But we differ importantly from other predators: we rely not upon a narrow range of prey but entire ecosystems.

Predacious species are subject to one of ecology's most fundamental laws — their vitality depends upon prey whose very abundance predation threatens. Overly successful predators collapse prey populations and in turn fade in their own success until prey re-establish a former abundance. As a species, we have defied this law by expanding our domain until it has encompassed the entire biosphere.

The *Living Planet Report 2006* affirms that we now appropriate the earth's biospheric resources faster than can be restored: our rapidly increasing impact now exceeds the planet's regenerative capacity by more than 25 percent. So now for the first time in human history we must seriously resort to the second way in which we differ from other predacious species. We must now rely upon our capacity for critical reflection. We must confront the choice and choose wisely between the continued overly successful appropriation of earth resources with its threat of subsequent collapse or a culturally constrained practice of appropriation in equilibrium with a larger earth community.

The Utah Population and Environment Coalition has prepared an analysis of the rapidly increasing impact that Utahns have upon the state's regenerative capacity. The research team has found that we exceed that capacity and are on a trajectory to strain it even further. Theirs is the first such assessment done for any of the 50 states. It is a pioneering effort. It should receive our applause. We should be particularly grateful for the way it provides an informed basis for reflection on what we Utahns require of the earth and how we might rectify the prospect of perpetuating life measurably out of balance.

Dr. Philip C. Emmi
Professor of Urban and Regional Planning
University of Utah

INTRODUCTION

The Utah Vital Signs Project is proud to present the results of the first state-level Ecological Footprint study in the United States, a comparison of Utah's Ecological Footprint in 1990 and 2003. The goal of Utah Vital Signs is to empower Utah citizens and decision-makers to make better choices about their future by providing clear, well-documented information about key indicators of environmental sustainability in Utah.

This study constitutes a crucial first step in a series of actions that can help us to live sustainably, i.e., to maintain the ecological underpinnings of our quality of life and unique natural heritage. We have adopted a variation on the frequently quoted definition of sustainability put forth by the United Nations World Commission on Environment and Development (often referred to as the Brundtland Commission), i.e., "meeting the needs of current life forms without compromising the capacity of future life forms to do likewise." Sustainability is related to the quality of life in a community — it asks whether the economic, social and ecological systems facilitate for its members now, and in the future, a healthy, productive, meaningful life.

Now is an important time to begin tracking sustainability indicators for Utah. Concerns are mounting over global warming, fossil fuel supply, expanding material consumption, and increasing geopolitical tensions related to control of traditional energy sources. Utahns have begun asking questions critical to our future: "Are we living within our means, in terms of the natural resources required to sustain us well into the future?" "What resources will our children and grandchildren require to continue to prosper?" "What can I do to ensure the preservation of our heritage?" "How much time do we have to consider our choices?"

A focus for Utah on sustainability puts us in alignment with the International Council for Local Environmental Initiatives (ICLEI). It is a global organization that focuses on building a sustainable future. Hundreds of cities, towns and counties through ICLEI's Local Governments for Sustainability initiative (http://www.iclei.org/) have made a commitment to sustainable development through supporting government implementation of sustainable development at the most local level.

Utah Vital Signs provides key data and analytical tools to Utahns to clearly articulate the impacts our choices have on the demand and supply of earth's ecological services. Through a more complete understanding of our responsibilities toward life's support systems, it becomes easier to understand how individual and collective actions affect the biosphere. With this knowledge, we will be informed about our behaviors, know how to effectively reduce our Ecological Footprint and thereby, should we choose, restore balance to life for generations to come.

RESEARCH PARTICIPANTS

Parent Organization: WHALE/UPEC

The Wellness Health and Lifestyle Education (WHALE) Center is a 501(c)(3) organization. The mission of WHALE is "to facilitate healing with individuals, families, organizations, communities, and the Earth in cooperation with others." The Utah Population and Environment Coalition (UPEC) is a program component of WHALE and the Utah Vital Signs effort is a project of UPEC.

Since 1997 UPEC has addressed the ongoing concerns of population increases and resource consumption in Utah, particularly along the Wasatch Front. The UPEC mission statement declares: “We believe it is our responsibility as citizens of the earth to be concerned about the environment, sustainability and population. Furthermore, we place special value on the unique heritage and landscape of the state of Utah.” UPEC’s goals are:

- To provide educational and research services to further understanding and cooperation regarding environmental and population issues, and to promote the concept of sustainability for individuals, organizations, and communities primarily in Utah.
- To operate on a non-profit, non-partisan basis for the promotion of the social welfare by working for:
  - The encouragement of programs that promote healthy environmental, sustainability and population practices and policy
  - The facilitation of communication between individuals and organizations in Utah regarding environment, sustainability and population issues
- To advance and develop a network and/or constituency for population, sustainability and environment issues within the state of Utah.
- To provide educational resources for schools, churches, and other interested organizations on population, sustainability and environment issues.

Project: Utah Vital Signs

In summer 2006, several individuals within UPEC wrote a proposal for an initial pilot round of a Utah Vital Signs study. Private funding was secured, the UPEC Board and the leadership of WHALE approved the project, and work commenced in October 2006. The Board contracted with Sandra McIntyre to serve as project director. A committee of the UPEC Board, chaired by Wayne Martinson, provided oversight and governance throughout the project. UPEC joined the Global Footprint Network for guidance with the footprinting methodology as well as access to its collection of national and international data.

University of Utah Participation

An academic–community collaboration with the College of Architecture + Planning at the University of Utah was initiated in Fall 2006, with Professors Philip C. Emmi and Maged Senbel actively participating in the Project’s Methodology Group as well as reviewing research results and calculations. Additionally, Professors Emmi and Senbel supervised the graduate work of Helen M. Peters, a Master’s of Urban Planning student in the College, in her professional project relating to researching Utah’s Ecological Footprint. Ms. Peters has worked side-by-side with Ms. McIntyre in data collection, research, and writing research findings for this study.

Public Outreach

In the course of conducting the research, the Utah Vital Signs project has communicated its plans and asked for feedback from its community of supporters and partners. In Fall 2006, the core team met with individuals within the conservation community and representatives of selected environmental organizations and government agencies. These persons provided historical perspective on various planning initiatives in Utah related to issues of sustainability and growth, and their advice about the political and intellectual landscape in Utah has proved invaluable.

After the work plan and methodology were developed for this project, the Utah Vital Signs team shared background information on the Ecological Footprint and the research plan with the community at one of UPEC's quarterly Roundtables on January 30, 2007. There was an excellent response from the community and multiple offers of assistance, particularly for disseminating the results upon completion of the project.

In March 2007, UPEC hosted an afternoon discussion with community partners and William E. Rees, professor of population ecology at the University of British Columbia and one of the creators of the Ecological Footprint methodology. Professor Rees shared a broad perspective on the dynamics of behavior change and the power of stories to shape our future. He pointed out how embedded we are in a "cultural myth consciously created in the 1950s" about unlimited economic growth, and the dangers of continuing to plan a world future based on increased consumption. He suggested actions that could help create a new set of stories describing "the Conserver Society."

PRIOR RESEARCH

The Utah Vital Signs Project is part of a much larger intellectual movement embracing community, urban and sustainability indicators. All seek to broaden the basis of information from which to assess our contemporary condition. All recognize that indicators are an important component of an enabled governance environment capable of responding to complexity and change. Exemplary documents include:

Bossel, H. 1999. *Indicators for Sustainable Development: Theory, Method and Application*. Toronto: International Institute for Sustainable Development.

Meadows, Donella H. (1998). *Indicators and Information Systems for Sustainable Development. A Report to the Balaton Group*. Hartland Four Corners, VT: The Sustainability Institute.

Organisation for Economic Cooperation and Development (1991). *Environmental Indicators: A Preliminary Set*. Paris: OECD.

Royal Society for the Protection of Birds (2003). *Measuring Real Progress: Headline Indicators for a Sustainable World*. London: RSPB.

Wackernagel, M. (2001). *Advancing Sustainable Resource Management: Using Ecological Footprint Analysis for Problem Formulation, Policy Development, and Communication*. Prepared for DGXI, European Commission. Oakland, CA: Redefining Progress.

United Nations. 2001. *Indicators of Sustainable Development: Guidelines and Methodologies*. New York: UNCSD.

While we have drawn upon the experience shared in this literature, the Utah Vital Signs Project moves beyond these in at least one notable regard: thanks in large part to the work of the Global Footprint Network on a United States national assessment, the Utah Vital Signs Project's Ecological Footprint assessment is the first state-level assessment in the nation.

Since the arrival of the Mormon pioneers in the Salt Lake Valley in 1847, Utahns have taken an active role in shaping their collective future. Efforts in recent decades include the Utah Tomorrow Strategic Planning Committee established by the Utah Legislature in 1990 and the resulting Utah Tomorrow Strategic Plan (Utah Tomorrow Strategic Planning Committee, 2003). Another state effort was the Utah Quality Growth Commission (http://www.governor.utah.gov/Quality/) established in 1999, whose annual report sets out trends, conditions, guiding principles, and recommendations. In addition, the Coalition for Utah's Future/Envision Utah was established in 1997 and led the Wasatch Choices 2040 effort, which involved residents in designing a quality long-term future (http://www.envisionutah.org/). At the local level, the Salt Lake City Futures Commission in the late 1990s developed recommendations on how to achieve a vision for the city's future development (Salt Lake City Futures Commission, 1998).

Nonprofit organizations, such as the Utah Foundation (http://www.utahfoundation.org/), have a long history of providing research and recommending policy changes on issues important to Utah citizens and their future. The newly established Park City Center for Public Policy (http://www.parkcitycenter.org/), formerly the Oquirrh Institute, released a report entitled "Utah's Growth Issues — People, Land and Water," which examines trends and explores potential responses (Oquirrh Institute, 2006). Margaret H. Christensen of the Wasatch Front Sustainable Communities Group created a "fact sheet" in 1995 to help citizens understand key indicators of local sustainability in Salt Lake County (Wasatch Front Sustainability Group, 1995).

All these efforts indicate an interest in assessing current conditions and anticipating future possibilities. We are grateful to have been able to build upon and extend the intellectual legacy of those who have gone before.

RESEARCH QUESTION

The research question for the Utah Vital Signs 2007 study was "How do Utah's population, housing, land use, transportation and lifestyle choices affect its demands on the biosphere's life-sustaining ecological services?" We have proceeded to answer this research question by completing an Ecological Footprint analysis for Utah.

ABOUT THE ECOLOGICAL FOOTPRINT

The Footprint Concept

The Ecological Footprint is a well-respected, internationally applied indicator of sustainability. This ecological accounting tool compares a particular human demand on the Earth's biosphere in a given year to the available biological capacity in that year. Such a measure of the supply of and human demand on natural capital is indispensable for tracking progress, setting targets and driving policies for sustainability. To manage our natural capital wisely, it is important to know how much we have and how much we use.

The Ecological Footprint as a concept has grown out of the work of a number of researchers, including William E. Rees and Mathis Wackernagel, whose collaboration at the University of British Columbia in the 1990s led to the publication of *Our Ecological Footprint: Reducing Human Impact on the Earth* (Wackernagel and Rees 1996). Wackernagel went on to work with Redefining Progress, a nonprofit research organization dedicated to "smart economics" in Oakland, California, to implement the Ecological

Footprint methodology for studies on a range of geographical levels. A few years ago, Wackernagel and Susan Burns established the Global Footprint Network to set up standards for footprinting worldwide, and this organization has taken the lead in developing the methodology. The mission of the Global Footprint Network is to "support a sustainable economy by advancing the Ecological Footprint, a measurement and management tool that makes the reality of ecological limits central to decision-making everywhere" (Global Footprint Network, 2007).

The Ecological Footprint attempts to answer one central sustainability question: "How much of the bioproductive capacity of the biosphere is used by human activities?" Footprint accounting answers this question by translating all human demands on the biosphere into the amount of productive area required to support those demands, either through producing resources or assimilating wastes. This can then be compared to the total amount of biologically productive land available at the global level or within a specific region. This measure of the supply of ecological capital is known as biocapacity.

Additional information about the Ecological Footprint is available at Global Footprint website, http://www.footprintnetwork.org, and at the related Global Footprint Network Standards Committee website, http://www.footprintstandards.org.

Comparing Supply to Demand

Footprint accounts are divided into two parts: ecological supply (bioproductive area, or *biocapacity*) and human demand on nature (*Ecological Footprint*).

SUPPLY: BIOCAPACITY

The Earth is covered with distinct bioproductive areas — cropland, forest, pasture, fisheries —as well as built-up land. These are the areas which provide economically useful concentrations of renewable resources. They constitute the bulk of the biosphere's regenerative capacity. While the remaining areas of the planet, such as the deep oceans or deserts, are also biologically active, their renewable resources are not concentrated enough to be a significant addition to overall biocapacity for the human economy.

The total supply of biocapacity in 2003 was 11.2 billion global hectares, or 1.8 global hectares per person. A global hectare is a hectare (2.471 acres) with world-average ability to produce resources and absorb wastes.

The Ecological Footprint Accounts identify six main bioproductive area types:

1. Cropland is land that is used for growing crops for food, animal feed and fiber. The Ecological Footprint accounting method tracks over 70 crops and 15 secondary crops in determining the area.
2. Grazing land is used to raise animals for meat, hides, wool and milk. This land is characterized by natural and semi-natural grassland and pasture.
3. Forest comprises natural and plantation forests. The two primary categories of wood counted are fuelwood and roundwood.
4. Fishing ground includes productive freshwater and marine fishing grounds. Eight categories of fish and aquatic animals and one category of aquatic plants are counted.

5. Built-up land contains infrastructure for housing, transportation, industrial production and capturing of hydroelectricity.
6. Energy or "carbon" land is the land or ocean that is needed to absorb the CO2 generated by the burning of fossil fuels.

DEMAND: ECOLOGICAL FOOTPRINT

The Ecological Footprint of a region includes all the cropland, pasture land, forests, and fishing grounds required to produce the food, fiber, and timber its population consumes, to absorb the wastes emitted in generating the energy it uses, and to provide space for its infrastructure. People consume resources and ecological services from all over the world, so their footprint is the sum of these areas, wherever they may be on the planet. In 2003 the global Ecological Footprint was 14.1 billion global hectares, or 2.2 global hectares per person.

WHAT IS NOT COUNTED

The Footprint reports only human demand based on actual yields from bioproductive land. The results presented exclude some ecologically significant human activities:

- human demands on the biosphere for which there are insufficient data (e.g., acid rain)
- those activities that systematically erode nature's capacity to regenerate, such as:
- uses of materials for which the biosphere has no apparent significant assimilation capacity (e.g., plutonium, polychlorinated biphenyls, dioxins, chlorofluorocarbons)
- processes that irreversibly damage the biosphere (e.g., species extinction, fossil-aquifer depletion, deforestation, desertification)

The footprint and biocapacity accounts also do not directly account for freshwater use and availability, since withdrawal of a cubic meter of freshwater affects biocapacity differently depending on local conditions. Removing one cubic meter from a wet area may make little difference to the local environment, while in arid areas every cubic meter removed can directly compromise ecosystem production.

Assumptions Inherent in the Ecological Footprint

The Ecological Footprint methodology is grounded on six assumptions:

1. The annual amounts of resources consumed and wastes generated by countries are tracked by national and international organizations.
2. The quantity of biological resources appropriated for human use is directly related to the amount of bioproductive land area necessary for regeneration and the assimilation of waste.
3. By weighting each area in proportion to its usable biomass productivity (that is, its potential annual production of usable biomass), the different areas can be expressed in terms of a standardized average productive hectare ("global hectare").
4. The overall demand in global hectares can be aggregated by adding all mutually exclusive resource-providing and waste-assimilating areas required to support the demand.

5. Aggregate human demand (Ecological Footprint) and nature's supply (Biocapacity) can be directly compared to each other.

6. Area demand can exceed area supply. This "ecological deficit" is compensated in two ways: either the deficit is balanced through imports, resulting in "ecological trade deficit," or the deficit is met through the overuse of domestic resources, leading to natural capital depletion ("ecological overshoot").

Limitations of the Ecological Footprint

The Ecological Footprint is not sufficient as a stand-alone measure of sustainability. To measure overall progress towards sustainable development, the Footprint needs to be complemented by other measures. Issues such as social satisfaction, human health, the integrity of natural ecosystems, or the conversion and management of non-renewable resources such as minerals must be assessed using other tools.

Also, while the Footprint analysis measures biocapacity, it does not determine how much of the total biocapacity is available to meet *non-human* demand. For example, if humans consume 100% of the Earth's biocapacity, then there is nothing remaining to support wildlife. The Footprint does not consider how much biodiversity is essential for human life on this planet, nor to what extent Utahns want to live in a biodiversity-rich world. The methodology is therefore fundamentally anthropocentric.

Finally, it is important to remember that the Ecological Footprint is only a snapshot in time. The Footprint Accounts are based on the actual consumption and production data reported by United Nations statistical agencies for a specified year. They reflect the analyzed year's consumption, land management and harvesting practices, without a forecast of future technologies, energy supply mixes, consumption patterns, or changes in land management practices, all of which will affect the Footprint in future years.

METHODOLOGICAL CHOICES

The Ecological Footprint methodology is in constant development and continually incorporates more detail and better data as they become available. Coordination of this task is led by the Global Footprint Network of Oakland, California.

Two distinct approaches exist for calculating Ecological Footprints: component-based and compound Footprinting (Simmons et al., 2000). A hybrid of the two methods, also described below, is applied in this and many other sub-national footprint studies.

Component Method

The component-based approach is bottom-up, summing the Ecological Footprints of all relevant components of a population's resource consumption and waste production. This is achieved by first identifying all the individual items, and amounts thereof, that a given population consumes and then assessing the Ecological Footprint of each component using life-cycle data.

The overall accuracy of the final result depends on the completeness of the component list as well as on the reliability of the life-cycle assessment of each identified component. The challenges of this approach include (a) measurement boundary problems associated with life-cycle assessments, (b) lack of accurate and complete information about products' life cycles, (c) problems of double counting in the case of complex chains of production, and (d) the large amount of knowledge required for each analyzed process.

Judging from the hundreds of projects employing this approach worldwide, the process of detecting all components and analyzing their respective resource demands has heuristic value.

Compound Method

Compound footprinting calculates the Ecological Footprint using aggregate national data. Such aggregate data captures the resource demand without having to know every single end use, and is therefore more complete than data used in the component approach. For instance, to calculate the paper Footprint of a country, information about the total amount consumed is typically available and sufficient for the task. In contrast to the component method, there is no need to know which portions of the overall paper consumption were used for which purposes, aspects that are poorly documented in statistical data collections.

At the national level, the compound method is often used for greater accuracy. Because material flows — i.e., imports and exports — to and from the nation are tracked, final consumption can be estimated by adding imports to domestic production from ecosystems, and subtracting exports. This input-output assessment also avoids the problem of double counting.

The Footprint and biocapacity at scales larger than a nation (such as a region or the world as a whole) are calculated simply by summing the national values.

Combination Method for Sub-national Studies

Footprints of areas smaller than a nation — i.e., sub-national footprints, such as that of a city, county, or state — require a different approach from that used for national and global footprinting. At a sub-national level detailed information about resource flows is typically not available, so the compound method is rarely possible. The component method is also not practicable, as consumption data for all households, businesses, and other entities is usually of low quality with much missing information.

Therefore, calculating a sub-national Footprint takes an indirect path. These Footprint studies are calculated by allocating the nation-level Footprint into different consumption activities (food, housing, mobility, goods, and services) and then scaling the national Footprint up or down based on comparisons between national averages for these activities and the averages for the population being studied. A sub-national study, therefore, can follow these four steps (ICLEI & Global Footprint Network, 2006):

1. Start with the national Footprint.
2. Analyze, for the national average, which activities and consumption items take up which portion of the overall Footprint, through the establishment of a Consumption–Land Use Matrix.
3. Identify the difference in consumption patterns locally as compared to national average.
4. Use this information to adjust the national average Footprint to local specificities.

Reliability and Validity of the Footprint Methodology

Footprint Accounts are managed so that, when in doubt, they underestimate the Footprint and overestimate the available biocapacity. In other words, overshoot and ecological deficits reported are most likely smaller than actual overshoot and deficits. Based on the many cases where the methodology errs on the side of over-reporting biocapacity and under-reporting Ecological Footprints, it is unlikely that accounting errors will reverse the conservative bias of the accounts (Wackernagel et al. 2005).

With every round of improvement in the accounts, the use of more comprehensive data sets and independent data sources, the consistency and reliability of data can be checked more effectively, and the robustness of the calculations improves. The accounts are updated every year, and methodologically refined (Wackernagel et al. 2005).

Global Footprint Network executive director Mathis Wackernagel, PhD, has identified ways in which the Ecological Footprint can be strengthened. These are explained in his report to the Global Environment Facility 2010 Biodiversity Indicators Partnership project, “2010 Biodiversity Indicator Development Plan: Ecological Footprint,” specifically in Section 3.1 (Wackernagel 2006).

Footprinting Standards

The Global Footprint Network supports the footprinting efforts of a large number of countries, cities, and counties, as well as efforts by individual businesses and institutions. Along with its 70 international partner organizations, the Global Footprint Network has developed standards for applying the Ecological Footprint methodology. The most current version of the methodology paper is available at http://www.footprintstandards.org. Utah Vital Signs adheres to those standards, and this report has received a preliminary review by staff of the Global Footprint Network.

PRIOR FOOTPRINT STUDIES

Thousands of students and, increasingly, adults as well, have used a footprinting tool at http://myfootprint.org to assess their individual impact on the planet. Footprinting analysis has been done also at a global level and at national levels for over 150 countries since 1961. The Ecological Footprint of the earth as a whole is calculated by the Global Footprint Network (see http://www.footprintnetwork.org) in conjunction with WWF International (see http://www.panda.org) resulting in the bi-annual publication of the *Living Planet Report*.

Government agencies, organizations, and communities worldwide have adopted the Footprint as a key component of their planning and public participation efforts. Footprinting analysis has been extended to use by cities, counties, and even individual businesses and universities. As it is increasingly standardized and used worldwide, the Ecological Footprint makes the reality of ecological limits central to decision-making everywhere.

Global Footprints

WWF International through its biennial *Living Planet Report* strives to show the impact of human activity upon the Earth. The *Report* explores two indices which measure the level of global biodiversity as well as the impact human consumption of natural resources has on the biosphere. Global biodiversity is measured by the Living Plant Index, which measures the health of the planet’s ecosystems. The Ecological Footprint is a measure of human demand on the ecosystems.

Figure 1 illustrates the concept of ecological overshoot. On the left side of the graph, it shows the number of Earths needed to support human consumption patterns that are represented in decades. The straight line shows the number of planets that we have: one. The brown line shows the demand to supply ratio, illustrating that we exceeded the biocapacity of the Earth in the late 1980s and have been in ecological overshoot ever since; that is we use each year all of the Earth's renewable resources and pollution sinks and then draw down on its reserve of natural capital for the remainder of our needs. Deforestation, soil loss, desertification, oceanic dead zones, groundwater depletion, diminished species diversity and globally accumulating greenhouse gases are common manifestations of ecological overshoot.

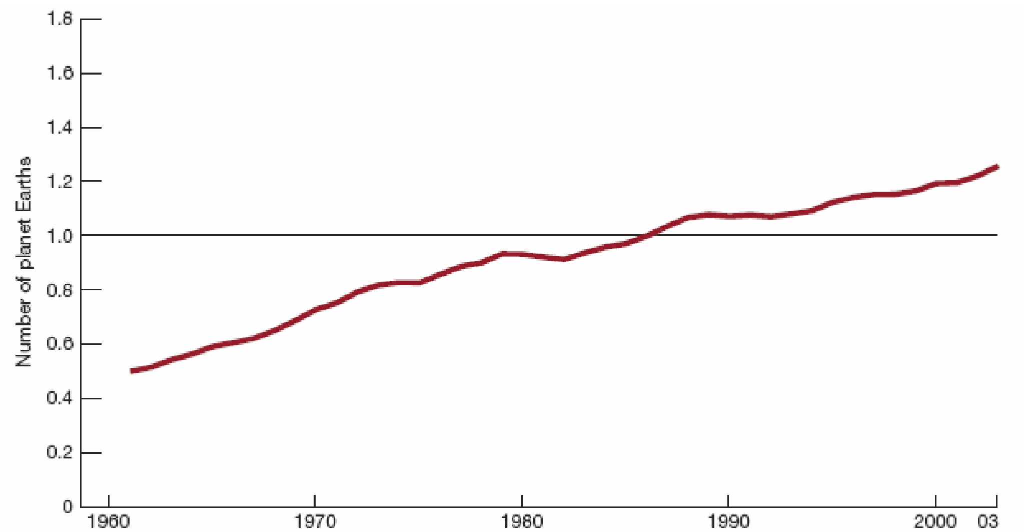

Figure 1. Humanity's Ecological Footprint, 1961-2003. Estimate of how much of the productive capacity of the biosphere people use. Source: *Living Planet Report 2006*, p. 2, available online at http://assets.panda.org/downloads/living_planet_report.pdf.

In addition to the presentation of data and its interpretation, scenarios have been prepared for the reader to consider. As shown in Figure 2 the scenarios provide an idea of possible future overshoot scenarios obtained through either no adjustment, a little or a large change in human consumptive patterns. The rapid-reduction scenario depicts an aggressive effort to move humanity out of overshoot by 2050. This scenario assumes a reduction in CO_2 emissions of 50 percent by 2050 and 70 percent by 2100. It assumes an optimistic growth in biocapacity – nearly 30 percent by 2100 – brought about by increases in cropland, fisheries, and forest yields through improved technology and management. It also allows for 30 percent of biocapacity to be used by wild species by 2100. The final piece of the Living Planet Report is a discussion on how we might transition to a sustainable society.

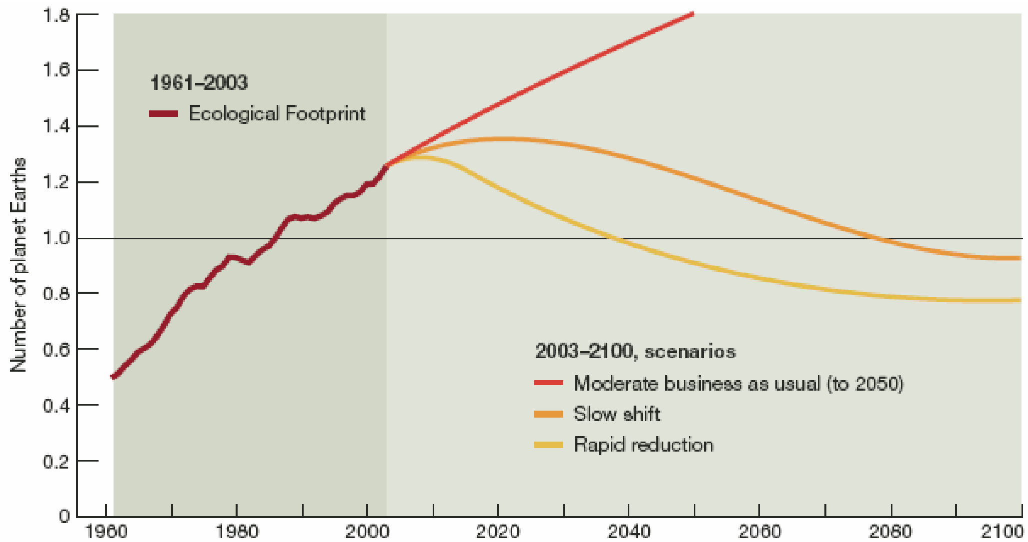

Figure 2. Three Ecological Footprint Scenarios, 1961–2100. Source: *Living Planet Report 2006*, p. 3, available online at http://assets.panda.org/downloads/living_planet_report.pdf

The cartogram in Figure 3 shows those countries that have the highest per capita demand upon nature's resources, as indicated by the color of the country. Additionally, the total national footprint is indicated by the size of the country.

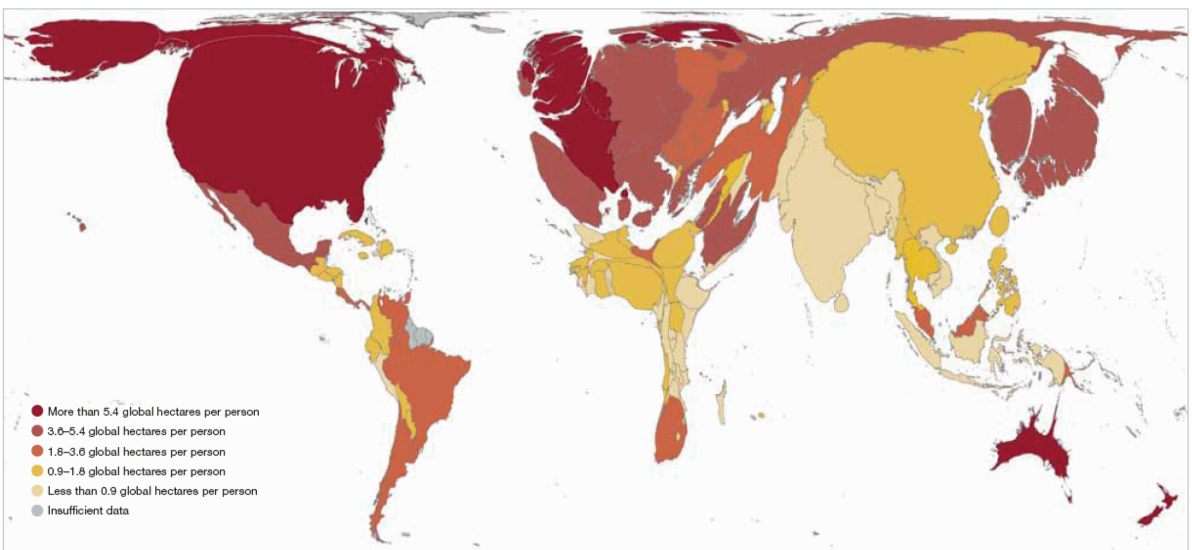

Figure 3. Footprints Across the World, 2003. Total national footprints as a portion of the global footprint are indicated by country size. National per-capita footprints are indicated by color. Source: *Living Planet Report 2006*, p. 16, available online at http://assets.panda.org/downloads/living_planet_report.pdf.

National Footprint

While the Ecological Footprint of the United States has been calculated for each year starting in 1961, the calculation has thus far been little used within the United States for policy making purposes or otherwise. In 2003, the Ecological Footprint of the United States was 2,819,262,000 global hectares, or 9.59 global hectares per person, far above the global average and exceeding the biological capacity of the United

States by more than double. The biocapacity of the United States in the same year was 1,393,920,000 global hectares, or 4.74 global hectares per person. If everyone on the Earth lived the way that United States residents live, more than five Earths would be required (Global Footprint Network, 2006).

Sub-national Footprints

Although the Ecological Footprint of the entire United States has been calculated for each year starting in 1961, this study represents the first time that a state of the United States has developed an Ecological Footprint according to the Global Footprint Network (personal correspondence, Steven Goldfinger, December 13, 2006).

In the United States, sub-national footprint studies have been accomplished for only a few cities and counties, including the City of Seattle, Washington, and Sonoma County and Marin County in California. In other countries, such as Canada and Australia, sub-national studies are more common. For example, in Canada, the City of Toronto emphasized the importance of its Ecological Footprint by placing it on the City's website for viewing. Calgary has also completed a Footprint analysis in order to consider choices for the future. So, too, has Vancouver. Victoria, Australia works with its national Environmental Protection Authority to use the Footprint analysis for policy making purposes. There are many more examples of efforts to complete an Ecological Footprint assessment to understand the impact of human consumption patterns on the planet's biocapacity.

STUDY BOUNDARIES

The study focused on the consumption of the human population within the political boundaries of the state of Utah. Two study years were included, 1990 and 2003, to show the trend within Utah. The year 1990 is significant as the base year for the Kyoto Protocol. The Kyoto Protocol is an international treaty designed to limit global greenhouse gas emissions to five percent below 1990 levels during the period of 2008 to 2012. Additionally, the choice of 1990 provides a baseline during a time when Utah's population was still well under two million, and when the previous five years had seen net out-migration from the state. In every year since 1990, net migration has been positive into Utah. The year 2003 is the latest year for which reliable international and national data are available. The statistics used in the Global Footprint Network's National Footprint Accounts for the United States published in November 2006 use 2003 data.

SELECTED METHODOLOGY

The Utah Vital Signs research employs the combination method described above for sub-national footprint studies, as recommended by senior scientists at the Global Footprint Network and described in other sub-national footprint studies.

Accordingly, the United States national footprint accounts were adjusted as follows:

1. Biocapacity: Utah biocapacity was calculated using the same procedure used at the national level. Biocapacity data was adjusted with the actual area of Utah land types — cropland, forests, pasture lands, etc. The productivity of each land type was not adjusted — i.e., the United States averages were used. Adjusting for the actual productivity of Utah lands and waters is a high priority for further research.

2. Consumption: Per capita consumption was adjusted with ratios of selected consumption components as detailed in the "Data" section below. The per capita consumption was multiplied by Utah population figures to get total consumption.

DATA AND CALCULATIONS

National and International Data

National and international data were provided by the Global Footprint Network through its "National Footprint Accounts for the United States" published in 2006 for both 1990 and 2003 data. The national analysis is based primarily on data published by the Food and Agriculture Organization of the United Nations, the International Energy Agency, the United Nations Statistics Division (providing the UN Commodity Trade Statistics Database — UN Comtrade) and the Intergovernmental Panel on Climate Change, among others. This data is summarized and processed in Global Footprint Network's National Footprint Accounts, available by subscription to member organizations and projects, like Utah Vital Signs.

These detailed National Footprint Accounts, as featured, for instance, in the *Living Planet Report 2004* (WWF et al., 2004) or on the website of the European Environment Agency at http://org.eea.eu.int/news/Ann1132753060, provide information about the various land areas used to support a nation's consumption. More details on how they are calculated are available in Wackernagel et al. (2005, extended and updated from Monfreda et al. 2004).

Utah and Regional Data

Utah and regional data were collected in phases, with each phase's research leading to a new iteration of the calculations. Starting with the Ecological Footprint national accounts for the United States, each iteration added data more specific to Utah. A total of three iterations were completed.

The Utah and regional data were collected from existing federal, state and university research sources. No original data collection was performed. Most data sources were published; some unpublished data was used as directly provided by the primary data collectors.

For each data source, a completed Data Reference Sheet is available online and in print, with complete details about the source and citation of the data. The printout of the data and the Data Reference Sheet for each data set are included in the printed version of this Report as Appendix D: Data and Data Sources.

ITERATION #1 – REFLECTS AN ADJUSTMENT FOR THE UTAH POPULATION AND LAND USE (TOTAL)

In Iteration #1, the researchers adjusted the national accounts with Utah population totals and Utah land totals, assuming the same consumption patterns for Utah as for the United States, and assuming the same percentage distribution of land types in Utah as in the United States. The following data sources were used:

Governor's Office of Planning and Budget, Demographic and Economic Analysis Section

The Demographic and Economic Analysis (DEA) section of the Governor's Office of Planning and Budget manages, analyzes, and disseminates economic, demographic, and fiscal data. Using the population for the United States given in the national accounts, the following comparison results:

POPULATION 1990

United States of America
255,712,000
Utah
1,729,227
Ratio Utah to U.S.
0.6762%

POPULATION 2003

United States of America
294,043,000
Utah
2,413,618
Ratio Utah to U.S.
0.8208%

The increase in population for Utah is represented in Figure 4.

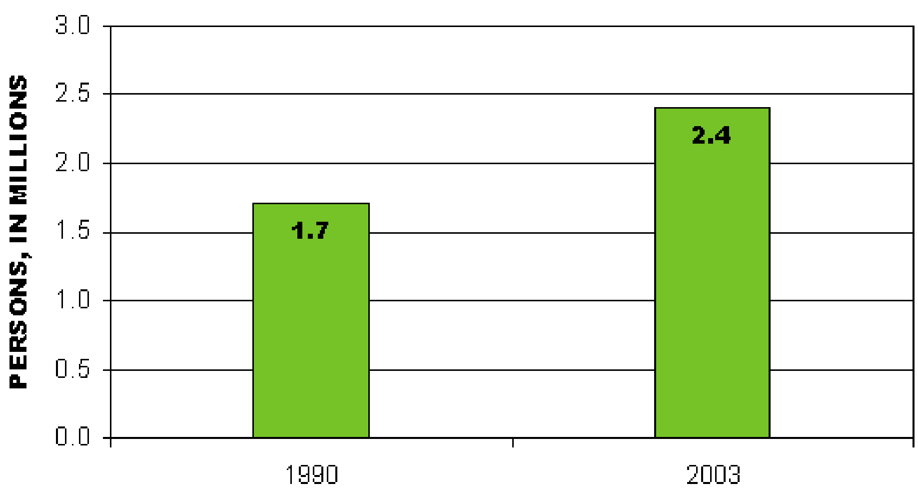

Figure 4. Utah population, 1990 and 2003.

United States Department of Agriculture, National Resources Conservation Service, National Resources Inventory (NRI)

The NRI is a survey of natural resource conditions and trends on non-Federal land in the United States; non-Federal lands include privately owned lands, tribal and trust lands, and lands controlled by State and local governments. Additionally, the NRI is a longitudinal sample survey using remote sensing (photo interpretation) supported by onsite field investigation. NRI data are collected for 800,000 sample sites. The NRI was conducted on a five-year cycle during the period from 1977 to 1997, and since 1997 has been conducted annually in a continuous process, with each area assessed once in a five-year cycle. The NRI is conducted by the U. S. Department of Agriculture Natural Resources Conservation Service (NRCS), in cooperation with Iowa State University's Center for Survey Statistics and Methodology.

Using the land area totals for the United States given in the national accounts, the following comparison results:

AREA (LAND AND WATER)	
US land area (ha)	962,909,000.00
Utah land area (ha)	21,990,172.65
Ratio Utah/U.S.	2.28%

ITERATION #2 – REFLECTS AN ADJUSTMENT FOR UTAH'S DISTRIBUTION OF LAND TYPES

With Iteration #2, the researchers found several sources for data regarding the distribution of land cover/use types in Utah:

United States Department of Agriculture, National Resources Conservation Service, National Resources Inventory (NRI)

As described above, the NRI is a survey of natural resource conditions and trends on non-Federal land in the United States. NRI categories were collapsed to Ecological Footprint categories as follows:

NRI Land Type	Ecological Footprint Land Type
Cropland	Cropland
Conservation Reserve Program (CRP) land	Unharvested cropland
Pastureland	Permanent pastures
Rangeland	
Forest Land	Forests
Other Rural Land	Unproductive land
Developed Land	Built-up land
Water Areas	Inland water

Like other states in the West of the U.S., and unlike many geographical regions under study for agricultural use of the land, Utah contains a large percentage of federally owned lands, which are not included in the NRI. Therefore, a complementary source of data for land use in Utah was required for non-Federal lands.

Census of Agriculture

The Census of Agriculture obtains agricultural statistics for each county or county equivalent, state, and the nation. The United States Department of Agriculture National Agricultural Statistics Service (NASS) collects census data from a list of all known potential agriculture operators. This list is assembled from previous census records, state and federal agencies, trade associations and similar organizations that could be identified as associated with agriculture. Every agricultural operator discovered within the selected tracts is interviewed and all land in each tract is accounted for. All data included in census totals are reported by census respondents. The agriculture census is taken on a 5-year cycle collecting data for years ending with the numerals 2 and 7.

Because of the potential for under-reporting and errors associated with self-reporting for the Census of Agriculture, it was used only as a confirmation of NRI data regarding agricultural use of the land.

United States Geological Survey National Gap Analysis Program and the Southwest Regional Gap Analysis Project (SWReGAP)

The Gap Analysis Project assesses to what extent native animal and plant species are being protected. Those species and communities not adequately represented in the existing network of conservation lands constitute conservation “gaps.” The United States Geological Survey Gap Analysis Program maps land cover to assist in the modeling of wildlife habitat and biodiversity for large geographic areas. Pertinent to our study’s search is the fact that it maps existing natural vegetation, using dominant and co-dominant plant species, and land ownership. The GAP Analysis Program was state-centered, each state having the responsibility for implementing a project design for the geographic area within its state boundaries. A comprehensive Gap Analysis for the United States was concluded in 1995.

The Southwest Regional Gap Analysis Project (SWReGAP) was the first formal GAP project designed at a regional, multi-state scale. The Southwest project area comprises the states of Arizona, Colorado, Nevada, New Mexico and Utah. Project duration lasted approximately 5 years, beginning in 1999 and ending in 2004. The land cover map was generated using regionally consistent geospatial data (Landsat ETM+ imagery and digital elevation model derivatives), similar field data collection protocols, standardized land cover legend, and a common modeling approach (decision tree classifier).

Gap Analysis categories were collapsed to Ecological Footprint categories as follows:

Gap Analysis Land Type	Ecological Footprint Land Type
Agriculture	Cropland
Urban	Built-up land
Water	Inland water
Pinyon-Juniper Juniper Aspen Pinyon Spruce-Fir	Forests

Gap Analysis Land Type	Ecological Footprint Land Type
Mountain_Fir Lodgepole Ponderosa_Pine Aspen/Conifer Lodgepole/Aspen Mountain-Mahogany Ponderosa_Pine/Mountain_Shrub Mountain_Fir/Mountain_Shrub Spruce-Fir/Mountain_Shrub	
Grassland Desert_Grassland Sagebrush/Perennial_Grass Maple Oak Mountain-Shrub Sagebrush Dry_Meadow Wet_Meadow Wetland Lowland_Riparian Mountain_Riparian Salt_Desert_Scrub Blackbrush Greasewood Creosote-Bursage	Permanent pastures
Pickleweed_Barrens Barren Alpine	Unproductive land

SWreGAP categories were collapsed to Ecological Footprint categories as follows:

Southwest Regional GAP Analysis Land Type	Ecological Footprint Land Type
Agriculture	Cropland
Developed, Medium-High Intensity	Built-up land
Developed, Open Space-Low Intensity	
Open Water	Inland water
Deciduous forest classes	Forests
Evergreen forest classes	
Mixed forest classes	
Shrub/scrub classes	Permanent pastures
Grassland/herbaceous classes	
Woody wetland classes	
Emergent herbaceous wetland classes	
Barren classes	Unproductive land
Altered or disturbed classes	

The land cover studies for the 1995 Gap Analysis Program were used in the 1990 calculation in conjunction with the NRI data, and Southwest Regional Gap Analysis data was used to supplement the NRI 2003 data for the 2003 calculation. Gap Analysis data was comprehensive for the state, and allowed us to avoid double-counting of land areas, but gave little detail about agricultural uses of the land, as the study is aimed at assessing wildlife diversity. Therefore a combination of Gap Analysis data and NRI data was deemed to be the best for reflecting the land components of the Ecological Footprint.

The datasets are included for comparison and grouping purposes in the Utah Vital Signs file named Utah_cover-types_data_comparison_v3f.xls in Appendix D. The assignment of land types for Utah is summarized as follows:

Land types	1990 (1000s hectares)	2003 (1000s hectares)
Cropland	935	920
Pasture	11,812	10,884
Forest	7,142	5,333
Fisheries	855	673
Built land	145	310

Land types	1990 (1000s hectares)	2003 (1000s hectares)
Total productive land	20,889	18,120
Unproductive/unused land	1,101	3,870
Total	**21,990**	**21,990**

We then multiplied the figures in hectares above by the U.S. yield factor for each land type and the equivalence factor for each land type. This converted the actual hectares into global hectares standardized for the entire planet. The results were as follows:

Land types	1990 (1000s global hectares)	2003 (1000s global hectares)
Cropland	2,675	2,663
Pasture	4,167	3,840
Forest	18,682	13,951
Fisheries	34	27
Built land	456	976
Total	**26,014**	**21,457**

ITERATION #3 – REFLECTS AN ADJUSTMENT FOR CONSUMPTION COMPARING RATIOS OF UTAH TO UNITED STATES

In Iteration #3, the researchers gathered existing data comparing Utah and United States consumption in the components areas of food, housing, mobility, goods and services. Consumption components were compared where comparable data could be obtained at both the state and national levels, for both 1990 and 2003. In addition, certain demographic data and some overall production data were compared for context and error-checking. The consumption components compared were as follows:

Average annual expenditures by consumer unit
Food
total food
Housing
new privately owned housing units (permitted)
value of new construction ($US unadjusted)
Energy
total energy consumption after net flows
electricity use (all end uses) after net flows
residential energy consumption
Mobility
.passenger vehicles [vehicle miles traveled]

.light rail [passenger mi.]
.passenger air transport [enplanements]
Goods and Services
housing
apparel and services
entertainment
transportation
healthcare
other categories

The data sources for Iteration #3 include the United States Department of Labor, Bureau of Labor Statistics; United States Department of Commerce, Bureau of Economic Analysis; and Federal Aviation Administration. Data Reference sheets for all data sources are available in Appendix D: Data and Data Sources.

For each component, a ratio was developed between Utah and United States per capita consumption. The full Consumption Components Ratios spreadsheet for 1990 is contained in Table 1. The same calculations were performed on 2003 comparisons as shown in Table 2.

The per-capita ratios were applied to the Consumption–Land Use Matrix contained in the Footprint National Accounts for the United States, to yield an adjusted Ecological Footprint for Utah. A partial view of the adjusted Consumption–Land Use Matrix is presented in Table 3 for 1990 and in Table 4 for 2003, with a summary presented in Table 5 for both years. Tables 3 and 4 show the totals on the right side of the Matrix for the United States consumption in terms of global hectares per person for each of the major consumption components, as calculated by the Global Footprint Network. To the right of that column, we added a new column for Utah's consumption, with the ratios from the Consumption Components Ratios spreadsheet applied to the U.S. consumption figures. The adjusted Utah consumption footprint is summed at the bottom of the column.

> *Note:* The Consumption–Land Use Matrix for the United States prepared by the Global Footprint Network was a rough draft designed to be merely indicative of U.S. consumption. Because of the large confidence intervals around many of the figures in the Matrix, the differences found in the consumption patterns between Utah and the United States may not be so great as to be statistically significant. Utah consumption is not, however, likely to be *less* than United States consumption per capita.

Data Transparency

Wherever possible, original sources for local data were used. Data given to Utah Vital Signs under the partnership agreement with the Global Footprint Network are subject to its provisions, which allow the publication of small sets of data and calculations from the national accounts, up to certain limits.

The sources of all data are cited in Appendix D: Data and Data Sources. Datasets are also shared publicly via the Utah Vital Signs website, with citations and hyperlinks to original sources for data sets and reports that are available online. Formulas used in calculations have been made available as well, via the Excel spreadsheets created. Data have been checked for internal consistency. Where possible, dataset correspondence checks have been introduced.

		1990				
		Utah	Utah per cap	U.S.	U.S. per cap	Ratio per cap
Demographic Data						
population		1,722,850		248,709,873		0.7%
households		537,273		91,947,410		
average household size		3.15		2.63		
Production						
Gross Domestic Product		3.144E+10	18,251	5.674E+12	22,814	80.0%
Income						
per capita personal income			14,913		19,477	76.6%
per capita disposable personal income			13,197		17,108	77.1%
Housing						
new privately owned housing units (permitted)		7,009	0.0041	1,110,766	0.0045	91.1%
value of new construction ($US unadjusted)		5.945E+08	345	8.652E+10	348	99.2%
Energy		trillion Btu	million Btu	trillion Btu	million Btu	
total energy consumption after net flows		551.6	320.2	84,730.0	340.7	94.0%
electricity use (all end uses) after net flows		174.1	101.1	30,684.0	123.4	81.9%
residential energy consumption		101.9	59.1	17,055.0	68.6	86.3%
Mobility						
.passenger vehicles [vehicle miles traveled]		1.46E+10	8,503	2.144E+12	8,622	98.6%
.light rail [passenger mi.]		0	0	5.710E+08	2	0.0%
.passenger air transport [enplanements]		5.968E+06	3	4.385E+08	2	196.4%
Expenditures (using Western Region)		**West, per consumer unit**	**West per cap**	**U.S., per consumer unit**	**U.S. per cap**	**Ratio per cap**
average annual expenditures by consumer unit		32,797	12,147	29,001	11,154	108.9%
Food						
food		4,676	1,732	4,284	1,648	105.1%
Goods and Services						
housing		10,697	3,962	8,979	3,453	114.7%
apparel and services		1,823	675	1,677	645	104.7%
entertainment		1,831	678	1,447	557	121.9%
transportation		5,467	2,025	5,135	1,975	102.5%
healthcare		1,525	565	1,517	583	96.8%
other categories		6,778	2,510	5,962	2,293	109.5%

Table 1. Consumption Components Ratios spreadsheet for 1990, comparing United States and Utah consumption total and per capita.

		2003				
		Utah	Utah per cap	U.S.	U.S. per cap	Ratio per cap
Demographic Data						
population		2,309,555		290,850,005		0.8%
households		752,030		108,419,506		
average household size		3.07		2.61		
Production						
Gross Domestic Product		7.618E+10	32,985	1.090E+13	37,464	88.0%
Income						
per capita personal income			25,220		31,463	80.2%
per capita disposable personal income			22,742		28,028	81.1%
Housing						
new privately owned housing units (permitted)		22,525	0.0098	1,889,214	0.0065	150.1%
value of new construction ($US unadjusted)		3.082E+09	1,334	2.497E+11	858	155.4%
Energy		trillion Btu	million Btu/cap	trillion Btu	million Btu/cap	
total energy consumption after net flows		704.9	305.2	98,273.0	337.9	90.3%
electricity use (all end uses) after net flows		262.3	113.6	38,359.0	131.9	86.1%
residential energy consumption		141.7	61.4	21,235.0	73.0	84.0%
Mobility						
.passenger vehicles [vehicle miles traveled]		2.39E+10	10,369	2.891E+12	9,939	104.3%
.light rail [passenger mi.]		1.010E+07	4	1.476E+09	5	86.1%
.passenger air transport [enplanements]		9.029E+06	4	6.517E+08	2	174.5%
Expenditures (using Western Region)		**West, per consumer unit**	**West per cap**	**U.S., per consumer unit**	**U.S. per cap**	**Ratio per cap**
average annual expenditures by consumer unit		45,058	17,330	40,748	16,299	106.3%
Food						
food		5,755	2,213	5,357	2,143	103.3%
Goods and Services						
housing		15,335	5,898	13,359	5,344	110.4%
apparel and services		1,835	706	1,694	678	104.2%
entertainment		2,465	948	2,069	828	114.6%
transportation		8,548	3,288	7,770	3,108	105.8%
healthcare		2,418	930	2,384	954	97.5%
other categories		8,702	3,347	8,115	3,246	103.1%

Table 2. Consumption Components Ratios spreadsheet for 2003, comparing United States and Utah consumption total and per capita.

Total U.S. [gha/cap]	Total UT [gha/cap]	Consumption Components
1.9410	**2.0401**	**Food**
0.6376	-	.plant-based
1.3033	-	.animal-based
1.6517	**1.4063**	**Housing**
0.5935	0.5887	.new construction
0.0275	0.0315	.maintenance
0.9114	0.7861	.residential energy use
0.5431	-	*..electricity*
0.3135	-	*..natural gas*
0.0549	-	*..fuelwood*
0.0000	-	*..fuel oil, kerosene, LPG, coal*
1.5241	**1.5254**	**Mobility**
1.1105	1.0952	.passenger cars and trucks
0.0002	0.0002	.motorcycles
0.0001	0.0001	.buses
0.0750	0.0000	.passenger rail transport
0.2188	0.4298	.passenger air transport
0.0002	0.0002	.passenger boats
1.3314	**1.4499**	**Goods**
0.0124	-	.appliances (not including operation energy)
0.0143	-	.furnishing
0.0000	-	.computers and electrical equipment (not including operation energy)
0.0570	-	.clothing and shoes
0.0496	-	.cleaning products
0.4222	-	.paper products
0.0085	-	.tobacco
0.6480	-	.other misc. goods
0.5846	**0.5081**	**Services**
0.0000	0.0000	.water and sewage
0.0000	0.0000	.telephone and cable service
0.0000	0.0000	.solid waste
0.0186	0.0186	.financial and legal
0.0142	0.0138	.medical
0.0000	0.0000	.real estate and rental lodging
0.0372	0.0453	.entertainment
0.0000	0.0000	.Government
0.0000	*0.0000*	*..non-military, non-road*
0.0000	*0.0000*	*..military*
0.3952	0.4304	.other misc. services
1.8452	**1.8452**	**Unidentified**
8.8780	8.7750	Checksum (%)
8.8780		Footprint [gha/cap]
8.8730		Checksum [gha/cap]

Table 3. Partial view of United States Consumption–Land Use Matrix for 1990, with Utah adjustments (in yellow highlighted cells).

Total U.S. [gha/cap]	Total UT [gha/cap]	Consumption Components
1.8174	**1.9102**	**Food**
0.6409	-	.plant-based
1.1765	-	.animal-based
1.8637	**1.9449**	**Housing**
0.6558	1.0194	.new construction
0.0215	0.0246	.maintenance
1.0720	0.9009	.residential energy use
0.7063	-	*..electricity*
0.3406	-	*..natural gas*
0.0251	-	*..fuelwood*
0.0000	-	*..fuel oil, kerosene, LPG, coal*
1.8440	**1.9408**	**Mobility**
1.4269	1.4885	.passenger cars and trucks
0.0002	0.0002	.motorcycles
0.0001	0.0001	.buses
0.0857	0.0738	.passenger rail transport
0.2167	0.3781	.passenger air transport
0.0002	0.0002	.passenger boats
0.8987	**0.9786**	**Goods**
0.0099	-	.appliances (not including operation energy)
0.0205	-	.furnishing
0.0000	-	.computers and electrical equipment (not including operation energy)
0.0670	-	.clothing and shoes
0.0397	-	.cleaning products
0.4178	-	.paper products
0.0059	-	.tobacco
0.2236	-	.other misc. goods
0.6182	**0.5498**	**Services**
0.0000	0.0000	.water and sewage
0.0000	0.0000	.telephone and cable service
0.0000	0.0000	.solid waste
0.0149	0.0149	.financial and legal
0.0115	0.0112	.medical
0.0000	0.0000	.real estate and rental lodging
0.0297	0.0362	.entertainment
0.0000	0.0000	.Government
0.0000	*0.0000*	*..non-military, non-road*
0.0000	*0.0000*	*..military*
0.4477	0.4875	.other misc. services
2.5567	**2.5567**	**Unidentified**
9.5985	9.8811	Checksum (%)
9.5985		Footprint [gha/cap]
9.5879		Checksum [gha/cap]

Table 4. Partial view of United States Consumption–Land Use Matrix for 2003, with Utah adjustments (in yellow highlighted cells).

Tables 3 and 4 are summarized by consumption component categories as follows:

Components	1990 (global hectares per capita)	2003 (global hectares per capita)
Food	2.04	1.91
Housing	1.41	1.94
Mobility	1.53	1.94
Goods	1.45	0.98
Services	0.51	0.55
Unidentified	1.85	2.56
Total	**8.78**	**9.88**

Table 5. Utah's consumption footprint, by consumption component.

The distribution of Utah's footprint among the different land types was calculated from the Consumer–Land Use Matrix, and the results are in Table 6.

Land type	1990 (1000s global hectares)	2003 (1000s global hectares)
Cropland	1,987	2,447
Pasture	783	1,150
Forest	2,192	3,030
Fisheries	423	560
Built land	816	1,136
Energy land	8,973	15,526
Total	**15,174**	**23,849**

Table 6. Utah's consumption footprint, by land type.

RESULTS

With each iteration, the Ecological Footprint of Utah was refined with more data specific to Utah. The Footprint results are given as an estimate of the global biocapacity in global hectares per person. As stated earlier, a hectare is equal to 2.471 acres. A global hectare is a hectare with world average productivity for all land types.

Starting Point: United States Averages

The starting assumption was that Utah's Ecological Footprint per capita is similar to the United States. Therefore, an initial calculation was made of Utah's Ecological Footprint based on the U.S. Ecological Footprint, as given in the national accounts provided by the Global Footprint Network. The U.S. footprint results, based on constant methodology and sources across both years, are as follows:

UNITED STATES

Indicators	Per capita		Total	
	1990	2003	1990	2003
Footprint (gha) – demand	8.87	9.59	2,268,900,000	2,819,300,000
Biocapacity (gha) – supply	5.55	4.74	1,419,400,000	1,393,900,000
Ecological reserve or deficit (gha)	-3.32	-4.85	-849,500,000	-1,425,400,000
Demand to Supply Ratio	1.60	2.02	1.60	2.02

The U.S. consumption demand, translated into area of biologically productive land and water, was almost 2.3 million global hectares in 1990 and over 2.8 million global hectares in 2003. U.S. biocapacity decreased slightly from 1.419 million global hectares in 1990 to 1.393 million global hectares in 2003.

As a result, the United States was clearly living in ecological overshoot in both study years. The ecological deficit increased 83% over the period, from 849 thousand global hectares in 1990 to over 1.4 million global hectares in 2003. The demand-to-supply ratio increased from 1.60 in 1990 — that is, consumption demand was 1.6 times the renewable biocapacity in that year — to 2.02 in 2003 —that is, an area of more than double the size of the United States, when standardized to world-average productivity, was required to meet the consumption demand of U.S. citizens in that year.

Utah Iteration #1

Iteration #1 adjusted the above U.S. Ecological Footprint accounts with Utah population and land area. With this calculation, Utah's biocapacity was still generous compared to consumption in the state. However, biocapacity decreased slightly over the period, from 32,416,000 global hectares in 1990 to 31,833,000 global hectares in 2003. Allocating this biocapacity across Utah's population, we see that there were 18.75 global hectares per capita in 1990, decreasing to 13.19 global hectares per capita in 2003.

Demand figures from U.S. consumption patterns were adjusted in this iteration only for population size in Utah. That is, the per-capita footprint for Utah remained the same as the per-capita footprint for the U.S. as a whole. Multiplying the per capita footprint by the population of Utah yields a total Utah footprint of 15,343,000 global hectares in 1990, increasing to 23,142,000 global hectares in 2003.

Therefore, in Iteration #1, Utah had ecological reserve in both 1990 and 2003, with a pronounced downward trend in the reserve. Another way to look at this is to examine the increase in the demand-to-supply ratio, which went from 0.47 in 1990 — that is, less than half of the available biocapacity was being used — to 0.73 in 2003 — that is, almost three-fourths of available biocapacity was being used.

UTAH

Indicators	Iteration #1			
	Per capita		Total	
	1990	2003	1990	2003
Footprint (gha) – demand	8.87	9.59	15,300,000	23,100,000
Biocapacity (gha) – supply	18.75	13.19	32,400,000	31,800,000
Ecological reserve or deficit	9.88	3.60	17,100,000	8,700,000
Demand to Supply Ratio	0.47	0.73	0.47	0.73

Utah Iteration #2

Iteration #2 adjusted Utah distribution of land types, with Utah-based data rather than drawing on national distribution patterns. This adjustment affected the biocapacity calculation, reducing it in both study years and increasing the difference it fell over the study period. Total biocapacity fell to 26,014,000 global hectares in 1990 and even more radically to 21,457,000 global hectares in 2003. Translated to per capita figures, this represents a change from 15.04 global hectares per capita in 1990 to 8.89 global hectares per capita in 2003.

With this reduced biocapacity, Utah went into ecological overshoot during the study period, using more of its resources than can be renewed annually in 2003. The ecological reserve of over 10 million global hectares in 1990 fell to an ecological deficit of 1.6 million global hectares in 2003. The demand-to-supply ratio therefore increased from 0.59 to 1.08 during the period.

UTAH

Indicators	Iteration #2			
	Per capita		Total	
	1990	2003	1990	2003
Footprint (gha) - demand	8.82	9.56	15,200,000	23,100,000
Biocapacity (gha) - supply	15.04	8.89	26,000,000	21,500,000
Ecological reserve or deficit	6.22	-0.67	10,800,000	-1,600,000
Demand to Supply Ratio	0.59	1.08	0.59	1.08

Utah Iteration #3

With Iteration #3, the focus turned from the supply side to the demand side, looking at consumption patterns in Utah. After the selected consumption components for Utah and the United States were compared and the resulting ratios applied to the national accounts, the results were a slight change in Utah demand. Utah consumption moved from 8.78 global hectares per capita in 1990 to 9.88 global hectares per capita in 2003, altering the demand-to-supply ratio slightly over the previous iteration.

UTAH

Indicators	Iteration #3			
	Per capita		Total	
	1990	2003	1990	2003
Footprint (gha) - demand	8.78	9.88	15,200,000	23,800,000
Biocapacity (gha) - supply	15.04	8.89	26,000,000	21,500,000
Ecological reserve or deficit	5.55	-0.99	10,800,000	-2,400,000
Demand to Supply Ratio	0.58	1.11	0.58	1.11

Thus, with this iteration, Utah's demand-to-supply ratio changed more dramatically across the study period, with a marked upward trend from 1990 to 2003. In 2003, Utahns demanded 11% more from the land than it was able to provide, using prevailing technology and resource management practices.

KEY FINDINGS AND ANALYSIS

Utah's footprint per person is larger than both the United States and World footprints. Utah citizens are drawing more from nature than citizens from the United States- as a whole, and more than world citizens, to support their consumption patterns. Figure 5 clearly shows how Utahns are exceeding the world average per capita consumption. Utahns were even in 2003 exceeding the high United States average, which is the second highest Footprint in the world (after the United Arab Emirates), although as mentioned earlier the differences in consumption may not be so great as to be significant.

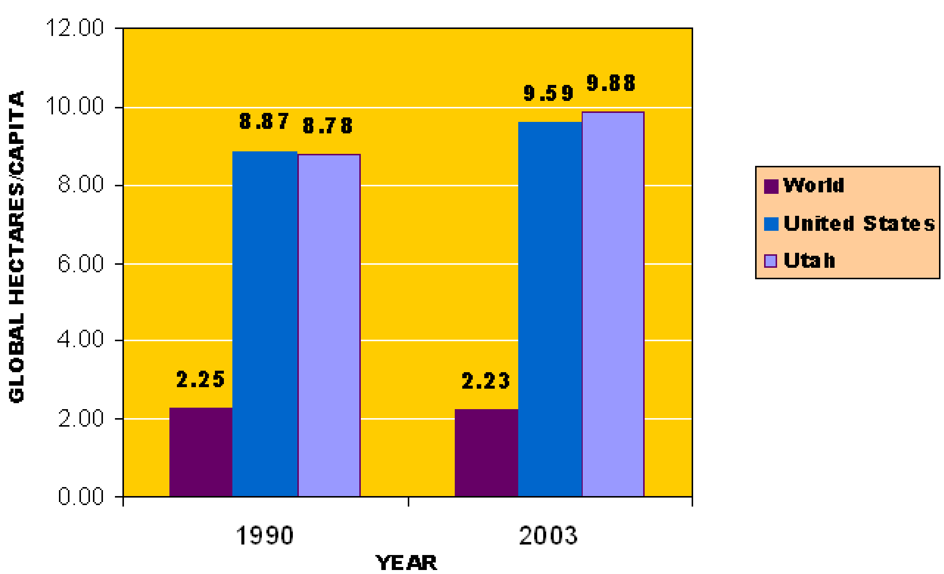

Figure 5. Footprints per capita, 1990 and 2003, for Utah, United States, and World.

Utah's total footprint — the per capita footprint multiplied by the population of Utah — increased from 1990 to 2003, as shown in Figure 6:

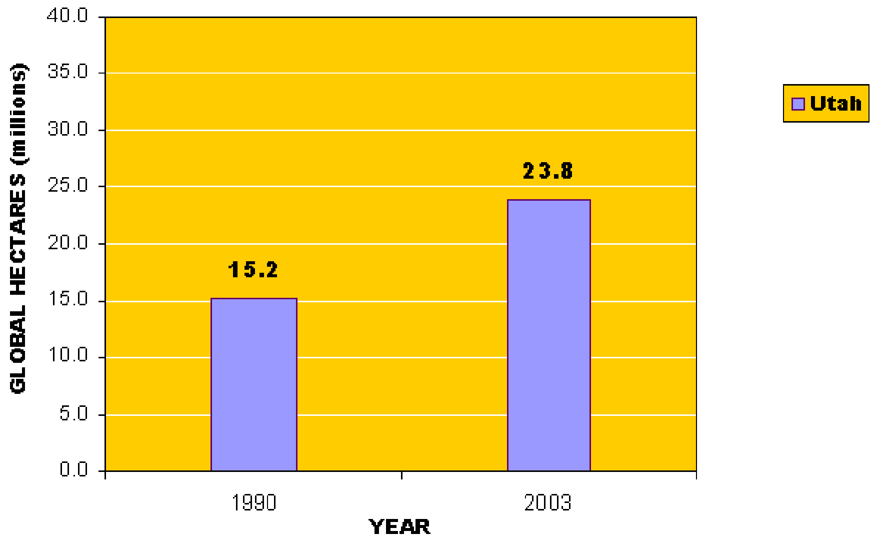

Figure 6. Utah total footprint, 1990 and 2003.

As shown in Figure 7, Utah's total biocapacity decreased from 26,014,000 global hectares in 1990 to 21,457,000 global hectares in 2003. The change in biocapacity shown in this study may be at least partially due to changes in the categorization of Utah lands across the study period. The Southwest ReGAP study for the 2003 land cover/use in Utah assigned more land subtypes as "altered or disturbed" and "barren" than had the earlier Gap Analysis Project. A more detailed analysis, in conjunction with the researchers involved in both studies, would likely permit us to achieve greater consistency in assignments across the two study years.

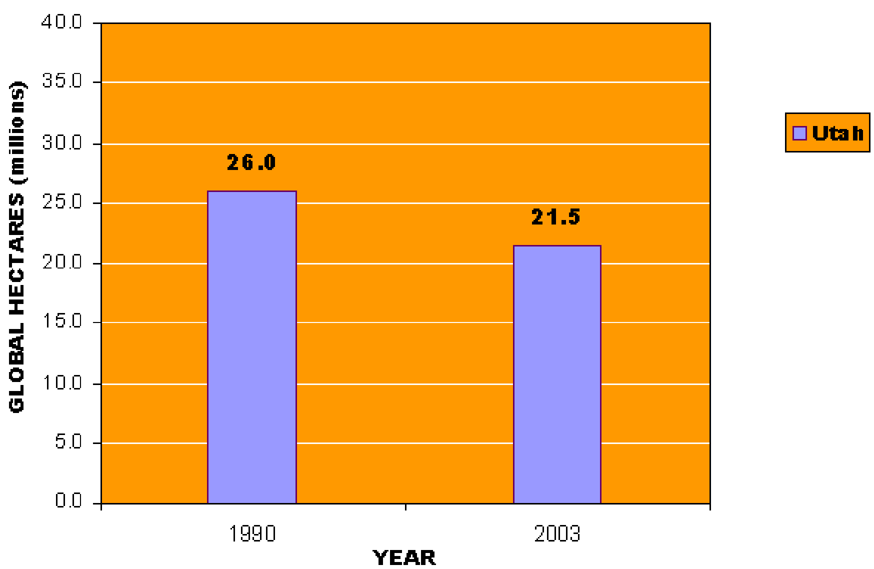

Figure 7. Total Utah biocapacity, 1990 and 2003.

The biocapacity available per person decreased 40.8%, from 15.04 global hectares per capita to 8.89 global hectares per capita, as shown in Figure 8. Utah's biocapacity per person still remains higher than that of the United States and the world.

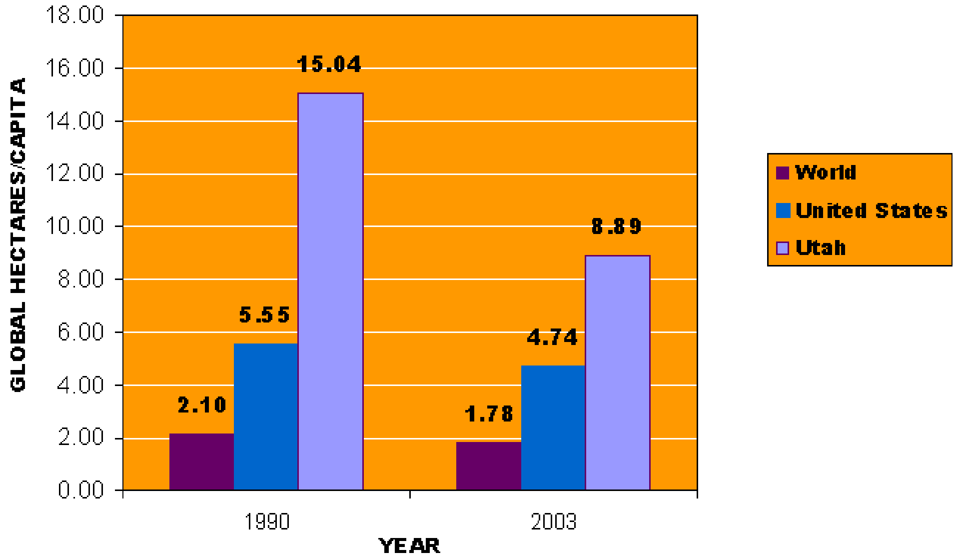

Figure 8. Biocapacity per capita for 1990 and 2003, for Utah, United States, and World.

Figure 9 combines the footprint (demand) with biocapacity (supply), to demonstrate how Utah moved from a situation of ecological reserve in 1990 to a situation of ecological deficit in 2003.

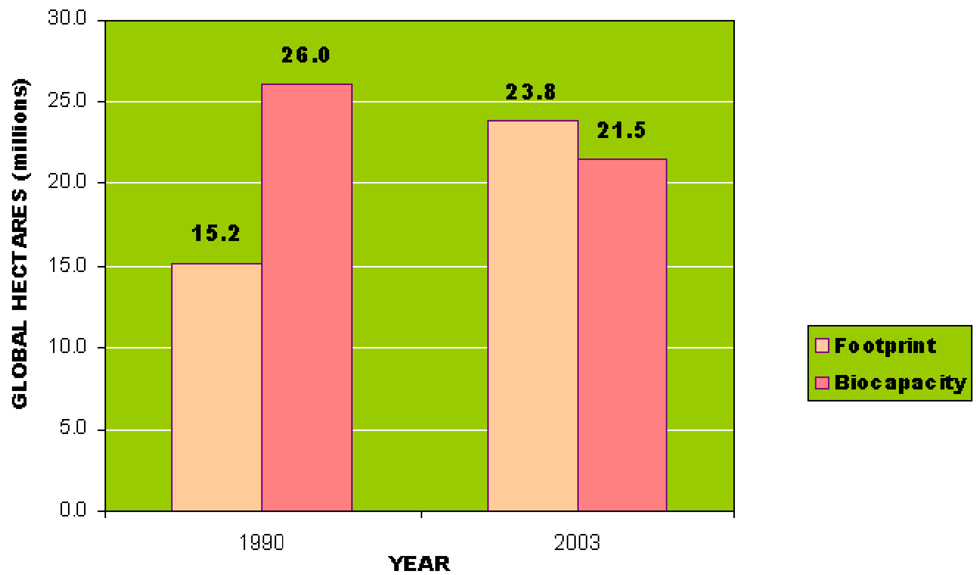

Figure 9. Shift from ecological reserve to ecological deficit in Utah, with Utah total footprint and total biocapacity, 1990 and 2003.

The annual reserve went below zero by 2003, as shown in Figure 10.

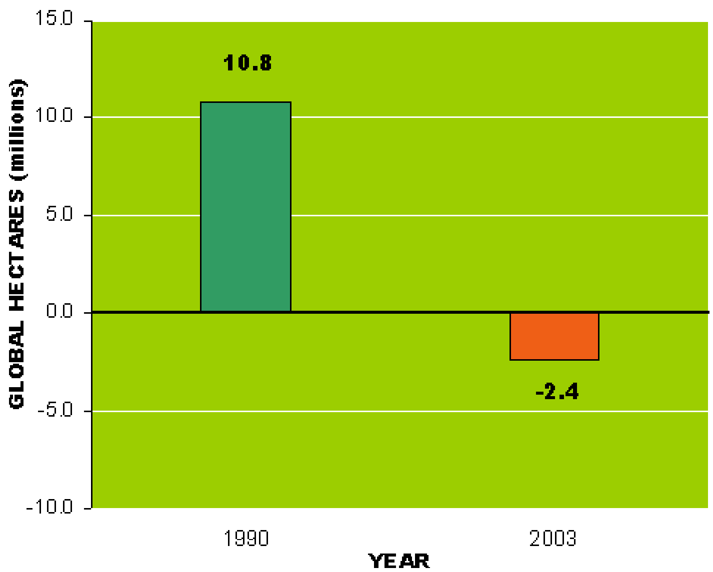

Figure 10. Utah's ecological reserve or deficit, 1990 and 2003.

Another way to look at this change is to examine the change in the demand-to-supply ratio. This directly compares consumption and biocapacity. Regions with a demand-to-supply ratio of less than 1.0 have human populations that are living within the means of nature, while regions with a ratio over 1.0 are in ecological overshoot. In Figure 11, all three iterations of the study are displayed, showing each ratio. With each iteration of data and calculations, the Utah Ecological Footprint demand-to-supply ratio increased for both 1990 and 2003. As we continued to look closer, we continued to find ever higher demand-to-supply ratios. By the second iteration, and holding true as well for the third iteration, Utah had an ecological deficit by 2003; i.e., Utah is in overshoot, using more renewable natural capital per person per year than Utah's lands and waters can replenish.

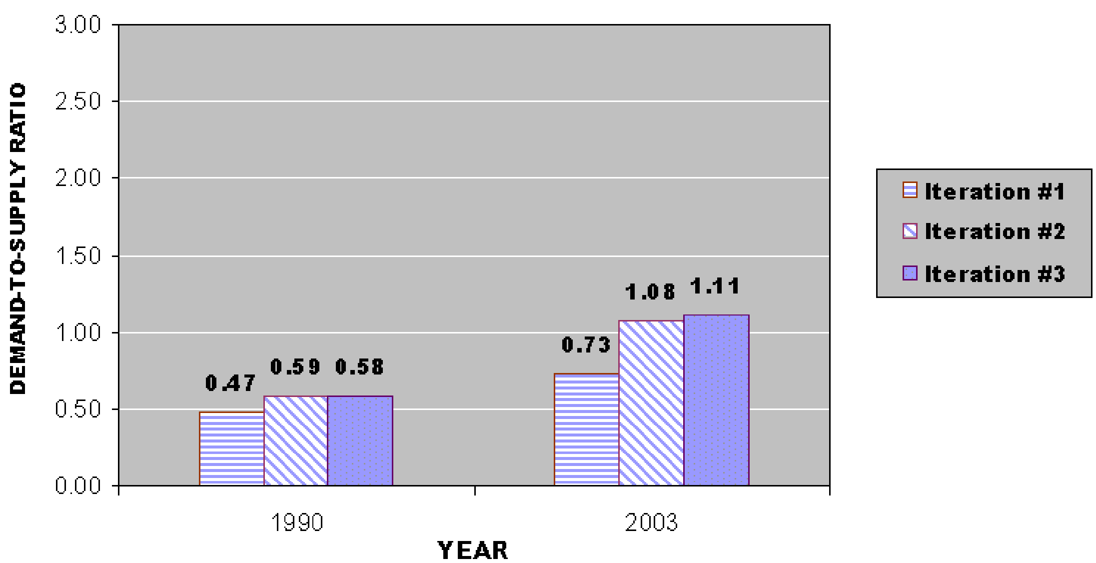

Figure 11. Demand to supply ratio for Utah, 1990 and 2003, based on per capita consumption and biocapacity, comparing three iterations.

The demand-to-supply ratio for Utah is far above the world's but less than that for the United States as a whole, as Figure 12 shows. In all three geographical cases, however, humans are living beyond their ecological means as of 2003.

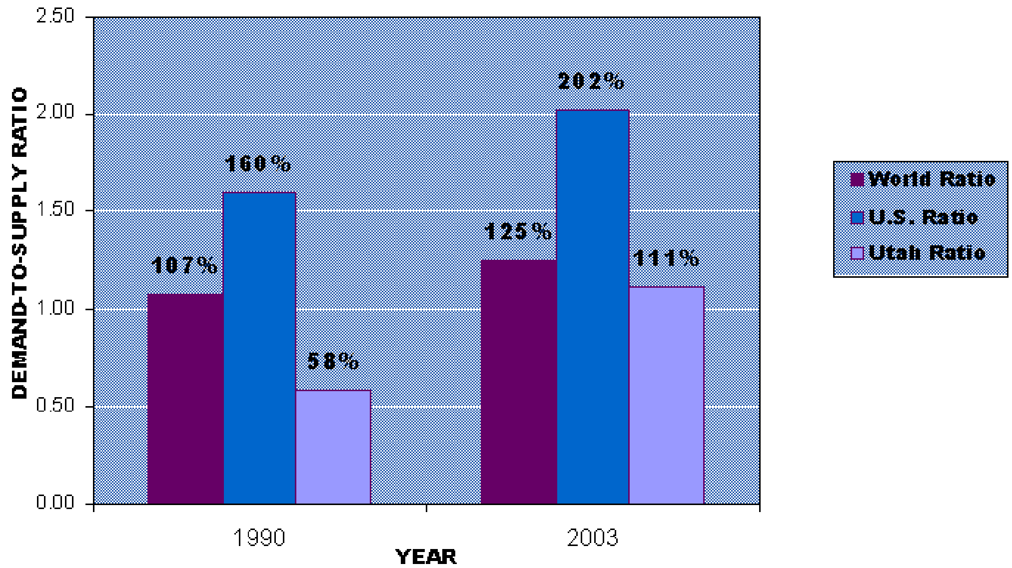

Figure 12. Demand to supply ratio for 1990 and 2003, comparing the total footprint to total biocapacity for World, United States, and Utah.

The demand-to-supply ratio worsens when Utah's consumption is compared with biocapacity nationally or internationally. If everyone in the world lived at Utah's level of consumption, it would have taken 5.43 Earths to sustain the world's population in 2003, as Figure 13 shows.

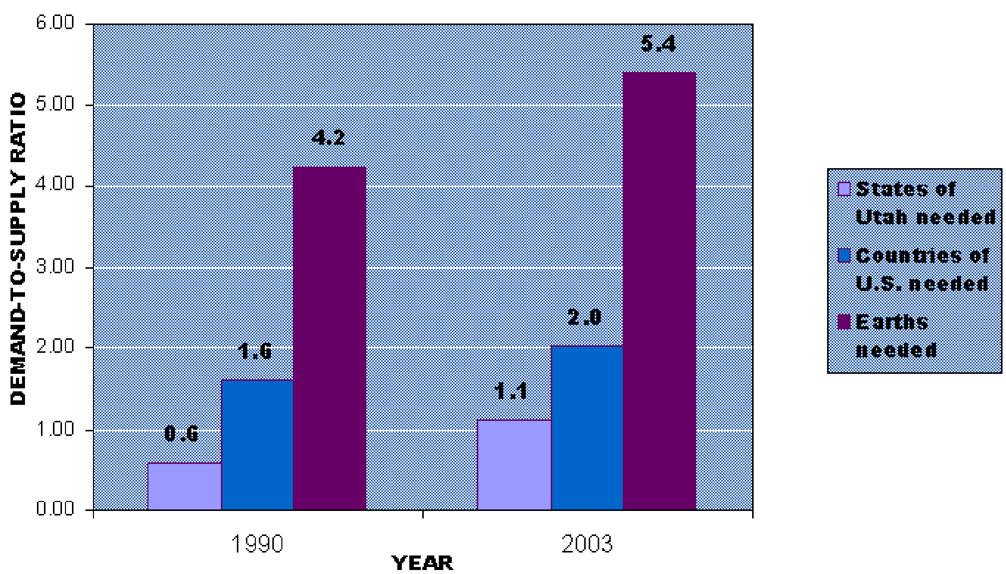

Figure 13. Demand to supply ratio for 1990 and 2003 for Utah's footprint compared to Utah's biocapacity, to United States' biocapacity, and World biocapacity.

This study questions Utah's ability to sustain its current level of consumption and afford its citizens a continuing high quality of life. These results suggest choices Utahns face in preserving our natural heritage and our history of stewardship of the land. The opportunities and challenges presented by this report provide fertile ground for further research and discussion about our collective future.

IMPLICATIONS FOR UTAH

An Initial Proviso

Our assessment of Utah's renewable biological capacity has not yet been adjusted from U.S.-average biological yields in recognition of Utah's specific local conditions. Because of Utah's limited precipitation, rugged terrain and difficult soil conditions, the bioproductivity of much of Utah lands is generally lower than U.S. average. Thus our representation of Utah's renewable biological capacity is, most likely, substantially overstated. Accordingly, any implication noted below that refers to Utah's biocapacity or its ecological deficit has been conservatively assessed and substantially understated. Should future studies correct this analytical limitation, they would most likely show for Utah a notably lower biocapacity, an earlier onset of ecological deficit and a larger total deficit than we now portray.

Going into Ecological Overshoot

Given the large land area of Utah as compared to the size of its population, until recently the biocapacity of Utah met the demands that Utahns placed on it, according to the findings of this study. In 1990, the first year in the study, Utah was living within its ecological means. With only 20 people per square mile in 1990, our land and waters were yielding enough renewable capacity on an annual basis to support our population and lifestyle. Although our consumption was still not frugal enough for planetary balance, we were consuming within the means of nature to renew its bounty to us within the state.

However, sometime in the early part of this decade, Utah slid into ecological deficit. From 1990 to 2003, Utah's population increased by approximately 700,000 persons, and this, coupled with an increase in the consumption per person resulted in an increase of demand of an estimated 7.5 million global hectares, an increase of 45% over the 1990 level. At the same time, the state's biocapacity decreased by 4.5 million global hectares, a decrease of 17.5%.This led to an ecological deficit by 2003, placing Utah in ecological overshoot. Utah citizens are now consuming 11% more of nature's annual "interest" of renewable biological capacity than the lands and waters of Utah can provide annually.

To keep consuming in spite of this deficit, either we are drawing down our biological reserves — the natural capital that has been built up over the centuries — or we are importing and using nature's "interest" and/or capital from other parts of the world, using up the ecological allotment of those regions. It is likely that both are happening.

Energy consumption accounts for the largest share of our footprint, approximately 65%. The burning of fossil fuels, especially the reliance on coal for electricity and the burning of gasoline for vehicle use, produces an excess of carbon dioxide. This places a large demand on the waste absorption capacity of the state's forests.

The Choices Ahead

The gap between what we consume and what the earth provides is likely to continue to grow, if we continue with the current trends. Utah's population is projected to increase steadily in the coming decades, to 4.1 million by 2030 and to 5.4 million by 2050, as Figure 14 shows (GOPB, 2007). If the population grows as expected, we will see our ecological deficit increase even further, unless there is a significant corresponding increase in biocapacity and/or a drastic decrease in consumption per capita.

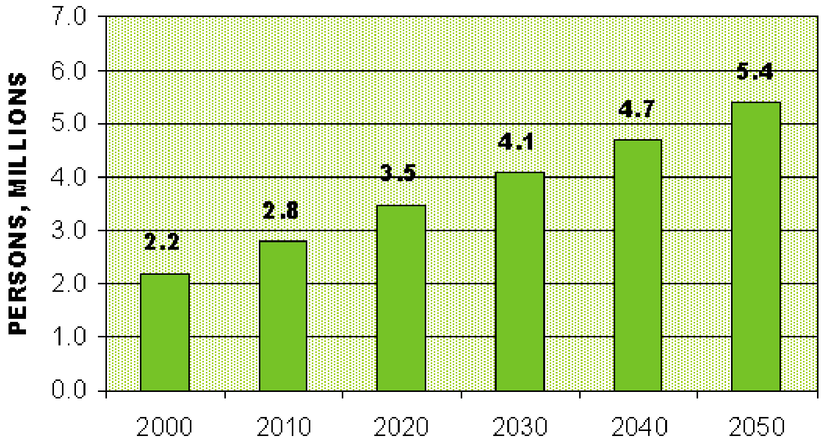

Figure 14. Utah population, 2000 and projected to 2050. Source: Governor's Office of Planning and Budget, Demographic and Economic Analysis Section, State of Utah.

Utah's biocapacity may well be increased in the coming decades. For thousands of years, humans have learned to manage their lands and waters to increase their useful yield. Land and water management practices will continue to evolve, and we will likely see better technologies for efficient harvesting and delivery of foods and increasing use of new agricultural techniques. However, these efforts also need to be undertaken in a way that does not increase biocapacity on a short-term basis at the expense of the long term. For example, farmers long ago learned to avoid measures to maximize short-term crop yield at the expense of the long-term health of the soil.

Since increases in biocapacity are gradual, even under the best of conditions, bringing Utah back into ecological balance will almost certainly need to involve a change in how much we consume. There are many examples of what can be done to decrease our consumption footprint, including:

- We can employ techniques for using fewer resources when making materials and focus on reuse and recycling of materials.
- Means for more efficient uses of resources are available to us via less energy-consumptive technologies, appliances, and automobiles.
- Distribution networks can be changed so that the slogan "local first" drives our purchases. We can bring production of food and goods closer to the point of consumption, and closer to the point of waste disposal.
- We can diversify our energy sources to include "clean" (i.e., non-carbon-producing) sources like solar, wind, and geothermal sources.
- An overall reduction in consumption is likely to be necessary, with greater efforts to conserve resources. For example in the transportation arena this could include decreased miles driven per individual.
- We can be conscious about population growth and its impact on Utah. Growth in population is the single largest contributor to the trend toward ecological deficit in Utah.

Considerations for Planners

Since decisions made now have an impact on Utah's sustainability for years to come, the work of planners at all levels is particularly important in managing Utah's Ecological Footprint. For example, planning discussions could well include new practices in government construction and new ways to create a sense of place. Also, we can work to increase housing opportunities that allow for a wider range of housing densities. Further, discussions need to focus on the use of energy and the types of energy alternatives available to us.

Some examples of the planning topics that are relevant to Utah's Ecological Footprint include:

- the design of the built environment to encourage mixed used high-density developments
- the type of building materials used to encourage conservation and energy efficiency
- public transportation and mobility options
- the use of public and open spaces to complement high-density development
- development of more renewable energy sources

To facilitate this conversation, planners might well challenge themselves to assist citizens in understanding the choices the Ecological Footprint presents. Planners need to help prepare governmental officials, individuals, and businesses for the choices ahead.

Tracking Our Progress

Given the importance of maintaining an adequate ecological reserve for Utah, calculating the Ecological Footprint can be an illuminating exercise when considered as part of decisions affecting stewardship of the land and waters of Utah. Such a measure of the supply and human demand on nature is important for tracking progress, setting targets and driving policies for sustainability. The Ecological Footprint of any proposed plan for development in Utah can be a valuable indicator for guiding us through the challenges of growth, helping us to maintain our quality of life and the ecological reserve needed to provide that quality of life for generations to come.

On an individual level, Utah's Ecological Footprint can make us more aware of the impact of our consumption patterns and help us understand which consumption components contribute most to "living beyond our means." Knowing our Ecological Footprint allows us to make choices and set goals for reducing consumption.

The future is filled with many challenges but also many opportunities to work together to decide our individual and collective futures. We can choose to develop in a sustainable manner and provide strong stewardship on behalf of our children and grandchildren, maintaining the natural legacy we inherited. In Utah, we are poised at the point of decision, and these results would suggest that the time for action is now.

NEXT STEPS

The Utah Vital Signs 2007 report is being released in June 2007 to the public. We hope that this will engender discussions relating to sustainability in Utah and the choices and challenges ahead. Members of the Utah Vital Signs team are available to present the research results and to participate in discussions about a more sustainable future for Utah.

A high priority for future research is calculating the actual productivity of Utah lands and waters – i.e., not using U.S. average productivity figures as this round of the study does. Utah Vital Signs hopes to work with, and encourages others to work with, range management and water management researchers to develop an accurate reflection of Utah's biocapacity.

Another high priority is refining the Consumption–Land Use Matrix for the United States, in conjunction with the Global Footprint Network and possibly other U.S. states. This would perhaps the calculation of more accurate results of consumption demand.

Additional indicators that reflect the state of Utah's ecosystems should be developed. A thematic feature on urbanization with historic trends and future planning scenarios would offer a targeted context for decision making.

UPEC is currently seeking funding to support these and other research agendas. We are also interested in collaborating with additional contributors in various subject areas for our knowledge team. UPEC also encourages others to take various steps to further this work.

We welcome your feedback, input and ideas. You can find contact information on the Utah Vital Signs website located at http://www.utahpop.org/vitalsigns.

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APPENDIX A: BIOGRAPHICAL SKETCHES OF SELECTED MEMBERS OF UTAH VITAL SIGNS PROJECT TEAM

- **Wayne Martinson, MSW**
  Chair of Utah Population and Environment Coalition (UPEC)
  Wayne Martinson was one of the founders of UPEC in 1998. Wayne has worked in Utah for the National Audubon Society since 1991 and is currently employed as Utah Important Bird Areas Coordinator. Wayne has a Master's degree in Social Work from the University of Utah with an emphasis in Administration and Community Planning. He founded the Utah Vital Signs Project in 2006 and provided oversight on behalf of the board of directors of UPEC.

- **Sandra McIntyre, MEd**
  Project Director
  Sandra McIntyre has worked in science education and educational publishing for 25 years. She has had extensive experience managing organizations and administering complex technical programs in a variety of organizations: academic, small business, nonprofit, and corporate. She started her career as a science teacher and in 1992 founded her own company, McIntyre Interactive, which developed custom online educational courseware for educational institutions and corporate training departments. She also served as program manager for an educational technology project at UCLA School of Medicine, supervising a virtual team of 14 people at three institutions. Sandra graduated from Swarthmore College with a bachelor's degree in philosophy and earned a Master's degree in science education from Georgia State University. She helped to write the original proposal for the Utah Vital Signs project and has served as Project Director since October 2006. She directed the research on sustainability indicators for the *Utah Vital Signs 2007* report.

- **Helen M. Peters MPA, MUP**
  Lead Researcher
  Helen M. Peters earned a Master's of Urban Planning degree from the University of Utah in May 2007. Using the knowledge gained through obtaining a Master's in Public Administration over a decade ago, Helen has been mastering her leadership skills by helping individuals and groups to transform into engaged citizens and effective organizations. Helen has provided key leadership in preserving over 100 acres of open space slated for development, the Parley's Rails Trails and Tunnels Coalition (PRATT) trail building efforts, guiding the development of the built environment in Sugar House and many other efforts that help to transform our community into a more just, equitable and sustainable society. She researched data sources for the Ecological Footprint components, provided analysis, and co-wrote the Report.

- **Philip C. Emmi, PhD**
  Academic Consultant
  Philip C. Emmi is Professor of Urban and Regional Planning at the College of Architecture + Planning at the University of Utah, where he serves as Director of the Urban Planning Program and of the interdisciplinary graduate certificate program in the Adaptive Management of Environmental Systems. He holds degrees from Harvard University and the University of North Carolina at Chapel Hill. He has been a Peace Corps Volunteer, a Fulbright Scholar, Lowell Bennion Community Service Professor, a frequent visiting scholar at the Swedish National Institute for Building Research, and a National Science Foundation grant recipient. His academic interests include planning theory; cities and sustainability; and the use of dynamic simulation modeling for

collaborative learning and consensus building. He helped design the research methodology for the project and provided review and oversight of the data collection and calculations.

- **Maged Senbel, PhD**
  Academic Consultant
  Maged Senbel is an assistant professor of urban planning at the College of Architecture + Planning at the University of Utah. He began conducting research on Ecological Footprint assessment and modeling over ten years ago. He has a PhD in urban planning from the University of British Columbia where his doctoral research was on leadership in sustainability planning. His current research and teaching work are in the areas of sustainable urban design and inclusive public participation in neighborhood planning. He helped design the research methodology for the project and provided review and oversight of the data collection and calculations.

APPENDIX B: ADDITIONAL RESOURCES

Books and Book Chapters

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Sustainability Programs and Courses of Study

- Great Basin Earth Institute on the website for Utah Society for Environmental Education, http://www.usee.org/services/GBEI/home.htm
- Environmental Center, Westminster College, http://www.westminstercollege.edu/environmental_center/

- Environmental Studies Program, Westminster College, http://www.westminstercollege.edu/environmental_studies/
- Environmental Studies Program, College of Social and Behavioral Science, University of Utah, http://www.envst.utah.edu
- Environmental Humanities Graduate Program, College of Humanities, University of Utah, http://www.hum.utah.edu/eh/
- Ecology and Environmental Biology specialty, Biology Department, University of Utah, http://www.biology.utah.edu/strong.php?area=ecol
- Department of Environment and Society, College of Natural Resources, Utah State University, http://www.cnr.usu.edu/departments/envs/envs

APPENDIX C: GLOSSARY

Note: Except as noted, these definitions are reproduced from the Global Footprint Network glossary at http://www.footprintnetwork.org/gfn_sub.php?content=glossary.

acre: One U.S. acre is equal to 0.405 hectares. For U.S. audiences, Footprint results are often presented in global acres (ga) , rather than global hectares. See global hectare, hectare, local hectare.

area type: see land type

biodiversity buffer: The amount of biocapacity set aside to maintain representative ecosystem types and viable populations of species. How much needs to be set aside depends on biodiversity management practices and the desired outcome.

biological capacity or biocapacity: The capacity of ecosystems to produce useful biological materials and to absorb waste materials generated by humans, using current management schemes and extraction technologies. "Useful biological materials" are defined as those used by the human economy Hence what is considered "useful" can change from year to year (e.g. use of corn stover for cellulosic ethanol production would result in corn stover becoming a useful material, and so increase the biocapacity of maize cropland). The biocapacity of an area is calculated by multiplying the actual physical area by the yield factor and the appropriate equivalence factor. Biocapacity is usually expressed in units of global hectares.

biological capacity available per person (or **per capita):** There were 11.2 billion hectares of biologically productive land and water on this planet in 2003. Dividing by the number of people alive in that year, 6.3 billion, gives 1.8 global hectares per person . This assumes that no land is set aside for other species that consume the same biological material as humans.

biologically productive land and water: The land and water (both marine and inland waters) area that supports significant photosynthetic activity and biomass accumulation used by humans. Non-productive areas as well as marginal areas with patchy vegetation are not included. Biomass that is not of use to humans is also not included. The total biologically productive area on land and water was approximately 11.2 billion hectares in 2003.

carbon Footprint: When used in Ecological Footprint studies, this term is synonymous with demand on CO_2 area. NOTE: The phrase "Carbon Footprint" or "carbon footprint" has been picked up in the climate change debate. There are several calculators that use the phrase "Carbon Footprint", but many just calculate tonnes of carbon, or tonnes of carbon per euro, rather than demand on bioproductive area.

CO_2 area (also CO_2 land): The demand on biocapacity required to sequester (through photosynthesis) the carbon dioxide (CO_2) emissions from fossil fuel combustion. Although fossil fuels are extracted from the Earth's crust and are not regenerated in human time scales, their use demands ecological services if the resultant CO_2 is not to accumulate in the atmosphere. The Ecological Footprint therefore includes the biocapacity, typically that of unharvested forests, needed to absorb that fraction of fossil CO_2 that is not absorbed by the ocean.

consumption: Use of goods or of services. The term consumption has two different meanings, depending on context. As commonly used in regard to the Footprint, it refers to the use of goods or services. A consumed good or service embodies all the resources, including energy, necessary to provide it to the consumer. In full life-cycle accounting, everything used along the production chain is taken into account, including any losses along the way. For example, consumed food includes not only the plant or animal matter people eat or waste in the household, but also that lost during processing or harvest, as well as all the energy used to grow, harvest, process and transport the food.

As used in Input Output analysis, consumption has a strict technical meaning. Two types of consumption are distinguished: intermediate and final. According to (economic) System of National Accounts terminology, intermediate consumption refers to the use of goods and services by a business in providing goods and services to other businesses. Final consumption refers to non-productive use of goods and services by households, the government, the capital sector, and foreign entities.

consumption components (also consumption categories): Ecological Footprint analyses can allocate total Footprint among consumption components, typically Food, Shelter, Mobility, Goods, and Services, often with further resolution into sub-components. Consistent categorization across studies allows for comparison of the Footprint of individual consumption components across regions, and the relative contribution of each category to the region's overall Footprint. To avoid double counting, it is important to make sure that consumables are allocated to only one component or sub-component. For example, a refrigerator might be included in the food, goods, or shelter component, but only in one.

consumption Footprint: The most commonly reported type of Ecological Footprint. It is the area used to support a defined population's consumption. The consumption Footprint (in gha) includes the area needed to produce the materials consumed and the area needed to absorb the waste. The consumption Footprint of a nation is calculated in the National Footprint Accounts as a nation's primary production Footprint plus the Footprint of imports minus the Footprint of exports, and is thus, strictly speaking, a Footprint of apparent consumption. The national average or per capita Consumption Footprint is equal to a country's Consumption Footprint divided by its population.

Consumption Land Use Matrix: Starting with data from the National Footprint Accounts, a Consumption Land Use Matrix allocates the six major Footprint land uses (shown in column headings, representing the five land types and CO_2 area) to the five Footprint consumption components (row headings). Each consumption component can be disaggregated further to display additional information. These matrices are often used as a tool to develop sub-national (e.g. state, county, city) Footprint assessments. In this case, national data for each cell is scaled up or down depending on the unique consumption patterns in the state, county or city.

Consumption Land Use Matrix

	Built-up Land	CO_2 Area *	Cropland	Grazing Land	Forest	Fishing Ground	**Total**
Food							
Shelter							
Mobility							
Goods							

Services							
Total							

* The Footprint of nuclear power is here included in CO2 Area,

conversion factor: A generic term for factors which are used to translate a material flow expressed within one measurement system into another one. For example, a combination of two conversion factors—"yield factors" and "equivalence factors"— translates hectares into global hectares. The extraction rate conversion factor translates a secondary product into primary product equivalents.

Conversion Factor Library: See Footprint Intensity Table.

daughter product: The product resulting from the processing of a parent product. For example wood pulp, a secondary product, is a daughter product of roundwood. Similarly, paper is a daughter product of wood pulp.

double counting: In order not to exaggerate human demand on nature, Footprint Accounting avoids double counting, or counting the same Footprint area more than once. Double counting errors may arise in several ways. For example, when adding the Ecological Footprints in a production chain (e.g., wheat farm, flour mill, and bakery), the study must count the cropland for growing wheat only once to avoid double counting. Similar, but smaller, errors can arise in analyzing a production chain because the end product is used in produce the raw materials used to make the end product (e.g. steel is used in trucks and earthmoving equipment used to mine the iron or that is made into the steel). Finally, when land serves two purposes (e.g. a farmer harvests a crop of winter wheat and then plants corn to harvest in the fall), it is important not to count the land area twice. Instead, the yield factor is adjusted to reflect the higher bioproductivity of the double-cropped land.

Ecological debt: Since the mid-1980s, when human demand on biocapacity first exceeded the available biocapacity, mankind has been in condition of overshoot, with its Footprint each year exceeding the planet's biocapacity. By demanding more than the biocapacity can supply, humanity is accruing an ecological debt. This debt is the sum of all the annual deficits.

ecological deficit / reserve: The difference between the biocapacity and Ecological Footprint of a region or country. An ecological deficit occurs when the Footprint of a population exceeds the biocapacity of the area available to that population. Conversely, an ecological reserve exists when the biocapacity of a region exceeds its population's Footprint. If there is a regional or national ecological deficit, it means that the region is either importing biocapacity through trade or liquidating regional ecological assets. In contrast, the global ecological deficit cannot be compensated through trade, and is therefore equal to overshoot.

Ecological Footprint: A measure of how much biologically productive land and water an individual, population or activity requires to produce all the resources it consumes and to absorb the waste it generates using prevailing technology and resource management practices. The Ecological Footprint is usually measured in global hectares. Because trade is global, an individual or country's Footprint includes land or sea from all over in the world. Ecological Footprint is often referred to in short form as Footprint (not footprint).

ecological reserve: See ecological deficit / reserve.

embodied energy: Embodied energy is the energy used during a product's entire life cycle in order to manufacture, transport, use and dispose of the product. Footprint studies often use embodied energy when tracking trade of goods.

energy Footprint: The sum of all areas used to provide non-food and non-feed energy . It is the sum of CO_2 area, hydropower land, forest for fuelwood, crop land for fuel crops, and area for nuclear energy.

equivalence factor: A productivity based scaling factor that converts a specific land type (such as cropland or forest) into a universal unit of biologically productive area, a global hectare. For land types (e.g., cropland) with productivity higher than the average productivity of all biologically productive land and water area on Earth, the equivalence factor is greater than 1. Thus, to convert an average hectare of cropland to global hectares, it is multiplied by the cropland equivalence factor of 2.21. Pasture lands, which have lower productivity than cropland, have an equivalence factor of 0.48. See also yield factor.

extraction rate: A processing factor comparing the quantity of a parent product to the quantity of the resulting daughter product. When a parent product is processed its mass changes. For example, when wheat is processed into white flour, the bran and germ are stripped lessening its mass. Therefore, in order to calculate the number of hectares needed to produce a given mass of flour, an extraction rate is needed. This extraction rate in this example is the ratio of tonnes of flour divided by the tonnes of wheat processed to produce the flour.

Footprint Intensity: The number of global hectares required to produce a given quantity of resource or absorb a given quantity of waste, usually expressed as global hectares per tonne. The National Footprint Accounts calculate a primary Footprint Intensity Table for each country, which includes the global hectares of primary land use type needed to produce or absorb a tonne of product (i.e., global hectares of cropland per tonne of wheat, global hectares of forest per tonne carbon dioxide)."

Footprint Intensity Table: A collection of the primary and secondary product Footprint intensities from the National Footprint Accounts. Footprint intensity is usually measured in gha per tonne of product or waste (CO_2). The Footprint Intensity Table is maintained by Global Footprint Network, supported by the Network's National Accounts Committee.

Footprint neutral or negative: Human activities or services that result in no increase or a net reduction in humanity's Ecological Footprint . For example, the activity of insulating an existing house has a Footprint for production and installation of the insulation materials. This insulation in turn reduces the energy needed for cooling and heating this existing house. If the Footprint reduction from this energy cutback is equal to or greater than the original Footprint of insulating the house, the latter becomes a Footprint neutral or negative activity. On the other hand, making a new house highly energy efficient does not by itself make the house Footprint neutral, unless at the same time it causes reduction in other existing Footprints. This Footprint reduction has to be larger than the Footprint of building and occupying the new house.

global hectare (gha): A productivity weighted area used to report both the biocapacity of the earth, and the demand on biocapacity (the Ecological Footprint). The global hectare is normalized to the area-weighted average productivity of biologically productive land and water in a given year. Because different land types have different productivity, a global hectare of, for example, cropland, would occupy a smaller physical area than the much less biologically productive pasture land, as more pasture would be needed to provide the same biocapacity as one hectare of cropland. Because world bioproductivity varies slightly from year to year, the value of a gha may change slightly from year to year.

Guidelines (for Footprint studies): Suggested criteria governing methods, data sources and reporting for use when Footprint Standards are not appropriate or not yet developed.

hectare: 1/100th of a square kilometre, 10,000 square meters, or 2.471 acres. A hectare is approximately the size of a soccer field. See also global hectare and local hectare

IO (Input-Output) analysis: Input-Output (IO, also I-O) analysis is a mathematical tool widely used in economics to analyze the flows of goods and services between sectors in an economy, using data from IO tables. IO analysis assumes that everything produced by one industry is consumed either by other industries or by final consumers, and that these consumption flows can be tracked. If the relevant data are available, IO analyses can be used to track both physical and financial flows. Combined economic-environment models use IO analysis to trace the direct and indirect environmental impacts of industrial activities along production chains, or to assign these impacts to final demand categories. In Footprint studies, IO analysis can be used to apportion Footprints among production activities, or among categories of final demand, as well as in developing Consumption Land Use Matrices .

IO (Input-Output) tables: IO tables contain the data that are used in IO analysis. They provide a comprehensive picture of the flows of goods and services in an economy for a given year. In its general form an economic IO table shows uses — the purchases made by each sector of the economy in order to produce their own output, including purchases of imported commodities; and supplies — goods and services produced for intermediate and final domestic consumption, and exports. IO tables often serve as the basis for the economic National Accounts produced by national statistical offices. They are also used to generate annual accounts of the Gross Domestic Product (GDP).

land type: The Earth's approximately 11.2 billion hectares of biologically productive land and water are categorized into five types of surface area: cropland, grazing land, forest, fishing ground, and built-up land. Also called "area type."

life cycle analysis (LCA): A quantitative approach that assess a product's impact on the environment throughout its life. LCA attempts to quantify what comes in and what goes out of a product from "cradle to grave," including the energy and material associated with materials extraction, product manufacture and assembly, distribution, use and disposal and the environmental emissions that result. LCA applications are governed by the ISO 14040 series of standards (http://www.iso.org).

local hectare: A productivity weighted area used to report both the biocapacity of a local region, and the demand on biocapacity (the Ecological Footprint). The local hectare is normalized to the area-weighted average productivity of the specified region's biologically productive land and water. Hence, similar to currency conversions, Ecological Footprint calculations expressed in global hectares can be converted into local hectares in any given year (e.g., Danish hectares, Indonesian hectares) and vice versa. The amount of Danish hectares equals the amount of bioproductive hectares in Denmark — each Danish hectare would represent an equal share of Denmark's total biocapacity.

National Footprint Accounts: The central data set that calculates the Footprints and biocapacities of the world and roughly 150 nations from 1961 to the present (generally with a three year lag due to data availability). The ongoing development, maintenance and upgrades of the National Footprint Accounts are coordinated by Global Footprint Network and its 70 plus partners.

natural capital: Natural capital can be defined as all of the raw materials and natural cycles on Earth. Footprint analysis considers one key component, life supporting natural capital, or ecological capital for short. This capital is defined as the stock of living ecological assets that yield goods and services on a continuous basis. Main functions include resource production (such as fish, timber or cereals), waste assimilation (such as CO_2 absorption or sewage decomposition) and life support services (such as UV protection, biodiversity, water cleansing or climate stability).

nuclear Footprint: The Footprint of electricity generated by nuclear power is treated as equivalent, per kilowatt, to the world average Footprint of fossil-fuel derived electricity. As of 2003, the nuclear Footprint is approximately 8% of the total carbon Footprint. This assumption is a placeholder, which is currently under review, and may be subject to change in a future Edition of the National Footprint Accounts.

overshoot: When humanity's demand on nature exceeds the biosphere's supply, or regenerative capacity, this global ecological deficit is called overshoot. Such overshoot leads to a depletion of Earth's life supporting natural capital and a build up of waste.

parent product: The product processed to create a daughter product. For example wheat, a primary product, is a parent product of flour, a secondary product. Flour, in turn, is a parent product of bread.

Planet Equivalent(s): Every individual and country's Ecological Footprint has a corresponding Planet Equivalent, or the number of Earths it would take to support humanity's Footprint if everyone lived like that individual or average citizen of a given country. It is the ratio of an individual's (or country's per capita) Footprint to the per capita biological capacity available on Earth (1.8 gha in 2003). In 2003, the world average Ecological Footprint of 2.23 gha equals 1.26 Planet Equivalents.

primary product: In Footprint Studies a primary product is the least processed form of a biological material that humans harvest for use. There is a difference between the raw product, which is all the biomass produced in a given area, and the primary product, which is the biological material humans will harvest and use. For example, a fallen tree is a raw product that, when stripped of its leaves and bark, results in the primary product of roundwood. Primary products are then processed to produce secondary products like wood pulp, paper, and so on. Other examples of primary products are potatoes, cereals, cotton, or forage. Examples of secondary products are kWh of electricity, bread, clothes, beef, or appliances.

primary production Footprint (also primary demand): In contrast to the consumption Footprint, a nation's primary production Footprint is the sum of the Footprints for all of the resources harvested and all of the waste generated within the defined geographical region. This includes all the area within a country necessary for supporting the actual harvest of primary products (cropland, pasture land, forestland and fishing grounds), the country's built-up area (roads, factories, cities), and the area needed to absorb all fossil fuel carbon emissions generated within the country. In other words, the forest Footprint represents the area necessary to regenerate all the timber harvested (hence, depending on harvest rates, this area can be bigger or smaller than the forest area that exists within the country). Or, for example, if a country grows cotton for export, the ecological resources required are not included in that country's consumption Footprint; rather, they are included in the consumption Footprint of the country that imports the t-shirts. However, these ecological resources are included in the exporting country's primary production Footprint.

productivity: The amount of biological material useful to humans that is generated in a given area. In agriculture, productivity is called yield.

secondary product: All products derived from primary products or other secondary products through a processing sequence applied to a primary product.

Ecological Footprint Standards: Specified criteria governing methods, data sources and reporting to be used in Footprint studies. Standards are established by the Global Footprint Net work Standards Committees composed of scientists and Footprint practitioners from around the world. Standards serve to produce transparent, reliable and mutually comparable results in studies done throughout the Footprint Community. Where Standards are not appropriate, Footprint Guidelines should be consulted. For more information, consult www.footprintstandards.org.

sustainability (Brundtland Commission definition): meeting the needs of current life forms without compromising the capacity of future life forms to do likewise.

tonnes: All figures in the National Footprint Accounts are reported in metric tonnes. One metric tonne equals 1000 kg, or 2205 lbs.

yield: The amount of primary product, usually reported in tonnes per year, that humans are able to extract per area unit of biologically productive land or water.

yield factor: A factor that accounts for differences between countries in productivity of a given land type. Each country and each year has yield factors for cropland, grazing land, forest, and fisheries. For example, in 2002, German cropland was 2.5 times more productive than world average cropland. The German cropland yield factor of 2.5, multiplied by the cropland equivalence factor of 2.2 converts German cropland hectares into global hectares: one hectare of cropland is equal to 5.5 gha.

Note that primary product and primary production Footprint are Footprint specific terms. They are not related to, and should not be confused with the ecological concepts of primary production, gross primary productivity (GPP) and net primary productivity (NPP).

APPENDIX D: DATA AND DATA SOURCES

This report has an accompanying binder that includes printouts of all data, along with a Data Reference Sheet for each data source. The same set is available electronically on the Utah Vital Signs website at http://www.utahpop.org/vitalsigns.