Assessing BEA's Prototype Integrated Economic and Environmental Satellite Accounts

RECENTLY, A BLUE-RIBBON panel of the National Academy of Sciences' National Research Council completed a Congressionally mandated review of the work that the Bureau of Economic Analysis (BEA) had published on integrated economic and environmental accounts. The panel commended BEA for its initial work in producing a set of sound and objective prototype accounts. In particular, the panel endorsed BEA's proposal not to redefine the core GDP estimates but to construct satellite, or supplemental, accounts of environmental activity. They also underlined the importance of BEA's development of a set of environmental accounts consistent with sound economic principles in areas such as the measurement of prices and the treatment of depletion and investment.

The panel found value in BEA's phased approach to economic accounting but recommended a more comprehensive approach that encompassed—in addition to environmental and natural resources—the value of unpaid work, the value of investments in human capital, and the uses of peoples' time. While finding that such augmented accounts would produce large public and private benefits, the panel emphasized that this work should not come at the expense of BEA's core national economic accounts.

Following are two articles that report on the panel's work. The first is an overview of the major issues and findings by William D. Nordhaus, the Chair of the National Academy of Sciences Panel on Integrated Environmental and Economic Accounting. The second is a reprint of chapter 5, "Overall Appraisal of Environmental Accounting in The United States," from the panel's final report, *Nature's Numbers.*

Next spring, as part of its promise to inform its users of the results of this evaluation, BEA will reprint several additional chapters from *Nature's Numbers*, which discuss in more detail the panel's evaluation of BEA's work on integrated environmental and economic accounting.

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The Future of Environmental and Augmented National Accounts

An Overview

By William D. Nordhaus

William D. Nordhaus is the A. Whitney Griswold Professor of Economics at Yale University, New Haven, Connecticut. He recently chaired the National Research Council Panel that produced the report Nature's Numbers: Expanding the National Economic Accounts to Include the Environment. This summary draws heavily on that report. The views expressed do not necessarily represent those of BEA.

*T*HE NATIONAL income and product accounts (NIPA's) are the most important measures of overall economic activity for a nation. Nevertheless, since their first construction by Simon Kuznets, there have been concerns that the accounts are incomplete and misleading because they omit nonmarket activity such as unpaid work, the value of leisure time, and most investment in human capital. Most recently, attention has focused on extending the accounts to include natural resources and the environment.

Intensive work on environmental accounting began in the Bureau of Economic Analysis (BEA) of the U.S. Department of Commerce in 1992. The BEA published the first official U.S. environmental accounts, known as the Integrated Environmental and Economic Satellite Accounts (or IEESA's), in 1994. Shortly thereafter, Congress directed the Commerce Department to suspend further work in this area and to obtain an external review of environmental accounting. A panel working under the aegis of the National Research Council's Committee on National Statistics was charged "to examine the objectivity, methodology, and application of integrated environmental and economic accounting in the context of broadening the national economic accounts" and to review "the proposed revisions...to broaden the national accounts..." This month's SURVEY OF CURRENT BUSINESS contains the highlights of that report, and other chapters are scheduled to be published next spring.

I had the opportunity to chair the panel, and I have been asked to summarize some of the major issues and conclusions in the report. While these are my personal views, I believe they accurately reflect the deliberations of the larger panel.

Integrated Environmental and Economic Accounting

Over the last quarter century, we have become increasingly aware of the interactions between human societies and the natural environment in which they thrive and upon which they depend. This awareness has been heightened by concerns about resource scarcity, local and national environmental degradation, and global environmental issues. The combination of increased awareness of the environment and recognition of the primitive state of much of the Nation's environmental data has led to a widespread desire to supplement U.S. national economic accounts to include the services of natural resources and the environment. The idea of including environmental assets and services in the national economic accounts is part of a larger movement to develop broader social and environmental indicators. This movement reflects the reality that economic and social welfare does not stop at the market's border, but extends to many nonmarket activities.

The traditional national accounts include primarily the final output of marketed goods and services—that is, of goods and services that are bought and sold in market transactions. Notwithstanding the importance of the traditional accounts, it has long been recognized that limiting them to market transactions distorts the accounts as a measure of economic activity and well-being. There is a vast and rapidly evolving array of "near-market" goods and services—ones that are similar to marketed goods but that are

omitted from traditional accounts. This boundary distorts our measures of economic activity. Nannies' services are reckoned as part of the gross domestic product (GDP), while mommies' and daddies' services are not; the value of swimming in a commercial swimming pool is captured by GDP, while the value of swimming in the Atlantic Ocean is not.

In response to growing concerns about the accuracy of traditional measures of economic activity, many efforts have been undertaken to broaden the traditional accounts to include important sectors of nonmarket activity. Most of the early efforts were undertaken by private scholars, beginning in the early 1970's, but there were few efforts to broaden the official national accounts until the 1980's.

Augmented national economic accounts are designed to provide better measures of genuine national output—of what consumers currently enjoy in the way of goods and services, and of the accumulation of capital, of all kinds, which will permit the future production of goods and services. Although many different approaches have been taken, the guiding principle in augmented economic accounts is to measure as much of economic activity as is feasible, regardless of whether it takes place inside or outside the marketplace.

Extending the accounts is not just an academic exercise. Better natural-resource and environmental accounts can provide valuable information on the interaction between the environment and the economy, help in determining whether the nation is using its stocks of natural resources and environmental assets in an unsustainable manner, and provide information on the implications of different regulations, taxes, and consumption patterns. We seek better measures for scorekeeping—to devise better measures of national saving and investment or broader measures of economic well-being. But the data in augmented accounts are also useful for management—to help the Nation better manage its subsoil assets, public lands, and precious environmental heritage.

BEA's proposal for developing the IEESA's envisions a phased approach, adding satellite accounts for other productive natural-resource and environmental assets in three phases—starting with minerals, expanding to renewable resources such as timber in forests, and then addressing nonmarket assets and public goods such as clean air. If the phased approach is undertaken, a useful initial step would be to refine the initial estimates of subsoil minerals. Constructing forest accounts, focusing initially on timber, is a natural next step for integrated economic and environmental accounts. Other sectors that should be high on the priority list are those associated with agricultural assets, fisheries, and water resources.

The panel urged the adoption of a more ambitious approach, under which a comprehensive set of near-market and nonmarket accounts would be developed. In addition to the environmental arena, significant extensions would include the value of home production and unpaid work, the value of research and development capital, the value of nonmarket time of the population, and the value of informal and home education. (A useful step in this direction came in the last round of NIPA revisions, which incorporated investment in software.) This work is motivated by the idea that expanding the boundaries of the accounts would provide a better estimate of the size, distribution, and growth of economic activity and economic welfare than that offered by the current accounts.

An important issue concerns the relationship of the environmental and other nonmarket accounts with the existing accounts. BEA proposed putting the IEESA's in satellite accounts, which are a useful innovation in national accounting. For the environment, satellite accounts provide the raw material needed by policy makers, businesses, and citizens to track important trends and to determine the economic importance of changes in environmental variables. In addition, developing environmental satellite accounts allows experimentation and encourages the testing of a wide variety of approaches.

BEA has not proposed redefining the core national income and product accounts to include nonmarket flows or investments in natural resources and the environment. The panel agreed that the core income and product accounts should continue to reflect chiefly market activity and that natural-resource and environmental flows should be recorded in satellite or supplemental accounts. Moreover, developing augmented accounts must not come at the expense of maintaining and improving the current core national accounts, which are a precious national asset.

The panel's central recommendation was that Congress should authorize and fund BEA to recommence its work on developing natural-

resource and environmental accounts and that BEA should be encouraged to develop a comprehensive set of near-market and nonmarket accounts.

Link Between Economic Accounting and Measures of Sustainable Income

In light of increasing environmental concerns, questions have been raised about the sustainability of current patterns of economic activity. What are the environmental and economic implications of continuing "business as usual"? Will the current path of population, energy use, and human settlements do irreversible harm to the natural ecosystems and life-support systems of the earth? Is our economy on a sustainable path?

Measures of national income take two fundamentally different approaches—one based on current production and one based on sustainable consumption. The definition of net domestic or national product used in the national income and product accounts of virtually every nation today—sometimes called Hicksian income—is production-based in the sense that it measures production in a given period measured at market prices. While standard production-based measures of income are useful tools, they do not directly address concerns about the sustainability of current decisions. Economists often define sustainable national income as the maximum amount that can be consumed while ensuring that all future generations can have living standards that are at least as high as those of the current generation.

What is the relationship between current measures of national output, such as net national product, and sustainable income? One of the most surprising results of modern economic theory is the output-sustainability correspondence principle. This principle holds that under idealized conditions net national product and sustainable income are identical. More precisely, when population is constant, when the national accounts include all stocks of capital and other dynamic features that affect production, and when market prices accurately capture the social value of economic activity, net domestic product is an accurate measure of sustainable income. In other words, in this idealized situation, the sum of total consumption and net capital formation is equal to the maximum sustainable level of per capita consumption that an economy can main-

tain indefinitely. The operational point is that, again under idealized conditions, extending the NIPA's to include comprehensive measures of consumption and net investment would make output and income more accurate indexes of sustainable income.

The principles for measuring sustainable income are useful for guiding decisions about the design of the NIPA's. However, important practical and theoretical qualifications to these principles must be emphasized. Augmented net domestic product will fail to measure sustainable income accurately (1) if the list of consumption and asset categories is incomplete, (2) if there are technological advances or similar processes that are not captured in investment data, (3) if there are revaluation effects not captured in the accounts, or (4) if prices do not adequately capture social values, as occurs most dramatically with public goods like the environment and increases in knowledge. While these qualifications are important, the basic insight is of great value for the designing of augmented accounts.

Accounting For Subsoil Mineral Resources

The first phase of BEA's integrated economic and environmental accounts, published in 1994, presented a full set of subsoil mineral accounts with estimates of the value of mineral reserves. From a substantive point of view, the subsoil mineral accounts provide a useful summary of trends in the value of subsoil mineral assets. The initial IEESA's found that subsoil assets constitute a relatively small portion of total U.S. wealth and that real proven mineral wealth has remained roughly constant over time. Mineral wealth as calculated by BEA represents a small fraction of the total nonhuman wealth of the United States. The total value of mineral resources in 1987 was between 3 and 7 percent of the tangible capital stock of the country. One surprise in the accounts was that conventionally measured corporate profits are significantly reduced when depletion of subsoil assets is taken into account.

Developing improved natural-resource accounts at home and abroad would be particularly useful for those sectors in which international trade is important. Indeed, as is evident from recent turmoil in financial markets—such as the Mexican crisis of 1994–95 and the financial crises of East Asian countries in 1997–98—the United States can suffer when foreign accounting

standards are poor. Better international mineral accounts would help improve understanding of resource consumption and production trends abroad and help assess the likelihood of major increases in oil and other minerals prices of the kind witnessed in the 1970's. To the extent that the United States depends heavily on imported fuels and minerals, it would benefit from better minerals accounts abroad because the reliability and cost of imports can be more accurately forecast when data from other countries are accurate and well designed.

For all these reasons, the panel recommended that BEA develop and maintain a set of accounts for domestic subsoil mineral assets and develop alternative measures for assessing trends in minerals scarcity.

Accounting For Renewable and Environmental Resources

BEA had not yet begun developing its accounts for renewable and environmental resources when Congress suspended BEA's work on environmental accounting. Environmental accounting is a useful way to represent interactions between market activity and the environment. There are three major types of interactions: Quantitative additions and depletions of natural resources occur when minerals and energy resources are discovered or mined, when timber grows or is harvested, and when groundwater is withdrawn or replenished; qualitative alterations in the natural environment occur when the composition of air, water, or soil changes; and expenditures are made to reduce the effect of economic activities on the environment. The main value of natural-resource and environmental accounting is to illuminate the full interactions between the economy and the environment.

Two central problems that arise in constructing environmental accounts are obtaining reliable data on quantity and valuing the quantities. Valuing environmental goods and services requires distinguishing between private and public goods. Private goods can be provided separately to different individuals with no external benefits or costs to others; public goods have benefits or costs that are spread indivisibly among the entire community or even the entire planet.

Price data are relatively reliable for private market goods, such as the timber produced from forestry assets. Values for near-market goods—such as freely collected firewood—can be constructed by comparing the near-market goods with their market counterparts. By contrast, techniques for valuation of public goods have proven costly and often unreliable. Some techniques—such as hedonic-price or travel-cost studies—rely on behavioral or market-based estimates; while these estimates are subject to significant measurement problems, they are conceptually appropriate in economic accounts. Other techniques, such as contingent valuation, are not based on actual behavior, are highly controversial, and are subject to potential measurement errors. The panel concluded that, for valuation, BEA should rely whenever possible on market and behavioral data. However, novel valuation techniques, such as contingent valuation, will be necessary for the development of a comprehensive set of nonmarket accounts.

A second major issue is obtaining reliable quantity data. Surprisingly, quantity data on many market and near-market environmental and natural-resource activities are relatively reliable because there are often well-established conventions for their measurement. Quantity data on some near-market activities, such as the collection of fuel wood for private use and recreational fishing, are conceptually straightforward, and many of these data are currently collected by Federal agencies. The measurement of quantities for nonmarket goods and services, particularly those that have public-good characteristics, suffers from severe methodological difficulties and insufficient data. There are relatively good physical data on emissions of many pollutants from industrial and human activities, but there is very little systematic monitoring of human exposures to most harmful pollutants. The data on many environmental variables are currently poorly designed for the construction of environmental accounts.

True public goods—including climate change, biodiversity, species preservation, and national treasures such as the Florida Everglades and Yellowstone National Park—present major conceptual difficulties for incorporation into a national accounting system. More work will be needed on techniques for measuring production flows and values for the assets and services of true public goods in order to make them compatible with the prices and quantities used in the

core accounts. Notwithstanding the awesome difficulties that arise in accounting for public goods like air quality, these are likely to be the single most significant sector in environmental accounts.

The panel recommended that BEA continue its work to develop accounts for renewable natural resources and the environment. The panel further recommended a concerted Federal effort to identify and collect the data needed to measure changes in the quantity and quality of natural-resource and environmental assets and associated nonmarket service flows. Greater emphasis should be placed on measuring effects as directly as possible, particularly for measuring actual human exposures to air and water pollutants.

Summary

In considering future directions for environmental and augmented accounting in the United States, the panel concluded that there is great value in developing a comprehensive set of near-market and nonmarket accounts. In a complex and wealthy country like the United States, providing information on the structure and interactions of the economy and the environment is an essential function of government. It deserves more support.

Overall Appraisal of Environmental Accounting in the United States

*T*HIS CHAPTER contains the panel's overall conclusions and recommendations, which are based on the analysis and findings presented in previous chapters; specific conclusions and recommendations related to accounting for subsoil mineral resources and for renewable and environmental resources are presented in Chapters 3 and 4, respectively. The sections that follow address in turn the basic questions that arise in constructing integrated environmental and economic satellite accounts, the budgetary implications of developing environmental accounts, and issues of data and implementation.

FUTURE DIRECTIONS FOR THE U.S. INTEGRATED ENVIRONMENTAL AND ECONOMIC ACCOUNTS

This section presents the panel's overall conclusions and recommendations with regard to eight key questions related to the construction of integrated environmental and economic accounts:

1. What is the role of natural-resource and environmental accounting?

2. What is the value of augmented nonmarket accounts?

3. Should the Bureau of Economic Analysis (BEA) resume work on the Integrated Environmental and Economic Satellite Accounts (IEESA)?

4. Should the United States pursue a phased or comprehensive approach to augmented national accounts?

5. Should the IEESA be developed in the core or satellite accounts?

6. What is the relationship of the IEESA to the United Nations System of Environmental and Economic Accounts (SEEA)?

7. What are appropriate techniques for measuring quantities and values for nonmarket activities in the national accounts?

8. What should be the next steps in extending the IEESA?

1. What Is the Role of Natural-Resource and Environmental Accounting?

BEA has developed integrated environmental and economic accounting in response to Presidential directives, as well as the growing interest in and importance of the subject (see Bureau of Economic Analysis, 1994a). Work on environmental accounting has been conducted over the last quarter-century under several administrations. Environmental accounting was introduced during the Ford Administration, when Secretary of Commerce Elliott Richardson called for environmental accounting to track capital investment expenditures on pollution abatement. This initiative was further developed by the Carter Administration. In 1990, the Council of Economic Advisers under President Bush recommended that BEA expand its work on environment-economy interactions. And in 1993, BEA was given a mandate by the Clinton Administration to develop first-phase resource accounts within the framework of the national accounts and to pursue construction of the IEESA.

Natural-resource and environmental accounting has been studied extensively by the United Nations and the European Union and is currently an area of intensive research in all major countries.[1] Many countries have developed additional accounts for minerals, forests, and pollution-control expenditures. The broad-based research that has been conducted on environmental accounting is an indication of the high priority

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1. The Organization for Economic Cooperation and Development (OECD) Council of Environment Ministers, the United Nations Conference on Environment and Development, the heads of government of the Group of Seven, the "London Group" of National Income Accountants, and numerous other international bodies have recommended that nations develop integrated environmental and economic accounts.

assigned to the development of integrated environmental and economic accounting in the United States and other countries.

As discussed further below, better natural-resource and environmental accounts would provide valuable insights into the interaction between the environment and the economy. They would also provide information on the implications of public and private investment and consumption decisions, and help determine whether the nation is running down its stocks of natural resources and environmental assets in an unsustainable manner. Better accounts can inform the nation about the implications of different regulations, taxes, and consumption patterns and thereby lead to more efficient economic, environmental, and natural-resource policies.

There is also a close connection between current approaches to augmented income and product accounts and measures of sustainable income. As discussed in Chapter 2, properly constructed national income and output can be interpreted as the maximum sustainable per capita consumption. Ideal measures of sustainable income include all consumption items (including the values of nonmarket consumption), along with the value of changes in the stocks of different assets. These ideal measures of national output and sustainable income can serve as a useful guide to the United States as it improves its national accounts by extending their boundaries.

5.1 The panel concludes that extending the National Income and Product Accounts (NIPA) to include assets and production activities associated with natural resources and the environment is an important goal for the United States. Environmental and natural-resource accounts would provide useful data on resource trends and help governments, businesses, and individuals better plan their economic activities and investments. The rationale for augmented accounts is solidly grounded in mainstream economic analysis. BEA's activities in developing environmental accounts (IEESA) are consistent with an extensive domestic and international effort to both improve and extend the NIPA.

2. What Is the Value of Augmented Nonmarket Accounts?

Developing natural-resource, environmental, and other nonmarket accounts is an investment in better information for the nation. Well-designed environmental accounts can overcome the recognized shortcomings of the current market-based accounts and provide information about the interaction between the economy and the environment that would support private and public decisions. There are three principal reasons why developing a set of environmental and nonmarket accounts would benefit the nation.

First, comprehensive accounts give a complete picture of economic activity; by contrast, traditional national accounts, which cover only market transactions, provide a misleading indicator of economic activity. Comprehensive accounts contribute to a better understanding of the functioning of the economy and of the interaction between the economy and the natural environment. Businesses and governments need and want to know about basic market conditions in the world, the nation, and their region. Without good market and nonmarket information, firms are flying blind.

There are many examples of how conventional accounts send misleading signals about economic activity. When companies discover large deposits of oil, gold, and other mineral assets, these are not counted in the nation's investments or as increases in its wealth. Similarly, even though forests contribute greatly to the nation's well-being, only timber production is counted in the national output. The value of hunting, fishing, and other forms of nonmarket forest recreation is not counted as part of the national output even though the total economic contribution of these nonmarket forest outputs probably exceeds the value of the timber production (see Chapter 4). Outside the environmental sector, traditional accounts provide misleading estimates of economic activity because they omit nonmarket production and investment in important areas such as human capital and education and nonmarket work at home.

The largest distortion in the environmental area probably arises in the sectors relating to environmental quality. Economic studies reviewed in Chapter 4 indicate that the nation is devoting more than $100 billion annually to pollution abatement and control expenditures. Yet many of the economic benefits derived from these expenditures are omitted from the national accounts. Even though investments in clear air and water produce benefits in improved health of the population, improved functioning of ecosystems, improved recreational opportunities, and lower property damages, virtually none of these benefits are captured by current market-based economic accounts.

Second, environmental accounts would provide important information for management of the nation's public and private assets and for improved regulatory decisions. For example, enhanced natural-resource and environmental accounts can provide useful information on natural assets under federal management. Better information on the value of minerals on federal lands would be useful in determining appropriate royalty rates and leasing policies for resources not allocated through competitive auctions. For renewable resources, better information on the stumpage value of timber in national forests would be useful not only for accounting purposes, but also for improved management of these forests and for decision making on the balance of different uses among timber harvesting, wilderness preservation, recreation, and other uses. Better information on fisheries would be valuable to federal agencies responsible for management of these assets.

In the case of environmental resources such as air and water quality, a comprehensive set of environmental accounts would provide useful information on the economic returns the nation is reaping from its environmental investments. The contrast between private and public investments is instructive in this regard. When a private company invests in an automobile factory or a power plant, company accounts can be used to estimate the economic costs and benefits of that investment. In contrast, even though the nation has allocated more than $1 trillion to environmental, health, and safety investments over the last quarter-century, it has no accounts by which to reckon the returns to those investments. Improved environmental accounts would also provide essential information for sound benefit-cost analyses in regulatory decision making. One of the most serious weaknesses in the U.S. environmental database is the lack of comprehensive and reliable data on actual human exposures to major pollutants. Better information on physical emission trends, human exposures, and the economic impacts and damages due to air and water pollution would be valuable for expanded accounting measures of productivity. Hence, both the underlying information and the aggregate dollar estimates in environmental accounts would provide valuable information for ensuring that the nation's environmental regulations pass an appropriate cost-benefit test.

Third, investing in improved accounts would have a high economic return for the nation. The federal government currently invests substantial amounts in collecting, analyzing, and distributing statistical data on the nation. Provision of statistical data is an investment because information is a public good. The gathering of high-quality, comprehensive, and timely data on economic activity requires the resources and data-collection abilities of the government. But the federal government has to date invested very little in the development of nonmarket economic accounts. And while many in the private sector have attempted to construct such accounts, private researchers have neither the resources nor the data required to do so. As a result, the United States today has no set of comprehensive economic accounts, public or private.

There are many examples of the economic benefits of comprehensive economic accounts. One area in which environmental data have proven valuable is analysis of the relationship between environmental regulation and productivity. A second area involves improving understanding of the costs and benefits of environmental regulations. Existing data and studies do not provide sufficient detail to allow pollutant-by-pollutant or sector-by-sector estimates of costs and benefits. Improved accounting systems for the environment can help sharpen both estimates and regulatory tools so that pollution control investments can be more effectively allocated. Yet a further important application with substantial potential value for the nation is management of our public lands.

An area of growing importance is analysis of the economic costs and benefits of steps to slow greenhouse warming. The United States is considering a major commitment to reduce its greenhouse gas emissions. Better estimates of the sources and sinks of these gases, particularly in forests could help reduce the costs of meeting this commitment. This area represents one of the most dramatic examples of the benefits of establishing comprehensive nonmarket physical and economic accounts, involving potential savings to the nation in the tens of billions of dollars annually.

5.2 The panel concludes that developing a set of comprehensive nonmarket economic accounts is a high priority for the nation. Comprehensive accounts would address such concerns as environmental impacts, the value of nonmarket natural resources, the value of unpaid work, the value of investments in human capital, and the uses of people's time. A set of comprehensive accounts would illuminate wide a wide variety

of issues concerning the economic state of the nation.

3. Should BEA Resume Work on the Integrated Environmental and Economic Satellite Accounts (IEESA)?

The central issues discussed in this report are whether BEA's IEESA represent a useful activity for the United States and whether work on IEESA should resume. In addressing these issues, the panel is concerned that, particularly since the congressional stop-work order of 1994, the United States has fallen behind in developing environmental and other augmented accounting systems. The United States has in place today only the bare outline of a set of extended environmental accounts, with numerical estimates limited to subsoil mineral assets; the nation has no set of satellite environmental accounts, no physical accounting system, and no environmental input-output system.[2]

In weighing future directions for environmental accounting in the United States, the panel offers three general conclusions, which are followed by three associated recommendations. First, it is clear that there are many alternative approaches to natural-resource and environmental accounting. Given BEA's expertise, along with its limited resources, BEA's phased approach is a reasonable alternative. As noted earlier, however, the shortcoming of the phased approach is that it is looking only where the lights are brightest and not where the needs are greatest. It is important, therefore, for the United States to develop the accounts in areas not illuminated by the bright light of market transactions. Developing a comprehensive set of nonmarket accounts is the most promising alternative to such a limited focus. In a country of the size, diversity, complexity, and wealth of the United States, providing this information is an essential function of government and one the federal government is supporting insufficiently at present.

Second, the task of developing a comprehensive set of nonmarket accounts for the United States is a large undertaking that would stretch the scope and specialized expertise of BEA. Moreover, if undertaken within the resources currently projected, such a task would clearly result in cutting back other important functions and proposed improvements planned by BEA. The panel therefore cautions that any serious attempt to develop environmental accounts will require additional funding. One potential approach, discussed in detail in the final section of this chapter, would be for BEA to undertake this project jointly with other agencies that are oriented to natural-resource and environmental issues. These agencies have considerable expertise in the analysis of environmental and nonmarket activities and would be useful partners in providing the data and developing prototype systems for nonmarket accounts.

Third, the panel is mindful of BEA's important mission and of the precious nature of the data on marketed economic activity it provides. In addition to providing key macroeconomic data and information on different sectors of the economy, BEA has been highly innovative in introducing new approaches, such as improved price and output indexes, and in enhancing the quality of its data on services and international transactions. These data cannot be provided by the private sector and are an important public good. The panel therefore emphasizes that appropriate support for these core activities of BEA is of paramount importance. Activities to develop environmental accounts should be incremental to ongoing activities and improvements and should not come at the expense of core activities. We recommend below that support not be at the expense of BEA's core activities. It is also important that the relevant work of other agencies in supporting these activities (such as the Bureau of the Census, the Bureau of Labor Statistics, the Environmental Protection Agency, and the U.S. Department of Agriculture) be adequately supported.

5.3a The panel was charged to analyze BEA's initial effort in constructing its environmental accounts. Having reviewed existing studies by BEA and other U.S. agencies, by other national statistical agencies, by international agencies, and by private researchers, the panel concludes that BEA should be commended for its initial efforts in developing a prototype set of environmental accounts for the United States. With very limited resources, it has prepared a set of useful subsoil mineral accounts. BEA's methodology is based on widely used and generally accepted principles, and the agency has relied on sound and objective measures in developing these prototype accounts.

5.3b Developing a full set of natural-resource and environmental accounts would contribute

2. The Netherlands and Denmark have done considerable work on the requirements and construction of an environmental input-output system. This work would be useful in understanding the data requirements for an input-output system for the United States. Fostering the development of such data will be an impetus for developing input-output models. See de Boo et al. (1991) and Jensen and Pedersen (1998).

significantly to understanding of the interactions between economic activity and the environment in the United States. Improved accounts would allow a better understanding of productivity, sustainability, and the environment; they would facilitate better forecasting of future trends and allow the nation to plan for potential critical shortages or environmental problems; and they would enable better public and private decisions on managing the nation's resources.

5.3c Congress should authorize and fund BEA to recommence its work on IEESA development. At me same time, appropriate support for BEA's core activities is of paramount importance to the United States. Activities to develop environmental accounts should be incremental to ongoing activities and improvements and should not come at the expense of the agency's core activities.

4. Should the United States Pursue a Phased or Comprehensive Approach to Augmented National Accounts?

There are two major approaches to developing nonmarket and environmental accounts: a phased approach and a comprehensive approach.

BEA's proposal for the IEESA envisions a *phased extension* of the accounts. The work plan involves developing environmental accounts in three phases. Phase I, completed in April 1994, focused on subsoil mineral assets. The proposal for Phase II is to extend the boundary of the accounts to renewable resources such as timber, fish, and water. Phase III would extend the boundaries to environmental areas such as clear air and water and recreational assets. The new accounts were to be published in supplementary or satellite accounts and would not, in the near future, affect the core NIPA.

In the initial stages, the interactions covered under BEA's plan are those that can be linked to market activities and therefore valued at market prices or at proxies for market prices. This was the rationale for dividing the work plan into the three phases—beginning with subsoil minerals that are entirely within the market economy and proceeding next to renewable resources, such as forests, that are substantially in the market sector. Only after completing its market and near-market accounts would BEA develop accounts for nonmarket environmental resources, such as air and water, and other important nonmarket economic activities, such as education and household work.

An alternative to the proposed BEA work plan is a *comprehensive approach* that would involve developing a broad set of nonmarket accounts in parallel with the near-market accounts. Under this approach, BEA would endeavor to develop accounts not only for the minerals and near-market sectors, but also for nonmarket activities and products, and for environmental and nonenvironmental products and activities.

The panel understands the rationale behind BEA's phased approach to extending the national economic accounts. The advantage of the phased approach is that the effort can draw on the work of other official statistical agencies and researchers and utilize the specialized competence of the agency. The panel is concerned, however, that the phased approach is focused where the light is bright but the terrain is relatively uninteresting—that the narrow focus of the phased approach will limit its usefulness. To reap the full benefit of augmented accounts, it will be necessary to develop nonmarket accounts fully and quickly.

The panel does not underestimate the challenges involved in developing comprehensive accounts that include nonmarket activities. This research is in its infancy, and most of the empirical studies on this topic for the United States have been conducted by private scholars. If the United States is to make significant progress in developing a comprehensive set of nonmarket economic accounts, this work must be undertaken by the federal government under the lead of an established statistical agency such as BEA.

5.4 The panel recommends that BEA develop a comprehensive set of market and nonmarket environmental and nonenvironmental accounts. The panel understands the rationale for BEA's plan to move in phases by first improving its accounts for subsoil mineral assets and then including other market and near-market resources. These steps would provide valuable information for the nation. But the comprehensive approach recommended by the panel would provide more complete, more meaningful, and more useful economic information.

5. Should the IEESA Be Developed in the Core or Satellite Accounts?

At present, BEA does not plan to redefine the core NIPA to include flows or investments in natural resources and the environment. The natural-resource and environmental flows would be recorded in satellite or supplemental accounts.

According to BEA, the advantage of satellite accounts is that they provide expanded detail and allow for the exploration of alternative methodologies without reducing the utility of the core national accounts for macroeconomic policy and analysis.

Placing environmental and nonmarket activities in a satellite account implies that these activities would not change the core estimates of gross domestic product (GDP), national income, consumption, or investment. One important reason for placing the IEESA estimates in satellite accounts is to preserve the continuity of the core NIPA, which are an essential tool for assessing the state of the economy and conducting macroeconomic stabilization policy. For example, economic research has shown a close link between movements in GDP and changes in the unemployment rate, changes in tax revenues, and the federal budget deficit. Understanding the economy requires comparing current trends and movements with historical periods in order to forecast the future. To the extent that the national product accounts become incomparable over time, the task of forecasters and policy makers becomes more difficult.[3]

Environmental satellite accounts serve the basic functions of a national accounting system: they provide the raw material needed for policy makers, businesses, and citizens to track important trends and determine the economic importance of changes in environmental variables. One important question is the extent to which depletion of mineral resources is reducing the nation's wealth in an imprudent manner (see Chapter 3). This kind of question can be addressed using the current IEESA mineral accounts for 1987 (as of this writing, later data are not available). In that year, the total change in proved subsoil assets (excluding revaluations) was somewhere between $-0.1 and +3.0 billion (see Bureau of Economic Analysis, 1994a). This figure can be compared with a net investment of $298 billion in "made assets" (which include structures, producer equipment, and inventories, but exclude a wide variety of intangible and other investments, such as those in research and development, software, or human capital). Under the framework of sustainable income developed in Chapter 2, these numbers suggest that the level of investment or disinvestment in subsoil assets was very small relative to the net investment in made assets or capital. The impact of net investment or disinvestment in

other natural-resource and environmental assets is likely to be much larger.

Two important issues arise in this context: the appropriate boundary for the core accounts and the state of the art in resource and environmental accounting. One of the fundamental principles of current national accounting is that national income and product occur chiefly within the boundary of the market economy. This boundary is drawn both for practical purposes of data availability and objectivity and because national output is a measure of production of market goods and services. It is also recognized by national accountants that because the core accounts are limited to market transactions, they will not necessarily reflect genuine economic welfare and may provide misleading measures of economic activity and distorted indexes for comparison over time and space (see Chapter 2). Because of the importance of the core accounts for many purposes, it is essential that comparable measures be retained. The core national accounts do not now include, nor would the panel recommend including, nonmarket activities by redrawing the boundary to incorporate, for example, all unwaged work or all natural-resource and environmental activities.

A particularly valuable approach is to present a wide variety of different measures and concepts so policy makers and private-sector analysts can develop their own preferred blend of concepts and measures. The core accounts would, in this view, retain their solid anchor in market transactions, but a wide variety of alternative approaches could be presented as the data and methodologies were developed, reported, and used.

5.5 The panel recommends that the core income and product accounts continue to reflect chiefly market activity. Given the current state of knowledge and the preliminary nature of the data and methodologies involved—especially in those areas related to nonmarket activities—developing satellite or supplemental environmental and natural-resource accounts is a prudent and appropriate decision.

6. What Is the Relationship of the IEESA to the United Nations System of Environmental and Economic Accounts (SEEA)?

Although BEA's proposal for the IEESA is broadly consistent with other international environmental accounting systems, it differs from the SEEA and other systems in some important respects

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3. These points are forcefully argued by Okun (1971).

(see Chapter 2). One important conceptual difference lies in the treatment of resource discoveries. Under the IEESA, in contrast with the SEEA, discoveries of resources, such as the proving of oil or gas reserves, are assumed to represent gross investment and therefore to increase both gross and net product measures. There are also some semantic differences in categorization: proved reserves in the IEESA are classified along with other developed assets, while they are treated as non-produced assets in the SEEA. In addition, soils are classified separately in the SEEA, while in the IEESA they are classified along with agricultural land. A final difference is that environmental degradation in the SEEA is valued at restoration cost and subtracted from gross income along with resource depletion. There is no comparable subtraction with the IEESA, apparently because of an assumption that pollution abatement outlays exactly offset any degradation.

The panel's assessment of these differences is twofold. First, the panel emphasizes that environmental accounting is still an emerging discipline. For this reason, as noted above, it is useful to provide ample room for alternative approaches and experimentation. It would be a mistake to close off promising, untested approaches because they currently appear to have shortcomings relative to other approaches.

Having said this, the panel recommends that in developing its environmental accounts BEA avoid many of the analytically defective shortcuts incorporated in some current proposals. The panel notes that many of the innovations introduced by BEA in the IEESA have a sound economic foundation. For example, the symmetrical treatment of additions and depletions in the minerals account is an economically sound modification of the treatment proposed by the SEEA. However, there is an inconsistency in the current IEESA, which neglect the production-account services provided by environmental assets while including the depreciation of those assets in the asset accounts. This would be analogous in the conventional accounts to including the depreciation of airplanes, but excluding the output or value added of air travel. In this respect, both the SEEA and IEESA appear to equate the terms "nonmarket" and "noneconomic." Omission of the economic services provided by environmental assets conflicts with the objective of permitting better analyses of environmental-economic interactions. Clearly, this conflict can be resolved only as a full set of nonmarket accounts is developed.

Regardless of the eventual direction taken by the U.S. environmental accounts, they should avoid some of the fundamental economic errors characteristic of the IEESA and many other environmental systems. Costs of pollution abatement should not be confused with the benefits of abatement or with pollution damage; depletion is not the same thing as true economic depreciation; and environmental control outlays in a given year never exactly offset environmental damage in that year. Undoubtedly, some of these errors are oversimplifications that were introduced for practical reasons: costs are easier to estimate than damages, depletion is easier to estimate than depreciation, and measuring the actual success of environmental outlays is very difficult. However, there is a real danger that continued uncritical use of such inappropriate proxies will lead to an equivalent uncritical acceptance of their widespread use in environmental accounting systems.

5.6 The panel endorses BEA's development of a set of accounts that are consistent with sound economic principles. In some respects, the IEESA represent a conceptual improvement over the principles underlying the SEEA. Experimentation and diversity in this preliminary stage are virtues, not vices. However, the IEESA should avoid the fundamental economic errors built into some environmental accounting systems.

7. What Are Appropriate Techniques for Measuring Quantities and Values for Nonmarket Activities in the National Accounts?

One of the thorniest issues in developing augmented accounts involves measuring quantities and values for nonmarket activities. Chapters 3 and 4 of this report review techniques for measuring quantities and values in environmental accounts. The discussion in those chapters points out that estimates of the physical flows of these quantities are generally based on established scientific or business principles. For example, there are well-established principles for measuring and monitoring the volumes of petroleum and other subsoil minerals, the volume of timber, different soil types, exposure to pollutants, and concentrations of greenhouse gases. The difficulties with respect to resource and environmental quantities arise because there are generally no routine measures when these flows take place outside the marketplace. One of the key requirements of improved environmental accounting, therefore, is

to improve these physical measures, particularly for environmental variables such as human exposures to pollutants. As is discussed in the next section, better measurement also would have important benefits for resource management and other public policies.

The largest conceptual issue that arises in extending the national accounts is how to value nonmarket activity. In the market sector, quantities are valued by their market prices, which reflect the valuation placed on marginal or "last" units purchased. Constructing nonmarket accounts that are fully consistent with market accounts requires finding proxies for marginal values in nonmarket behavior.

Environmental economists currently employ a wide variety of techniques in valuing nonmarket activities. Some rely on market activity or actual behavior. One example is the travel-cost method, which measures the value of a recreational site according to the time and other resources people expend to get there. A second behavioral approach, currently employed im the federal statistical system in both price indexes and the national output accounts, is hedonic analysis; under this approach, an activity is valued in terms of its components, such as when a computer is valued according to the implied market values of features such as memory and speed. Quite a different approach, relying on nonbehavioral data, is contingent valuation, which uses survey techniques to determine people's stated values for environmental or other variables, such as recreational sites or visibility at the Grand Canyon. Whatever the perceived strengths and weaknesses of these approaches, most specialists agree that nonmarket-value estimates have lower levels of precision, objectivity, and reliability than do hard market-based values, and much more validation of these nonmarket approaches remains to be done.

Techniques for valuation of nonmarket assets and activities are in their infancy, and new approaches and validation tests are now under way. As is true of new fields generally, there are fierce disputes, particularly about the validity and objectivity of nonbehaviorally based techniques such as contingent valuation. One major criticism of contingent valuation is that there is no budget constraint limiting the total expenditures on nonmarket activities to a total available amount. People's willingness to pay to save spotted owls or clean up Prince William Sound faces an unbounded psychic budget constraint on eleemosynary activities. Moreover, the task of

embedding nonmarket valuation and contingent valuation in a larger double-entry bookkeeping system has received little research attention to date.

BEA takes a middle ground between a purist approach that uses only market prices and an aggressive approach that employs the best available estimates.[4] BEA holds that methodologies used to value nonmarketed goods and services must include constraints based on market and nonmarket inputs, including those involving time and income, and would use techniques that rely on reliable market and objective behavior. BEA may well rely on hedonic estimates of nonmarket values because these have been tested, because the agency has had experience with these approaches, and because they are based on actual market and nonmarket behavior. BEA is reluctant to rely on contingent valuation and nonbehavioral, willingness-to-pay approaches because they are not constrained to fit into a double-entry bookkeeping system and because their results are seen as implausible in many cases, inconsistent with the overall accounting frame work, unstable when budget constraints are added, and extremely expensive to implement.

The panel is sympathetic with the reluctance of a government statistical agency responsible for producing the official national accounts to use controversial procedures. Moreover, we recognize that nonbehavioral approaches such as contingent valuation have not been thoroughly calibrated and tested to ensure that they are reliable proxies for actual behavior. At the same time, the panel hopes further research will help resolve the uncertainties and provide sound and reliable methodologies for nonmarket goods and services. The payoff to developing comprehensive nonmarket accounts is great, yet without some method of valuing nonmarket activities and public goods, there will be major gaps in a comprehensive accounting system. Therefore, the panel recommends continued work in developing valuation tools that would be appropriate for a full set of augmented accounts.

5.7a The principles of physical measures of stocks and flows of many natural-resource and environmental assets and activities are reasonably well established. Generally, however, there are no routine measures when these flows take place outside the marketplace. One of the important requirements of improved

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4. The aggressive approach was used in a study of the benefits of clean-air regulations conducted by the U.S. Environmental Protection Agency (1997), which is reviewed in Chapter 4.

environmental accounting is to improve such physical measures. These enhancements would yield substantial benefits in providing support for environmental and economic policies.

5.7b It has proven difficult to value many environmental and other nonmarket activities and assets. For natural-resource and environmental assets and activities, no single valuation method is free of problems or serves all the varied interests of potential users. Valuation methods used by BEA should rely on available market and behavioral data wherever and whenever possible. Although there are difficulties with nonbehavioral approaches such as contingent valuation, work on the development of such novel valuation techniques will be important for developing a comprehensive set of production and asset accounts.

Further research and validation on nonbehaviorally based techniques would be useful in order to determine their objectivity, stability, and reliability for national economic accounts (see recommendation 4.2).

8. What Should Be the Next Steps in Extending the IEESA?

A major decision involves the next steps in developing the environmental accounts. Before stopping work on the IEESA, BEA prepared a complete set of subsoil mineral accounts. It also undertook preliminary estimates of forest values, along with estimates for land underlying structures (see Chapter 4). In investigating other areas—recreational land, soil, wild fish, uncultivated forests, unproved subsoil assets, undeveloped land, air, and water—BEA found either data of questionable quality or no appropriate data on price or quantity.

Under BEA's phased work plan, assets such as forests that produce timber and vineyards that produce wine-grapes would be added. "Developed natural assets" such as oil, orchards, agricultural land, and forests would then be treated symmetrically with "made assets" such as houses, computers, and steel mills.

The panel agrees that improvements in valuing subsoil assets would be useful elements in a phased approach to environmental accounting. With respect to BEA's initial estimates for subsoil assets, the reported findings on the value of reserves—stocks, depletions, and additions—should be considered preliminary and tentative at this time. Improved accounts will require a better understanding of the value of mineral resources

that are not now counted as known reserves, the impact of ore-reserve heterogeneity on valuation calculations, distortions introduced by the constraints imposed on mineral production by existing capital and other factors, and differences between the market and social value of subsoil mineral assets.

In the panel's view, the next priority under the phased approach should be sectors that include a significant aspect of market or near-market activity. Developing accounts for the commodity-producing value of forests is the obvious next step in developing the IEESA. Estimating the volume and value of forest timber appears to be relatively straightforward at this time, and the issues involved in the valuation are similar to those for subsoil assets. Another useful extension would be agricultural assets, particularly those involving livestock, vineyards, and land values and quantities. Beyond these sectors, the data become more problematic. Currently, data on fish stocks are unreliable because wild fish are fugitive assets, and there is no reliable census of the fishes. The panel did not investigate the water-resource sector in detail, but it determined that there are inadequate data on water stocks and water quality, and valuation of these resources remains a thorny issue because water value is highly variable depending on time, location, quality, and priority of right to usage.[5]

While recognizing the value of these phased incremental extensions, the panel reiterates that extending the accounts to include nonmarket activities is of the greatest substantive importance for augmented accounts. The panel's review indicates that accounting for environmental assets such as air quality is likely to have a major impact on consumption and investment. Developing environmental accounts is part of the even larger task of developing comprehensive nonmarket economic accounts. As noted earlier, the panel does not underestimate the awesome challenges involved in developing nonmarket accounts. Development of a set of accounts in this area involves major conceptual issues, the development of appropriate physical measures and valuation of flows and stocks, and constitutes a major scientific undertaking. As suggested above, the task of developing a comprehensive set of nonmarket accounts transcends the current scope and budget of BEA. Developing such accounts will require continued basic research on the underlying science and economics involved in estimating

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5. Water valuation issues are discussed in detail by the National Research Council (1997).

the benefits of public goods such as clean air, as well as applied research on accounting tools and valuation of nonmarket activities and assets.

5.8a If a phased approach is undertaken, the panel recommends that work to extend natural-resource and environmental accounting resume as soon as possible. Incremental improvements should focus primarily on developing those interactions between the economy and the environment that have market consequences. A useful step would be to refine estimates of subsoil mineral and timber accounts. Other incremental extensions should incorporate additional marketable assets and near-market goods and services those that have close counterparts in marketed goods and services. There is a clear basis here for measuring quantities and establishing values for these market and near-market activities in a manner comparable to that used for the core accounts.

5.8b Construction of a set of forest accounts, focused initially on timber, is a natural extension for integrated economic-environmental accounts. The United States has much of the data needed for such accounts, and the analytical techniques are well researched. Other sectors that should be high on the priority list are those associated with agricultural assets, fisheries, and water resources.

5.8c While a phased approach to the development of environmental accounts is useful, a comprehensive set of natural-resource and environmental accounts will be critical to measuring the full impact of natural and environmental resources on long-term economic growth. Construction of a comprehensive set of economic accounts will require extensive research on the basic science and economics involved, as well as development of the appropriate tools for accounting and valuing nonmarket activities and assets.

BUDGETARY AND RESOURCE IMPLICATIONS

The cost to BEA and other agencies of constructing and maintaining the IEESA will depend on the intensity and extent of the effort. The costs would be small for a minimal program of small, incremental improvements limited to a few natural-resource sectors. Estimates from BEA indicate that the costs of such a small activity, including reinstatement of the pollution abatement survey, would be approximately $1.5 million annually.

It would be substantially more expensive to develop a full set of environmental and augmented accounts. In the long run, such an effort would require developing a comprehensive accounting framework for exhaustible minerals and renewable resources along with a set of nonmarket service and investment accounts. Substantial incremental resources would be required both within BEA to develop the accounts and outside BEA to provide the data. Although the cost would depend on the extent to which BEA could draw on data and expertise from other agencies, it is likely that developing a full set of accounts would require incremental outlays for BEA and other agencies on the order of $10 million annually for a decade or more.

While noting the importance of developing a set of environmental and augmented accounts, the panel emphasizes that this work should not be done at the expense of the timely and current production of the current core accounts, along with improvements that reflect changes in the structure of the economy. As a result of several years of budgetary stringency, BEA has been hard pressed to maintain its current program, has been forced to curtail some of its activities, and has needed to be extremely selective in its choice of new initiatives. The agenda for improvements is extensive and includes many other important issues, such as improving the measurement of service outputs, improving measurement of international transactions, and accounting for stocks of and investments in human and knowledge capital. Maintaining the vitality of the national accounts while providing innovative and valuable new information is a worthy objective for BEA in the years ahead. Continued improvements in our data infrastructure are one of the soundest investments the nation can make.

DATA AND RESEARCH NEEDS FOR IMPLEMENTING ENVIRONMENTAL ACCOUNTS

In its charge, the panel was asked to "compare methodologies with research in other countries and in non-governmental research . . . and recommend improvements and research needs." Extending the NIPA to include the economic impacts of resource and environmental flows and assets would require considerable upgrading of the national database in these areas. This section addresses issues related to data collection and design.

Need for Interagency Cooperation
on Data Collection

As noted in Chapters 3 and 4, much valuable information necessary for integrated environmental and economic accounts is already collected by the federal government and is potentially available to BEA. Extensive information is available in federal agencies on physical stocks and values of economically important natural resources, including subsoil minerals, energy, timber, commercial fisheries, and land. BEA's preliminary work on the Phase I accounts made use of existing data on the physical quantities and market values of such natural-resource assets. However, much of the data necessary for developing environmental accounts is currently unavailable or insufficient. One important step, therefore, would be to undertake a focused effort to increase and improve the data necessary for this work. Without significant improvement in this area, development of a full set of empirically based environmental accounts would be impossible.

Fortunately, much of the information needed to construct and maintain environmental accounts would also be useful to other federal agencies with resource management responsibilities. This is particularly the case for natural assets under federal stewardship. For example, better information on the value of minerals on federal lands and the net value of minerals extracted from federal lands would be useful in determining appropriate royalty rates and patenting policies for resources not allocated through competitive auctions. The same information would be useful to BEA in constructing environmental accounts for exhaustible natural resources.

In the case of renewable resources, better information on the stumpage value of timber in national forests would be useful not only for accounting purposes, but also for better management of these forests and for the difficult decisions required on the balance of different uses, including timber harvesting, wilderness preservation, watershed management, and recreation. Better information on fish stocks, depletion of fish stocks, and resource values net of extraction costs would be valuable to the National Marine Fisheries Service and to the Fisheries Management Councils and would also support U.S. negotiations in international fishing treaties. These agencies have been hamstrung in their efforts to prevent overfishing by a lack of reliable information on changes in stocks of commercial fisheries and on the dissipation of fisheries rents.

In the case of environmental resources such as air and water quality, better information on the economic value of marginal changes in air and water quality, which would be essential for constructing a comprehensive set of environmental accounts, would also be essential for sound benefit-cost analyses that the U.S. Environmental Protection Agency (EPA) is required to undertake in regulatory decision making. One of the most serious weaknesses in the U.S. environmental database is the lack of comprehensive and reliable data on actual human exposures to major pollutants. Better information on physical emissions trends, human exposures, and the economic impacts and damages due to air and water pollution would be valuable for expanded accounting measures of productivity. In summary, there are strong synergies between BEA's data needs for implementing its environmental accounts and other agencies' data needs for resource and environmental management.

Consequently, there would be great value in a cooperative and coordinated approach among federal agencies to the collection and management of improved natural-resource and environmental data. Definitions and coverage of existing surveys could be modified at relatively small cost to meet the needs of the environmental accounts while also providing better data for policy making. Raw data could be formatted and processed in more than one way to serve multiple purposes. Useful data collection efforts that might be found expendable by one agency operating under tight budgetary constraints might be continued under cost-sharing agreements among several agencies. Existing statistical coordinating and advisory bodies within the federal government, including the Office of Management and Budget, could play a useful role in coordinating data collection efforts—useful for both environmental accounting and other important federal purposes.

In addition to coordination of data collection and management efforts, there is also a need to coordinate standards for accounting and measurement. Even though the general conceptual basis for environmental accounting is reasonably well established in theory, many issues arise in constructing the empirical counterparts to general concepts. Estimation methods that are equivalent in theory will typically yield different empirical results when used with actual data, and choices must be made among alternative valuation methods and data sources. Work on the valuation of natural resources under federal con-

trol is ongoing under the auspices of the Federal Accounting Standards Advisory Board. Close cooperation among BEA, other federal statistical agencies, and private researchers would be important for providing estimates of quantities and values that are appropriate for national-income accounting.

5.9 Extending the national accounts to include a full set of natural-resource and environmental impacts would require a major, focused effort to improve the databases on quantities and values of key natural resources and environmental variables. Without significant improvement, it would not be possible to develop a full and reliable set of empirically based environmental accounts. Much of the information needed to construct and maintain environmental accounts would be highly useful to other federal agencies, particularly for natural assets under federal stewardship and for environmental activities for which the federal government has responsibility to undertake benefit-cost analysis. A cooperative and coordinated approach among analytic teams of researchers from different federal agencies and the private sector to collect, analyze, and manage improved natural-resource and environmental data would be valuable not only for developing natural-resource and environmental accounts, but also for promoting better monitoring, assessment, and policy making in these areas.

Data and Research Needs with Respect to Exhaustible Resources

BEA's preliminary implementation of its environmental accounts resulted in estimates of accounts for subsoil minerals, including fuels, metals, and nonmetallic minerals. In its 1994 article on minerals accounting (1994b), BEA addressed a number of data and implementation issues. Information on production, production costs, reserves, and reserve changes is less complete and accessible for most nonfuel minerals than for fossil fuels. Standardization of classifications among data collection agencies could improve the information base.

All the valuation methods attempted by BEA in Phase I—reviewed in Chapter 3 of this report— are approximations to ideal measures of the market value of subsoil resource stocks and flows. These approximations are required because the information needed to implement ideal measures is unavailable. Implementing ideal measures of resource values based on the discounted present

value of returns generated over the life of the resource would require projections of future prices, quantities, and discount rates. However, better approximations could be obtained with additional research and information. The most important topics include the following.

The heterogeneity of resources. Resources actually utilized, for which market data are available, tend to have the highest quality and lowest cost of those currently available. The unit value of additions to reserves may differ substantially from the unit value of extracted or harvested reserves. This is true both for exhaustible resources and for renewable resources, such as timber. Valuing additions to reserves or the entire body of reserves at the same price as resources currently extracted or harvested may seriously bias estimates of the value of the stock.

Information is potentially available on the distribution of many deposits of ores and mineral fuels by grade, depth, and other relevant characteristics. Similarly, information is available about the characteristics of standing timber stock by species, grade, accessibility, and age. Fish biologists have information about the size of the recruitment class added to a fish population in a given year. Such information could be used to refine the estimates of stock values and of changes in the stock over time, and could provide substantially more accurate estimates of the value of additions and depletions to the stock of resource assets.

Unproved reserves and resources. Under current approaches, only the value of proven reserves is usually included in the product and asset accounts. Proven reserves are, by definition, those resources which are known with reasonable certainty to be economical to produce at current prices and using currently available technology. Because unproven or speculative resources may be produced in the future as prices rise and technologies improve or as potential reserves are developed, they may have a market value. Although BEA has indicated plans to produce such estimates in the future, they are not included in current accounts. Further information on the value of unproven resources could be obtained from such sources as bids on offshore oil and gas leases.

Some mineral and timber resources, though known, are not commercially available because they occur on federal or state lands that have protected status. These resources also have an option value because their legal status may change. For example, the federal government recently sold

the Elk Hill petroleum reserve. Information on the extent of such resources, if made available for production purposes, could be obtained from federal land and resource management agencies.

Value of associated capital. Mineral reserves usually consist of mineral assets and associated physical capital constructed to exploit the reserves. It is necessary to estimate the value of the associated tangible capital in order to estimate the value of the natural-resource stock or flow (see Chapter 3). Otherwise, the estimated resource values may be substantially overstated. Though BEA has attempted to make such provisions, further information gathering is needed to refine these estimates. For example, Chapter 3 examines techniques for improving the simplest Hotelling valuation approach by incorporating a measure of the value of the physical capital constraint on production. Consequently, more empirical information is needed on the extent to which production of oil, gas, and nonfuel minerals is likely to be limited over short time periods by physical capital constraints. Such research would allow a better estimate of the value of associated capital.

Liabilities associated with resource extraction. For institutional reasons, mining historically has not provided private firms with adequate incentives to forestall or remedy many environmental effects. Consequently, there are thousands of active and inactive mine sites responsible for environmental harm to surrounding properties through leaching, subsidence, or visual impairment. Such sites could be termed natural-resource liabilities. Currently, there is no proper accounting either for the stock of such liabilities or for the change in their value. Data are available from federal oversight and regulatory agencies to account for such liabilities, and may also be obtainable from mineral leases that specify restoration once mining operations have been completed.

Regional disaggregation of resource accounts. BEA's preliminary estimates indicated that the value of exhaustible resource stock changes does not constitute a large fraction of national net capital formation. Nonetheless, such changes do represent substantially larger fractions of net investment in particular regions or individual states whose economies are relatively resource dependent. For example, extractive and other resource-based industries are economically significant in Alaska, the mountain states, the Northwest, and parts of the South and Northeast. Within a framework of supplemental accounts,

it would be useful to present regionally disaggregated resource accounts. Doing so could create additional data requirements. Since the underlying source data on production and stocks are generally collected for states and counties, the main requirement is that the locational tag not be lost in the process of data aggregation.

In improving BEA's accounts for subsoil assets, further analysis is needed to assess different valuation techniques. Preliminary assessments indicate that the standard Hotelling valuation approach overestimates resource values, and this finding should be incorporated in valuation approaches. Further work is necessary to determine the importance of heterogeneity of reserves, the value of unproven and speculative assets, the value of associated capital, the liabilities associated with resource extraction, and the regional impacts of activities associated with subsoil assets. Where the costs are reasonable, BEA should develop and report regional data on important natural-resource and environmental activities, such as those for subsoil assets. The recommendations of the panel in this area are contained in Chapter 3. See particularly recommendations 3.2 through 3.7.

Data and Research Needs for Accounting for Renewable Resources

Asset values. BEA's plans for developing the environmental accounts include making estimates of developed natural assets such as timber in managed forests, cattle, vineyards, orchards, cultivated fish stocks, and developed land. In a later stage, BEA would account for uncultivated biological resources such as wild fish, timber and other plants in unmanaged forests, and other uncultivated biological resources. The construction of accounts for agricultural, horticultural, and animal husbandry assets poses no major data issues, and the U.S. Department of Agriculture, together with the U.S. Bureau of the Census, has a comparatively full set of information on these issues. Similarly, data sources, though of varying accuracy, are available from which to estimate the market value of developed land.

Accounting for renewable resources such as forests encounters some of the same information issues and data gaps as does accounting for exhaustible resources. Managed forests other than plantations contain trees of heterogeneous ages, species, and other characteristics. Harvested trees will generally differ in unit value from the unharvested stock and from additions to that stock.

Data on the heterogeneity of timber stocks are particularly important because harvesting is likely to be limited to the more valuable stocks, and therefore stumpage price estimates derived from such commercial operations cannot be reliably extrapolated to other unexploited stocks.

Though the national forests contribute a small share of total harvested timber, there are particular problems in accounting for wood extracted from these forests. Though standing timber is typically sold through auction bids, sales prices will not represent the market stumpage value of the timber for those sales that have only a single bidder. In such sales, the winning bid usually corresponds to the Forest Services's administratively determined minimum acceptable bid. Bids are also influenced by cost considerations. Logging contractors are required to operate under conditions imposed to protect other multiple-use environmental values, such as water quality, habitat protection, and recreational and aesthetic values. These conditions may increase logging costs and therefore reduce the amounts potential contractors are willing to bid for logging rights. Offsetting these upward pressures on costs in the national forests, the government bears some logging costs, notably those of road construction, which are financed out of road credits. Research will be necessary to determine whether transaction data based on bids for logging rights in national forests are an accurate source of information on stumpage values, or whether they would require some adjustment to be useful in the environmental accounts.

With respect to timber harvested on private lands, difficulties arise in allocating joint production costs in industrial forestry operations carried out by integrated pulp and paper or forest product companies. A substantial fraction of total timber harvested originates on lands owned and operated by such companies. In addition to problems of joint cost allocation, there are also problems of establishing or inferring prices for logs that are not bought or sold but processed by integrated companies into final products. Further issues arise with respect to valuation of timber land, as opposed to the standing stock of trees. In its initial effort, BEA assumed that timberland, on average, is worth as much as agricultural land. BEA reasoned that if not worth at least that much, timberland would be converted to agriculture, which may be its next-best use. However, the opposite might also hold true—that timberland is kept in forest because the land is not worth converting to agriculture. Better region specific information on the capabilities and market value of forested land would be helpful in improving the estimates.

Measurement of service flows. The main challenge for research and data collection arises from the need in a comprehensive set of environmental accounts to estimate the environmental service flows provided by forests, freshwater, and other renewable resources. Because use patterns have historically been dominated by commodity production for the marketplace (such as agricultural production using land and timber production from forests), there is much more data available on commodity production values than on environmental service values. Nonetheless, economic research indicates that many renewable resources, especially those in the public domain, are today more valuable as sources of environmental service flows than as sources of marketed commodities. Ignoring service values would therefore substantially distort asset and production accounts.

There are many useful data sets on the use of publicly held renewable resources for recreational purposes. For example, the government collects data on the number of visitor-days for recreational purposes to national forests, public beaches, and other protected areas. Economic research has estimated service values and related those values to various qualitative aspects of the services, such as congestion, water and air quality, and visual characteristics. This research is based on methodologies developed by environmental economists. Some such methodologies derive estimates of values from observations of market or behavioral decisions, such as travel costs incurred to participate in recreational activities. Such information can be used to estimate the value of current service flows provided by renewable resources and the contribution of these service flows to the underlying asset values.

Problems can arise in the use of current estimates. Care must be taken to ensure that the values are marginal or incremental values, rather than total or consumer-surplus values. Many studies include consumer surplus and are therefore not comparable to the price and value approach used in the current national accounts. Moreover, the establishment of either values or quantitative estimates of environmental service flows related to such ecological functions as wildlife habitat, nutrient recycling, carbon sinks or sequestering, biodiversity, and hydrological regulation is still highly speculative. Inclusion of such estimates in the national accounts

is questionable today and might be postponed until data and methodologies in this area are improved.

More research is needed on the effect of stock changes on the value of these service flows because the relationship is complex and current information may be inaccurate. For example, a reduction in standing volume of timber may change water outflows from a forest, increase habitat for some animals and decrease habitat for others, and increase some kinds of recreational services while decreasing others. Storage and diversion of waterways for irrigation purposes may likewise provide habitat for some aquatic species and destroy it for others, and increase some recreational uses but eliminate others.

Many of the same issues arise in accounting for the market-related functions of renewable resources and subsoil assets. Much work already exists on valuation of forests and timber, but further research on valuation is necessary to determine the accuracy of the Hotelling approach. The major challenge in estimating both asset values and service flows lies in determining appropriate values for nonmarket aspects, which are particularly important for forests. Recommendations for forests are in Chapter 4 (see particularly recommendations 4.5, 4.8, and 4.9).

Accounting for Changes in Air and Water Quality

Developing improved accounts for environmental assets such as air and water quality or nonmarket services of natural-resource and environmental assets is an important goal of augmented accounting. Accomplishing this goal involves both measurement of the costs of pollution abatement and estimates of the value of the market and nonmarket services provided by these assets. One important initial step undertaken by BEA was the construction of a set of estimates of pollution abatement and control activities. This effort has unfortunately been discontinued because of budget cuts imposed on BEA. These estimates are an important aspect of any economic assessment of the environment.

The development of accounts for changes in air and water quantity was postponed to Phase III of the IEESA effort, as was accounting for uncultivated biological resources such as wild fish and undeveloped land. Though ambient environmental quality represents an important dimension of current consumption and from a conceptual point of view belongs within an expanded set of environmental accounts, data needed to implement this approach are currently unavailable except in a small number of cases.

Data on air and water pollution illustrate the difficulties. Although EPA often conducts benefit-cost analyses to support regulatory decision making, the resulting estimates of the economic value of marginal changes in environmental quality are typically limited to a limited class of pollutants, pollution sources, and geographical areas. They cannot be readily extended to the more comprehensive national estimates needed for a set of augmented accounts. Moreover, they usually examine the incremental costs and benefits of a regulation and seldom calculate the total damages or changes in damages from a historical or normative baseline. Finally, for the most part, the valuations of benefits contained in these studies are not derived from market transactions or behaviorally derived values. Unless EPA and other agencies undertake or underwrite a substantial effort to improve the data in this area, the lack of comprehensive information on the value of nonmarketed environmental goods and services is likely to constrain the development of a full set of environmental accounts.

The nub of the difficulty in constructing a set of environmentally adjusted national accounts lies in estimating the consumption services of environmental assets. Deriving such estimates through the conceptually correct "damages borne" approach—which measures the actual damages or impacts of changes in environmental flows—would require improved data on ambient air and water quality, which vary temporally and spatially, and on the profile of exposures of humans and other organisms to pollution. Perhaps the most important lacuna is data on actual human exposures to air pollution, which are virtually absent from the U.S. national data system.

Economic damage assessments—whether based on epidemiologically estimated dose-response relationships or more directly on hedonic property, wage, or travel-cost studies—do not now constitute an adequate empirical base on which to construct environmental accounts. Estimates are sensitive to specification and data and tend to be time- and location-specific. Moreover, econometric estimates based on compensating and equivalent variations often give substantially different results. Additional research on the valuation of pollution damages is needed, with special emphasis on the value of marginal changes in environmental quality. Research on so-called

"benefits transfer" techniques, which allow damage estimates to be adapted to other populations and pollution concentrations, is also needed. For these reasons, implementing Phase III of BEA's proposal would require a considerable research component.

Finally, two recommendations presented in Chapter 4 are worth reiterating here. First, BEA's annual survey of pollution control and abatement expenditures should be reestablished (see recommendation 4.7). Second, the nation needs improved measures of physical indicators for many environmental variables, particularly those involving human exposures. In the designing of environmental indicators, policy issues should dictate the choice of variables and the focus of the research. Measures should focus on human health and on social, economic, and ecosystem effects, rather than simply on pollutant concentrations or similar intermediate variables (see recommendation 4.3).

Frequency

The panel considered the issue of the frequency of estimation and publication of natural-resource and environmental accounts. Because the underlying physical activities generally take place at a slow pace, particularly relative to business cycles, it is not sensible to aim for reporting in the satellite accounts more frequently than on an annual basis. Annual reporting is recommended for those activities—particularly subsoil assets and forests—for which annual data are readily available. For other measures, including input-output analysis, measures of comprehensive or sustainable income, and similarly complex constructions, quinquennial reports may be a reasonable goal. Frequent analysis and reporting are not necessary given the source data, costs, and temporal evolution of assets and activities that are being measured. Neither the data nor the likely uses of such accounts would suggest the need for monthly or quarterly data, particularly given the problems created by the short-run volatility of mineral commodity prices.

5.10 The panel recommends regular periodic accounting in the natural-resource, environmental, and other augmented accounts. The accounts for subsoil assets and forests could be developed, calculated, and reported on an annual basis. For other measures, less frequent accounts, perhaps quinquennial, would be appropriate and cost-effective.