NATIONAL STRATEGY TO DEVELOP STATISTICS FOR ENVIRONMENTAL-ECONOMIC DECISIONS

A U.S. SYSTEM OF NATURAL CAPITAL ACCOUNTING AND ASSOCIATED ENVIRONMENTAL-ECONOMIC STATISTICS

OFFICE OF SCIENCE AND TECHNOLOGY POLICY
OFFICE OF MANAGEMENT AND BUDGET
DEPARTMENT OF COMMERCE

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The nation's economy and environment are deeply intertwined. A strong economy depends on a stable climate, clean air and water, and all nature has to offer. We have taken it for granted, but we can no longer afford to do so. Climate change and the loss and degradation of ecosystems impact our country's economic growth and opportunity. Historically, we've lacked a standard approach to track the condition of nature or its economic role and value, which impairs our ability to fight the climate crisis, build a strong and sustainable economy, and advance economic equity.

But now, the first-ever U.S. National Strategy to Develop Statistics for Environmental-Economic Decisions (National Strategy) recognizes and addresses this issue. It creates a U.S. system to account for natural assets—from the minerals that power our tech economy and are driving the electric-vehicle revolution, to the ocean and rivers that support our fishing industry, to the forests that clean our air—and quantify the immense value this natural capital provides. This National Strategy will help us understand and consistently track changes in the condition and economic value of land, water, air, and other natural assets. It will also help the federal government fulfill its responsibility to the American people to provide a fuller understanding of our economy. And it will provide data to guide the federal government and the economy through the transition we need for sustainable growth and development, a stable climate, and a healthy planet.

Natural assets, like land and water, underpin businesses, enhance quality of life, and act as a stabilizing force for economic prosperity and opportunity. They also help counteract the destabilizing risks to our environment and markets caused by climate change and nature loss. Yet the connections between nature and the economy are not currently reflected in our national economic statistics. When the government spends a dollar to restore a coral reef or a forest that will attract tourism, supply water, or clean the air, our current system does not capture the economic value of this investment. The National Strategy gives us a path to change that. Clearly measuring the quantity and value of natural capital will enable more accurate economic growth forecasts and facilitate a more complete picture of economic progress to inform how we prioritize investments.

Our understanding of the American economy keeps evolving, and our approach to measuring and tracking economic inputs and outputs must evolve too. In the wake of the Great Depression, the U.S. government developed innovative ways to better measure our economy, giving Americans an overall picture of the state of the nation's economy for the first time. That pioneering work fundamentally changed how we talk about the economy, conduct economic policy, and measure progress. Over the years, that system for measuring our economy has continued to evolve and our view of the economy must evolve with it, so we may enable policymakers, investors, business, and communities to make evidence-based decisions. Tackling climate change, restoring nature, cleaning our air, lakes, rivers, and the ocean, and regenerating degraded lands often are economic activities—they are investments in our economy and future, and thus need to be captured in our economic accounts.

We are proud of this National Strategy and the 27 Federal departments, agencies, and offices that collaborated to produce it. We are also grateful for the input from private citizens, businesses, trade groups, non-profits, and experts in economics, statistics, and science whose engagement strengthened the National Strategy. We look forward to measuring our economy more holistically, and finally including the valuable role that nature plays in our nation and world.

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Executive Summary

> *"Nature plays an immense role in our climate but also in every other aspect of our lives. What does it take to stop eroding nature that we depend on for so much in our lives? It starts by accounting for the economic value of land and water, fish and forests, and other natural assets, rather than effectively counting nature as zero on the balance sheet."*
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> – Dr. Arati Prabhakar, President Biden's Science Advisor and Director of the White House Office of Science and Technology Policy, 10/21/2022 remarks to AAAS

People depend on nature to supply important services and economic opportunities. For example, families escape their daily grinds to recreate in nature and travel to experience majestic mountains and tranquil beaches; soils, water, and bees work with America's farmers to grow food; and trees, grasses, and other plants are the original carbon capture and storage system and also filter other pollutants, complementing the efforts of nurses and doctors to make Americans healthier and more productive. With every passing year, scientists, innovators, and economists discover more evidence about how the economy relies on nature and how economic activities change nature's ability to provide services. The fact that nature provides people with services now and opportunities in the future is why economists refer to nature as a form of capital. This natural capital supports economic prosperity in similar ways to the financial capital that is traded on Wall Street or the buildings and machines that make up the physical capital on Main Street.

Natural assets or natural capital stocks are durable physical or biological elements of nature that persist through time and contribute to current or future economic production, human enjoyment, or other services people value.

Environmental-economic statistics are organized data that enable measurement of the quantity and value of natural assets, connecting their services to the economy and human wellbeing, and tracking changes in these values through time.

The National Strategy to Develop Statistics for Environmental-Economic Decisions: A U.S. System of Natural Capital Accounting and Associated Environmental-Economic Statistics charts a course to measure natural capital in official U.S. economic statistics. The current absence of these important economic metrics and the omission of nature from the national balance sheet lead to erosion of current and future economic opportunities. The proposed expansion of the national economic accounting system seeks to provide new information to capture links between nature and the economy. This Strategic Plan uses existing authorities and builds on and integrates numerous existing natural capital measurement efforts across many Federal agencies. The resulting multi-year effort will lead to more inclusive and forward-looking conversations about "the economy." It will provide and organize the information needed to make informed decisions that enhance economic prosperity in the present, while securing future nature-dependent economic opportunities.

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Why is a plan needed? Our current national economic accounts—the organized data describing the U.S. economy, often summarized as Gross Domestic Product (GDP)—are largely disconnected from the natural world. Yet American families, American businesses, and the American economy depend on nature. For example:

- **Nature starts many supply chains.** Critical minerals underlie many new technologies, water and pollinators help grow the fruits and vegetables eaten at the dinner table, and trees create much of the timber framing American houses.
- **Nature motivates many modern innovations.** Plants and wild animals inspire designs and provide critical models and raw materials for many drugs and cosmetics.
- **Nature undergirds many firms' successes, across many sectors.** Natural landmarks drive much of the tourism industry, and wild fish provide food for grocery stores and restaurants to sell.
- **Nature protects property and other infrastructure.** Reefs, dunes, and forests reduce the damage caused by storms, floods, and other extreme weather events.
- **Nature provides recreational opportunities and community and cultural connections.** Forests, beaches, and wildlife underpin recreational and cultural services that are important to Americans, and these services are often free of charge.
- **Nature promotes health.** Green and blue spaces and clean air facilitate mental health, and reduce heat stress, saving money on health care, increasing productivity, and improving quality of life.

Despite how the health of nature drives the health of the economy, implementation of the national economic accounts is disconnected from our understanding of nature. The national economic accounts guide how people see the economy, how governments discuss policy, and how statisticians measure economic growth. These accounts are imperfect, yet pragmatic. They were devised at a time when nature's ability to provide seemed limitless. Over many decades, the economic accounts have continued to evolve and expand to cover new sectors in response to new understanding of what drives the economy. For example, it wasn't until 2013 that the Bureau of Economic Analysis recognized in a blog post that producing artistic originals like making a movie or writing a book was recognized as investing in capital that could generate returns for years to come. Some elements of nature are part of the conceptual framework for national economic accounts but go unmeasured or are misattributed in practice. Other connections between nature and the economy are newly understood. The quantity, condition, and value of nature, however, still remain a blind spot in the national economic accounts.

This knowledge gap prompts the need to evolve the national economic accounting system and connect nature to the measurement of the economy. Policy makers are increasingly concerned about the role of nature in long-term economic forecasts. Banks, investors, insurers, and consumers increasingly demand information about environmental dependencies and risks to economic sectors. Regulators and regulated industries increasingly desire dependable information and structure to devise and plan for regulations that protect the environment, while growing the economy and creating good-paying jobs. The challenges of climate change, biodiversity loss, air and water pollution, and environmental injustice carry implications for the economy and the environment, and society cannot effectively or efficiently confront those challenges if economic and environmental accounting and policy proceed on two separate tracks.

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To unify these tracks most effectively, the United States needs a unified system of economic and environmental statistics. This Strategic Plan charts the path to achieving that goal.

This document, shortened hereafter to *Statistics for Environmental-Economic Decisions* or the Strategic Plan, presents a robust and pragmatic pathway to bring nature into the national economic accounts by developing natural capital accounts supported by environmental-economic statistics. The path articulated in this Strategic Plan treats nature as an asset and incorporates these natural assets on the national balance sheet. These accounts and statistics can work alongside traditional economic statistics, such as GDP, to help guide economic decision making to be more inclusive of the services—or benefits to humans—nature provides. The Strategic Plan also supports Executive Order 14072 that directs agencies to better understand, account for, and find solutions in nature.

Putting nature on the national balance sheet is an exciting effort for the Federal Government, but it is not a new idea. American economist Irving Fisher first proposed doing so over 100 years ago, and academic researchers, multiple Nobel laureate economists, Federal scientists, economists, and statisticians have been researching and prototyping this idea since the 1970s. The National Academy of Sciences has produced multiple reports and the U.K. Treasury released the high-profile Dasgupta Review in 2021 supporting the idea. The international statistical community adopted the United Nations-developed System of Environmental-Economic Accounting standards, and over 80 countries, including many U.S. allies, are formalizing natural capital accounting in their nations' economic statistical systems. Fortunately, the United States has the expertise and data to put nature on the national balance sheet.

Following the Administration's commitment to initiate natural capital accounts and environmental-economic statistics in April 2022, *Statistics for Environmental-Economic Decisions* makes five recommendations to Federal departments and agencies for how to develop and use natural capital accounts and environmental-economic statistics.

Recommendation 1. The natural capital accounts and environmental-economic statistics should be pragmatic and provide information to:

a. Guide sustainable development and macroeconomic decision making;
b. Support Federal decision making in programmatic, policy, and regulatory settings;
c. Provide structure and data that promote the competitiveness of U.S. businesses;
d. Support resilient state, territorial, Indigenous, Tribal, and local communities; and
e. Facilitate conservation and environmental policy.

Recommendation 2. The natural capital accounts and associated environmental-economic statistics should provide domestic comparability through time and advance international comparisons and harmonization in order to enable the United States to lead with respect to the development of global standards and implementation of those standards.

Recommendation 3. The natural capital accounts and associated environmental-economic statistics should be embedded in the broader U.S. economic statistical system, and guide the process of embedding with three sub-recommendations. Federal departments and agencies should:

a. Incorporate the internationally-agreed standards of the U.N. System of Environmental Economic Accounting to guide development of U.S. natural capital accounts, where those standards are relevant to the United States and robustly developed. This includes following the standard supply-use framework that structures national economic accounts;

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b. Adhere to more than one, but a small number of, specific asset boundaries, connected to economic activities, in order to accommodate different applications and contexts and be inclusive of different uses and perspectives; and
c. Use rigorous and the best available economic science for monetizing the value of natural assets.

Recommendation 4. Federal departments and agencies should use a 15-year phased approach to transition from research grade environmental-economic statistics and natural capital accounts to core statistical products, and produce a single headline summary statistic, along with supporting products, tables and reports that provide information in physical and monetary units.

a. The phased approach is designed to enable new information to be available early in the process, facilitate the first pilot accounts appearing in 2023, provide for testing and development, while over the long term meeting high statistical standards and producing a durable and more comprehensive set of statistics to expand the national economic accounts.
b. The Strategic Plan recommends that natural capital accounts produce a new forward-looking headline measure focused on the change in wealth held in nature: Change in Natural Asset Wealth. Integrating this new measure with changes in GDP would provide a more complete and more useful view of U.S. economic progress. Pairing Change in Natural Asset Wealth with GDP would help society tell if today's consumption is being accomplished without compromising the future opportunities that nature provides.
c. The Strategic Plan also recommends the use of dashboards for biological and physical measures.

Recommendation 5. The Federal Government should apply existing authorities and make use of the substantial expertise within Federal departments and agencies, by coordinating across agencies, to develop and update the system of natural capital accounts and environmental-economic statistics in an efficient manner.

American incomes and the American economy depend on nature. *Statistics for Environmental-Economic Decisions* provides the guidance to update the national economic accounting system so that it continues to provide clear-eyed information to guide policies and business decisions. Like other sectors measured in the national economic accounts, such as health and food for our families, the total value of nature cannot be fully measured in monetary terms. However, by adhering to the standards used elsewhere in the national economic accounting system, it is possible to connect information on nature and the economy to help America prosper as the country overcomes 21st century economic challenges, including those linked to climate change, biodiversity loss, air and water pollution, and environmental injustice.

The Interagency Policy Working Group and Process for Developing the Strategic Plan

On April 22, 2022, the Administration announced the "initiation of the first U.S. national system of natural capital accounts and standardized environmental-economic statistics."[1] The Office of Science and Technology Policy (OSTP), the Office of Management and Budget (OMB), and the Department of Commerce (DOC) organized and co-chaired an Interagency Policy Working Group (Working Group) to develop this Strategic Plan, which enables the United States to connect the national economic accounts with environmental-economic information. The Working Group operated in a way consistent with activities regularly conducted under existing legal authorities and by drawing on the breadth of expertise available across the Federal Government. This Working Group expanded over time, and today, consists of Federal Government employees from 27 Federal agencies and offices with experience and expertise in developing, using, and harmonizing ecological, statistical, and economic research and initiatives.

On August 18, 2022, OSTP, OMB, and DOC made public the draft national strategy for natural capital accounts and associated environmental-economic statistics, *Statistics for Environmental-Economic Decisions*,[2] and OMB issued a Request for Information through the Federal Register to solicit public comment on the draft Strategic Plan.[3] Public comments were primarily accepted through regulations.gov, and those comments can be viewed at https://www.regulations.gov/document/OMB-2022-0009-0001/comment. The Working Group is grateful to members of the public who took the time and effort to comment on the draft strategy.

The Working Group found the comments thoughtful, constructive, and overwhelmingly supportive of the initiative. Comments were received from the private sector and industry groups, not-for-profit and non-governmental organizations, private citizens, and academics and experts from around the world, including Nobel laureate economists and members of the National Academies. Common refrains included that this initiative is long overdue, that natural capital accounting is something the Federal Government is capable of doing, and U.S. Federal leadership is important and should contribute to, and align with, international standards such as the System of Environmental Economic Accounts (SEEA). Commenters also provided suggestions for clarifying language, data sets, and methods for consideration. More information

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[1] The White House. (2022, April 22). *Fact Sheet: President Biden Signs Executive Order to Strengthen America's Forests, Boost Wildfire Resilience, and Combat Global Deforestation.* https://www.whitehouse.gov/briefing-room/statements-releases/2022/04/22/fact-sheet-president-biden-signs-executive-order-to-strengthen-americas-forests-boost-wildfire-resilience-and-combat-global-deforestation/;
U.S. Secretary of Commerce Gina Raimondo. (2022, April 22). *White House Roundtable – "Knowledge In Nature: How Nature Can Help Grow a Better Future."* YouTube. https://www.youtube.com/watch?v=9DvHgx4nmUI (Timestamp 48:32).

[2] The White House. (2022, Aug. 18). *A New National Strategy to Reflect Natural Assets on America's Balance Sheet.* https://www.whitehouse.gov/omb/briefing-room/2022/08/18/A-New-National-Strategy-to-Reflect-Natural-Assets-on-Americas-Balance-Sheet/.

[3] The White House Office of Management and Budget. (2022, Aug. 22). *Request for Information to Support the Development of a Strategic Plan on Statistics for Environmental-Economic Decisions.* U.S. National Archives — Federal Register. https://www.federalregister.gov/documents/2022/08/22/2022-17993/request-for-information-to-support-the-development-of-a-strategic-plan-on-statistics-for.

on the main themes from the public comment are in Appendix E. The Working Group reviewed and revised the Strategic Plan based on the comments received.

The Working Group

The Working Group is co-chaired by OSTP, OMB, and DOC. In addition to OSTP, OMB, and DOC, the Working Group includes representatives from the following departments, agencies, and offices (listed alphabetically):

- Department of Agriculture (USDA)
  - Economic Research Service (ERS)
  - National Agricultural Statistics Service (NASS)
  - U.S. Forest Service (USFS)
- Department of Commerce (DOC)
  - Bureau of Economic Analysis (BEA)
  - Bureau of the Census (Census)
  - National Oceanic and Atmospheric Administration (NOAA)
- Department of Defense (DOD)
- Department of Energy (DOE)
  - U.S. Energy Information Administration (EIA)
- Department of Health and Human Services (HHS)
  - Centers for Disease Control and Prevention – National Center for Health Statistics (CDC)
- Department of the Interior (DOI)
  - Bureau of Land Management (BLM)
  - Bureau of Ocean Energy Management (BOEM)
  - U.S. Geological Survey (USGS)
- Department of Labor (DOL)
  - Bureau of Labor Statistics (BLS)
- Department of State (State)
- Department of the Treasury (Treasury)
- Environmental Protection Agency (EPA)
- Executive Office of the President (EOP)
  - Council of Economic Advisers (CEA)
  - Council on Environmental Quality (CEQ)
  - National Economic Council (NEC)
  - National Security Council (NSC)
  - Office of Domestic Climate Policy (CPO)
- U.S. Trade Representative (USTR)
- Federal Reserve System
- National Aeronautics and Space Administration (NASA)

Strategic Plan: Audience, Goals, and Organization

Statistics for Environmental-Economic Decisions is a strategic plan for implementing and institutionalizing natural capital accounting and environmental-economic statistics in the Federal Government. This Strategic Plan incorporates and identifies research and development, outreach, and department and agency actions required for short-term and long-term success. The Working Group's recommendations include actions agencies can take under existing resources and those that require some additional outyear investments. The combination of these efforts will lead to significant developments in the natural capital accounts and environmental-economic statistics. The Working Group's recommendations, including the proposed start and completion dates, are subject to the availability of resources, and OSTP, based on discussions with the Working Group, recommends that agencies prioritize the resources necessary for this work, as appropriate and feasible.[4]

How "Statistics for Environmental-Economic Decisions" is Organized

Statistics for Environmental-Economic Decisions is written to communicate with multiple audiences with different backgrounds, different focuses and concerns, and different levels of interest in the ecological, economic, and statistical and technical aspects of the Strategic Plan. This section is intended to enable the American public and experts with a variety of backgrounds to engage with this Strategic Plan. *Statistics for Environmental-Economic Decisions* explains what natural capital is and why natural capital accounting and environmental-economic statistics are important on a strategic level, while providing enough technical detail on national accounting, statistics, and economics for experts to have a plan to follow at an operational level. At times, this means using the terminology of national accounting, statistics, and economics. U.S. economic accounts have persisted as an important, apolitical tool for nearly 100 years, in part because of an adherence to a rule-based system with technical detail. *Statistics for Environmental-Economic Decisions* endeavors to follow the rigorous statistical standards of the national economic accounts, while making as many elements of the Strategic Plan as broadly accessible as possible.

Statistics for Environmental-Economic Decisions is organized in six sections with additional details available in the Appendices. Each section includes two categories of recommendations: **Strategic recommendations (in bold)** and ***Supporting recommendations (in italics)***. In most sections, the Working Group makes ***Supporting recommendations*** that guide implementing agencies through steps and decisions needed to deliver the **Strategic recommendation,** and ultimately, natural capital accounts and environmental-economic statistics. These ***Supporting***

[4]Young, S.D. and Nelson, A. (2022). Multi-Agency Research and Development Priorities for the FY 2024 Budget. https://www.whitehouse.gov/wp-content/uploads/2022/07/M-22-15.pdf

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recommendations enable the reader to skim the Strategic Plan to understand how the Working Group recommends delivering on the **Strategic recommendation,** or the reader can read the section in full if more information is desired.

The six sections of *Statistics for Environmental-Economic Decisions* are:

1. The Need for a System of Statistics for Environmental-Economic Decisions
2. Renewing U.S. Leadership and Building on Strength
3. Connecting Natural Capital Accounts and Environmental-Economic Statistics with National Economic Accounts
4. Developing a U.S. System of Statistics for Environmental-Economic Decisions: Targets, Timelines, and Tasks
5. Administrative Coordination Across the Federal Government
6. Conclusion

The first two sections focus on providing the rationale, categories of use, and global context for natural capital accounts and environmental-economic statistics. The third section develops organizing principles for U.S. natural capital accounts and environmental-economic statistics. The fourth section focuses on how to develop natural capital accounts and environmental-economic statistics. It provides the greatest number of supporting recommendations. The fifth section addresses how Federal agencies should work together to deliver natural capital accounts and environmental-economic statistics. The sixth section offers a brief conclusion.

Any references to private companies or products are not endorsements by the Federal Government. They are simply intended to provide concrete, verifiable examples.

I. The Need for a System of Statistics for Environmental-Economic Decisions

> "The ***nation behaves well if it treats the natural resources as assets*** which it must turn over to the next generation increased, and not impaired, in value; and behaves badly if it leaves the land poorer to those who come after it. That is all I mean by the phrase, Conservation of natural resources. Use them; but use them so that as far as possible our children will be richer, and not poorer, because we have lived."
>
> – THEODORE ROOSEVELT, SPEECH TO THE COLORADO LIVESTOCK ASSOCIATION IN DENVER ON AUGUST 29, 1910

KEY TERMS

Natural assets or natural capital stocks are durable physical or biological elements of nature that persist through time and contribute to current or future economic production, human enjoyment, or other services people value.

Environmental-economic statistics are organized data that enable measurement of the quantity and value of natural assets, connecting their services to the economy and human wellbeing, and tracking changes in these values through time.

National economic accounts are statistics on U.S. production, consumption, investment, exports, imports, and savings.

Ecosystem services is the income, including in-kind and implicit income, attributable to natural capital stocks.

Nature connects to society in many ways, including through connections to the economy. Stocks of harvestable natural resources, such as fish, timber, water, and minerals, underpin the economy and are the first links in many supply chains. Nature supports economic security and progress beyond providing harvestable resources. For example, standing forests and wetlands purify water, regulate climate, and provide opportunities for outdoor recreation. Whether harvested or left in place, nature provides economic opportunities in the present and stores economic opportunities for the future. This is why economists refer to stocks of nature as natural capital or natural assets.

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Americans understand that the economy is intertwined with our climate,[5] ecosystems, and biodiversity.[6] Nearly every economic sector uses services from,[7] and has important dependencies on, natural assets. Many important crop species depend on animal pollination to some degree, and slowing pollinator declines would likely improve food production.[8] The quality of the air that Americans breathe influences worker productivity.[9] Families rely on natural assets, from green spaces to local ponds (often without entrance fees) for recreation and rejuvenation, and these assets contribute to measurable physical and mental health benefits and can capitalize into property values, reduce health care expenditures, and generally improve lives.[10]

Measuring natural assets and maintaining related environmental-economic statistical series—repeated measurements over time that relate the environment to the economy—are critical planning tools for a robust economy and financial stability. Economic decision-makers, from Federal leaders to businesses, are looking for information that puts nature in the language of economics and business. Many central bankers and financial regulators understand that "[b]iodiversity loss could have significant macroeconomic implications. Failure to account for, mitigate, and adapt to these implications is a source of risks relevant for financial stability."[11] Many business leaders know that it is critical to understand how natural assets are changing to

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[5] Pörtner, H.-O., Roberts, D. C., Poloczanska, E. C., Mintenbeck, K., Tignor, M., Alegría, A., Craig, M., Langsdorf, S., Löschke, S., Möller, V., & Okem, A. (2022). *IPCC, 2022: Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press. https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_FullReport.pdf;
Hsiang, S., Kopp, R., Jina, A., Rising, J., Delgado, M., Mohan, S., Rasmussen, D. J., Muir-Wood, R., Wilson, P., Oppenheimer, M., Larsen, K., & Houser, T. (2017). Estimating economic damage from climate change in the United States. *Science, 356*(6345), 1362–1369. https://doi.org/10.1126/science.aal4369.

[6] Dasgupta, P. (2021). *The Economics of Biodiversity: The Dasgupta Review*. HM Treasury;
NGFS-INSPIRE Study Group on Biodiversity and Financial Stability. (2022). *Central Banking and Supervision in the Biosphere: An Agenda for Action on Biodiversity Loss, Financial Risk and System Stability.* https://www.ngfs.net/sites/default/files/medias/documents/central_banking_and_supervision_in_the_biosphere.pdf.

[7] These services are often called "ecosystem services" or "environmental services." The latter term refers to cases when only abiotic natural assets contribute to income, including in-kind or implicit income. A more expansive definition based on the *System of Environmental-Economic Accounting – Ecosystem Accounting* manual §2.14-15 is that ecosystem services are the "contributions of ecosystems to the . . . goods and services that are ultimately used and enjoyed by people and society . . . [which] may be captured in current measures of production (e.g., food, water, energy, recreation) or may be outside such measures (e.g., clean water, clean air, protection from floods)." United Nations. (2021). *System of Environmental-Economic Accounting Ecosystem Accounting*. https://seea.un.org/sites/seea.un.org/files/documents/EA/seea_ea_white_cover_final.pdf.

[8] Klein, A. M., et al. (2007). Importance of pollinators in changing landscapes for world crops. *Proceedings of the Royal Society B: Biological Sciences*, *274*(1608), 303-313. https://doi.org/10.1098/rspb.2006.3721.

[9] Zivin, J. G., & Neidell, M. (2012). The Impact of Pollution on Worker Productivity. *American Economic Review, 102*(7), 3652–3673. https://doi.org/10.1257/aer.102.7.3652;
Kahn, M. E., & Li, P. (2020). Air Pollution Lowers High Skill Public Sector Worker Productivity in China. *Environmental Research Letters, 8*, 084003. https://doi.org/10.1088/1748-9326/ab8b8c;
Aguilar-Gomez, S., Dwyer, H., Graff-Zivin, J.S. & Neidell, M.J. (2022). This is Air: The "Non-Health" Effects of Air Pollution. *Annual Review of Resource Economics, 14*(1), 403-425. https://doi.org/10.1146/annurev-resource-111820-021816.

[10] Schell, C. J., Dyson, K., Fuentes, T. L., Des Roches, S., Harris, N. C., Miller, D. S., Woelfle-Erskine, C. A., & Lambert, M. R. (2020). The Ecological and Evolutionary Consequences of Systemic Racism in Urban Environments. *Science, 369*(6510). https://doi.org/10.1126/science.aay4497;
Shanahan, D. F., Bush, R., Gaston, K. J., Lin, B. B., Dean, J., Barber, E., & Fuller, R. A. (2016). Health Benefits from Nature Experiences Depend on Dose. *Scientific Reports, 6,* Article 28551. https://doi.org/10.1038/srep28551.

[11] NGFS-INSPIRE Study Group on Biodiversity and Financial Stability. (2022). *Central Banking and Supervision in the Biosphere: An Agenda for Action on Biodiversity Loss, Financial Risk and System Stability.* Network for Greening the Financial System. https://www.ngfs.net/sites/default/files/medias/documents/central_banking_and_supervision_in_the_biosphere.pdf.

help manage business risks, so called "de-risking." They are looking to the Federal Government to model leadership in accounting for natural capital on balance sheets.

The Federal Government can provide this leadership by including natural capital in the national economic accounts. The national economic accounts provide foundational economic accounting and balance sheet information. Currently, national economic accounts are disconnected from environmental data, and natural assets are omitted from the balance sheet. The existing national economic accounts data for the United States provide an incomplete view of the Nation's economic opportunities and economic dependencies on natural assets. The United States has not regularly reported official statistics on changes in the quantity, condition, or value of natural assets or aggregated them into measures that connect with the existing national economic accounts or complement common economic headline statistics such as Gross Domestic Product (GDP).

Nobel laureate economists have repeatedly noted that maintaining or increasing national wealth, inclusive of natural capital wealth, is an important element of sustainable development.[12] Yet, information on the quantity and value of natural assets remains disconnected from the core statistical measurements of the economy that drive the economic conversation and ultimately drive long-term national and subnational planning. The adage "what gets measured gets improved" can only be true when the measurement is connected with the broader national economic accounting systems that policy and management respond to, such as the Nation's core economic statistics, the National Income and Product Accounts (NIPA)[13] used to compute GDP, or the national balance sheet used to make long-term growth forecasts.[14]

Contemporary economic policy and broader discourse often focuses on "economic growth," a term and concept that hardly existed before the NIPA.[15] If that accounting system ignores key assets and critical services, as it currently does, then talking about growth can be misleading. Growth in terms of marketable economic output at the expense of wealth, value, and future opportunity is not what most Americans understand meaningful and sustainable economic growth to be. A fuller accounting of natural capital in the national economic accounts will help provide public and private decision makers with this essential context for understanding GDP growth.

This kind of accounting is possible. World Bank data suggest that, between 2010 and 2018, the value that the United States held in forest and mangrove assets declined by 10%, and the value of ten mineral resource holdings declined by 51%.[16] Analysis of groundwater in Kansas between

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[12] Arrow, K., Dasgupta, P., Goulder, L., Daily, G., Ehrlich, P., Heal, G., Levin, S., Mäler, K.-G., Schneider, S., Starrett, D., & Walker, B. (2004). Are We Consuming Too Much? *Journal of Economic Perspectives, 18*(3), 147–172. https://doi.org/10.1257/0895330042162377;
Stiglitz, J. E., Sen, A., & Fitoussi, J.P. (2010). *Mismeasuring Our Lives.* The New Press.

[13] U.S. Bureau of Economic Analysis. (2022). *NIPA Handbook: Concepts and Methods of the U.S. National Income and Product Accounts.* https://www.bea.gov/resources/methodologies/nipa-handbook.

[14] Bureau of the Fiscal Service. (2022). *Financial Report of the United States Government - Financial Statements of the United States Government for the Fiscal Years Ended September 30, 2021, and 2020.* https://fiscal.treasury.gov/reports-statements/financial-report/balance-sheets.html;
U.S. Bureau of Economic Analysis. (2021). *Fixed Assets.* https://apps.bea.gov/iTable/index_FA.cfm.

[15] Nordhaus, W. D., & Tobin, J. (1973). Is Growth Obsolete? In *The measurement of economic and social performance. National Bureau of Economic Research*, 509 - 564. https://www.nber.org/system/files/chapters/c3621/c3621.pdf.

[16] World Bank. (2021). *Changing Wealth of Nations.* https://datanalytics.worldbank.org/content/853/.
These minerals include bauxite, copper, gold, iron ore, lead, nickel, phosphate, silver, tin, and zinc, which are defined in the

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1996 and 2005 revealed a decline in water wealth of around $1 billion,[17] while other analysis suggests that, nationwide, productivity from water across the United States rose 65% between 2000 and 2015.[18] Evidence suggests that air quality improvements following the Clean Air Act have generated substantial increases in implicit income and that ignoring air quality improvements has led to an underestimate of national income growth on the order of 1.5 to 3% per year.[19] Spending on outdoor recreation (not including outdoor recreation for which no fees are required) contributes approximately $374 billion to economic output.[20]

The Strategic Plan builds on existing research on natural capital accounting and charts a path to execute the Administration's commitment to realize natural capital accounts within an integrated system of environmental-economic statistics that are aligned with the national economic accounts and suitable for reliable use in decision making.

Recommendation 1: Develop U.S. natural capital accounts and environmental-economic statistics that provide pragmatic information to:

a) Guide sustainable development and macroeconomic decision making;
b) Support Federal decision making in programmatic, policy, and regulatory settings;
c) Provide structure and data that promote the competitiveness of U.S. businesses;
d) Support resilient state, territorial, Indigenous, and local communities; and
e) Facilitate conservation and environmental policy.

The remainder of this section explains each of these categories of use.

A. Natural Capital Accounting and Sustainable Development of the U.S. Macro-Economy

Natural capital is a core asset class within the macro-economy of the United States.[21] However, natural assets are currently omitted from the national balance sheet. A statistical accounting system provides a comprehensive, internally consistent framework for compiling, organizing, and reporting relevant information about economic performance and enables analyses to guide decisions. The balance sheet and the rest of the NIPA are important to the Congressional Budget Office's and OMB's forecasting and budgeting exercises, along with Central Bank products.

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accompanying report: World Bank. (2021). *The Changing Wealth of Nations 2021: Managing Assets for the Future*. https://openknowledge.worldbank.org/handle/10986/36400.

[17] Fenichel, E. P., Abbott, J. K., Bayham, J., Boone, W., Haacker, E. M. K., & Pfeiffer, L. (2016). Measuring the Value of Groundwater and Other Forms of Natural Capital. *Proceedings of the National Academy of Sciences, 113*(9), 2382–2387. https://doi.org/10.1073/pnas.1513779113.

[18] Bagstad, K. J., Ancona, Z. H., Hass, J., Glynn, P. D., Wentland, S., Vardon, M., & Fay, J. (2020). Integrating Physical and Economic Data into Experimental Water Accounts for the United States: Lessons and Opportunities. *Ecosystem Services*, *45*, Article 101182. https://doi.org/10.1016/j.ecoser.2020.101182.

[19] Muller, N. Z. (2014). Boosting GDP Growth by Accounting for the Environment. *Science, 345*(6199), 873–874. https://doi.org/10.1126/science.1253506.

[20] U.S. Bureau of Economic Analysis. (2021). *Outdoor Recreation Satellite Account, U.S. and States, 2020*. https://www.bea.gov/data/special-topics/outdoor-recreation.

[21] Barbier, E.B. (2019). The concept of natural capital. *Oxford Review of Economic Policy, 35*(1), 14- 36. https://academic.oup.com/oxrep/article/35/1/14/5267896.

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Natural capital accounting is critical for macroeconomic policy, which aims to create conditions for sustained growth, financial and price stability, and full employment. Considering dependencies on climate and nature strongly enhances the ability to meet these goals.[22] Omitting economic dependencies on nature leads to misattribution of systematic macroeconomic change.

In the case of natural assets, change in their aggregate value—or Change in Natural Asset Wealth—is an important indicator for sustainable development and future economic opportunity.[23] A high-level summary that describes the state of natural-resource-based opportunity is important for shaping key national discussions and can complement changes in GDP and other macroeconomic indicators and provide visibility into one of GDP's well-known "blind spots." GDP has dominated discourse because it provides a simple summary of a complex process using a single number. Yet, Americans have watched GDP grow at a faster pace than median wages and generally faster than their own abilities to enjoy the goods and services of a growing economy,[24] while also being increasingly concerned about important services that are not well measured by GDP.[25] This blind spot in GDP leads to a disconnect between the measure driving the economic discussions and people's everyday experience. International and domestic pressures imply that it is important for the United States to expand its core economic indicators in order to have broader conversations about economic policy that can address 21st century challenges.[26] Measuring changes in the value of natural assets is an important step toward achieving this goal.

Experts agree that indicators beyond GDP are necessary. The Stiglitz Commission on the Measurement of Economic Performance and Social Progress recommended a dashboard approach to measuring economic progress, where GDP has a smaller role than it is traditionally given.[27] Economists often state that Net Domestic Product (NDP), which deducts for loss of assets—including natural assets—is a better benchmark measure of economic progress than GDP.[28] The international community is expected to call for increased accounting for and attention to natural resource depletion, degradation, and growth and increased focus on NDP and Net National Income (NNI) as part of the 2025 update to the internationally agreed upon System of National Accounts (SNA).[29,30] Change in wealth, inclusive of natural asset wealth, is also a

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[22] Agarwala, M. & Zenghelis, D. (2020). *Natural Capital Accounting for Sustainable Macroeconomic Strategies*. United Nations Department of Economic and Social Affairs. https://seea.un.org/content/natural-capital-accounting-sustainable-macroeconomic-strategies.

[23] Dasgupta, P. (2021). *The Economics of Biodiversity: The Dasgupta Review*. HM Treasury.

[24] U.S. Bureau of Economic Analysis. (n.d.). *Regional Data: GDP and Personal Income*. Retrieved August 5, 2022, from https://apps.bea.gov/iTable/iTable.cfm?reqid=70.

[25] This includes environmental and ecosystem services, health care, and education.

[26] U.S. Bureau of Economic Analysis. (2022). *Prototype Measures of Economic Well-Being and Growth.* https://apps.bea.gov/well-being/.

[27] Stiglitz, J. E., Sen, A., & Fitoussi, J.P. (2010). *Mismeasuring Our Lives*. The New Press.

[28] Asheim, G. B., & Weitzman, M. L. (2001). Does NNP Growth Indicate Welfare Improvement? *Economics Letters*, *73*(2), 233–239. https://doi.org/10.1016/S0165-1765(01)00493-1.

[29] Net domestic product differs from gross domestic product by subtracting depreciation, and in some cases loss, of capital. For example, as machines wear out this reduces net domestic product but does not affect gross domestic product. Net domestic product also may treat capital formation slightly differently. National measures differ from domestic measures by focusing on Americans as opposed to activities conducted within U.S. borders. This largely relates to the economic activities of overseas Americans. Income measures differ from product measures in the way they treat taxes, imports, and exports. Net national income is a better measure of economic progress than GDP, but it is often measured less precisely.

[30] United Nations Statistics Division. (2022). *Wellbeing and Sustainability Task Team*. https://unstats.un.org/unsd/nationalaccount/snaupdate/wstt.asp;

critical indicator of sustainable development.[31] By considering changes, rather than only depreciation, NDP or NNI can be linked to Adjusted Net Savings.[32]

Research indicates that natural assets are important for long-term financial forecasting and assessing economic stability.[33] The dominant macroeconomic modeling frameworks implicitly assume, through the common "all else equal" assumption, a constant environment and climate and an unchanging stock of natural capital. However, climate change and systematic changes in natural capital generally pose micro- and macro-prudential risk that can cause system-level shocks. A lack of clear accounting generates greater vulnerability by undermining the ability to predict such shocks or by generating systemic errors, through misallocation of causality and a failure to account for connections among sectors, in the models used for macroeconomic planning.[34] The most likely place changes in climate and other natural capital appear is through measurement of other critical factors, such as productivity because that captures residuals inputs not counted by other factors. Also, a lack of aggregate information about the market value of traded natural capital assets (e.g., land or mineral assets) makes it difficult to identify price inflation or deflation among some asset classes. The organized data contained within natural capital accounts and other environmental-economic statistics are important to achieving financial stability.

Natural capital accounts can provide important early-warning mechanisms associated with physical and transition risk from climate change because many of the economic impacts of climate change are mediated through changes in natural assets. For example, environmental-economic statistics will provide a foundation to better interpret the interviews and surveys that district Federal Reserve Banks use to guide policy. The Federal Open Markets Committee (FOMC) Teal and Beige Books regularly capture statements and survey information about how business depends on nature and on environmental influences on business performance; common examples include mentions of water, forest fires, storms, and other environmental processes. In one case, the Beige Book documents a four-day forest fire, in 1998, that cost the Daytona Beach area $300 million. In 2022, the Federal Reserve announced plans to begin to assess the resilience

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The website and personal conversations with authors reveal a paper on net measures is being produced;
Advisory Expert Group on National Accounts. (2020). *Accounting for Economic Ownership and Depletion of Natural Resources.*https://unstats.un.org/unsd/nationalaccount/aeg/2020/M14_6_2_Accounting_Economic_Ownership_Depletion_Natural_Resources.pdf.

[31] Arrow, K., Dasgupta, P., Goulder, L., Daily, G., Ehrlisch, P., Heal, G., Levin, S., Mäler, K.-G., Schneider, S., Starrett, D., & Walker, B. (2004). Are We Consuming Too Much? *Journal of Economic Perspectives, 18*(3), 147–172. https://doi.org/10.1257/0895330042162377;
U.S. Bureau of Economic Analysis. (2022). *Prototype Measures of Economic Well-Being and Growth*. https://apps.bea.gov/well-being/.

[32] Barbier, E. B. (2016). Sustainability and development. *Annual Review of Resource Economics*, *8*(1), 261-280. https://doi.org/10.1146/annurev-resource-100815-095227.

[33] NGFS-INSPIRE Study Group on Biodiversity and Financial Stability. (2022). *Central Banking and Supervision in the Biosphere: An Agenda for Action on Biodiversity Loss, Financial Risk and System Stability*. https://www.ngfs.net/sites/default/files/medias/documents/central_banking_and_supervision_in_the_biosphere.pdf.

[34] Brunetti, C., et al. (2021, March 19). *FEDS Notes - Climate Change and Financial Stability.* Board of Governors of the Federal Reserve System. https://doi.org/10.17016/2380-7172.2893.

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of financial institutions to climate-related financial risk in 2023.[35] Understanding trends in natural capital could make these assessments easier.

More structured information will make some environmental shocks better understood as persistent trends within macroeconomic analysis. The Banque de France recently published a paper investigating the links between natural capital loss and financial instability and found that 42% of securities, by value, held by French financial institutions are highly or very highly dependent on services generated by natural capital.[36] Change in natural capital may also affect the real neutral rate of interest (r-star), which is an important element in monetary policy and may be influenced by environmental conditions.[37] There is also growing interest in the role of natural capital in sovereign credit ratings.[38]

B. Natural Capital Accounting and Federal Decision Making

The Federal Government regularly encounters situations in which regulatory and other Federal decisions affect the generation and distribution of benefits and costs through environmental pathways (that is, the regulation of one sector can influence generation of, access to, and distribution of environmental benefits experienced in other sectors).[39] Currently, when the Federal Government analyzes how decisions change the value of natural assets or ecosystem services, the analysis is done without the support of a broader system that provides a clear understanding of how the environment fits together with other economic activities in the same way the statistical system provides clear information about the way economic sectors fit together. For example, agencies can list relevant North American Industry Classification System (NAICS) codes in their regulatory agendas, regulations, and regulatory analysis. A similar classification and taxonomy system does not exist for nature. Economic statistics are available to highlight connections to, and among, industries, but no similar system exists for the environment or natural assets. Today, there is increasing understanding of how regulation of one sector can influence prices and quantities in other sectors, and data from national economic accounts can help in identifying these interactions. Environmental-economic statistics can bring the environment and natural assets into this system in a way that is analogous to other economic sectors. For example, investments made to remediate hazardous waste sites under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) are currently accounted for in the NIPA, but these investments are not classified as

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[35] Federal Reserve Board. (2022, Sept. 29). *Federal Reserve Board announces that six of the nation's largest banks will participate in a pilot climate scenario analysis exercise designed to enhance the ability of supervisors and firms to measure and manage climate-related financial risks*. https://www.federalreserve.gov/newsevents/pressreleases/other20220929a.htm.

[36] Svartzman, R., Espagne, E., Julien, G., Paul, H.L., Mathilde, S., Allen, T., Berger, J., Calas, J., Godin, A., & Vallier, A., 2021. A 'Silent Spring' for the Financial System? Exploring Biodiversity-Related Financial Risks in France. *Banque de France,* Working Paper 826. https://dx.doi.org/10.2139/ssrn.4028442.

[37] Muller, N.Z. (2021). On the Green Interest Rate. *National Bureau of Economic Research*, Working Paper 28891. https://www.nber.org/papers/w28891.

[38] Agarwala, M., Burke, M., Klusak, P., Kraemer, M., & Volz, U. (2022). *Nature Loss and Sovereign Credit Ratings*. Finance for Biodiversity Initiative. https://www.f4b-initiative.net/post/nature-loss-and-sovereign-credit-ratings.

[39] Under current OMB guidance (e.g., OMB Circulars A-4 and A-94) and Presidential directives (e.g., Executive Order 12866), many Federal decisions must be accompanied by a benefit-cost analysis. As part of this analysis, agencies should endeavor to account for how their actions change the value of services provided by natural assets. The need for direction on accounting for the changing value of natural assets and the ecosystem services they provide was clarified and emphasized by Executive Order 14072.

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environmental protection expenditures in GDP. Linking land remediation investments through a system of natural capital accounts will enable accounting for these investments as environmental activities. The returns on these investments would be reflected as increases in land or recreation values and would appear on the national balance sheet as increases in the Nation's fixed capital.

The Federal Government is already working to support this kind of analysis,[40] but data need to be better organized, standardized, and regularly updated. Natural capital accounts and associated environmental-economic statistics will provide a guiding framework for how currently disparate data can come together to better inform regulatory decision making.

Supporting recommendation: The system of Statistics for Environmental-Economic Decisions should provide national, regional, and state-level statistics. A large number of Federal decisions have broad non-localized impacts, in which case national statistics are often most appropriate. In some cases, Federal agencies lack the resources to conduct localized evaluations. In such cases, the aggregations provided in a national system of natural capital accounts will improve Federal decision making and provide greater predictability for entities affected by changes in natural capital. While developing and using the environmental-economic statistics, decision makers will need to recognize that a national set of statistics cannot provide all the information for every local decision, and there will be cases when localized measurement will remain important and outside the scope of *Statistics for Environmental-Economic Decisions*.

Non-regulatory Federal decisions related to programs and projects can also benefit from natural capital accounts. The United States faces numerous current and foreseeable policy challenges, such as infrastructure development, supply chain security, changes in U.S. labor supply, adapting to a changing climate, and addressing legacy environmental injustices. Natural capital accounts provide visibility to key elements of U.S. supply chains, their vulnerabilities, and their role in securing economic and financial stability. Currently, the United States is investing billions of dollars to develop new infrastructure and protect existing infrastructure[41] while committing to accelerating nature-based solutions.[42] New human-built infrastructure will appear as a produced asset on national balance sheets, but investment in nature-based solutions will likely be miscategorized in, and potentially lost to, the traditional economic accounting system.

C. Natural Capital Accounting and Competitiveness of U.S. Businesses

The development of national natural capital accounts and environmental-economic statistics serves to model good accounting behavior and spur private action. The Federal Government often focuses on claims made to environmental and other regulators about firm impact and

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[40] Marten, A., Schreiber, A., & Wolverton, A. (2021). *SAGE Model Documentation (2.0.1).* U.S. Environmental Protection Agency. https://www.epa.gov/environmental-economics/cge-modeling-regulatory-analysis.

[41] U.S. Department of Agriculture. (2022). *Biden Administration Announces Bipartisan Infrastructure Law Wildfire Mitigation Investments in Colorado*. https://www.fs.usda.gov/news/releases/biden-administration-announces-bipartisan-infrastructure-law-wildfire-mitigation.

[42] Council on Environmental Quality, Office of Science and Technology Policy, & Domestic Climate Policy Office. (2022, Nov.). *Opportunities to accelerate nature-based solutions: A roadmap for climate progress, thriving nature, equity, & prosperity. A Report to the National Climate Task Force*. https://www.whitehouse.gov/wp-content/uploads/2022/11/Nature-Based-Solutions-Roadmap.pdf.

dependencies on nature. Firms also increasingly make claims about their relationship to nature, including impacts and dependencies on nature, when communicating with banks, investors, insurance providers, consumers, and other stakeholders. A system of natural capital accounts puts nature in language that investors and banks understand. It enables banks to identify connections between natural assets and their loan books, leading to shifts in lending practices. When reliable data are not available, making such claims may expose firms to legal and reputational risk, and the inability to make such claims may limit access to financing, insurance, and market share. A Federal system of environmental-economic statistics will help de-risk (i.e., reduce the risk posed by) these claims by providing an official data source and demonstrates a systematic accounting system that firms can safely emulate or build upon. Furthermore, a standardized system could help clarify and inform expectations for firms, thereby de-risking the claims firms make. Beyond the data themselves, the supporting structure and taxonomy of the environmental-economic statistics can provide assurance in a Federally-designed structure on which to base auditing of environmental claims.

The business sector increasingly understands that tens of trillions of dollars of economic output depend on natural capital.[43] This is especially true in emerging sectors such as the bioeconomy. A Credit Suisse report found that 70% of investors feel that the data to manage natural capital is insufficient.[44] Firms increasingly focus on securing long-term stakeholder value, managing supply-chain risks, and minimizing environmental risk exposure. Access to organized, reliable data on natural assets and changing environmental-economic conditions will benefit the U.S. private sector. The U.S. approach to natural capital accounts and environmental-economic statistics will increase U.S. private sector competitiveness by making it substantially easier for firms to expand environmental reporting by providing a benchmark data series and structure.[45] Businesses currently use existing economic data compiled under the SNA[46] and the NIPA. Major business consulting firms regularly extract data from the NIPA to help explain business conditions and assist individual enterprises in making strategic decisions. Law firms increasingly need to advise enterprises on corporate responsibility as it relates to environmental impacts and are looking to the Federal Government to lead with reliable accounting practices. Natural capital accounting data and associated environmental-economic statistics are relevant to all these businesses, which need, or want, to make nature-related claims that are trusted, standardized, and based on regularly reported data.

Major financial institutions offer natural capital insurance products[47] that are likely to increase in importance as nature-based solutions expand. The New York Stock Exchange is initiating a

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[43] Herweijer, C., Evison, W., Mariam, S., Khatri, A., Albani, M., Semov, A., & Long, E. (2020). *Nature Risk Rising: Why the Crisis Engulfing Nature Matters for Business and the Economy*. World Economic Forum. https://www3.weforum.org/docs/WEF_New_Nature_Economy_Report_2020.pdf.

[44] Credit Suisse. (2021). *Unearthing investor action on biodiversity*. https://www.credit-suisse.com/media/assets/microsite/docs/responsibleinvesting/unearthing-investor-action-on-biodiversity.pdf.

[45] Ingram, J. C., Bagstad, K. J., Vardon, M., Rhodes, C. R., Posner, S., Casey, C. F., Glynn, P. D., & Shapiro, C. D. (2022). Opportunities for Businesses to Use and Support Development of SEEA-Aligned Natural Capital Accounts. *Ecosystem Services*, *55*, Article 101434. https://doi.org/10.1016/j.ecoser.2022.101434.

[46] United Nations Statistics Division. (2022). *System of National Accounts 2008*. https://unstats.un.org/unsd/nationalaccount/sna2008.asp.

[47] SwissRe. (2022). *Designing a New Type of Insurance to Protect the Coral Reefs, Economies and the Planet*. https://www.swissre.com/our-business/public-sector-solutions/thought-leadership/new-type-of-insurance-to-protect-coral-reefs-economies.html.

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partnership that enables trading of natural assets in the form of "Natural Asset Companies" to facilitate liquidity between natural capital and financial capital.[48] Firms increasingly focus on voluntary frameworks to guide environmental, social, and governance (ESG) reporting, such as the framework developed by the Taskforce on Nature-related Financial Disclosures (TNFD)[49] and the Natural Capital Protocol.[50] However, business leaders often cite uneven data quality and definitions as a barrier to using natural capital in decision-making. A standardized, regularly-updated, national system of natural capital accounts and associated environmental-economic statistics is necessary for these frameworks to succeed and to enable U.S. firms to compete as other countries develop such accounting systems.

D. Natural Capital Accounting and Resilient State, Territorial, Local, Tribal, and Indigenous Communities

Subnational and Tribal governments rely on national economic accounting data to parameterize regional planning models.[51] The system of natural capital accounts will provide data and structure to embed the environment into these planning tools in a streamlined, low-burden fashion. This is especially true for infrastructure investments and climate resilience planning. Coordination with subnational and Tribal governments is especially important because the economic value of most natural capital is partially determined by its geographic location.

Remote work and a changing labor force influence how jobs are tied to the environment and may increasingly influence local tax revenue and bond rates. This includes natural resource-dependent jobs and the location-based quality-of-life tradeoffs American workers make when given the option of remote work. Natural capital accounting can help anticipate this labor transition, helping towns and cities across America.

Supporting recommendation: Develop engagement plans to coordinate with state, territorial, local, and Tribal Governments and with Indigenous Organizations to support their needs and collect information on natural assets, as appropriate, with plans tailored to each groups' specific needs. Governments increasingly recognize the importance of accounting for and appropriately valuing natural assets to improve decision making. Multiple states have begun investigating, to varying degrees, whether natural capital accounting could improve state-level decision making. Existing accounts contain information that may be relevant to diverse state agencies, including those responsible for agriculture, economic development, resource development, tourism, state parks, wildlife, and environmental quality. States may also have data sources to contribute. States are often familiar with dashboard-style interfaces that summarize

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[48] New York Stock Exchange. (n.d.). *Introducing Natural Asset Companies*. Retrieved July 15, 2022, from https://www.nyse.com/introducing-natural-asset-companies;
Intrinsic Exchange Group. (n.d.). *Intrinsic Exchange Group (IEG).* Retrieved July 15, 2022, from https://www.intrinsicexchange.com/.

[49] Taskforce on Nature-related Financial Disclosures. (2022). *Developing and Delivering a Risk Management and Disclosure Framework for Organisations to Report and Act on Evolving Nature-Related Risks.* https://tnfd.global/.

[50] Natural Capital Coalition. (2016). *Natural Capital Protocol*. https://capitalscoalition.org/wp-content/uploads/2021/01/NCC_Protocol.pdf.

[51] For example, IMPLAN. (2019). *Economic Impact Analysis for Planning*. https://implan.com/.

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state performance across various indicators;[52] such information, properly distilled from accounts into policy-relevant indicators, may be relevant and accessible for state-level decision making. Engagement is discussed further in Section V.

Supporting recommendation: Consider the equity implications of technical decisions related to classifications and the geographic groupings,[53] be clear about biases that may emerge as a result of these decisions, and make design choices that illuminate existing inequities and biases and attempt to avoid future ones. What is counted in the American economy is not separable from who is counted in the American economy. Natural capital accounts will begin to clarify the existing allocation of natural assets. From that starting point, it may be possible to better target investments in natural capital that, if pursued, could address some of the roots of environmental injustices.

Accounting for natural capital adds previously overlooked assets to the balance sheet. By making the balance sheet more inclusive of nature, the national accounting system implicitly will be more inclusive of the people who contribute to the caretaking and stewardship of natural assets, especially Indigenous Communities and rural Americans.

The Working Group acknowledges, and many public comments reflect, that natural capital accounts and environmental-economics statistics cannot resolve inequity and environmental injustice alone. Accurate statistical information is one of many important tools to reduce inequity and environmental injustice. Still, it is likely that environmental-economic statistics will not be provided at sufficiently local scales to address all localized problems.

Supporting recommendation: Acknowledge that an economics-based statistical system may not fit with some worldviews, especially those of some Indigenous Peoples, and follow three paths forward to partially ameliorate this risk. These are:

1. Work to weave in elements of these world views via the multiple accounting boundaries that this Strategic Plan recommends.
2. In reports and documents based on the natural capital accounts or environmental-economics statistics, reference other Federal activities, such as the National Nature Assessment,[54] which may reflect world views that are incongruent with an economics-based statistical system.
3. Continue public engagement throughout the development process. Engagement is further discussed in Section V.

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[52] Georgia Governor's Office of Planning and Budget. (n.d.). *State Dashboards*. Retrieved June 10, 2022, from https://opb.georgia.gov/state-dashboards;
Hawai'i Green Growth. (2018). *Aloha+ Challenge Dashboard: Measuring Hawai'i's Sustainability*. https://aloha-challenge.hawaiigreengrowth.org/dashboard/;
State of Utah. (2022). *Dashboards.* https://www.utah.gov/about/dashboards.html;
State of Washington. (2018). *Results Washington*. https://results.wa.gov/.

[53] Geographic grouping also referred to as "spatial scale" refers to aggregation considerations (e.g., whether to consider individual trees, the forested area on a parcel, a Census tract, or a county).

[54] U.S. Global Change Research Program. (n.d.). *National Nature Assessment*. https://www.globalchange.gov/nna.

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E. Conservation as an Economic Necessity

Conservation and the protection of the environment are often pitted against economic progress. This is a false dichotomy but is unsurprising when measurement of conservation and economic success occur in different units and are seldom integrated into a single system. The *Statistics for Environmental-Economic Decisions* system can give rise to economic policy that incorporates conservation as an investment in the economy, such as enhancing worker productivity, health, and supporting the tourism and travel industries. As national natural capital accounts bring water, soil, and other natural assets onto balance sheets, it is reasonable to expect that the private sector will accelerate transformation of its own balance sheets to create similar accounting. This may enable conservation activities and stewardship of natural capital to become a credit-enhancing activity for America's landowners who contribute to increasing the stock of U.S. natural capital.

Natural capital accounts will clarify the importance of natural assets in areas where economic output differs from social outcomes. For example, individual studies have demonstrated that access to parks can drive physical health improvements for people, improving their quality of life, and reduce medical costs. But the magnitude of these services, and changes in them, are not regularly reported at a national scale, even in the healthcare accounts.[55] Similarly, case studies of nature-based solutions, like wetlands and rain swales for storm water management, show that these investments reduce "defensive expenditures" by reducing stormwater management expenditures and flood risks. However, the value added of major national investments in nature-based solutions, such as those made in resilient infrastructure through the Bipartisan Infrastructure Investment and Jobs Act of 2021 (IIJA), will not be visible on the nation's balance sheet as it is compiled today. As natural capital accounts become available, the return on nationwide investment in the nature-based infrastructure sector and other sectors will become clearer.

Supporting recommendation: The Conservation Stewardship Atlas, National Nature Assessment, annual reports, and emerging natural capital accounts should be aligned and complementary where feasible. The natural capital accounts will provide a critical input to the National Nature Assessment,[56] which will report on the status and trends in U.S. lands, waters, wildlife, biodiversity, ecosystems, and the benefits they provide, including to the economy. The planned Conservation Stewardship Atlas is a tool for tracking a range of conservation benefits provided by U.S. lands and waters, particularly for biodiversity, climate and equity benefits. Natural capital accounts, once developed, could complement other data in the Atlas by identifying how conservation actions are contributing to economic conservation goals, and helping to quantify the return on conservation and investment in nature-based solutions.

[55] U.S. Bureau of Economic Analysis. (n.d.) *Health Care*. https://www.bea.gov/data/special-topics/health-care.
[56] U.S. Global Change Research Program. (n.d.). *National Nature Assessment*. https://www.globalchange.gov/nna.

II. Renewing U.S. Leadership and Building on Strength

Recommendation 2: Federal departments and agencies should produce natural capital accounts and associated environmental-economic statistics that provide domestic comparability through time and pursue an approach that supports international comparisons and harmonization. This will enable the United States to lead with respect to the development of global standards and lead in implementation of those standards.

Developing natural capital accounts and environmental-economic statistics presents a unique opportunity for the United States to lead on a forward-looking agenda where it is likely to find strong global support. The United States was a research pioneer in the area of environmental-economic statistics. Today, the global community is actively advancing environmental-economic statistics (see Appendix A for more historical details). Countries including Australia,[57] Canada,[58] China,[59] France,[60] Germany,[61] the Netherlands,[62] and United Kingdom,[63] have initiated efforts to develop informative sets of official national environmental-economic statistics and have, to varying degrees, embedded them as core statistical products within their respective statistical systems. For example, the United Kingdom includes land on its national balance sheet, and, in 2020, began including natural capital accounts in its statistical Blue Book. The United Kingdom has also released a road map for further development of their natural capital accounts,[64] and

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[57] Australian Bureau of Statistics. (2022). *Environmental Management*. https://www.abs.gov.au/statistics/environment/environmental-management.

[58] Statistics Canada. (2021). *Preliminary Data on Canada's Natural Resource Wealth, 2020.* https://www150.statcan.gc.ca/n1/pub/11-627-m/11-627-m2021081-eng.htm;
Statistics Canada. (2022). *Canadian System of Environmental-Economic Accounts - Ecosystem Accounts.* https://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=5331;
Statistics Canada. (2022). *Accounting for ecosystem change in Canada*. https://www150.statcan.gc.ca/n1/en/pub/16-201-x/16-201-x2021001-eng.pdf?st=N3mBHTDh.

[59] Ouyang, Z. (n.d.). *Gross Ecosystem Product (GEP) and Ecological Assets (EA).* Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences. Retrieved May 20, 2022, from http://www.stats.gov.cn/english/pdf/202010/P020201012524235640534.pdf;
Ye, Y. (2021, April 12). *GEP, a Green Alternative to GDP, Gaining Ground in China*. Sixth Tone. https://www.sixthtone.com/news/1007199/gep%2C-a-green-alternative-to-gdp%2C-gaining-ground-in-china; Ouyang, Z., Song, C., Zheng, H., Polasky, S., Xiao, Y., Bateman, I. J., Liu, J., Ruckelshaus, M., Shi, F., Xiao, Y., Xu, W., Zou, Z., & Daily, G. C. (2020). Using Gross Ecosystem Product (GEP) to Value Nature in Decision Making. *Proceedings of the National Academy of Sciences, 117*(25), 14593–14601. https://doi.org/10.1073/pnas.1911439117.

[60] Svartzman, R., Espagne, E., Julien, G., Paul, H.L., Mathilde, S., Allen, T., Berger, J., Calas, J., Godin, A., & Vallier, A., (2021). A 'Silent Spring' for the Financial System? Exploring Biodiversity-Related Financial Risks in France. *Banque de France,* Working Paper 826. https://dx.doi.org/10.2139/ssrn.4028442.

[61] Statistisches Bundesamt (Destatis). (2022). *Environmental Economic Accounting.* https://www.destatis.de/EN/Themes/Society-Environment/Environment/Environmental-Economic-Accounting/_node.html.

[62] Centraal Bureau voor de Statistiek (Statistics Netherlands). (2021). *Integrating Monetary Environmental Accounts*. https://www.cbs.nl/en-gb/background/2021/09/integrating-monetary-environmental-accounts.

[63] U.K. Office for National Statistics. (n.d.). *Environmental Accounts*. Retrieved May 5, 2022, from https://www.ons.gov.uk/economy/environmentalaccounts/.

[64] U.K. Office for National Statistics. (2022). *Natural capital accounts roadmap: 2022.* https://www.ons.gov.uk/economy/environmentalaccounts/articles/naturalcapitalaccountsroadmap/2022.

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Australia has developed an environmental-economic accounting strategy and action plan.[65] U.S. leadership depends on learning from these efforts and ensuring international alignment and comparability.

If the United States does not reestablish itself as a leader in this area, it is likely to see its sway over developing and finalizing international rules and standards for natural capital accounting diminish, including within the 2025 revision of the SNA and ongoing development of the U.N.-supported System of Environmental-Economic Accounting (SEEA), which is being implemented in over 90 countries[66] (see Section III for more information on SEEA). Some countries that have implemented less rigorous natural capital accounting approaches may be able to advocate successfully for these weaker accounting standards and less rigorous methodologies, as opposed to the high accounting and statistical standards the United States often advocates for. Moreover, countries implementing some form of natural capital accounting, from the United Kingdom to China, are finding that they can successfully build on their leadership in this space into a persuasive soft power tool as they promote environmental accounting, often paired with other objectives, globally.

There is also some risk of geopolitical incoherence if other countries adopt different natural capital accounting standards than the United States. One reason to do asset accounting is to assert a right over the flow of services from the asset. Natural capital accounts could be used as a means to make strategic claims over disputed areas and resources—for example, over regions like the Arctic or over marine fisheries. If there are different standards for how to account for natural assets as part of a country's economy, then multiple countries are more likely to claim ownership over a contested natural asset using different standards. This pluralism is most likely to occur when the ability to implement high quality standards goes undemonstrated. U.S. leadership in methodological development is the best way to ensure high quality standards are demonstrated, helping minimize these geopolitical risks.

It is in the interest of the United States to lead in practice and promote the norms for an international system of natural capital and environmental-economic accounting, given the potential for such accounts to provide important international comparisons. The United States faces increased pressure to do so in a variety of economic forums, including the G7 and G20. In the 2022 G7 Climate, Energy, and Environment Ministers' Communique,[67] for instance, the United States agreed to the following:

"*Committed to further mainstreaming biodiversity in decision-making, we will ensure implementation of the System of Environmental Economic Accounting, which includes a Central Framework and the recently adopted Ecosystem Accounting, a regular and institutionalized compilation of accounts, will use related indicators for policy and decision-making, and provide international support for further development and implementation of SEEA Ecosystem Accounting, including knowledge and capacity development and system refinements.*"

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[65] Australian Department of Climate Change, Energy, the Environment, and Water. (2020). *Environmental Economic Accounting: A common national approach – Strategy and Action Plan*. https://eea.environment.gov.au/media/52.
[66] United Nations. (n.d). *System of Environmental Economic Accounting*. Retrieved August 16, 2022, from https://seea.un.org/.
[67] G7 Ministers of Climate, Energy, and the Environment. (2022, May 27). *G7 Climate, Energy and Environment Ministers' Communiqué.* https://www.g7germany.de/resource/blob/974430/2044350/84e380088170c69e6b6ad45dbd133ef8/2022-05-27-1-climate-ministers-communique-data.pdf?download=1.

III. Connecting Natural Capital Accounts and Environmental-Economic Statistics with National Economic Accounts

Recommendation 3: Federal departments and agencies should embed the system of natural capital accounts and associated environmental-economic statistics in the broader U.S. economic statistical system through the following actions:

a) Incorporate the internationally agreed-upon SEEA to guide development of U.S. natural capital accounts and environmental-economic statistics, where the SEEA standards are relevant and robustly developed.

b) Adhere to three specific asset boundaries—direct contribution, defensive expenditures, and individual and household production—to accommodate different applications and contexts, which implies creating three partitions in the natural capital accounts.

c) Use rigorous and the best available economic science for monetizing the value of natural assets, with monetization being consistent with the three established asset boundaries.

The United States has long been a leader in national economic accounting and implements the internationally agreed-upon guidance on national economic accounting, the SNA, with the NIPA. More detail about relations between environmental-economic statistics and national economic accounts can be found in Appendix B.

Structuring National Capital Accounts and Environmental-Economic Statistics

Recommendation 3a: Incorporate the internationally agreed-upon SEEA to guide development of U.S. natural capital accounts and environmental-economic statistics, where the SEEA standards are relevant and robustly developed.

The SEEA was developed by the international statistical community and adopted by the U.N. Statistical Commission, and it is increasingly being connected to the SNA.[68] SEEA consists of two parts. First, the SEEA Central Framework (SEEA CF) is an international statistical standard that quantifies connections between the environment and the economy through (1) stocks of environmental assets, (2) environmental flows into and out of the economy, and (3) economic activity related to the environment. Information about resources—such as land, water, agriculture, fisheries, forestry, minerals—and unintended production outputs—such as pollution and waste (or "residuals")—are combined into a system designed for compatibility with the

[68] See papers in this series: United Nations Statistics Division. (2022). *Wellbeing and Sustainability Task Team (WSTT).* https://unstats.un.org/unsd/nationalaccount/snaupdate/wstt.asp.

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SNA. Second, the SEEA Ecosystem Accounting (SEEA EA) quantifies ecosystems' (1) extent, (2) condition, (3) supply and use of ecosystem services in physical, (4) monetary terms, and finally (5) asset accounts that quantify the net present value of stocks of ecosystem assets. SEEA EA was revised from 2019 to 2021, and, in 2021, the U.N. Statistical Commission adopted the physical measurement elements of the SEEA EA.[69] However, the U.N. Statistical Commission simultaneously recognized the less mature state of monetary ecosystem accounting, and it recommended that further experimental work continue on valuation and monetization.[70] The SEEA community has provided interim recommendations on ecosystem monetization,[71] and it is important that the United States engage with the further development of these standards.

Supporting recommendation: Use the best-available biophysical science to support quantification and economic valuation of natural capital assets. The quantification of stocks of natural assets and flows of environmental or ecosystem services is a precursor to economic valuation.[72] Quantification relies on diverse scientific expertise, from many biological and physical science disciplines. Equally diverse methods are used, including field surveys, statistical programs like the U.S. Forest Service's FIA Program, satellite-based remote sensing, and process-based and machine learning models. U.S. Federal Government science and natural resource management agencies have been world leaders in biophysical quantification for many decades.

Given the breadth of experience in biological and physical quantification of natural capital assets within the United States, natural capital accounts and environmental-economic statistics should rely on high-quality, statistically robust quantification approaches that are well supported by the scientific community. Particularly during pilot and prototype stages of the accounts, experimentation with various approaches and incorporation of new scientific developments is appropriate. For production-grade accounts, a balance needs to be struck among the relative information gain from updated science, the resources available to update the biological or physical information, and the state of scientific consensus on the approaches—in line with other production-grade statistical products.

Supporting recommendation: Develop robust supply-use tables to underpin U.S. natural capital accounts and use the supply-use framework as an organizing concept for U.S. environmental-economic statistics. Supply-use tables[73] and the related input-output tables[74] are

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[69] United Nations. (2021). *System of Environmental-Economic Accounting — Ecosystem Accounting*. https://seea.un.org/sites/seea.un.org/files/documents/EA/seea_ea_white_cover_final.pdf.

[70] Edens, B., Maes, J., Hein, L., Obst, C., Siikamaki, J., Schenau, S., Javorsek, M., Chow, J., Chan, J. Y., Steurer, A., & Alfieri, A. (2022). Establishing the SEEA Ecosystem Accounting as a Global Standard. *Ecosystem Services*, *54,* Article 101413. https://doi.org/10.1016/j.ecoser.2022.101413;
Brown, N., Femia, A., Fixler, D., Gravgård O.G., Kaumanns, S. C., Oneto, G. P., Schürz, S., Tubiello, F. N., & Wentland, S. (2021). Statistics: Unify Ecosystems Valuation. *Nature*, *593*(7859), 341. https://doi.org/10.1038/d41586-021-01309-z.

[71] NCAVES and MAIA (2022). *Monetary valuation of ecosystem services and ecosystem assets for ecosystem accounting: Interim Version 1st edition*. United Nations Department of Economic and Social Affairs, Statistics Division, New York. https://seea.un.org/sites/seea.un.org/files/techreportvaluationv15_final_21072022.pdf;

[72] United Nations Department of Economic and Social Affairs – Statistics Division. (2022). *Guidelines on Biophysical Modelling for Ecosystem Accounting*. https://seea.un.org/ecosystem-accounting/biophysical-modelling.

[73] A primer on supply-use tables is provided by: Young, J.A., Howells T.F., Strassner, E.H., & Wasshausen, D.B. (2015, Sept.). Supply-Use Tables for the United States. *Survey of Current Business, 95*(9). https://apps.bea.gov/scb/pdf/2015/09%20September/0915_supply_use_tables_for_the_united_states.pdf

[74] U.S. Bureau of Economic Analysis. (n.d.) *Input-Output Accounts*. Retrieved December 5, 2022, from https://www.bea.gov/data/industries/input-output-accounts-data.

core components of international standards for economic and environmental-economic accounts provided by the SNA, the SEEA CF, and the SEEA EA, each of which is important for comparability across countries and consistency across time. More information on supply-use tables is available in Appendix B. The United States generally adopts the concepts, definitions, and classifications recommended in the SNA for valuing and recording stocks and flows in the United States. NIPA, with exceptions for improvements and alternative interpretations based on conceptual or practical considerations that reflect U.S. institutions. Likewise, the United States generally intends to adopt the concepts, definitions, and classifications recommended in the SEEA CF and EA, with exceptions for improvements and alternative interpretations for specific U.S. institutions and context. Additional adjustments may be made to make use of new data, methods, and technology in order to explore alternative production and asset boundaries. This may go beyond or refine the current international standards (e.g., in order to develop a new satellite account with a scope that serves U.S. interests or key users of the data); and, while such innovation provides an opportunity for U.S. leadership, the U.S. statistical system needs to ensure that at least one set of boundaries aligns with emerging international standards.

Supporting recommendation: Supply-use tables should evolve to provide greater spatial resolution as such data become available. The supply-use connections for natural assets generally should be spatially-specific because the spatial context matters for the services that natural capital generates. The location of natural capital influences its value. For example, an additional acre foot of water in the water-scarce deserts of the southwestern United States is expected to be more valuable than in the Great Lakes Basin. Furthermore, understanding the location of natural capital will help inform adaptation to the changing climate. Accounting for this geographic variation is challenging for some natural assets given current data and methods. The system of natural capital accounts and environmental-economic statistics should be built in a manner that allows and encourages improvement as relevant spatial data and analytics advance.

Public, spatial data that underlies the accounts are often produced at relatively fine spatial resolution (e.g., 30 meters). Such data can be flexibly re-aggregated to various sub-national geographies to support various user needs—for example, aggregating at the scale of counties, metro areas, or cities, as well as regions subject to particular management regimes, like protected areas, farmland, and areas managed for timber.

Supporting recommendation: Lead on including Indigenous Peoples and incorporating Indigenous Knowledge within environmental-economic statistics. SEEA does not provide guidance on engagement or inclusion of Indigenous Peoples or Indigenous Knowledge.[75] Statistical classification systems should enable partitioning for relevant Tribal and other Indigenous Community concerns. It is also important that the environmental-economic statistics evidence base include Indigenous Knowledge, in line with applicable Federal guidance.[76]

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[75] Normyle, A., Vardon, M., & Doran, B. (2022). Ecosystem accounting and the need to recognise Indigenous perspectives. *Humanities and Social Sciences Communications*, *9*(133), 1-7. https://doi.org/10.1057/s41599-022-01149-w.

[76] Prabhakar, A., & Mallory, B. (2022, Nov. 30). *Memorandum for the Heads of Departments and Agencies: Guidance for Federal Departments and Agencies on Indigenous Knowledge*. White House Office of Science and Technology Policy & White House Council on Environmental Quality. https://www.whitehouse.gov/wp-content/uploads/2022/12/OSTP-CEQ-IK-Guidance.pdf. Prabhakar, A., & Mallory, B. (2022, Nov. 30). *Memorandum for the Heads of Departments and Agencies: Implementation of Guidance for Federal Departments and Agencies on Indigenous Knowledge*. White House Office of Science and Technology Policy & White House Council on Environmental Quality. https://www.whitehouse.gov/wp-content/uploads/2022/12/OSTP-CEQ-IK-Guidance.pdf.

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Including Indigenous Knowledge and perspectives in the U.S. natural capital accounts and environmental-economic statistics can highlight important dependencies between natural capital and the income, including in-kind income, that natural capital generates now and in the future. While some aspects of natural asset value held by Indigenous Peoples are expressed outside of natural capital accounts, others are aligned with the approach. Robust development of natural capital accounts in partnership with Indigenous Knowledge holders may lead to a clearer recognition of how much Indigenous Communities' economies are affected by changes in natural assets, and may provide a more complete reflection of how Indigenous management of natural assets contributes to the economy. The Federal Government welcomes engagement with Indigenous Knowledge holders in the production of natural capital accounts (see Section V of this Strategic Plan). Including Indigenous Knowledge can enhance the ability to frame nature as assets, track metrics, and manage nature much like a portfolio, in order to justify appropriations, programs, and policies necessary to mitigate the impacts of climate change and nature loss.

Supporting recommendation: Follow statistical standards to express and communicate uncertainty in statistical series, and consider revisions to past measures as new data emerge or uncertainty is resolved, in line with standard statistical practice. The treatment of uncertainty is thoroughly assessed in literature related to nature, global change, and economics. There will be uncertainty related to precision of measurements and price imputation in the natural capital accounts. It is important to align with standard statistical approaches for addressing uncertainty to be transparent about these uncertainties. Although methods and approaches may differ, the standards related to uncertainty for natural capital accounts and environmental-economic statistics should not be higher than for the rest of the statistical system.

Accounting Boundaries

Recommendation 3b: Information on natural assets should adhere to three specific asset boundaries in order to be inclusive of different uses and perspectives. These three boundaries are direct contribution (the SNA boundary), defensive expenditures, and individual and household production—to accommodate different applications and contexts. This implies creating three partitions in the natural capital accounts.

Choosing accounting boundaries is a core challenge of national accounting and influences many other decisions. The statistics and data included in national accounts are determined by production, consumption, and asset boundaries. These boundaries ultimately determine what counts as part of "the economy" and what does not. Determining what counts in the economy determines who is viewed as contributing to economic prosperity. Therefore, a key pathway through which natural capital accounts and environmental-economic statistics can improve equity and address environmental injustices involves looking beyond the current economic

accounting boundaries to capture otherwise missed environmental-economic relationships. This aligns with broader international discussions about "Beyond GDP" economic statistics.[77]

An important tension in establishing accounting boundaries is that there are many uses for national accounts, and alternative boundaries are relevant for different uses. Natural capital accounts are no exception. National account compilers must balance consistency, reliability, and generality with purpose-built accounts—while keeping use cases and user experience in mind. Modern data management enables the ability to work with a small number of conceptually well-defined boundaries.

[77] Stiglitz, J.E., Fitoussi J.P., & Durand, M. (2018). *Beyond GDP: Measuring What Counts for Economic and Social Performance*. OECD. https://www.oecd.org/social/beyond-gdp-9789264307292-en.htm;
World Economic Forum. (n.d.). *Beyond GDP*. https://www.weforum.org/focus/beyond-gdp.

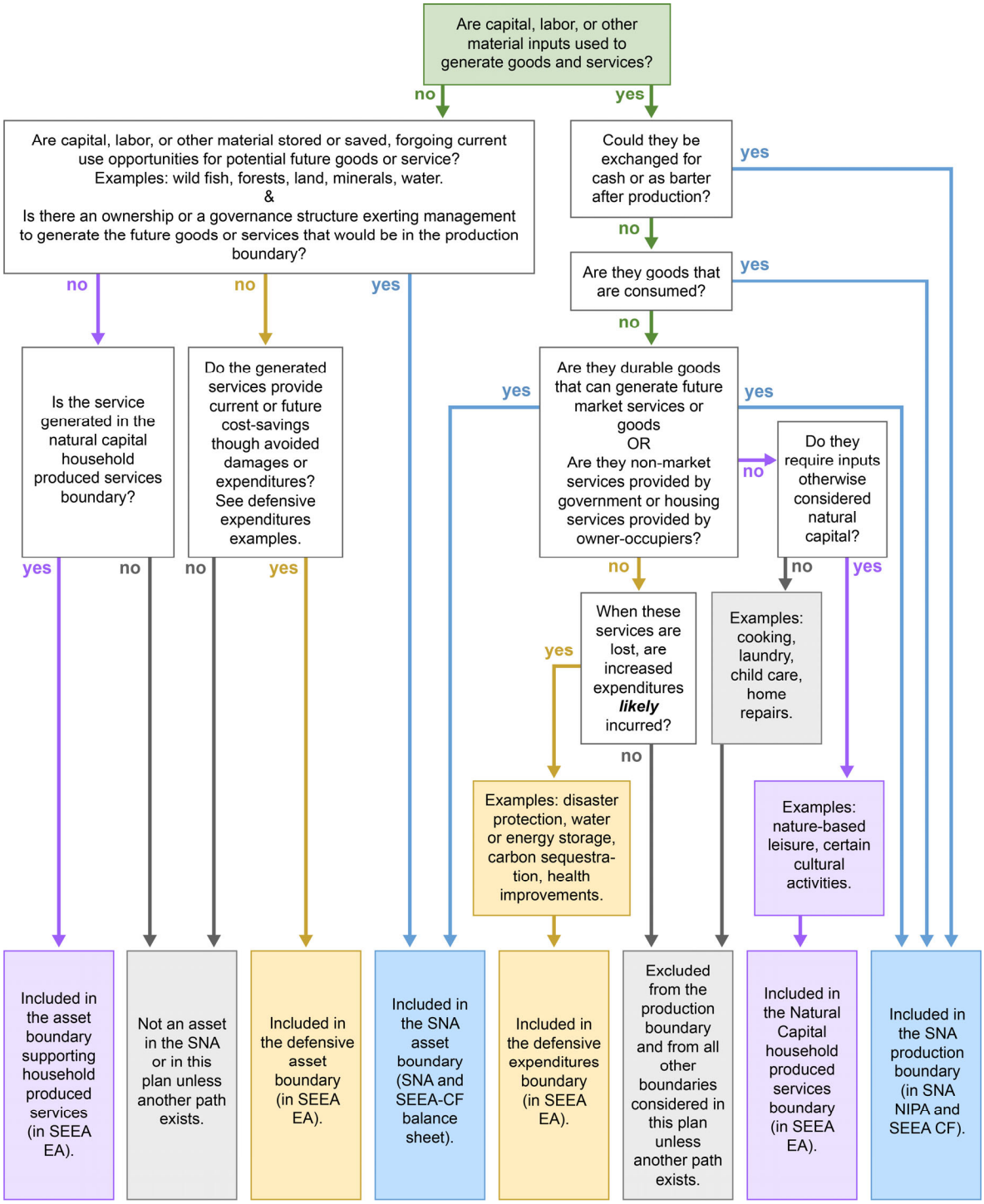

Figure 1. Relationships among SNA, defensive expenditures, and household-production-related production and asset boundaries. SEEA CF services and assets are contained within the SNA boundary, while services and assets that do not involve natural capital may be contained in the SNA boundary, but are not part of the SEEA system. This figure expands "The production decision tree" provided by: Lequiller, F. & Blades, D. (2014). *Understanding National Accounts: Second Edition*. OECD, 108. https://www.oecd.org/sdd/UNA-2014.pdf.

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The SNA production boundary focuses on monetary flow information (Figure 1, blue end points), but this leaves out aspects that are economically significant for broad policy and decision making. Monetary flow information on market exchanges has historically been useful for policy decisions related to analysis of inflation, Federal budget analysis, specific industrial policies, and other specific financial policy questions. However, monetary flow information alone is insufficient for judging economic progress.

Policy leaders speak about national economic accounts, or their summaries such as GDP, in terms mostly focused on broad economic policy questions. This aligns with the "primary purpose" of the SNA as supporting "economic analysis, decision-making and policymaking."[78] However, the current production boundary is narrower, focusing only on monetary flows within markets. The SNA acknowledges the economic importance of non-market services but states that goods and services not exchanged in markets, "have little relevance for the analysis of inflation or deflation or other disequilibria within the economy. The inclusion of large non-monetary flows of this kind in the accounts together with monetary flows can obscure what is happening in markets and reduce the analytical usefulness of the data."[79] A new chapter in the 2025 SNA is planned to begin addressing this disconnect.[80] Furthermore, the SNA's statement about non-market services may not account for cases when systematic changes in non-market services introduce systematic measurement error into the value added of market goods, and such measurement errors are likely from the effects of climate change and nature loss.

The SNA asset boundary depends on the production boundary, but the asset boundary includes non-financial and non-produced assets, including some biological and natural assets. For example, language in the internationally agreed-upon SNA states, "natural resources are treated as assets in the SNA. Natural resources such as land, mineral deposits, fuel reserves, uncultivated forests or other vegetation and wild animals are included in the balance sheets . . . . Assets need not be privately owned and could be owned by government units exercising ownership rights on behalf of entire communities. Thus, many environmental assets are included within the SNA."[81] Creation, depletion, or degradation of these assets does not directly affect current production, but when it influences future production, then these assets are within the SNA asset boundary (Figure 1). Including natural assets on national balance sheets with monetary information that informs macroeconomic policy remains in its infancy in the United States and is uncommon globally, though a few countries do have some natural assets on their balance sheets, most notably land.[82] Implementation of the existing SNA boundaries can be challenging for many

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[78] United Nations Statistics Division. (2022). *System of National Accounts 2008 – Sections 1.1 & 1.78*. https://unstats.un.org/unsd/nationalaccount/sna2008.asp.
[79] United Nations Statistics Division. (2022). *System of National Accounts 2008 – Section 1.41*. https://unstats.un.org/unsd/nationalaccount/sna2008.asp.
[80] Advisory Expert Group on National Accounts. (2020). *A Broader Framework for Wellbeing and Sustainability in the System of National Accounts*. https://unstats.un.org/unsd/nationalaccount/aeg/2020/M14_6_5_Wellbeing_Sustainability_Framework.pdf.
[81] United Nations Statistics Division. (2022). *System of National Accounts 2008 – Section 1.46*. https://unstats.un.org/unsd/nationalaccount/sna2008.asp.
[82] Bagstad, K. J., Ingram, J. C., Shapiro, C. D., La Notte, A., Maes, J., Vallecillo, S., Casey, C. F., Glynn, P. D., Heris, M. P., Johnson, J. A., Lauer, C., Matuszak, J., Oleson, K. L. L., Posner, S. M., Rhodes, C., & Voigt, B. (2021). Lessons Learned from Development of Natural Capital Accounts in the United States and European Union. *Ecosystem Services*, *52,* Article 101359. https://doi.org/10.1016/j.ecoser.2021.101359.

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national statistical offices. However, the United States has the expertise to put natural assets on its balance sheet. Complying with the SNA boundary, and putting the natural assets that are within the SNA boundaries on the balance sheet, will be a substantial step in connecting nature with the economy. This is a focus in the 2025 SNA revision.[83] Early-stage physical accounts and experimental monetary accounts are useful to the countries already experimenting with implementation.

The need to move beyond the SNA boundaries in order to tackle 21st century economic challenges is well known. This is often captured by "Beyond GDP" economic statistics. Hundreds of "Beyond GDP" statistics and indicators have been proposed,[84] and the boundaries of what is "Beyond GDP" are not always well-defined. Having well-defined boundaries to guide the first steps beyond the SNA boundaries is important for practical implementation.

Supporting recommendation: Begin moving beyond SNA boundaries by focusing on asset boundaries associated with services acknowledged in the SNA, but excluded from the SNA production boundary, and other well-accepted service types. In order for natural assets to appear on a balance sheet, there must be a system to describe how changes in the quantity of these assets affect real income. Priority should be given to future market services and other near market services, along with natural assets that provide non-market services for which there are well-established measurement methods in the economics literature.

Supporting recommendation: Include all natural assets that belong within the SNA asset boundary in the national economic accounts and move systematically beyond the SNA asset boundary to measure assets that provide sources of income, including cases of implicit or in-kind income, and production that is beyond the SNA production boundary. *Statistics for Environmental-Economic Decisions* must address three asset boundaries defined by sources of income, including implicit or in-kind income:

(1) **Direct contribution to direct production and market or market proximate income that corresponds to the SNA production boundary or its implementation in the U.S. NIPA.** For example, changes in pollinator populations may change agricultural production of pollinator-dependent fruits and vegetables, while changes in groundwater may influence net revenue of row crops. Including these assets is straightforward and aligns with current measures of production, gross or net. While the current production boundary considers monetary investment in these assets, it ignores investment by forbearance, so actions that lead to natural growth in natural assets are not considered an investment adding to GDP, NDP, or NNI. However, the 2025 SNA revision may call for growth of these stocks to be treated as fixed capital formation, which would help address

[83] Advisory Expert Group on National Accounts. (2022). *Accounting for Biological Resources.* https://unstats.un.org/unsd/nationalaccount/aeg/2022/M19/M19_6_WS8_Accounting_Biological_Resources.pdf; Advisory Expert Group on National Accounts. (2020). Accounting for Economic Ownership and Depletion of Natural Resources. https://unstats.un.org/unsd/nationalaccount/aeg/2020/M14_6_2_Accounting_Economic_Ownership_Depletion_Natural_Resources.pdf.

[84] Hoekstra, R. (2019). *Replacing GDP by 2030: Towards a common language for the well-being and sustainability community.* Cambridge University Press.

this challenge.[85] Including natural capital is a precursor to enabling this treatment and enabling certain activities of forbearance and conservation to be accounted for as investment.

(2) **Offsetting defensive expenditures captured as output in the NIPA. Such defensive expenditures should illustrate potential trade-offs concerning national income within this boundary.** Defensive expenditures are expenditures that prevent or reduce "bad outcomes" such as injuries and deaths.[86] Expenditures that replace or enhance unpriced natural capital are defensive expenditures. These expenditures often involve providing substitute services or complementary capital investment.[87] The standard production of national accounts, however, requires recording expenditures or economic output rather than physical, biological, or social outcomes. The defensive expenditures boundary is especially important for accounting for a variety of services generated from natural capital, including physical and mental health services. For example, medical care expenditures are recorded rather than the value of increased quality-adjusted life years. Consider a case where an increase in urban forests, at a cost of $40 million, reduces heat stress sufficient to avoid $60 million (measured in present value) in medical expenditures. This case suggests that spending money on the forests saves the economy $20 million by avoiding medical bills.[88] GDP, however, provides an incomplete picture of this scenario. GDP-based economic growth is reduced by $60 million from lost medical expenditure, and only gains $40 million in forest investment. Gross production is measured as $20 million less – even though the forest strategy saves resources. This illustrates the counterintuitive way that defensive expenditures enter GDP. National accounts have no counterfactuals to illustrate this tradeoff, particularly if natural capital investments are not fully accounted for. The extra $20 million is not included in the accounts unless it is spent elsewhere. If spent elsewhere, then it is not necessarily attributable to the health savings or the production from the forest. Formally, "the economy" grows by $20 million less with the forest than without the forest, despite "the economy" receiving $20 million more in net benefits. In such cases, valuing the forest based on the net present value of the flow of services would capture the $60 million increase in wealth on the balance sheet. The suite of natural capital accounts, accounting for defensive expenditures, and the NIPA together provide a more complete picture of the economy, where natural assets are valued at their net present value of the flow of services

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[85] Advisory Expert Group on National Accounts. (2022). *Accounting for Biological Resources.* https://unstats.un.org/unsd/nationalaccount/aeg/2022/M19/M19_6_WS8_Accounting_Biological_Resources.pdf.

[86] The appropriate treatment of defensive expenditures has been debated since the dawn of national economic accounts. Initially, American economist Simon Kuznets believed defensive expenditures should not contribute to national income and production. British economist Maynard Keynes reversed that view so that paying for World War II would increase British national income.

[87] Cohen, F., Hepburn, C. J., & Teytelboym, A. (2019). Is natural capital really substitutable? *Annual Review of Environment and Resources*, *44*, 425-448. https://doi.org/10.1146/annurev-environ-101718-033055;
Rouhi Rad, M., et al. (2021). Complementarity (Not Substitution) between Natural and Produced Capital: Evidence from the Panama Canal Expansion. *Journal of the Association of Environmental and Resource Economists*, *8*(6), 1115-1146. https://doi.org/10.1086/714675.

[88] This misattribution is unimportant for a measure of economic output, if one assumes the funds would have been invested elsewhere in new capital. However, this does not account for the potential for debt reduction, which does matter for fiscal and budgetary policy.

provided, rather than at the cost of provision. Alternatively, one might think of some final expenditures in the economy as intermediate inputs,[89] where the gross value add of the production in the example above would be $20 million greater if the forest were used to provide the intermediate input in place of the medical industry. However, rather than constantly redefining intermediate inputs, a suite of natural capital accounts that include defensive expenditures can illuminate this more complete accounting of economic activity.

(3) **In-kind income that stems from the set of services that individuals and households produce for themselves.** These services are generally beyond the production boundary of the SNA. Still, many of these services, such as some forms of outdoor recreation, are important to economic prosperity and are relevant to economic decision-making. The SNA, and by extension the U.S. NIPA, places these services outside the production boundary because these services are not marketable production[90] and are seen as making analysis of topics such as inflation more challenging. However, labor supply, wage rates, and policy do impact financial stability. In some cases, the state of natural capital may affect employment choices and wage rates. There is some evidence that employees may accept lower wages to work for environmentally-friendly firms,[91] require a wage premium to work in a pollution-intensive industry,[92] and may accept reduced wages in exchange for high-quality natural amenities in the work space. Furthermore, cleaner air and easier access to forests and green spaces may raise the value of leisure time, possibly leading workers to demand higher wages to forgo leisure. Thus, it is important to assess the monetary value of these natural capital-dependent services that individuals and households produce for themselves. These effects may be partially captured within the SNA boundary but are not attributed to the contributions of natural capital. Furthermore, given the way the accounts are used to assess overall economic prosperity, extensions to include services that individuals produce for themselves is important. This topic is closely related to "unpaid household service work," a topic being taken up in the 2025 SNA revision.

Ideally, these three boundaries would be mutually-exclusive. However, as the prior examples illustrate, in practice this is not the case. Figure 1 illustrates that a single natural asset may produce services that correspond to multiple boundaries. Therefore, a physical inventory of U.S. natural assets includes all assets covered by these three boundaries, with care needed not to double count. These boundaries cover most of the services identified in the SEEA (Figure 2). Some defensive expenditures and household-produced goods related to natural capital are within the SNA boundaries. For example, home gardening production is within the SNA boundary, but it is seldom measured. Likewise, some assets that reduce defensive expenditures are within the

[89] International standards do not treat medical expenditures as intermediate goods as a matter of practicality. Not all medical treatment would be treated as an intermediate good. The requirement is that there is a direct dependency that does not flow through income or population growth.

[90] This includes services that you could not pay someone else to do for you, like taking a relaxing walk in a local park. It also includes some cultural services where nature supports community building.

[91] Wolman, J. (2022). *The B-schooler embracing lower pay*. Politico. https://www.politico.com/newsletters/the-long-game/2022/03/03/talkin-straight-business-00013183.

[92] Cole, M. A., Elliott, R. J., & Lindley, J. K. (2009). Dirty money: Is there a wage premium for working in a pollution intensive industry? *Journal of Risk and Uncertainty*, *39*(2), 161-180. https://doi.org/10.1007/s11166-009-9077-x.

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SNA boundary, but they are misattributed. For example, flood protection from coastal dunes, marshes, and wetlands likely capitalizes into property values but are not attributed to the natural assets within the SNA.[93] This is why Figure 2 shows overlap among the boundaries. Figure 2 also shows that some aspects of the Earth system, and perhaps even the SEEA system, are outside the accounting boundaries established in this Strategic Plan. This is inevitable for a system of environmental-*economic* statistics, as the economic system exists in the context of a broader global system. Some of the elements outside of the boundaries associated with this Strategic Plan may be assessed in the National Climate Assessment and the National Nature Assessment.

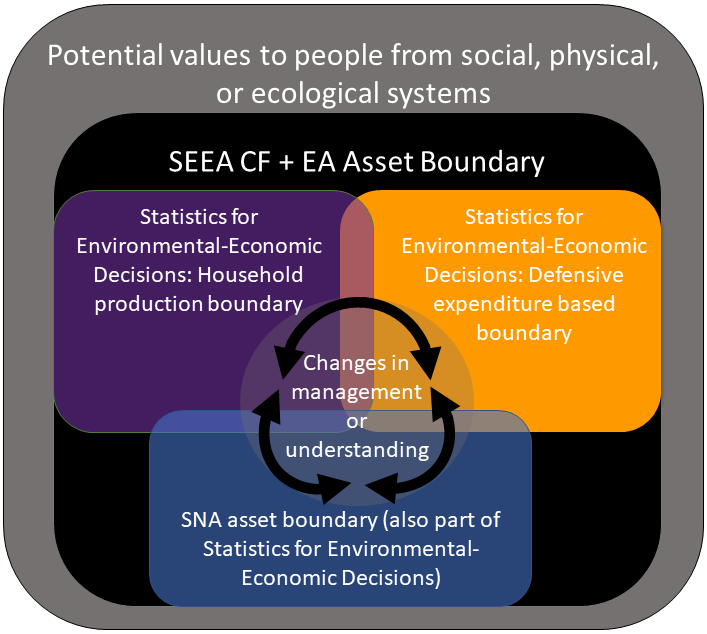

Figure 2. Relationships among potential and actual accounting boundaries. Which boundary applies to a given natural asset depends on management and understanding of interactions.

Supporting recommendation: When a natural asset, or the value attributable to a natural asset, can be included within the SNA boundaries, then it should be included in the SNA partition, with residual natural assets or value placed within one of the other appropriate boundaries established in this Strategic Plan. This recommendation enables the United States to have complete SNA and SEEA-CF accounts that are comparable to other countries. It will enable transparent aggregation across the three boundaries for headline statistics discussed below. It does mean that physical measures of some natural assets will likely be included under multiple boundaries, with their asset value split across boundaries because a single asset can contribute to the marginal production of more than one service.

It is important to understand that which assets are covered by which boundaries can change as private and government sector behavior changes to internalize the services from natural assets. The boundaries need to reflect actual behavior and innovation. For example, coral reefs provide

[93] Barbier, E.B. (2014). Challenges to ecosystem service valuation for wealth accounting. *Inclusive Wealth Report 2014 – Measuring progress toward sustainability.* Cambridge University Press, 159-177.

many ecosystem services, including storm protection and recreational opportunities that support tourism. However, traditionally, coral reefs are considered outside of the asset boundary, as these services are provided in-kind. AXA XL[94] and Swiss Re[95] insure coral reefs against storm damage. This is an acknowledgement by the private market that coral reefs contribute to future income streams and are thus productive assets. This reclassification of ecosystem assets moves coral reefs from a defensive asset to inside the standard SNA asset boundary.[96] This illustrates how changes in the transaction arrangements can change what is in and what is out of various boundaries, which is why a small number of boundaries that enable different valuation concepts, needs to be considered. The multiple boundaries prepare the economic statistical system to adapt to rapid innovation that brings nature into the market economy.

Anchoring in Economics

Recommendation 3c: Use rigorous and established economic science for monetizing the value of natural assets, with monetization being consistent with the three established asset boundaries.

The first boundary respects the SNA production boundary, while implying a more careful and inclusive treatment than is traditionally done for the SNA asset boundary in practice. For example, many natural assets are within the SNA boundary, where they are often referred to as biological assets, and they are intended to be valued at the net present value of their future contributions to production and income, so long as the natural asset is subject to management. This brings many assets like U.S. fish stocks inside the SNA boundary, where future services include future harvest and reproduction and possibly contribution to the production of higher-valued fish products.[97] The international taskforce revising the SNA is not suggesting changes to the asset boundary, but it is projecting a desire for countries to practice more inclusive measurement with respect to the existing asset boundary, particularly with respect to natural capital.[98]

In the cases of the second and third boundaries, this recommendation implies respecting the real tradeoffs that people make in determining what creates value. Economists call this respecting consumer sovereignty. This is consistent with Krutilla's notion of the value of conservation.[99] The national natural capital accounts should take care to include diverse voices, preferences, and

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[94] Pernet, E., & Whalley, K. (n.d.). *How Insurance Coverage is Protecting Coral Reefs from Hurricanes*. AXA Climate. Retrieved July 13, 2022, from https://www.climate.axa/how-insurance-coverage-is-protecting-coral-reefs-from-hurricanes.

[95] SwissRe. (2022). *Designing a New Type of Insurance to Protect the Coral Reefs, Economies and the Planet*. https://www.swissre.com/our-business/public-sector-solutions/thought-leadership/new-type-of-insurance-to-protect-coral-reefs-economies.html.

[96] Reefs generate multiple services, and some of the other service generation will require their continued inclusion under the defensive expenditures and household production boundaries.

[97] While fish stocks are used as an example in the SNA, similar arguments may apply to: beaches and dunes actively managed by Federal agencies; protected marshes, wetlands, and forests that are part of storm and water management systems; and ecosystems that store carbon subject to Federal policy.

[98] Advisory Expert Group on National Accounts. (2022). *Treatment of Renewable Energy Resources as Assets.* https://unstats.un.org/unsd/nationalaccount/aeg/2022/M19/M19_7_WS11_Renewable_Energy_Resources.pdf; Advisory Expert Group on National Accounts. (2022). *Valuation of Mineral and Energy Resources.* https://unstats.un.org/unsd/nationalaccount/aeg/2022/M19/M19_4_WS10_Valuation_Mineral_Energy_Resources.pdf.

[99] Krutilla, J.V. (1967). Conservation Reconsidered. *The American Economic Review*, *57*(4), 777-786.

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behaviors to avoid imposing one set of preferences on others in the process of measuring natural assets and their associated services.

Adjusting for defensive expenditures implies that when this boundary is used, the avoided damages associated with actual increases in natural capital investment should be factored into the marginal value of natural capital. For example, using the SNA boundary, a sand dune that protects houses from flooding is valued at the cost of acquiring the sand dune. If the dune is naturally-produced, this may be zero. With a defensive expenditure's adjustment, it is reasonable to value a protected sand dune based on how the storm protection service capitalizes into property prices or insurance premium savings. The third boundary, related to household-produced services, is similar. For example, a common household-produced service that is beyond the SNA production boundary is cleaning one's own house or yard. Improvements in air quality can complement cleaning activities by reducing soot and by increasing cleaning productivity—just as air quality improves worker productivity. The second and third boundaries do not cover all of the use cases for nature (Figure 2), but they provide a concrete pathway to go beyond the SNA production boundary and include a number of additional services from nature.

Supporting recommendation: Focus on the changes in the quantities of natural assets and changes in their marginal values (prices, implicit prices, revealed shadow prices, or accounting prices).[100] The value of a change in natural capital, like all capital, is the change in the net present value of future real income from a change in quantity or quality of natural capital.[101] This is how flows from services are connected to the value of stocks. Changes in asset values represent changes in future opportunities. It is seldom meaningful to talk about the total value of natural capital, which may well be infinite. Still, changes in the quantity or quality of natural capital can affect real wealth. Consider water, for example. The value society would assign to all water—to shift from the water we have today to not a drop at all—is certainly incalculable. However, this is not an economically meaningful change. The value of all water is not a meaningful economic question. Rather, we might consider additional gallons or acre-feet becoming available at a specific quality. An extra 10,000 gallons of swimmable water has a finite value, which we can observe in market transactions for water or behavioral responses to the availability of that water. Price (marginal value) measures economic scarcity, therefore in general the extra 10,000 gallons of swimmable water is also likely of greater value when a water body's overall volume is low than when it is high. This illustrates how changes can be well-measured and appropriately reflect changes in how people value assets and services, whereas it may not be possible to value the total amount of some natural assets. Moreover, this example underscores that the economic value of any asset (environmental or otherwise) is limited in scope, as market value, while tractable, is a subset of its total value to society.

[100] The literature uses a number of terms for this marginal value. For instance, revealed shadow price and accounting price are alternative terms for implicit price, which are "exchange values."
[101] The appropriate income concept is Fisherian income, which maintains distinct and balanced notions of capital and income.

IV. Developing a U.S. System of Statistics for Environmental-Economic Decisions: Targets, Timelines, and Tasks

Recommendation 4: Federal departments and agencies should use a phased approach to transition from research-grade environmental-economic statistics and natural capital accounts to Core Statistical Products, and produce a single headline summary statistic, along with supporting products, tables, and reports that provide information in monetary and physical units. The Working Group recommends that the first pilot accounts should begin development in 2023, with the goal and intent that the full system is operational by 2036. Realizing that this timeline requires resources, the Working Group recommends that agencies prioritize the resources necessary to implement these efforts.

Development of a system of *Statistics for Environmental-Economic Decisions*, inclusive of natural capital accounting and associated environmental-economic statistics, requires identifying: (1) headline summaries and products—how the environmental-economic change will be communicated, (2) environmental sectors or themes—exactly what is included in the system, ultimately built into a fully-connected supply-use table, and (3) supporting activities that are either necessary to develop and manage the system or important for ensuring its usefulness (Figure 3). The Federal Government is making use of the substantial literature on environmental-economic statistics to develop this section of the Strategic Plan and will continue to use the best-available scientific and economic information to develop the accounts and statistics.

Supporting recommendation: In order to produce relevant summaries and policy reports in the aggregate or for specific natural capital sectors, a U.S. system should include supporting products, such as:

- A set of classification systems for assets and ecosystem services connecting natural assets and economic activity;
- Standardized methods for asset and service measurement and valuation;[102]
- Balance sheet components with physical quantities, which may be categorized by quality attributes,[103] and prices (partitioned according to the three accounting boundaries) for natural assets that are updated regularly; and
- Chaining rules or index number formulas to measure the changes in value of natural assets when quantities are also changing.

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[102] Brown, N., Femia, A., Fixler, D., Gravgård O.P., Kaumanns, S. C., Oneto, G. P., Schürz, S., Tubiello, F. N., & Wentland, S. (2021). Statistics: Unify Ecosystems Valuation. *Nature, 593*(7859), 341. https://doi.org/10.1038/d41586-021-01309-z.

[103] For example, SEEA EA condition accounts provide an approach to quantify changes in ecosystem quality attributes over time. Czucz, B., et al. (2021). Selection criteria for ecosystem condition indicators. *Ecological Indicators, 133*(5), Article 108376. http://doi.org/10.1016/j.ecolind.2021.108376.

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To ensure the necessary commitment from relevant departments and agencies, it is important to lay out a clear timeline for development and the steps required to achieve a production-grade system of core environmental-economic statistics and natural capital accounts, acknowledging that execution will be dependent on the availability of resources. It is also important to acknowledge that natural capital accounts will continue to evolve beyond 2036, much like the national economic accounts have been evolving for the past 70 years.

U.S. statistical agencies traditionally use a three-tier system to develop new statistical or information products. First, products are considered research or developmental. Next, products may be labeled as pilot (earlier-stage) or prototype (later-stage) products, which can more generally be considered experimental products. Once products meet quality standards, products may become core statistical products or production grade statistical products. For more information on this process, see Appendix C.

National economic accounts track sectors and have expanded over time to include new sectors as the economy has changed. A similar sectoral approach is useful for natural capital accounts. The accounts will be a compilation of several different natural asset accounts, and these individual accounts will be phased in at different rates (Figure 3). Aside from the environmental sectors, natural capital accounts need to develop the supporting components of a statistical system. Natural capital accounts should include information that needs to be summarized to be useful. This includes a headline or high-level summary and sector specific summaries and reports. One term of art for a sector-specific summary is a "satellite account."[104] Along with supporting summaries and reports, natural capital accounts need to provide the organized data that support modeling and other decision-support tools. To develop the system and communicate the information compiled within the system, some supporting activities are necessary. These include developing guidelines and manuals, securing and organizing the computational support to process data and distribute results, and engaging with the international community to ensure international comparability of national statistics.

Supporting recommendation: Over the 15-year development period, the Federal Government should phase in use of the natural capital accounts and environmental-economic statistics as they become available, and the weight the Federal Government gives to pilot and prototype accounts should depend on the decision being made, a quality assessment from experts, and the relative quality of other information available. The seemingly long development period speaks to the importance of developing environmental-economic statistics in a robust and transparent manner. For some decisions that these statistics will support, other, more case-specific evidence may exist, even once products become core statistical products. At the other extreme, environmental-economic statistics may speak to relationships and provide evidence for which no other evidence readily exists. In such cases, it will be appropriate to begin using evidence from the pilot accounts, as that evidence becomes available, while adhering to applicable Federal standards relating to evidence and information. In many cases, the experimental accounts may be able to provide useful information, especially when combined with other data.

[104] "Satellite account" is the term of art for accounts connect to the SNA but either take a piece from or append to the SNA. They are not part of the SNA. "Thematic account" is an emerging alternative term that is sometimes used.

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Supporting recommendation: Sector-specific data should be updated regularly. This Strategic Plan recommends that the headline summary be updated annually. Nevertheless, statistical information feeding into the headline summary may be updated at different intervals. Meaningful intra-annual variation or seasonality associated with some sectors may necessitate more frequent updates or alternative timelines for some sectors. Other baseline data may change slowly, or they may be costly to collect annually. It would be appropriate to collect these data at regular, but less frequent, intervals. Design decisions around timing and update frequencies should be clearly documented and justified.

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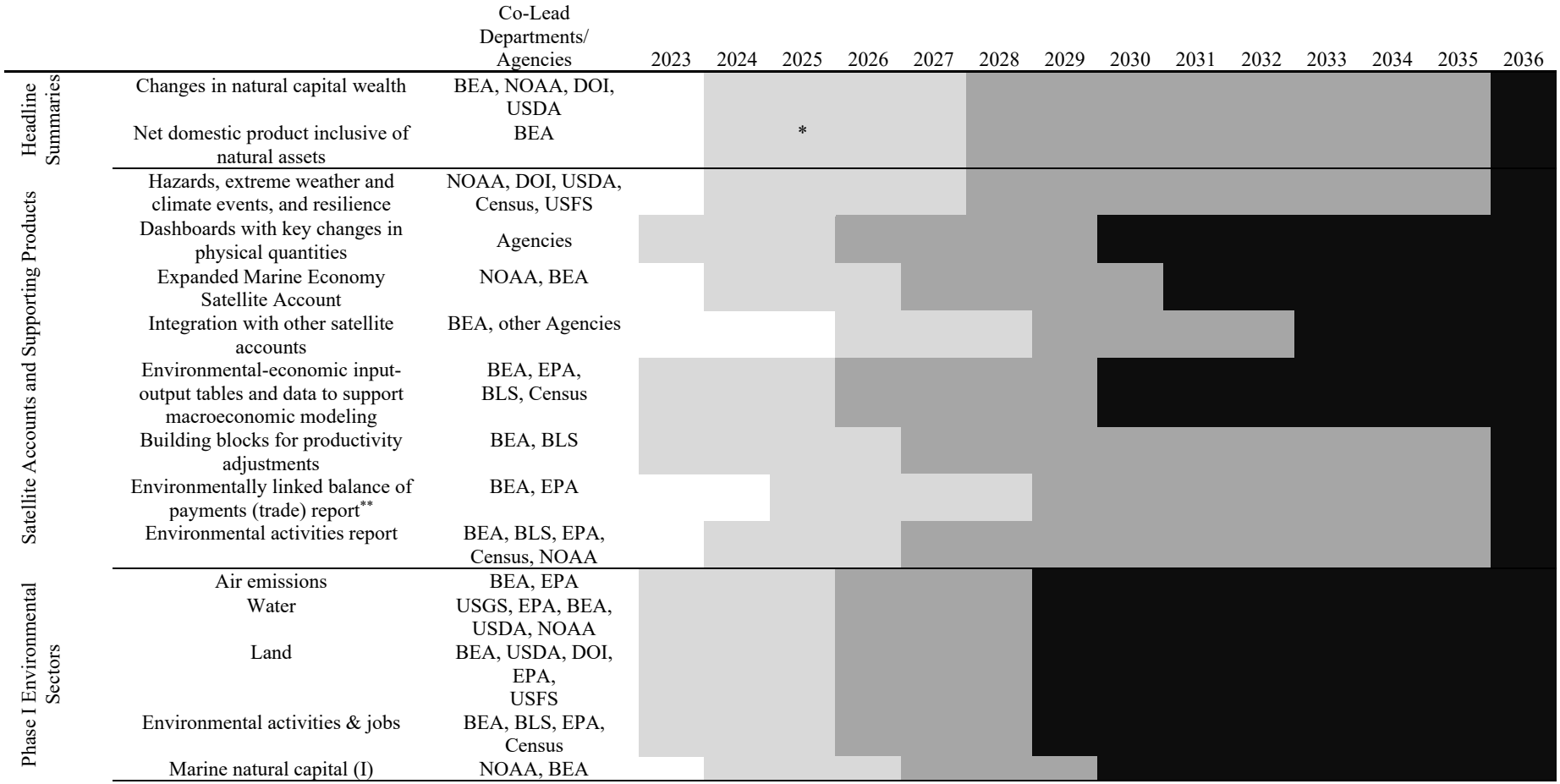
Figure 3. Development Plan by Environmental Sector and Timeline

This Gantt Chart indicates when activities will take place and when resources are needed. Deliverables may not be produced in each year and may be incomplete, especially in the pilot phase.

White indicates research activities, light gray indicates pilots and first versions, dark gray is prototypes or second versions, and black represents core statistical series inclusion or finalized methodologies.



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		Co-Lead Departments/ Agencies	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Phase II Environmental Sectors	Minerals & Energy	DOI, BEA, NOAA														
	Forests	USDA, USFS														
	Urban green space	DOI, USDA, NOAA, USFS														
	Pollinators	USDA														
	Marine natural capital (II)	NOAA, BEA														
Phase III Environmental Sectors	Wildlife, including birds, mammals, and fish	DOI														
	Wetlands and peatlands	DOI, NOAA														
	Soils	USDA														
	Grasslands, deserts, tundra, etc.	USDA, DOI														
	Marine natural capital (III)	NOAA, BEA														
	Non-traditional geologic assets	DOI, BEA														
Supporting Activities	Classification systems	CSOTUS, BEA, EPA, BLS, Census, DOI														
	Data sharing protocols	CSOTUS, NASA, DOI, NOAA, Census														
	Valuation standards for national accounting	OMB, BLS, BEA, EPA, NOAA, DOI, USDA														
	Guidance for using the system in Federal benefit-cost analysis	OMB														
	International engagement	CSOTUS, Treasury, State							Ongoing							
	Website and data serving system	BEA or other														

*Pending expected new guidance from the international statistical community in 2025.
**May articulate to the G20 data gaps initiatives.

Generally, departments are listed when either the main office (e.g., the chief economist's office) or multiple agencies are involved. BEA is called out within DOC because of its broad leadership role. NOAA and Census are called out within DOC because of uniqueness within DOC. USFS is separated from USDA because of its unique role within USDA. Department and agencies listed include: Bureau of Economic Analysis (BEA), Bureau of Labor Statistics (BLS), Census Bureau (Census), Chief Statistician of the United States (CSOTUS), Department of the Interior (DOI), Environmental Protection Agency (EPA), National Aeronautics and Space Administration (NASA), National Oceanic and Atmospheric Administration (NOAA), Office of Management and Budget (OMB), Department of State (State), Department of the Treasury (Treasury), Department of Agriculture (USDA), U.S. Forest Service (USFS), United States Geological Survey (USGS).

Headline Summaries

Supporting recommendation: The natural capital accounts and associated environmental-economic statistics have one headline product—Change in Natural Asset Wealth. Headline summaries are important for communicating statistical information.[105] This has contributed heavily to GDP's influence. GDP provides a single estimate summarizing recently mobilized resources for consumption, complemented by a rich data set underlying the statistic. A similar headline summary for natural capital accounts, aggregated across the three established accounting boundaries, would provide a complement to GDP.

> *"It's possible that the clarity brought to the idea of sustainability by this approach [economic measurement of the environment] could lift the policy debate to a more pragmatic, less emotional level. But I am inclined to think that a few numbers, even approximate numbers, would be much more effective in turning discussion toward concrete proposals and away from pronunciamentos."*
>
> – NOBEL LAURATE ROBERT SOLOW, 1992

Change in Natural Asset Wealth is a measure that has been suggested by Nobel laureate economists and the Dasgupta Review because Natural Asset Wealth is an important component of change in wealth, which is itself a necessary condition for sustainable economic development.[106] The Change in Natural Asset Wealth, which can come from quantity or price changes for specific natural assets,[107] provides an index of whether society is maintaining the capacity or capabilities of nature to provide services on which society depends. In other words, it provides the concrete measure that Roosevelt sought: whether America is turning over its natural resources to the next generation, increased and not impaired, in value, preserving opportunities for generations to come. This measure provides a unique and long-term perspective on what economic progress means. Specifically, the Change in Natural Asset Wealth ultimately tells society if today's consumption is being accomplished without compromising the future opportunities that nature provides.

A Change in Natural Asset Wealth provides a long-term perspective that complements other headline economic measures, such as GDP, unemployment, and inflation. These other measures provide near-term information that is also important, but incomplete for decision making. GDP reflects current income and mobilized resources for consumption. Unemployment and other

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[105] Solow, R. M. (1993). *An Almost Practical Step Toward Sustainability*. RFF Press. http://doi.org/10.4324/9781315060736.

[106] Arrow, K., Dasgupta, P., Goulder, L., Daily, G., Ehrlich, P., Heal, G., Levin, S., Mäler, K.-G., Schneider, S., Starrett, D., & Walker, B. (2004). Are We Consuming Too Much? *Journal of Economic Perspectives, 18*(3), 147–172. https://doi.org/10.1257/0895330042162377;
Arrow, K. J., Dasgupta, P., Goulder, L. H., Mumford, K. J., & Oleson, K. (2012). Sustainability and the Measurement of Wealth. *Environment and Development Economics, 17*(3), 317–353. https://doi.org/10.1017/S1355770X12000137;
Dasgupta, P. (2021). *The Economics of Biodiversity: The Dasgupta Review*. HM Treasury;
Hamilton, K., & Hartwick, J. (2014). Wealth and Sustainability. *Oxford Review of Economic Policy, 30*(1), 170–187. https://doi.org/10.1093/oxrep/gru006.

[107] Price, as used here, refers to the marginal value measured or imputed in the system, sometimes called "shadow price" or "revealed shadow price."

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labor statistics reflect the state of human capital. Inflation reflects the balance of supply and demand for financial capital. Natural capital accounts are expected to inject a forward-looking perspective that captures the dependence on nature into economic thinking.[108] Natural capital accounting can provide the foundation for business, investors, insurers, and banks to consider the role of nature—beyond just climate—in economic decision-making.

Change in Natural Asset Wealth is an important component of Net National Income, another important headline indicator. Formally, Net National Income accounts for changes in value of natural assets or the Change in Natural Asset Wealth.[109] However, in practice this adjustment has not been made in the United States (or in many other countries) because the change in the value of natural assets has not been measured or included on balance sheets. Developing the headline product would help to embed environmental considerations in economic policy discussions. For example, at the national scale, the natural capital accounts could make clear the dependencies of U.S. production of many specialty crops (for example, fruits and nuts) on pollinators and reflect that we grow wealthier as a country when pollinators are conserved.

Measuring the change in Natural Asset Wealth requires ascribing a monetary value to changes in natural assets in order to provide a common unit that can be compared. These changes require measurement of quantity changes, price changes, and appropriate index number adjustments.[110] When change in natural capital wealth is measured this way, it is possible to reflect the substitution and complementary opportunities that nature provides. However, aggregation does not eliminate trade-offs among assets and multiple allocations could lead to the same change in Natural Asset Wealth over a specific time period. These are general characteristics of economic statistics. This Strategic Plan unifies environmental sectors and traditional economic sectors under a single framework.

Supporting recommendation: The Federal Government should produce annual assessments of Change in Natural Asset Wealth. The metric ideally would be reported with fourth quarter GDP in early April, to help inform conversations about the environment that often occur around Earth Day (which comes approximately three weeks later). The Change in Natural Asset Wealth would be reported for all three asset boundaries, as different boundaries would help bridge different perspectives, while the headline metric should reflect aggregation across the three boundaries. Change in Natural Asset Wealth should be reported in a way that models best practices in communicating summaries from natural capital accounts. The choice of annual reporting is a practical one that should be revisited if more frequent information becomes necessary. Much like changes in GDP over time, it is expected that some of the data used for the updates will be collected, and possibly reported, more frequently—particularly when intra-annual variation matters—while other components may be updated less frequently. This follows applicable statistical standards.

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[108] Accounting is often viewed as a backward-looking exercise, and this is true in that it is based on existing data. However, capital prices are forward-looking, reflecting savings for future opportunities.
[109] In the SNA guidance only assets within the SNA asset boundary are included in these adjustments. However, if the recommendations of this Strategic Plan are followed, then the United States will produce adjustments that correspond to well-defined extensions of the asset boundary.
[110] The price of a unit of natural capital is likely to change over time for a variety of reasons.

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Supporting recommendation: Computation of the Change in Natural Asset Wealth should use an appropriate chaining procedure.[111] Generally speaking, the price of something falls as it becomes more abundant because prices reflect scarcity. This raises the question of whether a change in quantity, which is large enough to result in a price change, should be valued at the starting price or the ending price. The answer is that neither is exactly correct, and a weighted average is needed. The exact weight depends on the details. These details are employed in a technical process to determine a chaining rule that is based on index number theory.[112] Chaining rules are not relevant for households or most businesses, since how much of an asset they own seldom affects the price, but it does matter for how much natural capital a country like the United States possesses. Such chaining rules are regularly used for GDP[113] and will also be needed for the Change in Natural Asset Wealth.

Supporting recommendation: In order to support developing a headline indicator for the natural capital accounts, BEA should lead an interagency team to review the natural capital accounts as a system, to ensure alignment across the accounts, and review the ability to aggregate information across accounts while avoiding double counting. For Change in Natural Asset Wealth to be a useful headline indicator, it is important to be able to aggregate across accounts without double counting. However, initial development of accounts may lead to some overlap because of the way ecosystems interact or the way natural assets provide multiple services that do not all fit within one boundary. For example, land accounts and forest accounts may both include the value of standing timber assets. Resolving such potential overlaps is an important step in developing a meaningful headline indicator.

Supporting recommendation: Change in Natural Asset Wealth is factored into future NDP and NNI calculations using depletion and capital formation. A key challenge to this use of the natural capital accounts is that current methods to compute NDP only deduct natural asset losses, while ignoring natural asset gains. Anticipated international guidance will change this, recommending that losses of natural assets be recorded as depletion, while regeneration and growth be recorded as gross fixed capital formation.[114]

Satellite Accounts, Other Reports, and Supporting Products

National economic accounts provide a great deal of information beyond the headline summary of GDP. It is the additional data and reports that are often useful at the decision level.

Supporting recommendation: Federal departments and agencies should produce supporting and additional summary products that are phased in before 2036. These include:

a) Dashboards with key changes in physical quantities or attributes.
b) An annual report on an Environmental Activities Account that connects production, jobs, and consumer and government expenditure with nature and the environment, with the

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[111] SEEA EEA Revision Working Group 5 on valuation and accounting treatments (2019). *Discussion Paper 5.3: A Framework for the Valuation of Ecosystem Assets*. United Nations. https://seea.un.org/sites/seea.un.org/files/discussion_paper_5.3.pdf.
[112] Diewert, W. E. (2007). *Index Numbers*. Department of Economics, University of British Columbia.
[113] U.S. Bureau of Economic Analysis. (n.d.). *National Economic Accounts*. Retrieved April 10, 2022, from https://apps.bea.gov/iTable/definitions.cfm?did=1&reqId=19.
[114] Advisory Expert Group on National Accounts. (2022). *Accounting for Biological Resources*. https://unstats.un.org/unsd/nationalaccount/aeg/2022/M19/M19_6_WS8_Accounting_Biological_Resources.pdf.

potential to move to quarterly reporting, perhaps beyond 2036, if there is demand for intra-annual reports.

c) Expansion of relevant satellite accounts such as the Marine Economy and Outdoor Recreation Satellite Accounts to include natural capital to fully comply with the SNA boundaries, include activities that extend beyond the current GDP production boundary, or both. Other satellite accounts may also be produced or expanded.
d) An environmentally-linked balance-of-payment report that would connect trade flows and the environment. Such accounts would provide the United States with an advantage in international negotiations related to environmentally-linked trade actions. Such trade actions are increasingly discussed in the context of climate and are likely on the horizon for other environmental issues. They could also be useful in identifying the environmental consequences of non-tariff trade barriers.[115]
e) A special, regularly produced report or satellite account that measures damage from, and resilience to extreme weather, climate events, and other disasters.
f) Documents guiding the use of environmental-economic statistics in analysis of Federal Government decisions, for example, in government benefit-cost analysis. The first edition of this guidance would be based on experimental accounts, and the recommendation is to develop it by December 2026.

Supporting recommendation: Develop dashboards to communicate changes in physical quantities of natural capital early in the process and update them regularly. A headline summary requires aggregation to a single unit, and a monetary unit is the natural unit for aggregation in an environmental-economic accounting system. Information about physical units is also important, but different physical units cannot be aggregated into a single measure. Dashboards can provide clear communication, transparency, and decision-relevant information about the physical changes measured with natural capital accounts. The data for these dashboards should come from the physical supply-use tables.

Supporting recommendation: Continue to develop, produce, update, and expand, where possible, existing natural capital-linked satellite accounts, incorporating information from environmental-economic statistics, as feasible and appropriate, and explore opportunities for new satellite accounts made possible by natural capital accounts and environmental-economic statistics. Existing satellite accounts, such as the Marine Economy Satellite Account, Outdoor Recreation Satellite Account, Travel and Tourism Satellite Account,[116] and Health Satellite Account can potentially be enhanced through the inclusion of natural capital and other information organized in environmental-economic statistics. As the system of natural capital accounts and environmental-economic statistics develops, Federal agencies can explore opportunities for environmentally-inclusive balance-of-payments accounts or reports and a system-wide satellite account or report related to biodiversity and the economy.

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[115] Shapiro, J. S., & Walker, R. (2018). Why is pollution from US manufacturing declining? The roles of environmental regulation, productivity, and trade. *American Economic Review*, *108*(12), 3814-54. https://doi.org/10.2139/ssrn.3160315.
[116] The World Tourism Organization's statistical framework (https://www.unwto.org/tourism-statistics/statistical-framework-for-measuring-the-sustainability-of-tourism) aligns with SEEA and could be helpful for connecting natural capital accounts and the U.S. travel and tourism satellite account.

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Supporting recommendation: Develop satellite accounts or regularly provided reports on natural capital related hazards, extreme weather and climate events, and resilience. Between January 1,1980 and October 11, 2022, the United States sustained 338 climate and weather disasters at a cost exceeding $2.29 trillion.[117] Nearly half of all Americans live in areas at risk of earthquakes.[118] Recovery efforts in the quarter in which a disaster occurs, and the quarter(s) immediately following, may produce increases in expenditure and GDP associated with hazard recovery. However, these disasters divert financial capital from other investments and may increase debt. They also often destroy natural capital, reducing services from nature. Together, these effects are why extreme weather and climate events and other disasters cause depressed long-run growth.[119] In summarizing national accounts or developing reports related to extreme weather and climate events and other disasters, it could be important to differentiate potentially climate-driven disasters from those clearly not driven by climate change.

Environmental Sectors for Natural Capital Accounts and Environmental-Economic Statistics

The Working Group recognizes deep expertise in natural capital accounting and environmental-economic statistics distributed across the Federal Government and recommends maintaining and expanding this expertise. The Federal Government has a long history of conducting research on natural capital accounting and on environmental-economic statistics, going back to the 1970s (see Appendix A for more details). In 2016, agencies including the United States Geological Survey (USGS), the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA), the Environmental Protection Agency (EPA), the U.S. Forest Service (USFS), the Bureau of Economic Analysis (BEA), and others began to self-organize informally to develop coordinated natural capital research products. These efforts have produced several peer-reviewed research papers on natural capital accounting.[120] This research provides a foundation on which to build land accounts,[121] water accounts,[122] urban ecosystem accounts,[123] and natural capital accounts at the regional scale,[124] as well as a synthesis

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[117] NOAA National Centers for Environmental Information. (2022). *U.S. Billion-Dollar Weather and Climate Disasters*. https://www.ncei.noaa.gov/access/billions/.
[118] U.S. Geological Survey. (2015, Aug. 10). *Nearly half of Americans exposed to potentially damaging earthquakes.* https://www.usgs.gov/news/featured-story/nearly-half-americans-exposed-potentially-damaging-earthquakes.
[119] Hsiang, S. M., & Jina, A. S. (2014). The causal effect of environmental catastrophe on long-run economic growth: Evidence from 6,700 cyclones. *National Bureau of Economic Research*, Working Paper 20352. https://doi.org/10.3386/w20352.
[120] Bagstad, K. J., Ingram, J. C., Shapiro, C. D., La Notte, A., Maes, J., Vallecillo, S., Casey, C. F., Glynn, P. D., Heris, M. P., Johnson, J. A., Lauer, C., Matuszak, J., Oleson, K. L. L., Posner, S. M., Rhodes, C., & Voigt, B. (2021). Lessons Learned from Development of Natural Capital Accounts in the United States and European Union. *Ecosystem Services*, *52,* Article 101359. https://doi.org/10.1016/j.ecoser.2021.101359.
[121] Wentland, S. A., Ancona, Z. H., Bagstad, K. J., Boyd, J., Hass, J. L., Gindelsky, M., & Moulton, J. G. (2020). Accounting for Land in the United States: Integrating Physical Land Cover, Land Use, and Monetary Valuation. *Ecosystem Services*, *46,* Article 101178. https://doi.org/10.1016/j.ecoser.2020.101178.
[122] Bagstad, K. J., Ancona, Z. H., Hass, J., Glynn, P. D., Wentland, S., Vardon, M., & Fay, J. (2020). Integrating Physical and Economic Data into Experimental Water Accounts for the United States: Lessons and Opportunities. *Ecosystem Services*, *45,* Article 101182. https://doi.org/10.1016/j.ecoser.2020.101182.
[123] Heris, M., Bagstad, K. J., Rhodes, C., Troy, A., Middel, A., Hopkins, K. G., & Matuszak, J. (2021). Piloting Urban Ecosystem Accounting for the United States. *Ecosystem Services*, *48*, Article 101226. https://doi.org/10.1016/j.ecoser.2020.101226.
[124] Warnell, K. J. D., Russell, M., Rhodes, C., Bagstad, K. J., Olander, L. P., Nowak, D. J., Poudel, R., Glynn, P. D., Hass, J. L., Hirabayashi, S., Ingram, J. C., Matuszak, J., Oleson, K. L. L., Posner, S. M., & Villa, F. (2020). Testing Ecosystem Accounting

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of this experience and recommended next steps. The Federal Government has also produced satellite accounts related to natural resources that would benefit from the inclusion of natural capital, including the Marine Economy Satellite Account, the Outdoor Recreational Satellite Account, the Travel and Tourism Satellite Account, and the Health Account.[125] Agencies have begun research to develop crop pollination accounts, forest accounts, and environmental activities accounts, including efforts to connect the environment and job creation.[126] There have also been initiatives within the Federal Government to develop harmonized classification systems for ecosystem services[127] and to develop extended environmental input-output tables.[128] Federal agencies already collect many of the data needed for natural capital accounts, but these data are not organized in a way that enables them to be connected to the U.S. or global economy. The SEEA has yet to adopt finalized guidance on valuation of some ecosystem services and assets; this is an opportunity for U.S. global leadership in an area where the United States has invested substantial resources over the years.

Supporting recommendation: Prioritize the phasing in of natural asset accounts based on expected importance, feasibility, and adjacency to core national accounts. The Working Group has been harmonizing existing U.S. efforts. Subgroups focused on specific environmental sectors[129] have been established to develop the technical details of accounts and specific timelines and to execute account-specific deliverables. There are dependencies among the environmental sectors as well as with other economic sectors. Developing the natural capital accounts and environmental-economic statistics by sector is a practical decision. A great success of the NIPA was taking the broad concept of an economy and organizing it in a useful way, so that connections among sectors could be understood. One reason for phasing the development of the accounts is to provide opportunities to systematically examine dependencies. For example, forests, wildlife, minerals and energy, and other environmental sectors have strong interactions with land accounts and may indeed be factors within the land account. Another example includes carbon sequestration, which is important for the defensive expenditure boundary, and many asset classes have the ability to provide carbon sequestration services. These should be connected to the Air Emissions sector. As new environmental sectors are developed, previously developed environmental sectors may require revision.

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in the United States: A Case Study for the Southeast. *Ecosystem Services*, *43,* Article 101099. https://doi.org/10.1016/j.ecoser.2020.101099.

[125] U.S. Bureau of Economic Analysis. (2022). *Marine Economy Satellite Account, 2014-2020*. https://www.bea.gov/news/2022/marine-economy-satellite-account-2014-2020;
U.S. Bureau of Economic Analysis. (2021). *Outdoor Recreation Satellite Account, U.S. and States, 2020*. https://www.bea.gov/data/special-topics/outdoor-recreation;
U.S. Bureau of Economic Analysis. (2020). *Travel and Tourism*. https://www.bea.gov/data/special-topics/travel-and-tourism;
U.S. Bureau of Economic Analysis. (n.d.). *Health Care.* https://www.bea.gov/data/special-topics/health-care.

[126] U.S. Bureau of Labor Statistics. (2017). *Green Jobs.* https://www.bls.gov/green/home.htm;
U.S. Department of Commerce. (2010). *Measuring the Green Economy*. https://www.commerce.gov/data-and-reports/reports/2010/04/measuring-green-economy.

[127] U.S. Environmental Protection Agency. (2022). *National Ecosystem Services Classification System Plus - Frequently Asked Questions*. https://www.epa.gov/eco-research/national-ecosystem-services-classification-system-plus-frequently-asked-questions.

[128] Yang, Y., Ingwersen, W., Hawkins, T., Srocka, M., & Meyer, D. (2017). USEEIO: A New and Transparent United States Environmentally-Extended Input-Output Model. *Journal of Cleaner Production, 158,* 308–318. https://doi.org/10.1016/j.jclepro.2017.04.150.

[129] Some other countries use the term "theme" rather than "sector."

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Federal government priorities for phasing in natural capital accounts and environmental-economic statistics are based on four elements: (1) expected importance to sustainable economic development within the United States; (2) feasibility, existing products under development, and experience; (3) the sectors' role in national accounts or the natural capital account, including dependencies on other accounts; and (4) the Federal Government's stewardship role. These criteria have been repeatedly raised in reports that call for environmental-economic statistics for the United States.

Some potential topic areas were excluded because they are subsectors of named sectors (e.g., lakes are within water). Others were excluded as they could not be defined as proper sectors because, while they represent important concepts, they lack units appropriate for statistics and accounting, though some aspects and conceptual features are included as aggregations or partitions of other sectors (e.g., biodiversity). Others were excluded because they represent goods or services that are products of multiple listed sectors and other inputs. The latter two groups can be captured in environmental-economic statistics but may not be explicitly highlighted in the development process.

First, the Federal Government is considering expected importance. Some natural capital stocks or environment-economy connections are expected to have farther-reaching or greater consequences for economic production and economic welfare under current socio-economic conditions. All else being equal, the Federal Government is prioritizing development of natural capital accounts for these stocks. It is important to remember that some natural assets may be important because of expected large changes, even if those changes are small relative to the overall economy. Furthermore, importance may also include natural assets that are more likely to lead to security concerns and conflict—e.g., water and fish stocks.

Second, Federal Government and academic researchers have been developing natural capital accounting research products for a number of years. For some natural assets, intellectual issues related to measurement and valuation are mostly resolved, whereas others will require additional research and experimentation. Rather than wait, it is important to develop the more advanced accounts soon, based on feasibility and the current state of development. It is also possible that some Phase II (or Phase III) environmental sectors have dependencies on Phase I.

Third, some environmental sectors, such as land accounts, may nest other natural assets within frameworks like the SEEA Central Framework. Focusing on these sectors first enables the U.S. statistical system to rapidly bring natural assets into the economic accounting system, and then to disaggregate in Phases II and III.

Fourth, the Federal Government is considering mandates from Congress, the Federal Government's role in stewarding management of various natural assets, and whether the asset is already indicated as intended to be within the national accounting system. This means that natural assets that are primarily within the domain of the states may be developed last, if at all—such as non-migratory game animals. One reason for this is that a national account will require coordination with many states, introducing logistical and technical challenges. However, when states generate the data, the Federal Government would work with the states to develop and use natural capital accounts.

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Phase I Environmental Sectors

Air Emissions

Based on the criteria described above, Air Emissions accounts will be prioritized in the first phase.

Supporting recommendation: The Air Emissions account should begin with the development of physical flow air emissions and greenhouse gas emissions accounts. Statistical data on the physical flow emissions of greenhouse gases and air pollutants by economic agents (i.e., businesses, households, and governments) are key pieces of information needed to measure changes in pollution intensity of production and consumption activities in the U.S. economy. Academic researchers have already developed research products in this area.[130] A physical flow air emissions account will be compiled based on the same national account concepts, classifications, and definitions used to compile BEA's supply-use tables and other accounts, which facilitates the direct linking of data on physical flow air emissions to economic information in the supply-use tables and other accounts.

A physical flow air emissions account and related indicators is one of the targets for climate change measures mandated by the G20 central bank governors and finance ministers as part of the Data Gaps Initiative.[131] BEA and EPA are currently working on developing the first U.S. physical flow air emissions account consistent with SEEA, which will include carbon dioxide, six other greenhouse gases, and one criteria air pollutant (fine particulate matter). This account will include emissions from economic units attributed to industries and households in a supply-use framework.[132]

To assemble this account, the cooperating agencies are using existing data products, including EPA's Greenhouse Gas Inventory (GHGI), consistent with the U.N. Framework Convention on Climate Change and the National Emissions Inventory (NEI) for criteria air pollutants and hazardous air pollutants.

Supporting recommendation: Two key tasks should be resolved as part of the pilot Air Emissions account related to emission data. First, the pilot account leverages EPA's Air QUAlity TimE Series (EQUATES) project, which generates a consistent time series that is currently not available for the NEI. The EQUATES project was not funded after 2019, so an alternative time series would need to be developed beyond 2019, with active participation from the EPA's NEI program. Second, source data required to adjust the GHGI and NEI to SEEA-consistent concepts do not currently exist or have not been made available to BEA and EPA for the pilot account, so either new source data need to be developed, or U.S. agencies and non-governmental organizations need to resolve source data-sharing processes. Once these two areas are resolved, a prototype account will be possible for physical flow accounts.

Supporting recommendation: EPA and DOC should explore the potential of valuing the emissions in the account, utilizing existing EPA models, once the physical flow accounts are

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[130] Muller, N.Z. (2014). Boosting GDP Growth by Accounting for the Environment. *Science*, *345*(6199), 873-874. https://doi.org/10.1126/science.1253506.

[131] International Monetary Fund. (2022). *G20 Data Gaps Initiative*. https://www.imf.org/en/Publications/SPROLLs/G20-Data-Gaps-Initiative#sort=%40imfdate%20descending.

[132] Currently, emissions from ecosystems, such as methane from wetlands, are excluded as indicated by SEEA.

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built. For valuing the damages associated with fine particulate matter emission, the EPA Environmental Benefits Mapping and Analysis Program – Community Edition (BenMAP-CE) software could be utilized to estimate the health and economic damages associated with this air pollutant.[133] One key input for BenMAP-CE is a contiguous U.S. grid of average annual surface concentrations of fine particulate matter. Currently, EPA uses data derived from modeling emissions data using the Community Multiscale Air Quality Modeling System (CMAQ) paired with the EQUATES product. The CMAQ-EQUATES model outputs emissions from all included sectors for 2002 through 2017. Additional air modeling for sector-specific emissions is needed to produce economic-sector-specific valuations beyond 2017. For greenhouse gas emissions, estimates for the social cost of carbon dioxide, methane, and nitrous oxide are available and regularly used to monetize the climate damages associated with emissions of these gases. A technical support document developed by the Interagency Working Group on Social Cost of Greenhouse Gases (IWG) provides the current IWG-recommended estimates while work on a more comprehensive update is underway.[134] In addition, EPA is currently soliciting public comment on a newly developed set of draft social cost of greenhouse gas estimates[135] that incorporates recent research addressing recommendations of the National Academies of Sciences, Engineering, and Medicine.[136]

[133] U.S. Environmental Protection Agency. (2021). *Environmental Benefits Mapping and Analysis Program - Community Edition (BenMAP-CE)*. https://www.epa.gov/benmap.
[134] Interagency Working Group on Social Cost of Carbon. (2021). *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide: Interim Estimates under Executive Order 13990.* United States Government. https://www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf.
[135] Environmental Protection Agency. (2022). *EPA External Review Draft of Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances (Docket ID No. EPA-HQ-OAR-2021-0317)*. https://www.epa.gov/system/files/documents/2022-11/epa_scghg_report_draft_0.pdf.
[136] National Academies of Sciences, Engineering, and Medicine. (2017). *Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide.* National Academies Press. https://doi.org/10.17226/24651.

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By the end of the pilot stage, Federal agencies, states, and private firms will understand how air quality and emissions connect with traditional economic sectors. The pilot phase will explore an estimate of the damages associated with these key air emissions and potential estimates of economic growth adjusted for air emission damages. At later stages, air quality improvements or declines will be factored into the Change in Natural Asset Wealth. This information will be helpful to Federal regulators and private firms wishing to develop, implement, and monitor emissions-reduction strategies.

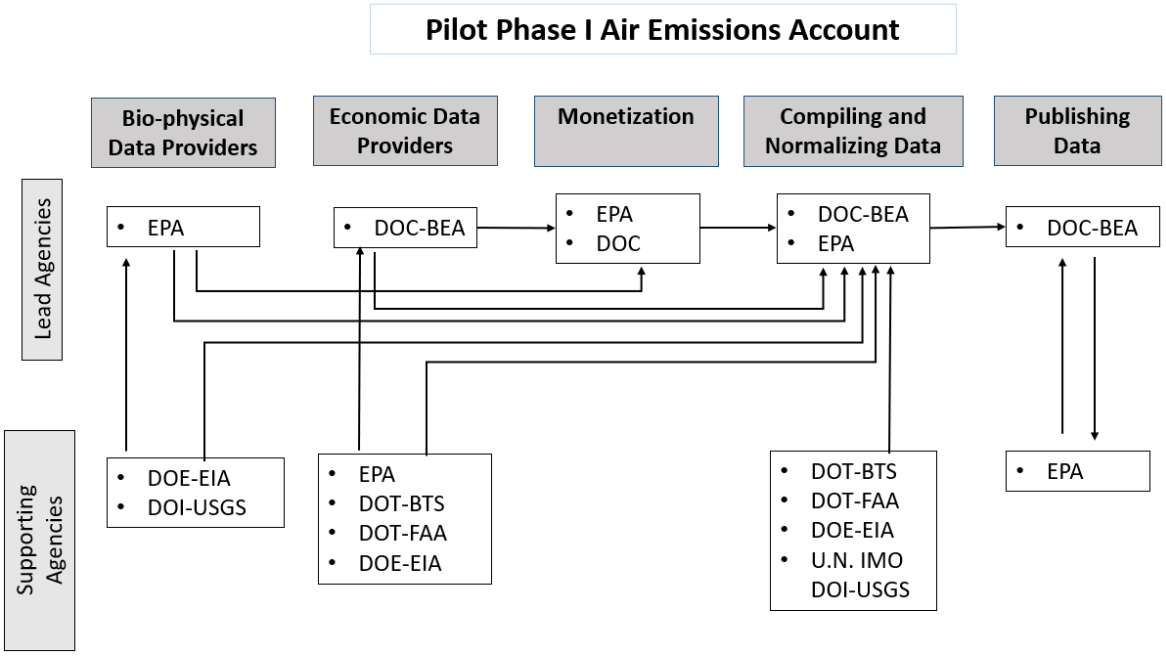

Figure 4. Agencies involved in producing the Air Emissions account.

Land

Land accounts stand at a unique crossroads in the set of international statistical standards for national accounting. Specifically, land accounts lie at the intersection of the SNA, SEEA CF, and (as a spatial unit) SEEA EA, making land an important early-phase account and a priority for developing natural capital accounts. By quantifying land physically and monetarily, land accounts have a number of applications, as they can provide descriptive snapshots of U.S. land use and value, as well as, insights into aggregate changes to the physical environment as indicated by land use-land cover (LULC) changes over time.

The Federal Government has undertaken efforts to quantify and value land for decades. These have often been limited in scope to a particular type of land (e.g., USDA's valuation of farmland)[137] or a medium specific to analyzing the biophysical aspects of land (e.g., USGS's

[137] U.S. Department of Agriculture National Agricultural Statistics Service. (2022). *USDA - National Agricultural Statistics Service Homepage*. https://www.nass.usda.gov/.

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National Land Cover Database).[138] In a 2020 collaboration between USGS and BEA, researchers published the Federal Government's first effort to explore the feasibility of constructing land accounts in the United States consistent with the SEEA CF, integrating physical and monetary aspects of land in a consistent framework. [139] This study used microdata ("big data") from Zillow's ZTRAX database to estimate the value of land for most of the United States. The project utilized detailed information from hundreds of millions of property transactions within a hedonic framework to estimate property-level land values of residential, agricultural, commercial, and industrial land. These values can be aggregated to local, state, regional, and national levels.[140]

Supporting recommendation: The Land account should build on the BEA-USGS study that demonstrated that property-level estimates of land value can be linked to updated land use-land cover data for the lower 48 states to construct a pilot set of SEEA land account tables. The study documented gaps in current data sources and suggested steps that BEA could take to remedy those data gaps in order to produce a full set of SEEA land accounts (in collaboration with USGS for the physical land cover land use tables) and land valuation for the non-produced, non-financial assets on the national balance sheet in the Integrated Macro Accounts.

Supporting recommendation: The Land account should make use of the numerous efforts across the Federal Government that quantify biophysical aspects of land or corresponding land-based ecosystem services. For example, the Multi-Resolution Land Characteristics Consortium (MRLC), an interagency group tasked with producing land cover information, regularly (currently every 2 to 3 years) publishes the National Land Cover Database, which quantifies land cover in a consistent national framework and tracks changes over time.[141] The USGS Earth Resources Observation and Science (EROS) Center has developed the Land Change Monitoring, Assessment, and Projection (LCMAP), a next-generation effort that reduces latency, improves temporal frequency, and provides a longer historical record than NLCD.[142] Ongoing USGS integration of NLCD and LCMAP products, in addition to several other remote-sensing-based analyses that characterize different attributes of landscape change, offer the capability to inform analysis such as the 2020 pilot study by Wentland et al.,[143] demonstrating how these data can be used to produce physical land asset accounts consistent with the SEEA CF.

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[138] Multi-Resolution Land Characteristics Consortium. (2022). *Homepage.* https://www.mrlc.gov/.

[139] Wentland, S. A., Ancona, Z. H., Bagstad, K. J., Boyd, J., Hass, J. L., Gindelsky, M., & Moulton, J. G. (2020). Accounting for Land in the United States: Integrating Physical Land Cover, Land Use, and Monetary Valuation. *Ecosystem Services*, *46*, Article 101178. https://doi.org/10.1016/j.ecoser.2020.101178.

[140] The U.K.'s Office for National Statistics has used a similar hedonic approach from its national house price index for its new project valuing land underlying dwellings as a "non-produced, non-financial asset" on its national balance sheet. U.K. Office for National Statistics. (2022). *Improving Estimates of Land Underlying Dwellings in the National Balance Sheet, UK: 2022*. https://www.ons.gov.uk/economy/nationalaccounts/uksectoraccounts/articles/improvingestimatesoflandunderlyingdwellingsinthenationalbalancesheetuk/2022.

[141] U.S. Geological Survey. (2018). *National Land Cover Database*. https://www.usgs.gov/centers/eros/science/national-land-cover-database.

[142] U.S. Geological Survey. (2022). *Land Change Monitoring, Assessment, and Projection.* https://www.usgs.gov/special-topics/lcmap.

[143] Wentland, S. A., Ancona, Z. H., Bagstad, K. J., Boyd, J., Hass, J. L., Gindelsky, M., & Moulton, J. G. (2020). Accounting for Land in the United States: Integrating Physical Land Cover, Land Use, and Monetary Valuation. *Ecosystem Services*, *46*, Article 101178. https://doi.org/10.1016/j.ecoser.2020.101178.

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Supporting recommendation: Utilize USDA's multiple initiatives and resources related to land that could complement and aid in the production of next-generation Land Accounts. USDA's National Agricultural Statistics Service (NASS) produces regular statistics on the value of agricultural land and real estate in the United States, as well as information on land use, ownership, and tenure. The USFS Forest Inventory and Analysis (FIA) Program provides regular statistics on the nation's forests on public and private lands. The program includes data on forest extent, ownership, and changes in condition. Subsamples include data on soils, understory vegetation, and invasive species. The FIA Program is a key component of national carbon accounting and is currently updating entity-scale (farm and forest stand) guidelines for forest greenhouse gas estimates. The Resources Planning Act (RPA) Assessment, produced by USFS Research and Development, reports on the status and trends of the Nation's renewable resources on all forests and rangelands, as required by the Forest and Rangeland Renewable Resources Planning Act of 1974.[144] Existing data sets provide a sufficient information to initiate the Land Accounts.

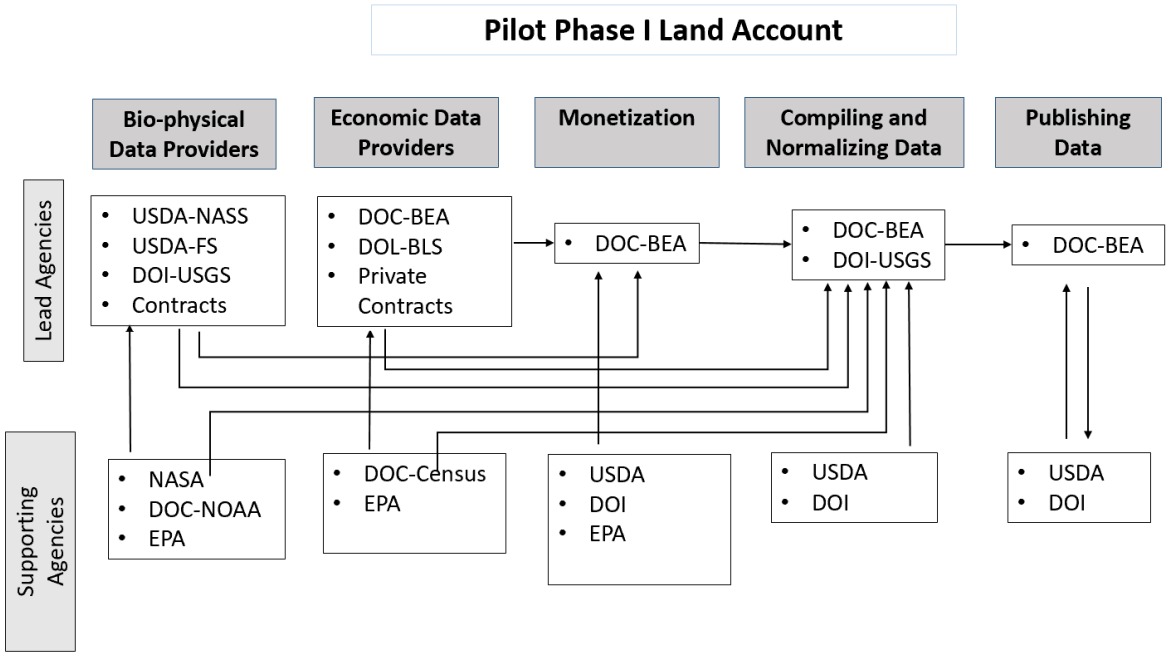

Figure 5. Agencies involved in producing the Land account.

Supporting recommendation: BEA should initiate piloting Land on the non-produced non-financial balance sheet by the end of 2023, inclusive of the value of multiple land-use types, including agricultural, residential, commercial, and industrial lands, but initially exclusive of public lands and certain other land types that are not regularly bought and sold in private markets. This work will make use of commercially sourced data; USGS's NLCD, LCMAP, and Protected Areas Database; Bureau of Land Management's (BLM) Public Land Statistics and underlying data; USDA's Cropland Data Layer and Agricultural Resource Management survey; and USFS FIA data.

[144] 16 U.S.C. §§ 1600 et seq.

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Supporting recommendation: The land accounts should be extended beyond the contiguous 48 states, first to Alaska and Hawai'i, and then to U.S. territories. It is important that national accounts for the United States cover the entire United States including the territories.

Supporting recommendation: BEA should build on the research SEEA Land account by coordinating with USGS and other agencies to update the SEEA pilot accounts with new data and methods sufficient for transitioning into regular production of these accounts. For example, BEA and USGS's EROS Center would need to coordinate the regular production of land-use data, similar to what is used by the pilot account published in Wentland et al.[145] This joint effort would result in a prototype or experimental account that quantifies land use in the United States, which would work in conjunction with land value data to produce detailed aggregate (and regional) estimates of land value at regular intervals for the entire United States and its territories. Along with proper review of the data and methods, this interagency effort would result in well-developed prototype accounts published by BEA by 2026. Following the recommendations of this Strategic Plan will enable regular production of a full set of land asset accounts by 2029.

Marine Natural Capital (Phase I)

As with the entire economy, existing efforts to characterize the U.S. marine economy do not account for specific natural assets, other environmental inputs, and the ecosystem services that support economic activities.[146] Existing measurement reveals that the market-based marine economy contributes substantially to the U.S. economy—$361.4 billion contributed to the national GDP in 2020, $610.3 billion generated in sales, and more than 2.2 million jobs supported. In addition, the marine environment provides key habitats and resources to support important portions of U.S. wealth and wellbeing not traded in formal markets. NOAA has been developing better measures of the U.S. marine economy for over a decade. These measures include the Marine Economy Satellite Account (MESA),[147] which was developed in collaboration with BEA, and the Economics: National Ocean Watch (ENOW),[148] created using data from BLS and Census, which has provided marine economy statistics for states and counties for almost a decade.

Supporting recommendation: The Phase I Marine accounts should focus on marine natural assets that are clearly within the asset boundary of the NIPA, such as fish stocks and marine minerals. This will enable the United States to track progress on some marine conservation activities, identify areas for improvement, highlight trade-offs that may exist related to resource

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[145] Wentland, S. A., Ancona, Z. H., Bagstad, K. J., Boyd, J., Hass, J. L., Gindelsky, M., & Moulton, J. G. (2020). Accounting for Land in the United States: Integrating Physical Land Cover, Land Use, and Monetary Valuation. *Ecosystem Services*, *46,* Article 101178. https://doi.org/10.1016/j.ecoser.2020.101178.

[146] Stuchtey, M., et al. (2020). "Ocean Solutions That Benefit People, Nature and the Economy." Washington, DC: World Resources Institute. www.oceanpanel.org/ocean-solutions.;
Hoagland, P., Jin, D., & Beaulieu, S. (2020). A Primer on the Economics of Natural Capital and Its Relevance to Deep-Sea Exploitation and Conservation. In *Natural Capital and Exploitation of the Deep Ocean*, 25–52. Oxford University Press. http://doi.org/10.1093/oso/9780198841654.003.0002.

[147] U.S. Bureau of Economic Analysis. (2022). *Marine Economy Satellite Account, 2014-2020*. https://www.bea.gov/news/2022/marine-economy-satellite-account-2014-2020.

[148] NOAA Office for Coastal Management, U.S. Bureau of Labor Statistics, & U.S. Bureau of Economic Analysis. (2022*). Economics: National Ocean Watch*. https://coast.noaa.gov/digitalcoast/data/enow.html.

use and in marine planning, and consistently track the health of marine ecosystems and their capacity to provide goods and services to society. Additional recommendations include:

- Using NOAA Fisheries' quarterly National Fish Assessment reports for Federally-managed fish stocks and the annual Commercial Landing Statistics by species, supplemented by NOAA's Marine Recreational Information Program as data sources for the physical stocks and flows of marine fish.
- That the data for stocks and flows of marine minerals come from the U.S. Energy Information Administration (EIA)'s U.S. Crude Oil and Natural Gas Proved Reserves and the Bureau of Ocean Energy Management (BOEM)'s Outer Continental Shelf Reserve Estimates.
- Combining these statistics with other information on fixed assets (e.g., boats) and environmental stressors (e.g., pollutants), which can be obtained from NOAA's Vessel Surveys and the Integrated Ecosystem Assessments.
- Connecting to the market activities through supply-use tables, based on models already used in the MESA.

The MESA framework can also be adjusted to better reflect the expenditures of the public and private sectors on pollution prevention and mitigation to achieve sustainable fisheries.

Key tasks and deliverables for the Phase I pilot include a summary of the provisional services flowing from ecosystems to the fisheries and minerals industries, which are within the production boundary of the national account; stocks of the natural assets and associated ecosystem conditions; and spatial mapping of the relevant marine assets overlaying physical features and economic activities.

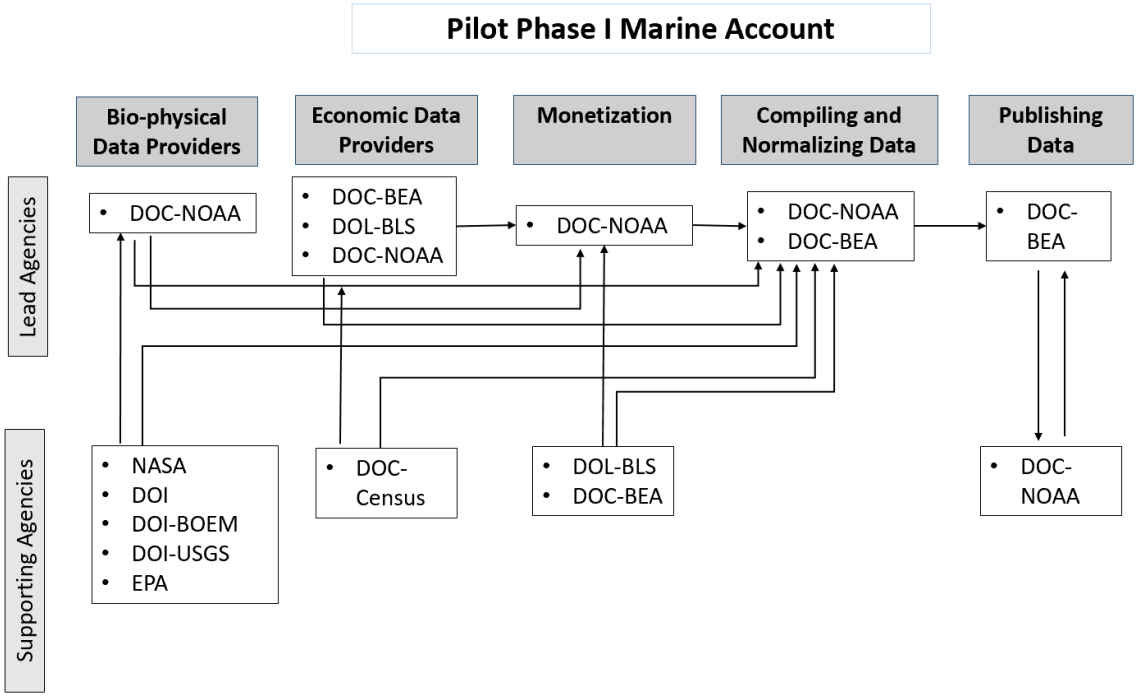

Figure 6. Agencies involved in producing the Marine account.

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Supporting recommendation: Use the Phase I Pilot Marine account as the foundation for expansion of MESA with natural capital accounting for non-extractive industries (e.g., marine transportation and construction), complex industries with extractive and non-extractive uses of the marine resources (e.g., tourism and recreation), and supporting activities (e.g., government, education, and research). This will enable more marine assets to be included on the national balance sheet. For example, the connections among prey and predator fish, when both are harvested, are currently relevant for fish assets, since the interactions between species can be captured in their asset price.[149] Developing fish asset accounts will lay the groundwork to include other ecological interactions with, for example, seagrass, coral, and mangrove ecosystems by Phase II.

Water

Long-term and episodic water stress continue to be a problem in many parts of the United States, including in the Western United States and in regions not traditionally thought to be water-scarce but which are vulnerable to the impacts of climate change (e.g., the Southeast).[150] The Secure Water Act highlights the need to better understand the supply and use of water in the United States, and agencies like USGS have been working to improve needed data, modeling, and reporting capacity around water.[151]

Supporting recommendation: The quantity, quality, and timing of water availability should be included in water accounts. Water accounts can inform decisions related to water allocation, productivity, reuse, and distribution. Diverse policy and water-management instruments are used to influence water use, availability, and quality, ranging from water permits and pricing, built infrastructure for water storage and distribution, and water-use efficiency improvements, to laws and legal frameworks at multiple scales.[152] The supplemental information in Bagstad et al.[153] specifically describes: (1) the relationship between water policies and management strategies and the entities responsible for implementing them (i.e., individuals, private sector, community groups, public utilities, and local to national government); (2) the types of water accounting information that could be most useful for each of the above groups for different water management policies and strategies; and (3) examples of how major policy drivers, such as the Endangered Species Act, Clean Water Act of 1973, interstate water compacts, and Federal agencies responsible for enabling stream navigation, would benefit from information contained in various water accounts.

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[149] Yun, S. D., et al. (2017). Ecosystem-based management and the wealth of ecosystems. *Proceedings of the National Academy of Sciences*, 114(25), 6539-6544; Fenichel, E. P., Abbott, J. K., & Do Yun, S. (2018). The nature of natural capital and ecosystem income. In *Handbook of environmental economics, 4*, 85-142. https://doi.org/10.1016/bs.hesenv.2018.02.002.

[150] Heidari, H., Arabi, M., & Warziniack, T. (2021). Vulnerability to Water Shortage Under Current and Future Water Supply-Demand Conditions Across US River Basins. *Earth's Future*, *9*(10). https://doi.org/10.1029/2021EF002278.

[151] 42 U.S.C. §§ 10361 et seq. (as enacted in Omnibus Public Land Management Act of 2009 §§ 9501 et seq.).

[152] Bagstad, K. J., Ancona, Z. H., Hass, J., Glynn, P. D., Wentland, S., Vardon, M., & Fay, J. (2020). Integrating Physical and Economic Data into Experimental Water Accounts for the United States: Lessons and Opportunities. *Ecosystem Services*, *45,* Article 101182. https://doi.org/10.1016/j.ecoser.2020.101182.

[153] Bagstad, K. J., Ancona, Z. H., Hass, J., Glynn, P. D., Wentland, S., Vardon, M., & Fay, J. (2020). Integrating Physical and Economic Data into Experimental Water Accounts for the United States: Lessons and Opportunities. *Ecosystem Services*, *45,* Article 101182. https://doi.org/10.1016/j.ecoser.2020.101182.

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Supporting recommendation: Build off of the U.S. research SEEA Water account produced in 2020[154] to develop an account regularly updated with recent data. Key data sources used by the 2020 account included: (1) USGS water-use data, compiled every 5 years from 1950 to 2015 to produce a physical supply-use account for water; (2) BEA GDP data, used with water-use data to develop a water productivity account (quantifying economic activity generated per unit of water use); (3) surface and groundwater quality data from USGS's National Water-Quality Assessment (NAWQA) Program, which collected data from USGS, EPA, state, and local monitoring programs nationwide in a water quality account; and (4) water pollution emissions data from EPA's Permit Compliance System and Integrated Compliance Information System (PCS-ICIS) database, which enabled production of a water emissions account describing pollutant emissions by industry.

Supporting recommendation: Carefully consider the three major needs that the 2020 U.S. pilot SEEA Water account identified for next-generation water accounts. First, physical supply-use tables should be compiled for more specific water-use categories and (annual) temporal resolution. The former support detailed water productivity accounts, and the latter enable analysis of long-term water-use trends in the context of drought cycles. Second, there is a need to assemble additional emissions and water-quality data that support analysis of the full causal chain of water-quality impacts to understand when and where changes in water quality may impact water uses, including instream flows that support pollutant dilution and biological

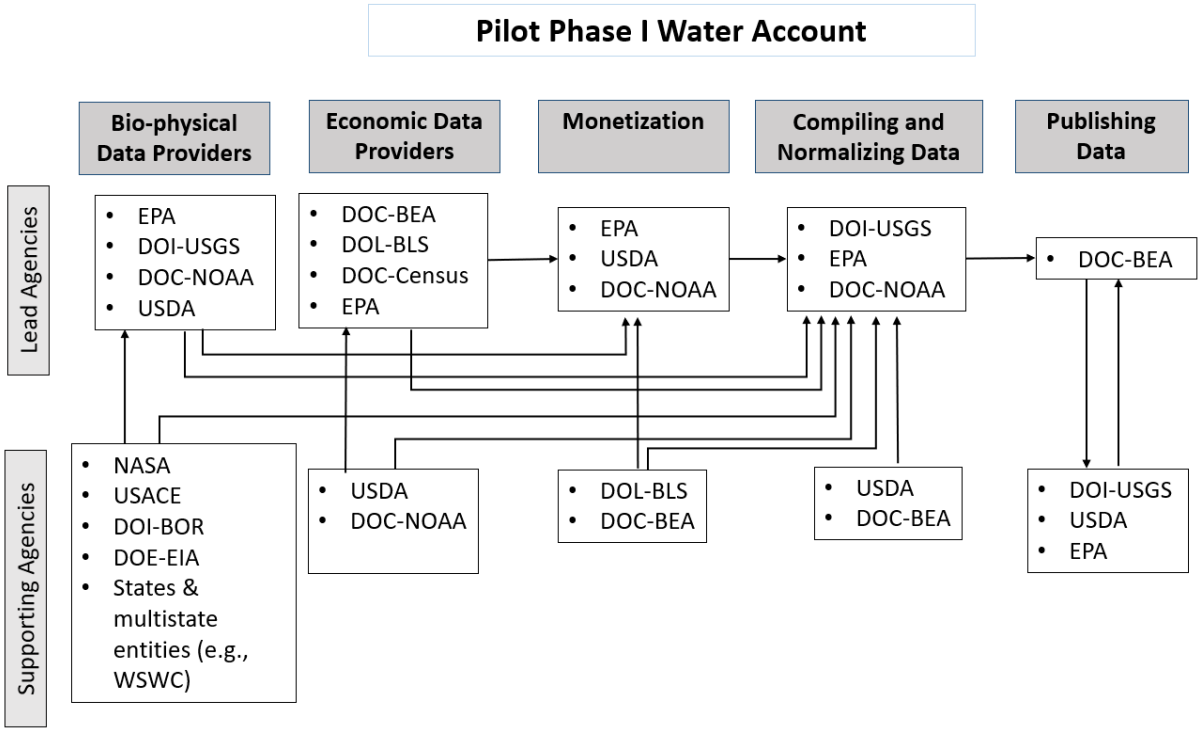

Figure 7. Agencies involved in the Water account.

[154] Bagstad, K. J., Ancona, Z. H., Hass, J., Glynn, P. D., Wentland, S., Vardon, M., & Fay, J. (2020). Integrating Physical and Economic Data into Experimental Water Accounts for the United States: Lessons and Opportunities. *Ecosystem Services*, *45,* Article 101182. https://doi.org/10.1016/j.ecoser.2020.101182.

resources. Third, water asset accounts need to track water stocks and their year-to-year changes, including groundwater resources.

The USGS-modeled estimates of annual water-use data can be used to develop water accounts further. The three largest national water-use categories—irrigation, thermoelectric power, and public supply—will be released first, in 2023, and more use categories will be included in annual releases over the next several years as funding is available. Models providing these estimates build on data from Federal, state, and private-sector sources. USGS national water-quality networks and regional water-quality data collection densities through the Next Generation Water Observing System (NGWOS) support improved water prediction capacity. Additionally, key data sources could include: (1) relatively new fine-scale GDP data from BEA for water productivity accounts (e.g., GDP by county); (2) water quality data from EPA's National Aquatic Resource Surveys (NARS) and USGS; (3) USDA Natural Resources Conservation Service (NRCS) Snow Pack Telemetry (SNOTEL) data; (4) Gravity Recovery and Climate Experiment (GRACE) satellite data; and (5) various modeling approaches and results from NOAA, USDA, and others. These efforts, in conjunction with improved water prediction capacity at USGS for more accurate estimates of water availability and use nationwide, will enable the construction of water asset accounts. Following the recommendations in this Strategic Plan can enable production grade water accounts by around 2029.

Water accounts have numerous linkage points to SEEA land and ecosystem accounts. Notably, land use-land cover change can have notable impacts to the quantity, quality, and timing of water flows, which can be jointly recorded across land, water, and ecosystem accounts. Water supply and the regulation of its quality, quantity, and timing are well-recognized as ecosystem services measured in SEEA EA using biophysical modeling; such modeling can also be useful in producing water asset and nonpoint source emissions accounts.

Environmental Activities and Jobs

Supporting recommendation: Develop an Environmental Activities and Jobs account as part of Phase I, with deliverables from this phase to include an Environmental Goods and Services Sector (EGSS) account and a public sector Environmental Protection and Expenditure (EPE) account.

Environmental activity accounts are a set of satellite accounts that quantify flows of transactions in the economy that are undertaken to protect, rehabilitate, or preserve the environment. Environmental activities are one way of connecting environmental goods and services and natural capital to other economic sectors and capturing relationships among produced, natural, and human capital. The SEEA CF highlights that environmental activity accounts are "critical to understanding whether economic resources are being used effectively to reduce pressures on the environment and maintain the capacity of the environment to deliver benefits."[155] Environmental Activities and Jobs accounts will help decision-makers understand how the production of goods and services that directly serve an environmental purpose is a growing part of the overall economy (examples include the domestic output manufacturing of solar panels or electric cars,

[155] For additional details about these accounts and their methods, see: United Nations. (n.d.). *Environmental Activity Accounts - System of Environmental Economic Accounting*. Retrieved June 1, 2022, from https://seea.un.org/content/environmental-activity-accounts.

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along with the jobs associated with this production, as well as, organic farming).[156] This account can help the Federal Government track its commitments to nature-based solutions and Justice40. The Environmental Activities account can also help private firms benchmark industry standards to make sector-specific claims about environmental performance.

Supporting recommendation: Build on lessons learned from previous experimental environmental activities-like accounts. Earlier Federal Government initiatives provide building blocks for developing these accounts, such as the Measuring Green Jobs Initiative by BLS,[157] Measuring the Green Economy by DOC's Economics and Statistics Administration,[158] and the Survey of Environmental Products and Services by Census.[159]

Supporting recommendation: The Environmental Activities and Jobs account development team should first explore how far existing data sources can be used to produce these accounts. Many of the data for this project will come from source data provided to BEA from a variety of sources, including Economic Census – Industry and Product Data, BEA supply-use tables and gross output by product (internal BEA data), BLS Occupational Employment and Wage Survey, BLS Consumer Expenditure Survey, National Science Foundation (NSF) Survey of Federal Funds for Research and Development, NSF Business Enterprise Research and Development Survey, Census Value of Construction Put in Place, Annual Survey of Manufactures, and potentially data from the private sector like Refinitiv's Environmental, Social, and Corporate Governance (ESG) Database[160] and the GIST-MSCI database[161] that draw data from ESG disclosures from public companies.

Supporting recommendation: BEA should publish the first version of the EGSS account and a public sector EPE account in 2023. This research will also document gaps in current data collections, identify supplementary sources of data, and propose potential modifications to source data collections that will be required for producing a full set of accounts up to international statistical standards and Federal standards. In cooperation with Census, BLS, EPA, and other agencies who provide source data and expertise for these accounts, BEA intends to build on this research by constructing prototype environmental activity accounts as described above, and then initiate phases of production and procurement of requisite data.

Supporting recommendation: The Environmental Activities and Jobs pilot accounts and supporting documents should be used to generate recommendations for alterations to the Economic Census data collection efforts. For example, BEA can cooperate with BLS, Census, and others on the Economic Classification Policy Committee (ECPC), which is directed by OMB, to explore ways NAICS and the North American Product Classification System (NAPCS) can be revised to better align with collection and classification efforts related to environmental

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[156] The farm sector contributes many conservation management activities so not all of these would fall under the heading of farm-related, particularly in years where fields are out of production. This sort of detail will be addressed as the accounts are implemented.
[157] U.S. Bureau of Labor Statistics. (2017). *Green Jobs.* https://www.bls.gov/green/home.htm.
[158] U.S. Department of Commerce. (2010). *Measuring the Green Economy*. https://www.commerce.gov/data-and-reports/reports/2010/04/measuring-green-economy.
[159] U.S. Census Bureau. (1998). *Survey of Environmental Products and Services*. https://www.epa.gov/sites/default/files/2017-08/documents/ee-0413_acc.pdf.
[160] Refinitiv. (2022). *Environmental, Social and Corporate Governance - ESG.* https://www.refinitiv.com/en/financial-data/company-data/esg-data.
[161] GIST. (2022). *Impact Valuation*. https://www.gistimpact.com/.

activity, while maintaining current levels of usability and quality for existing NIPA accounts. The 2027 Economic Census will require multiple-year lead times for requests to add content to the surveys or other adjustments to the surveys. The pilot accounts will facilitate making any requests for adding content or special inquiries that would support the production of environmental activity accounts by 2025.

Once this initial phase of work is done, and if resources permit all the above data collection efforts, classification alterations and revisions, and staffing, a full set of environmental activity accounts could be produced by 2029.

This new set of accounts will fit with BEA's established record of using economic accounting frameworks to provide otherwise unavailable detail on specific activities or emerging sectors of the economy. The new accounts will fully complement BEA's core statistics, while harnessing cutting-edge techniques to isolate and identify the impact of U.S. environmental goods and services. These accounts will also aid the United States Government in reporting aggregate economic statistics to the U.N., Organization for Economic Co-operation and Development (OECD), and International Monetary Fund (IMF),[162] which are sourced from similar accounts produced by numerous countries. In the end, policymakers, private sector decision-makers, and the American public will have meaningful, easy-to-access statistics that detail the importance of this evolving sector of the U.S. economy. These data will directly support the Federal Government's ability to monitor and drive growth in the environmental industry and understand the implications of economic decision-making on the environment.

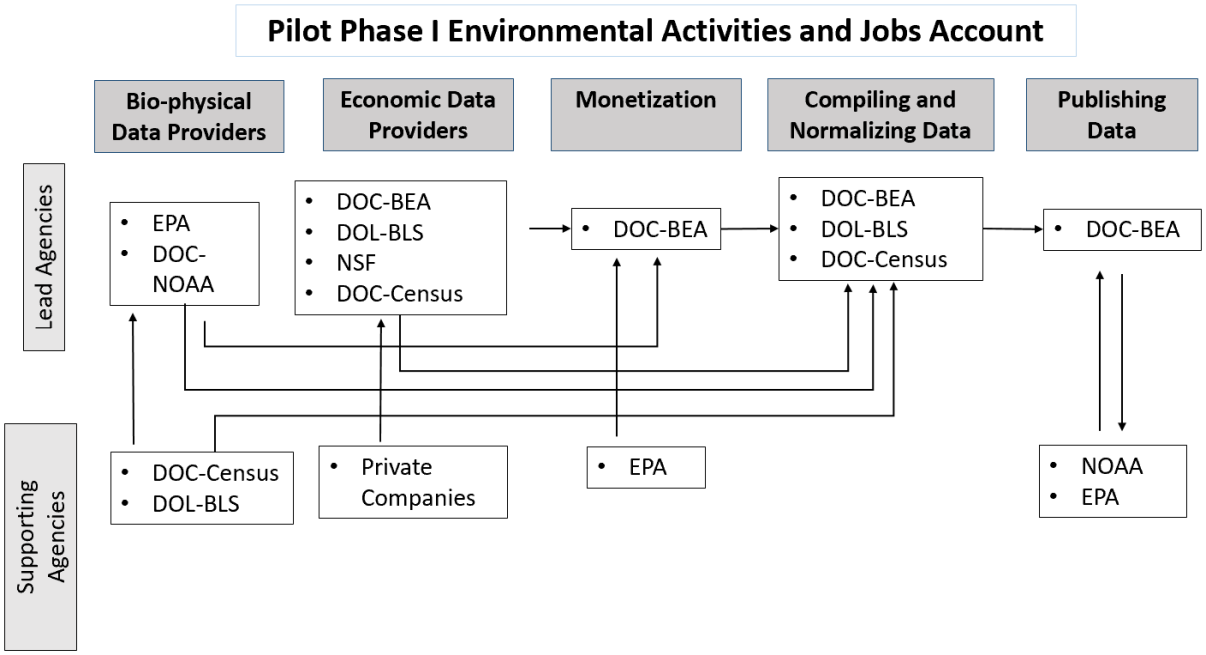

Figure 8. Agencies involved in the Environmental Activities and Jobs account.

[162] For example, these accounts could contribute to the IMF's Climate Change Indicators. See International Monetary Fund. (n.d.). *Climate Change Indicators Dashboard*. Retrieved August 15, 2022, from https://climatedata.imf.org/.

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Phase II Environmental Sectors

Environmental sectors in Phase II often require information obtained during Phase I. In other words, the Federal Government has less experience measuring these sectors in natural capital accounts.

Forests

The U.S. forest estate is the fourth largest in the world, covering 635 million acres, or about one third of the U.S. land area.[163] U.S. forests and the durable wood products removed from them offset the equivalent of 14% of U.S. emissions every year[164] and provide 39% of the nation's water.[165] Other ecosystem services provided by forests include climate regulation, air purification, regulation of water quantity and quality, fish and wildlife habitat, food, medicine, shelter, wood and other forest products, outdoor recreation, and spiritual and aesthetic benefits.[166] Lack of nationally consistent natural capital accounting data for forests hinders natural resource policy and management. In 2020, for example, Federal wildfire suppression costs exceeded $2.2 billion.[167] The IIJA authorized approximately the same amount ($2.42 billion) for fiscal years 2022 through 2026 to reduce wildfire risk throughout the country. Data provided through natural capital accounting for forests would help measure returns on investment in these and other activities aimed at protecting lives and restoring forest health. Forest accounts would also be developed alongside land and water accounts and possibly complement urban accounts related to urban forestry.

Supporting recommendation: Leverage existing forest inventory data to release extent and condition statistics ahead of monetary statistics for forests. To date, natural capital accounts do not exist for U.S. forested lands. Efforts have begun in USFS Research and Development (R&D), in partnership with other Federal agencies, to create a first set of research forest accounts. This effort uses extensive forest inventory data in the USFS R&D portfolio, including those produced by the Forest Inventory and Analysis (FIA) program and the Resources Planning Act (RPA) program.[168] These programs have an extensive body of data and research that can provide the foundation for forest natural capital accounts, possibly allowing forest extent and condition accounts to be created well ahead of the timeframe for monetary statistics associated with forests.

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[163] Food and Agriculture Organization of the United Nations. (2020). *Global Forest Resources Assessment 2020*. http://doi.org/10.4060/ca9825en;
Oswalt, S., Smith, B., Miles, P., & Pugh, S. (2019). *Forest Resources of the United States, 2017: A Technical Document Supporting the Forest Service 2020 RPA Assessment*. U.S. Forest Service. https://doi.org/10.2737/WO-GTR-97.

[164] Domke, G. M., Oswalt, S. N., Walters, B. F., & Morin, R. S. (2020). Tree Planting Has the Potential to Increase Carbon Sequestration Capacity of Forests in the United States. *Proceedings of the National Academy of Sciences, 117*(40), 24649–24651. https://doi.org/10.1073/pnas.2010840117.

[165] Based on data from Heidari, H., Arabi, M., Ghanbari, M., & Warziniack, T. (2020). A Probabilistic Approach for Characterization of Sub-Annual Socioeconomic Drought Intensity-Duration-Frequency (IDF) Relationships in a Changing Environment. *Water, 12*(6), 1522. https://doi.org/10.3390/w12061522.

[166] Not all of these will be included in the natural capital accounts under this Strategic Plan.

[167] National Interagency Fire Center. (n.d.). *Suppression Costs*. Retrieved July 10, 2022, from https://www.nifc.gov/fire-information/statistics/suppression-costs.

[168] The FIA and RPA programs originate in legislation that requires analysis of use, demand for, and supply of renewable resources, including the potential to improve their yield of "tangible and intangible resources" (e.g., Forestry Research Act of 1928, Forest and Rangelands Resources Planning Act of 1974).

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FIA data are the largest continuous body of forest inventory data in the world and cover private and public lands throughout the United States. FIA data include measures of forest extent, ownership, and changes in vegetation conditions and forms the basis for greenhouse gas inventories on forested lands in the United States. FIA products are combined with other data on forest and rangeland health in the RPA Assessment, a Congressionally-mandated assessment of the status and trends on the nation's renewable resources. The RPA Assessment includes forests, rangelands, wildlife, water, and outdoor recreation. The Assessment also evaluates the U.S. land base, examining past trends and making future projections for land use, land cover, and forest fragmentation. USFS also uses FIA data to report annually to the U.N. Food and Agricultural Organization on various indicators of forests (e.g., area, inventory volume) and forest-products outputs, and USFS periodically reports forest-related Montreal Process Criteria and Indicators.

Supporting recommendation: Develop new approaches to connect forest-generated services with users in order to build supply-use tables for the Forest accounts. Some linkages already exist. For example, the USFS Forests to Faucets 2.0 Assessment and work by Liu et al. (2021)[169] link forests to downstream drinking water intakes, but they do not consider how far downstream forest cover affects water provision. Further research on this topic is being done on connections between forests and users as part of the IIJA to better understand green infrastructure and risks related to wildfire.

[169] Liu, N., Caldwell, P. V., Dobbs, G. R., Miniat, C. F., Bolstad, P. V., Nelson, S. A., & Sun, G. (2021). Forested Lands Dominate Drinking Water Supply in the Conterminous United States. *Environmental Research Letters*, *16*(8), Article 084008. https://doi.org/10.1088/1748-9326/ac09b0.

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Supporting recommendation: The Forests account should develop data sets on the economic value for the most important forest-generated services. Timber values are available through some state and subscription data, but there is currently no nationwide database for timber and log prices. Economic data for the forest sector and supporting industries are also regularly collected by Federal agencies and reported by BLS, BEA, and Census. Next steps involve working with agencies with experience generating SEEA-compatible accounts to format currently available physical forest data into tables that are compatible with natural capital accounting. Formatting physical data tables will occur in coordination with USDA and the creation of land accounts. Because timber and forest-products industry data are already collected by BEA and BLS, early work can also be done using existing data on economic contributions of forested lands through collaboration with USFS and agencies already collecting economic data on the forest sector.

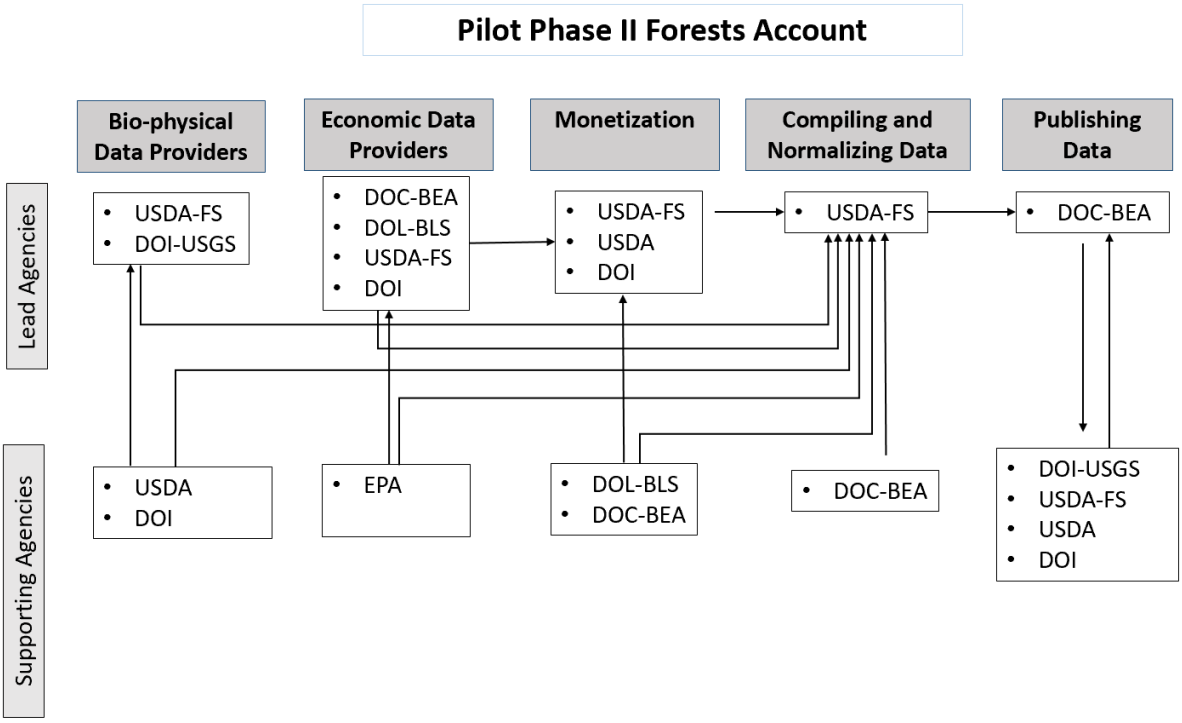

Figure 9. Agencies involved in the forest account.

Supporting recommendation: The set of monetized forest provided services should expand over time, consistent with the three established boundary conditions. Forests provide a wide array of ecosystem services, and work is ongoing to determine which ecosystem services should be tracked in the forest natural capital accounts. Woodland and trees are important to landscapes outside of forests and agro-forested areas. For example, forests play an important role in removing air pollutants, cooling urban areas, and stabilizing soils. Such considerations can ultimately be taken into account to align forest accounts with air, land, and urban accounts and to clearly define the production boundaries of forest accounts.

Marine Natural Capital (Phase II)

Data and techniques for accounting for marine natural capital are developing rapidly, as is the treatment of marine natural assets in national economic systems, and these will be used to

expand Phase I Marine Natural Capital accounting to begin including defensive expenditures and household production, building on examples from other countries. For example, Australia has begun accounting for mangroves and seagrasses, with a focus on carbon sequestration and storage.[170] Canada has developed a framework for salt marsh ecosystem accounting.[171] Private reinsurers, including AXA XL[172] and Swiss Re,[173] have developed insurance instruments for reefs. The Federal Government can learn from these initiatives and begin implementing similar initiatives in a second phase of developing marine natural capital accounts. The second phase of marine natural capital accounts will also begin to address coastal natural assets, building from information in the land account. For example, beach width can capitalize into home prices,[174] which are part of the land account.

The same agencies that participate in the Phase I marine natural capital accounts will participate in the Phase II accounts (Figure 6).

Minerals and Energy

Mineral and energy resources collectively play a critical role in the U.S. economy. The United States has inventories for some of its major geologic resources. These inventories include physical metallic minerals, non-metallic minerals, industrial minerals such as construction materials, petroleum resources (e.g., oil, natural gas, and gas hydrates), coal, uranium, and energy gases. The United States also has assessments of storage potential of gases (e.g., carbon dioxide, hydrogen, helium), and renewable resource potential (e.g., geothermal resources). The value of these assets, however, is not reflected on our national balance sheet. The physical data in the United States measuring these stocks are also not currently compiled in a way that aligns with the national economic accounts. Minerals and Energy accounts will change this, as the SEEA CF has outlined methods and principles to develop these accounts and numerous countries have recently developed experimental and, in some cases, core statistical accounts to provide a more detailed and useful economic accounting of these resources. Documents related to the 2025 SNA revision suggest that the revision will encourage these sorts of accounts.[175]

For decades, the Federal Government has collected detailed information on mineral and energy resources, quantifying reserves, extractions, and other important information about these natural capital assets. For example, USGS's Mineral Resources Program collects and reports supply and demand data for about 100 essential minerals and materials, along with a host of other information relevant to quantifying the stocks and flows of minerals domestically and

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[170] Australian Bureau of Statistics. (2022). *Towards a National Ocean Account*. https://www.abs.gov.au/articles/towards-national-ocean-account.
[171] Rabinowitz, T., & Andrews, J. (2022). *Valuing the Salt Marsh Ecosystem: Developing Ecosystem Accounts (16-001-M)*. Statistics Canada. https://www150.statcan.gc.ca/n1/pub/16-001-m/16-001-m2022001-eng.htm.
[172] Pernet, E., & Whalley, K. (n.d.). *How Insurance Coverage is Protecting Coral Reefs from Hurricanes*. AXA Climate. https://www.climate.axa/how-insurance-coverage-is-protecting-coral-reefs-from-hurricanes.
[173] SwissRe. (2022). *Designing a New Type of Insurance to Protect the Coral Reefs, Economies and the Planet*. https://www.swissre.com/our-business/public-sector-solutions/thought-leadership/new-type-of-insurance-to-protect-coral-reefs-economies.html.
[174] Landry, C. E., & Hindsley, P. (2011). Valuing beach quality with hedonic property models. *Land Economics*, *87*(1), 92-108. https://doi.org/10.2139/ssrn.1824429.
[175] Advisory Expert Group on National Accounts. (2022). *Valuation of Mineral and Energy Resources.* https://unstats.un.org/unsd/nationalaccount/aeg/2022/M19/M19_4_WS10_Valuation_Mineral_Energy_Resources.pdf.

internationally.[176] The USGS Energy Resources Program and Mineral Resources Program publish assessments quantifying undeveloped geologic resources domestically and globally, and, under the IIJA, the Mineral Resources Program is expanding its assessments to include evaluation of mineral resources in mine wastes. In addition, the EIA collects and compiles information on reserves of U.S. oil and natural gas, as well as projections of future extractions modeled through 2050.[177] More recently, given the importance of a wide range of "critical minerals" that are identified as "essential to the economic prosperity and national defense,"[178] the USGS is leading an interagency effort through the National Science and Technology Council Critical Minerals Subcommittee to evaluate how the Federal Government can improve understanding of domestic critical minerals resources, which was a key Call to Action outlined in the 2019 "A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals,"[179] and supports Section 7002 of the Energy Act of 2020[180] and Section 40210 of the IIJA.[181]

In coordination with rich data from the former U.S. Bureau of Mines, BEA began testing valuation methods for minerals accounts as early as the 1990s; however, at the time there was no internationally agreed-upon standard for valuing these assets in the national economic accounts.[182] Since then, national statistical offices have reached general consensus on aggregate valuation of these assets. The United Nations Statistical Commission adopted the 2012 SEEA CF, which prescribes guidelines for a net present value (NPV) calculation of minerals. Most countries have adopted these calculations in their minerals accounts. In 2020, BEA researchers evaluated a variety of methods consistent with this framework in preliminary internal research.

[176] For more information on the NMIC, see: U.S. Geological Survey. (n.d.). *National Minerals Information Center*. https://www.usgs.gov/centers/national-minerals-information-center/about.
[177] For a recent example of how this data is reported, see the EIA's January 2022 release of its report on "U.S. Crude Oil and Natural Gas Proved Reserves": U.S. Energy Information Administration. (2022, Jan. 13). *Proved Reserves of Crude Oil and Natural Gas in the United States, Year-End 2020.* https://www.eia.gov/naturalgas/crudeoilreserves/.
[178] U.S. Department of Commerce. (2019, June 4). *A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals.* https://www.commerce.gov/data-and-reports/reports/2019/06/federal-strategy-ensure-secure-and-reliable-supplies-critical-minerals.
[179] The full text of the Federal Strategy can be found here: U.S. Department of Commerce. (2019, June 4). *A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals.* https://www.commerce.gov/data-and-reports/reports/2019/06/federal-strategy-ensure-secure-and-reliable-supplies-critical-minerals.
[180] 30 U.S.C. § 1606.
[181] 42 U.S.C. § 18743.
[182] For a detailed account of this effort and recommendations for further work to be completed by the Federal Government in collecting and reporting on natural capital accounts, see Nordhaus, W. D., & Kokkelenberg, E. C. (1999). *Nature's Numbers: Expanding the National Economic Accounts to Include the Environment*. National Academies Press, Washington, D.C. https://doi.org/10.17226/6374.

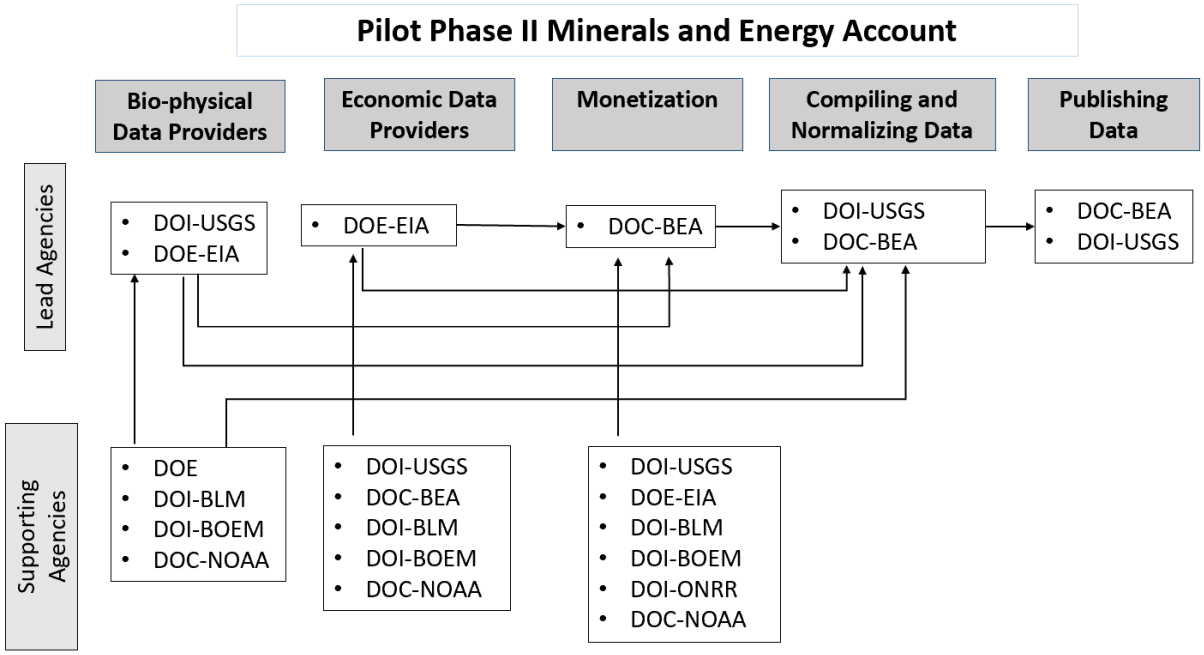

Figure 10. Agencies involved in the Minerals and Energy account.

This work explored how current U.S. data would conform to methods pursued by other countries, and which NPV approach was best suited to existing U.S. mineral data.

Supporting recommendation: The Minerals and Energy subgroup should expand on prior Federal Government work by facilitating further collaboration across the government to identify and correct data gaps and to shape physical data to conform to SEEA physical accounts tables in order to advance to a full set of Minerals and Energy resource accounts. It is important to cultivate a consistent valuation methodology that will extend to all mineral and energy resources being valued and to strive to assess value at as local a scale as possible.[183] We note that renewable energy resources will require particularly careful research on valuation methodologies; unlike subsoil energy resources, renewable energy resources, such as sunlight and wind, are flows within the environment, not stocks. Defining *what* is to be valued, in a manner conceptually consistent with other accounts, is a necessary first step.

Supporting recommendation: By 2025, BEA should collaborate with USGS and EIA, and other scientists and analysts within DOI and DOE with relevant expertise, to begin construction of pilot accounts for a narrow set of minerals with the best data available to demonstrate the feasibility of a SEEA-consistent NPV methodology based on U.S. data. This will require working with DOI and DOE agencies in the coming years to modify data-collection efforts that will provide more detailed information by mineral,[184] which could complement and

[183] Advisory Expert Group on National Accounts. (2022). *Valuation of Mineral and Energy Resources.* https://unstats.un.org/unsd/nationalaccount/aeg/2022/M19/M19_4_WS10_Valuation_Mineral_Energy_Resources.pdf.

[184] As with other economic accounts, U.S. statistical agencies protect survey participants from revealing identifying information to the public. To safeguard against mineral accounts (broken down by mineral, for example) from revealing identifying information (e.g., if a particular firm is the only domestic firm mining a particular mineral), statistical agencies would aggregate

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augment efforts to map potential resources and reserves domestically, including critical minerals. If the research producing a narrower set of pilot accounts is sufficiently checked, and the data collection efforts within USGS and EIA have been modified to enable a full accounting of all minerals and energy resources, BEA could begin producing a full set of prototype SEEA mineral accounts by 2028, if resources permit. This interagency effort will pave the way to a full production of mineral and energy resource accounts by 2032 to be added as satellite accounts and as items on the non-produced, non-financial asset balance sheet.

Pollinators

The pollination of crops by insects, birds, and bats is an essential ecosystem service. A substantial share of global crop species depend to some degree on such pollination, as does 35% of global food production and 23% of U.S. food production.[185] Pollination-dependent crops include many nutritionally important crops[186] that are critical to human health.[187] Declines in managed honeybee hives and in wild pollinator populations lend further urgency to the issue of pollination. Production Grade crop pollination accounts would provide a much more complete view over time and space of past and present patterns of crop pollination, its value, and risks and opportunities to enhance crop pollination and the quality, volume, and reliability of harvests of pollination-dependent crops. The Federal Government's effort to account for pollinator populations would support agricultural investors and insurers' efforts to bring pollinators onto their balance sheets, likely helping agricultural producers obtain lower-cost financing when they are making investments that reduce the risk of pollination failure. Natural capital accounts will help Federal and state agricultural agencies better track the economic contributions of pollinators and design incentive programs for conservation of on-farm pollinator habitat.

USGS has begun development of a pilot crop pollination account that will quantify the monetary value of wild pollination from 2008 to 2020 using the pollination model by Lonsdorf et al. (2009),[188] which is based on data on land cover (NLCD), crop types (USDA Cropland Data Layer),[189] crop yield and price data from NASS, and expert-derived coefficients for pollination dependency and pollinator habitat.[190] To move from a pilot account toward production, a number of improvements to the model are needed. Further work will move beyond the Lonsdorf model,

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in ways that do not compromise identifying information (e.g., combining categories of minerals in a way that conceals such information in the public-facing data, thereby protecting the integrity of anonymous survey collection efforts).

[185] Klein, A.-M., Vaissière, B. E., Cane, J. H., Steffan-Dewenter, I., Cunningham, S. A., Kremen, C., & Tscharntke, T. (2007). Importance of Pollinators in Changing Landscapes for World Crops. *Proceedings of the Royal Society B: Biological Sciences, 274*(1608), 303–313. https://doi.org/10.1098/rspb.2006.3721;
Sinnathamby S., Assefa, Y., Granger, A., Tabor, L., & Douglas-Mankin, K. (2013). Pollinator Decline: US Agro-Socio-Economic Impacts and Responses. *Journal of Natural & Environmental Sciences, 4*(1), 1–13.

[186] Calderone, N. W. (2012). Insect Pollinated Crops, Insect Pollinators and US Agriculture: Trend Analysis of Aggregate Data for the Period 1992–2009. *PLOS ONE, 7*(5), Article e37235. https://doi.org/10.1371/journal.pone.0037235.

[187] However, the majority of the world's calories come from crops that are wind- or self-pollinated. Ellis, A. M., Myers, S. S., & Ricketts, T. H. (2015). Do Pollinators Contribute to Nutritional Health? *PLOS ONE, 10*(1), Article e114805. https://doi.org/10.1371/journal.pone.0114805.

[188] Lonsdorf, E., Kremen, C., Ricketts, T., Winfree, R., Williams, N., & Greenleaf, S. (2009). Modelling Pollination Services Across Agricultural Landscapes. *Annals of Botany, 103*(9), 1589–1600. https://doi.org/10.1093/aob/mcp069.

[189] U.S. Department of Agriculture National Agricultural Statistics Service. (2022). *CroplandCROS, Cropscape, and Cropland Data Layer*. https://www.nass.usda.gov/Research_and_Science/Cropland/SARS1a.php.

[190] Koh, I., Lonsdorf, E. V., Williams, N. M., Brittain, C., Isaacs, R., Gibbs, J., & Ricketts, T. H. (2015). Modeling the Status, Trends, and Impacts of Wild Bee Abundance in the United States. *Proceedings of the National Academy of Sciences*, *113*(1), 140–145. https://doi.org/10.1073/pnas.1517685113.

which considers a single "generic insect pollinator," to more realistically account for diverse groups of native pollinators and how ecosystems support the managed beehives that are used in agriculture.

Supporting recommendation: Identify a small number of pollinator types that can be connected to specific agricultural activities in supply-use tables. The list of groups may expand in the future. This work would focus on groups of pollinator species with known importance to crops, together with improved information being developed by USDA on pollinator habitat needs and plant-pollinator interactions.

Supporting recommendation: Estimates of changes in pollinator populations should be reported in physical flow accounts and pollination should be thought of as an exchange service to develop monetized values for changes in pollinator stocks. Valuation of pollinators needs to be done as locally as possible.

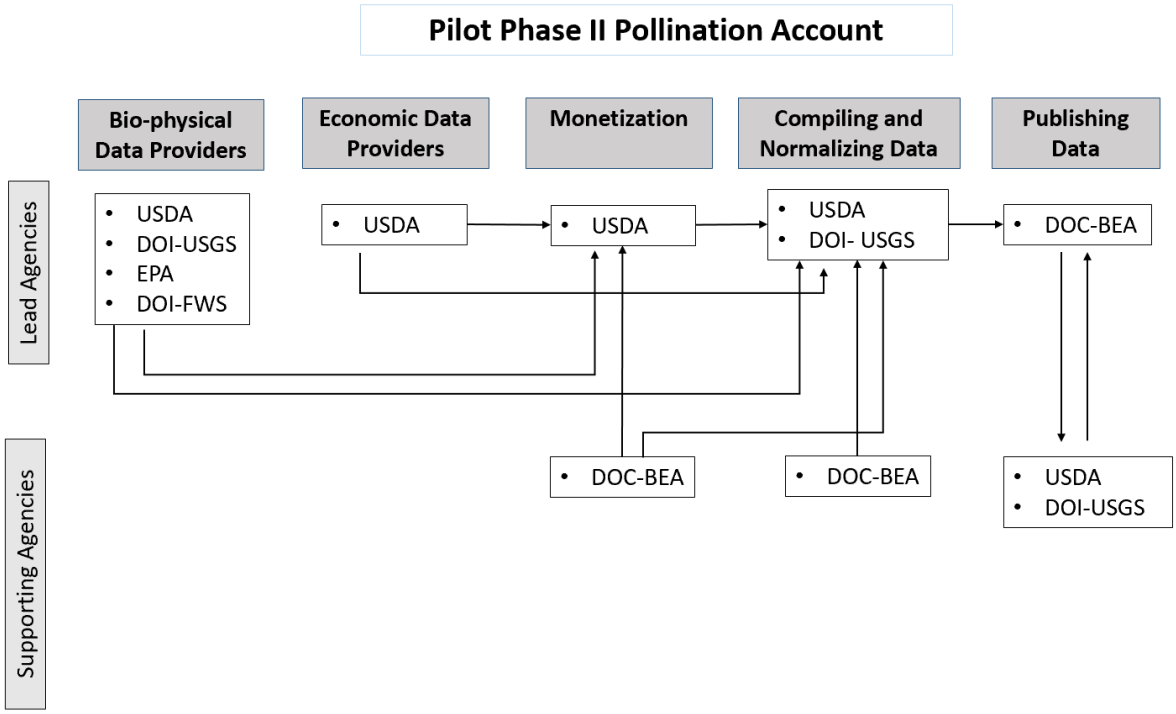

Figure 11. Agencies involved in the Pollination account.

Urban Green Space

For decades, urban planners and urban ecologists have recognized the importance of urban green spaces in providing multiple ecosystem services, such as climate mitigation and resilience, pollution and noise reduction, and physical and mental health benefits. Urban green space is a key infrastructure element, and nature-based solutions are increasingly recognized as win-win solutions for nature and people. Urban green space and its services are important to track to determine which groups and neighborhoods receive the benefits from nature, in order to address long-standing equity issues in cities. Tracking urban green assets and the services they provide requires investment from policy makers, private industry, and non-profits alike. Urban green space also has important connections to land and forest accounts.

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With an urban green space account of assets and derived services, the United States can be in a strong position to determine nationwide and city-specific baselines of current urban green assets and services in cities across the country. Currently, the knowledge base regarding urban green space capital assets and services is limited to research-grade results, or city-specific data that lack consistency and replicability. Existing data may be out of date because of rapid changes in urban land cover (particularly as urban land is regularly developed and redeveloped and as trees are planted, grow, and die), or because of coarse-scale or dated methods that need refinement. Once urban green space assets and services are measured coherently and reputably across multiple U.S. cities, national and local-scale stakeholders will be able to identify gaps and trade-offs across the country.

A pilot urban green space account quantified the services from urban trees for heat mitigation and rainfall interception in physical and monetary supply-use tables for 768 U.S. cities with populations of 50,000 people or more.[191] Ongoing work is needed to expand the scope of these pilot accounts to cover additional ecosystem services, improve the quality of the estimates, and develop a rigorous and consistent definition of urban areas.

***Supporting recommendation: Urban green space accounts should leverage: (1) the USFS's Urban Field Station Network and Urban Forest Inventory and Analysis program, which provides urban tree inventories designed to serve as inputs to the Forest Service's i-Tree ecosystem service model; and (2) new data sources, including high-resolution land cover data (important for mapping small features in cities), Light Detection and Ranging (LiDAR) remote sensing data that can measure building and tree height and structure, sensor networks for temperature, pollution, and other key variables, and relevant data collected via the Internet of Things*.** A production-grade urban green space account will bring together traditional process-based models with data-driven models using, among other things, modern sensor technology, integrating these techniques to most accurately and effectively model, monitor, and value services delivered by urban green space. Finally, further work is needed to measure and monetarily value urban green space at the national scale and for individual cities, while also robustly estimating values at the scale of the city block. Such fine-scale analyses are critical to making this information useful for city planners, who are often interested in questions like "how many trees should be planted, and where should they be planted, to lower summer heat on this block by 3 degrees?" With adequate resources, such work could develop production-grade urban green space accounts by 2030 that would comprehensively track the distribution and value of urban green space and the services it provides in U.S. cities.

[191] Heris, M., Bagstad, K. J., Rhodes, C., Troy, A., Middel, A., Hopkins, K. G., & Matuszak, J. (2021). Piloting Urban Ecosystem Accounting for the United States. *Ecosystem Services*, *48,* Article 101226. https://doi.org/10.1016/j.ecoser.2020.101226.

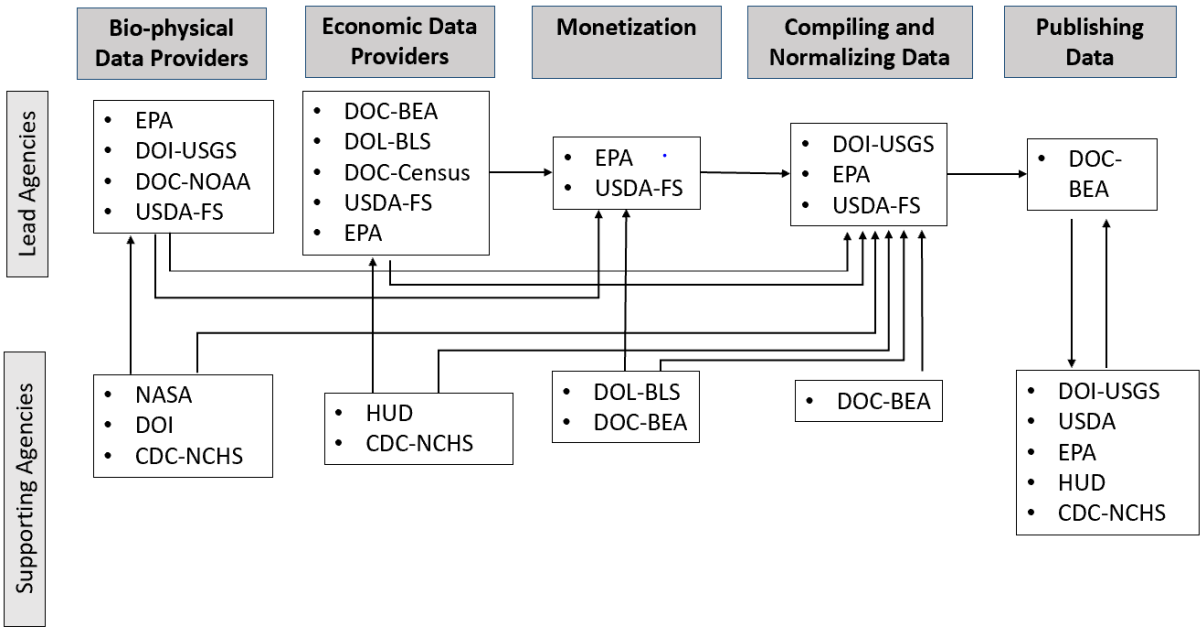

Figure 12. Agencies involved in the Urban Green Space account.

Phase III Environmental Sectors

There are many important natural assets not included in Phase I or Phase II, and the Federal Government anticipates developing natural capital accounts and associated environmental-economic statistics for assets listed in Phase III, which will cover all remaining major forms of natural capital. Pilot projects for Phase III accounts will generally begin in 2029. However, in some cases, research has already begun, and the Working Group expects research to accelerate in the coming years.

Supporting recommendation: Phase III accounts should focus on not-yet-mentioned land-cover or ecosystem types such as wetlands, peatlands, grasslands, deserts, and tundra. Having functional land, forest, and water accounts are a precursor to developing many of the Phase III accounts.

Supporting recommendation: Phase III should include developing accounts for wildlife, including mammals, birds, freshwater fish, and other relevant taxa, focusing first on migratory species.[192] The migratory nature of these animals introduces some novel challenges into natural capital accounting, related to the fact that national accounts do not view this as trade.[193] There is also interest in developing accounts for non-migratory wildlife, which will require cooperation with states, territories, and Tribes. While research exists on natural capital

[192] Accounts for marine fish will be developed as part of the Phase I marine accounts.
[193] Advisory Expert Group on National Accounts. (2022). *Accounting for Biological Resources.* https://unstats.un.org/unsd/nationalaccount/aeg/2022/M19/M19_6_WS8_Accounting_Biological_Resources.pdf.

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accounting for wild animals that are under some form of Federal or state stewardship,[194] there are technical research questions and administrative questions that need resolution to initiate the pilot account in 2029.

Supporting recommendation: Soil accounts should be included in Phase III. Soil is an important natural asset that underpins U.S. food security, but there are existing challenges in measuring changes in soil. Soil is an ecosystem, and there are many soil ecosystem types that soil scientists are just beginning to be able to measure.[195] There is ongoing research in the area of soil as natural capital,[196] and functional water and land accounts will also facilitate developing soil accounts.

Supporting recommendation: A non-traditional geological assets account that includes renewable energy potential and geologic carbon storage should be developed in Phase III. There is a need to conduct research in this area prior to initiating pilot natural capital accounts in 2029. This aligns with the likely direction of the 2025 SNA revision related to renewable energy.[197] A functional minerals and energy account will facilitate development of the non-traditional geological assets account.

Supporting recommendation: Continued expansion of marine natural capital accounts. The expanded marine account will include reefs, dunes, seagrass, marine pollution, salt marsh, and other marine assets if they are not already included in Phases I and II of the marine natural asset accounts.

Other Supporting Technical Activities

The Federal Government must engage in supporting activities to ensure that natural capital accounts and environmental-economic statistics function as a system. This includes developing the necessary supply-use tables and report-out summaries, along with the tools that underpin their development. There remain two critical, cross-cutting topics—classification systems and valuation standards—in need of development to support a preliminary natural capital accounting and environmental-economic statistics manual. The intent is to use the Federal statistical system and the Chief Statistician of the United States to coordinate developing these by 2026.

Classification Systems

Supporting recommendation: The Chief Statistician of the United States should lead development of a classification manual, to be released approximately one year before the Phase I accounts enter final-stage experimentation as prototype accounts, that makes

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[194] Maher, S. M., et al. (2020). The Economics of Conservation Debt: A Natural Capital Approach to Revealed Valuation of Ecological Dynamics. *Ecological Applications*, *30*(6), Article e02132. https://doi.org/10.1002/eap.2132.
[195] Bradford, M. A., et al. (2021). Quantifying Microbial Control of Soil Organic Matter Dynamics at Macrosystem Scales. *Biogeochemistry*, *156*(1), 19-40. https://doi.org/10.1007/s10533-021-00789-5.
[196] Robinson, D. A., Panagos, P., Borrelli, P., Jones, A., Montanarella, L., Tye, A., & Obst, C. G. (2017). Soil Natural Capital in Europe - A Framework for State and Change Assessment. *Scientific Reports*, *7*, Article 6706. https://doi.org/10.1038/s41598-017-06819-3;
Brady, M. V., et al. (2015). Valuing Supporting Soil Ecosystem Services in Agriculture: A Natural Capital Approach. *Agronomy Journal*, *107*(5), 1809-1821. https://doi.org/10.2134/agronj14.0597.
[197] Advisory Expert Group on National Accounts. (2022). *Treatment of Renewable Energy Resources as Assets*. https://unstats.un.org/unsd/nationalaccount/aeg/2022/M19/M19_7_WS11_Renewable_Energy_Resources.pdf.

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recommendations to enable harmonization across classification systems as appropriate. This timeline promotes consistency and comparability in the measures. Reviews and revisions of the manual will likely be required, with the first review likely occurring around December 2028. The first review will likely be based on lessons learned in the pilot and prototype stages, in order to facilitate the first set of production series accounts in December 2029.

The classification systems should span the system of natural capital accounts and environmental-economic statistics, clarifying the connection among environmental sectors and between the environmental sectors and existing economic statistical taxonomies. Agencies use multiple classification systems, which address different purposes. Attempts to use them together without appropriate modifications can lead to inconsistencies and coding errors. In developing natural capital accounts and environmental-economic statistics, agencies have opportunities to harmonize these systems where appropriate and feasible.

Statistical classification systems enable organization of data into mutually exclusive, comparable categories. They also provide a foundation for business sector taxonomies. OMB, through the Office of the Chief Statistician, oversees the development of statistical classification systems. For example, the United States uses the NAICS to classify business establishments.[198] Similar classifications for natural assets or services from natural capital (i.e., ecosystem services) are not broadly accepted, or standardized for use, across Federal agencies. Different classification systems (e.g., for industries, occupations, products, natural assets, and ecosystem services) require different groups of experts, and they should all be at the table to develop the needed classification systems to underpin U.S. natural capital accounts and environmental-economic statistics.

La Notte and Rhodes (2020)[199] review classification system candidates for environmental-economic accounting systems. For ecosystem services, EPA has developed a National Ecosystem Service Classification System.[200] Internationally, the SEEA CF[201] provides a classification framework and examples for natural capital relevant for the SNA and SEEA CF boundaries. Some organizations, such as the International Union for Conservation of Nature, have proposed elements for an ecosystem classification system.[202]

Supporting recommendation: The classification systems should:

- Accommodate the recommendation of three different boundaries, including a standard boundary, an offsetting and defensive expenditures boundary, and services beyond the standard production boundary.
- Connect the various environmental sectors with each other and with other economic classification systems.

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[198] U.S. Census Bureau. (2022). *North American Industry Classification System (NAICS).* https://www.census.gov/naics/?58967?yearbck=2022.
[199] La Notte, A., & Rhodes, C. (2020). The Theoretical Frameworks Behind Integrated Environmental, Ecosystem, and Economic Accounting Systems and Their Classifications. *Environmental Impact Assessment Review*, *80,* Article 106317. https://doi.org/10.1016/j.eiar.2019.106317.
[200] U.S. Environmental Protection Agency. (2022). *National Ecosystem Services Classification System Plus - Frequently Asked Questions*. https://www.epa.gov/eco-research/national-ecosystem-services-classification-system-plus-frequently-asked-questions.
[201] United Nations. (2014). *System of Environmental-Economic Accounting 2012 — Central Framework.* https://seea.un.org/sites/seea.un.org/files/seea_cf_final_en.pdf.
[202] i.e., the IUCN Global Ecosystem Typology.

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- Provide the foundation for the accounting taxonomies that private business and assurance require to account for their dependencies and impacts on natural capital.[203]
- Accommodate spatially specific information.

Two features of natural assets differentiate them from many of the objects classified in traditional economic classification systems: (1) the ease with which objects may be discretized, which relates to the resolution of measurement; and (2) the importance of the position of an object in geographic space. Classification systems should be attentive to these differences.

Supporting recommendation: The classification systems should address questions of spatial resolution and should connect geographic-location information with other classification attributes. When considering these issues, it is important to consider the role of remote sensing data. Currently, biophysical data are often available at a 30-meter resolution, which is sufficient for many, but not all, applications. The quality and resolution of remotely and *in situ* sensed data are rapidly improving. The classification systems should accommodate future technological improvements. Another challenge involves ensuring spatial scale of measurement of natural assets aligns with spatial scale at which economic data are reported.

Valuation Standards for Natural Capital Accounting and other Environmental-Economic Statistics and Connections to Benefit-Cost Analysis

"The challenges encountered in valuing capital should not be understated. But neither should they be exaggerated."[204] The international statistical community has adopted valuation guidance as part of the SEEA CF, and it has provided interim recommendations for ecosystems,[205] but it has not yet finalized a standard for valuation. The theory of valuation of a change in natural capital, based on the change in future expected net value of the flow of services, is well-established.[206] While practical challenges in implementing the theory in a consistent fashion remain, many of these challenges are being overcome rapidly, such as in the Land Accounts.[207] A production set of environmental-economic statistics requires a standardized approach to measuring the marginal value of a defined unit of natural capital that meets U.S. statistical standards, and can be combined with the development of index numbers to calculate the changes in wealth over time. Valuation standards should account for challenges concerning how to adjust prices to account for product quality change and the introduction of entirely new products into

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[203] Numerous NGOs and coalitions are building such taxonomies. The Federal government will consider these as it builds its classification schema where appropriate. However, having Federal classification systems will help harmonize the private sector space as well.

[204] Agarwala, M. and Zenghelis, D. (2020). *Natural Capital Accounting for Sustainable Macroeconomic Strategies*. United Nations Department of Economic and Social Affairs. https://seea.un.org/content/natural-capital-accounting-sustainable-macroeconomic-strategies.

[205] NCAVES and MAIA. (2022). *Monetary valuation of ecosystem services and ecosystem assets for ecosystem accounting: Interim Version 1st edition*. United Nations Department of Economic and Social Affairs, Statistics Division, New York. https://seea.un.org/sites/seea.un.org/files/techreportvaluationv15_final_21072022.pdf.

[206] Irwin, E.G., Gopalakrishnan, S., Randall, A. (2016). "Welfare, wealth, and sustainability." *Annual Review of Resource Economics,* 8: 77-98.; Karp, L. (2017). Natural Resources as Capital. MIT Press, pp 307=309; Fenichel, E.P., Abbott, J.K., & Do Yun, S. (2018). The Nature of Natural Capital and Ecosystem Income. *Handbook of Environmental Economics, 4,* 85-142. https://doi.org/10.1016/bs.hesenv.2018.02.002.

[207] Wentland, S. A., Ancona, Z. H., Bagstad, K. J., Boyd, J., Hass, J. L., Gindelsky, M., & Moulton, J. G. (2020). Accounting for land in the United States: Integrating physical land cover, land use, and monetary valuation. *Ecosystem Services*, *46*, Article 101178. https://doi.org/10.1016/j.ecoser.2020.101178.

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existing national income accounts.[208] Accounting for such challenges, even imperfectly, improves overall understanding of the economic system. It is also consistent with past processes in the development of the national economic accounts.

Exchange (or marginal) value provides the relevant theory of value for natural capital accounting. However, valuation is connected to the accounting boundaries, and at times this has been confused with the value concept. The core challenge is that most valuations of services from the environment, which are used to calculate the value of natural capital, are conducted in the context of benefit-cost analysis. In the United States, Federal benefit-cost analysis is guided by OMB Circulars A-94 and A-4. These circulars follow best practices and recommend comparing conditions with a change to baseline conditions without the change; this clear counterfactual enables the calculation of consumer surplus. Specifically, the marginal value of the first unit of change need not equal the marginal value of the last unit of change. National accounts have no counterfactual because, in practice, there could be an infinite number of counterfactuals at any point in time. Therefore, national accounts exclude consumer surplus measures because all changes are considered marginal. When this cannot be the case, consumer surplus is considered to be supplied by services outside of the production boundary.

A focus on marginal valuation, careful adherence to economic theory, and index numbers provide a path for national accounting to perform valuation using many of the environmental-valuation methods common in benefit-cost analysis.[209] The marginal valuation plus index-number approach could be applied because many Federal agencies have experience, and some agencies have specific handbooks, that guide the valuation of ecosystem services, natural capital, or both in the context of benefit-cost analysis. Appropriate index-number theory for natural capital is still being developed. Guidance for translating these measures into a national-accounting context and back again will help strengthen the monetization components of the accounts and enable the natural capital accounts to be a starting place for benefit-cost analysis.

Supporting recommendation: Make use of the substantial expertise within Federal agencies and U.S. academics on the economics of monetary valuation for natural assets and their services to develop concrete norms for implementing the SEEA CF guidance and development of standards for ecosystems. Reliable, repeatable, and scalable monetary valuation is one area that the Working Group identified as an area of need. It is important for economists working on this topic in collaboration with natural scientists to move beyond project-level valuation to focus on the need for repeated and scalable measurement. Specific attention should be paid to using market measurements, near-market techniques in non-market valuation, and more general non-market valuation methods. Each of these classes of valuation methods merits dedicated attention. Furthermore, a number of technical elements of valuation are country-specific, and Federal expertise is needed for application within the United States. Approaches for how pricing

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[208] This issue is not unique to natural assets and lessons from accounting for digital and other "free" services should be considered. Brynjolfsson, E., Collis, A., Diewert, W. E., Eggers, F., & Fox, K. J. (2019). GDP-B: Accounting for the value of new and free goods in the digital economy. *National Bureau of Economic Research,* Working Paper 25695. https://doi.org/10.3386/w25695.

[209] SEEA EEA Revision Working Group 5 on valuation and accounting treatments. (2019). *Discussion Paper 5.3: A Framework for the Valuation of Ecosystem Assets*. https://seea.un.org/sites/seea.un.org/files/discussion_paper_5.3.pdf.

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techniques address risk, tipping points, and other challenges related to imputing asset prices should be considered.[210]

Supporting recommendation: Develop research on index numbers and how to harmonize valuation across natural capital accounts. A well-known challenge in economics is measuring the change in value of an asset or set of services over time when prices and quantities change overtime. Researchers[211] have used simple indexing approaches based on Hicks (1939)[212] and Harberger (1971)[213] to conduct analyses. However, index number theory for market goods has advanced substantially, and similar rigor is needed when prices are measured implicitly, which is often the case with natural capital.

Supporting recommendation: OMB, with the support of OSTP, should convene an expert group to develop the necessary crosswalk between valuation in the context of benefit-cost analysis and national accounting by 2025. In order to harmonize approaches, this interagency group will develop primary guidance and apply lessons learned from early-stage pilot and prototype accounts. National accounting data typically cannot be directly integrated into benefit-cost analyses. Crosswalks are needed to make them applicable, and this expert group should develop those. Natural capital accounts can also help frame treatment of ecosystem and environmental services and changes in the value of natural assets within benefit-cost analysis by establishing connections and pathways to help quantify or monetize ecosystem service benefits and costs.

Guidance on Biodiversity

Supporting recommendation: Develop other specific guidance documents as needed related to biodiversity. Many stakeholders, including through the public comment process, have noted the importance of developing a biodiversity natural capital account. The SEEA EA begins to address biodiversity in a single account, which is a species account, while acknowledging this is a partial measure.[214] Many science-based definitions of biodiversity go beyond species and recognize diversity at the genetic level and at the larger ecosystem level that involves interactions among biotic and abiotic elements of ecosystems at multiple scales. The Convention on Biodiversity,[215] for instance, defines biodiversity as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems."

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[210] Lemoine, D. (2021). The climate risk premium: how uncertainty affects the social cost of carbon. *Journal of the Association of Environmental and Resource Economists*, *8*(1), 27-57. https://doi.org/10.2139/ssrn.2560031.
[211] Arrow, K. J., Dasgupta, P., Goulder, L. H., Mumford, K. J., & Oleson, K. (2012). Sustainability and the Measurement of Wealth. *Environment and Development Economics*, *17*(3), 317–353. https://doi.org/10.1017/S1355770X12000137; Yun, S.D., et al. (2017). Ecosystem-Based Management and the Wealth of Ecosystems. *Proceedings of the National Academy of Sciences*, *114*(25), 6539–6544. https://doi.org/10.1073/pnas.1617666114.
[212] Hicks, J.R. (1939). *Value and Capital: An Inquiry into Some Fundamental Principles of Economic Theory*. New York: Oxford University Press.
[213] Harberger, A. C. (1971). Three Basic Postulates for Applied Welfare Economics: An Interpretive Essay. *Journal of Economic Literature, 9(3)*, 785–797. https://www.jstor.org/stable/2720975.
[214] King, S., Vardon, M., Grantham, H. S., Eigenraam, M., Ferrier, S., Juhn, D., Larsen, T., Brown, C., & Turner, K. (2021). Linking Biodiversity into National Economic Accounting. *Environmental Science & Policy, 116*, 20–29. https://doi.org/10.1016/j.envsci.2020.10.020.
[215] United Nations. (1992). *Convention on Biological Diversity*. https://www.cbd.int/doc/legal/cbd-en.pdf.

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Therefore, biodiversity cannot be included as its own environmental sector, but it may still be informative about the condition and extent of certain ecosystem assets. Further, it may also be possible to make statements about changes in biodiversity based on information in the natural capital accounts or other environmental-economic statistics once a sufficient number of sectors have been developed. Caution is merited in using traditional biodiversity indices in natural capital accounts because they do not map uniquely from the physical state of nature. The ecological science is moving away from one-dimensional biodiversity indices in general.[216] Therefore, guidance should be developed on if and how to use the accounts to make reasonable inferences and statements about biodiversity, recognizing that there are many other mechanisms for assessing changes in biodiversity beyond natural capital accounts.[217] Monetary valuation has an important role in this context because the implicit (i.e., realized shadow) prices of natural capital can reflect ecological relationships.[218] Research on understanding how implicit prices for natural capital reflect ecological relationships and what that means for interpreting changes in biodiversity is nascent. Therefore, it will be important to develop guidance as subject knowledge and expertise grow in this field.

[216] Jetz, W., et al. (2019). Essential biodiversity variables for mapping and monitoring species populations. *Nature Ecology & Evolution*, *3*(4), 539-551. https://doi.org/10.1038/s41559-019-0826-1.
[217] King, S., Vardon, M., Grantham, H. S., Eigenraam, M., Ferrier, S., Juhn, D., Larsen, T., Brown, C., & Turner, K. (2021). Linking Biodiversity into National Economic Accounting. *Environmental Science & Policy, 116*, 20–29. https://doi.org/10.1016/j.envsci.2020.10.020.
[218] Yun, S. D., et al. (2017). Ecosystem-Based Management and the Wealth of Ecosystems. *Proceedings of the National Academy of Sciences, 114*(25), 6539–6544. https://doi.org/10.1073/pnas.1617666114.

V. Administrative Coordination Across the Federal Government

Recommendation 5: The Federal Government should apply existing authorities and make use of the substantial expertise within Federal departments and agencies, by coordinating across agencies, to develop and update the system of natural capital accounts and environmental-economic statistics in an efficient manner.

Coordination

Supporting recommendation: The Chief Statistician of the United States, within OMB, should use authorities provided by the Paperwork Reduction Act of 1995 (PRA) and the Foundations for Evidence-Based Policymaking Act of 2018 (Evidence Act) to coordinate the development and future updating of natural capital accounts, including through engagement with the Interagency Council on Statistical Policy (ICSP) and establishment of interagency groups, as needed. The Chief Statistician of the United States (CSOTUS), a statutorily-created position under the Paperwork Reduction Act of 1995, plays a coordinating role to ensure the efficiency and effectiveness of the decentralized, interconnected U.S. Federal statistical system. Coordination is especially relevant for statistical initiatives that span across the Federal statistical system, including for environmental-economic statistics, because expertise is distributed across the Federal Government. Chaired by CSOTUS, the ICSP advises and assists CSOTUS in the coordination of the Federal statistical system; the implementation of statistical policies, principles, standards, and guidelines; and the assessment of statistical program performance. ICSP currently includes 26 members in addition to the Chair. Pursuant to the PRA, the heads of all 13 principal statistical agencies and units are members. Pursuant to the Evidence Act, all 24 Statistical Officials[219] are also members.[220] The ICSP is a forum for collaboration, coordination, and information-sharing among the principal statistical agencies and units and additional statistical programs across its member agencies, including on issues such as ensuring data quality and confidentiality, attaining and providing data access, and playing an effective role in agency-wide data governance. In addition, CSOTUS uses interagency technical working groups, or other types of interagency bodies, to facilitate and coordinate interagency engagement and efforts. See Appendix D for more information.

Supporting recommendation: BEA should oversee the assembly of the natural capital accounts into a sequence (or system) of natural capital accounts and environmental-economic

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[219] The position of Statistical Official was created by the Evidence Act to include the head of any statistical agency or unit within a Federal agency or, in the case that an agency does not have a statistical unit, a senior agency official with appropriate expertise. Pursuant to the Evidence Act, Statistical Officials are tasked with advising their respective agencies on statistical policy, techniques, and procedures. 5 U.S.C. § 314(a). This designation applies to each of the 24 agencies enumerated in the Chief Financial Officers Act of 1990. 31 U.S.C. § 901(b)(1).

[220] Eleven of the Statistical Officials are also heads of principal statistical agencies or units, which is why the numbers to do not sum.

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statistics. This will require resources to ensure that staff and the requisite data purchases are available for these activities.

Supporting recommendation: Other agencies (listed in Figure 3) should provide dedicated support, including staff, data, analysis, and subject matter expertise. While BEA is the primary economic statistics agency responsible for national economic accounts, much of the subject matter expertise and data to support natural capital accounts and environmental-economic statistics is distributed across the Federal Government.

Supporting recommendation: OMB, with support from OSTP, should help coordinate budget requests from agencies to ensure resources to carry out the Strategic Plan. Developing statistics takes resources. Given the distributed model that the Working Group is recommending, it will remain important for White House leadership to ensure that modest resources, including for staffing and data procurement, for carrying out this Strategic Plan consistently are included in the President's Budgets.[221]

Supporting recommendation: Adhering to applicable laws and executive guidelines for statistical standards, scientific integrity, and information quality promotes credibility and trust in the end products, and as such, all agencies involved with the development of natural capital accounts or environmental-economic statistics should comply with applicable laws and executive guidelines. Applicable laws, OMB memoranda, and other Executive Branch policies seek to promote consistency, comparability, appropriate protection of sensitive information, and fitness for purpose of relevant data products. Consistent compliance with such laws, memoranda, and policies across agencies involved in developing natural capital accounts and environmental-economic statistics is therefore important to the initiative. For example, this would include policies related to updating statistical standards as new information and methods emerge and ensuring the quality of the information produced is fit for the purpose or purposes for which it is designed to be used.

Facilitating Data Sharing and Promoting Interoperability

Natural capital accounting will require access to and integration of large volumes of diverse data produced by many sources, and in some cases the use of modeling techniques. Thus, promoting increased access to data for the statistical agencies developing the measures and improving data interoperability[222] is of high importance in making production-level natural capital accounts easier to compile. It will be important that efforts around natural capital accounting promote and align with the many other initiatives underway across the Federal Government to improve the sharing and interoperability of Federal data, while ensuring proper protections of those data are maintained.

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[221] For example, natural capital accounts and environmental-economic statistics were included in the Multi-Agency Research and Development Priorities for the FY 2024 Budget memo issued by OMB and OSTP.
Young, S., & Nelson, A. (2022, July 22). *Memorandum for the Heads of Executive Departments and Agencies: Multi-Agency Research and Development Priorities for the FY 2024 Budget [M-22-15]*. Office of Management and Budget & Office of Science and Technology Policy. https://www.whitehouse.gov/wp-content/uploads/2022/07/M-22-15.pdf.

[222] Interoperability is the ability of independently produced data or tools to integrate or work together with minimal effort.

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Supporting recommendation: Experts across the Executive Branch in collaboration with Chief Data Officers should develop data management protocols and properly document these protocols. The Foundations for Evidence-Based Policymaking Act of 2018 established the position of Chief Data Officer for Federal agencies. These and other experts should be engaged to promote data interoperability, data sharing, and data serving.

Interoperability

Given its importance for SEEA, interoperability has received increasing attention from the U.N. Statistics Division (UNSD). UNSD has collaborated with the Basque Centre for Climate Change and USGS to produce a tool called ARtificial Intelligence for Ecosystem Services (ARIES) for SEEA,[223] which uses artificial intelligence to automate the construction of natural capital accounts using interoperable data and models, as well as a general strategy to improve the interoperability of data and models for SEEA accounting.[224] The primary challenge to applying ARIES for SEEA in the United States lies in the vast amount of U.S. data and models, very few of which have been curated in a way that maximizes their interoperability.
Substantial further work will thus be required to make U.S. data and models interoperable enough to be used within the ARIES framework. In summary, natural capital accounting imposes a need for greater interoperability than currently exists for Federal Government data and models, and several potential solutions exist, from ad hoc approaches to those explicitly designed to support natural capital accounting (i.e., ARIES for SEEA) to potential other solutions, all of whose advantages and disadvantages should be clearly evaluated in support of U.S. natural capital accounting.

Data Sharing

In part because of its decentralized nature and in part because of specific laws governing the handling of non-statistical data, there is uneven success across the U.S. statistical agencies in acquiring data from other sources. For example, some statistical agencies have explicit authority in their authorizing statutes to request administrative data from other Federal agencies (e.g., Title 13 for the Census Bureau), while others rely entirely on system-wide authorities, like the Confidential Information Protection and Statistical Efficiency Act of 2018 (CIPSEA 2018), which creates a presumption that agencies make their data accessible to statistical agencies and units[225] for the purposes of developing evidence, subject to confidentiality restrictions and other statutory requirements.[226] This default is consistent with the PRA's goal to eliminate duplication by coordinating efforts across the decentralized Federal statistical system. Prior to the enactment of CIPSEA 2018, OMB Memorandum M-14-06, which discusses sharing of administrative data for statistical purposes, provides sample principles that could guide any memoranda of understanding or other data-sharing mechanisms or agreements. Specifically, it calls for fostering interagency cooperation, implementing data stewardship practices, documenting data quality

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[223] United Nations. (n.d.). *ARIES for SEEA*. https://seea.un.org/content/aries-for-seea.
[224] United Nations. (2021). *An Interoperability Strategy for the Next Generation of SEEA Accounting*. https://seea.un.org/sites/seea.un.org/files/seea_interoperability_strategy.pdf.
[225] 44 U.S.C. § 3561(11).
[226] 44 U.S.C. § 3581(a).

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control measures, and creating formal interagency agreements.[227] Similar principles could guide data sharing efforts related to natural capital accounting.

Supporting recommendation: NASA, NOAA, and USGS should play a coordinating function related to space-based remote sensing data for natural capital accounts and environmental-economic statistics. Remote sensing data are increasingly available, important, and relevant to natural capital accounts and environmental-economic statistics. NASA, NOAA, and USGS should play a coordination role with respect to Federal and private sector space-based remote sensing data.

Website and Data Serving

Because the U.S. statistical system is decentralized, data generated by the U.S. statistical system are generally hosted by the agency or agencies responsible and funded for a given statistical program. For example, the Census Bureau hosts data from the Decennial Census of Housing and Population and the quinquennial Economic Census. BLS hosts data on employment, jobs, and productivity. BEA hosts data on the NIPA and balance of payments. In cases where statistical data are compiled collaboratively among two or more agencies, data may be hosted by one or each of the agencies. For example, BEA and the Federal Reserve host the same data on the Integrated Macroeconomic Accounts, and BLS and BEA host the same data on the Integrated Industry-Level Production Accounts. However, BEA is the single host of data for the Marine Economy Satellite Account, which was developed collaboratively with NOAA, and the Outdoor Recreation Satellite Account, which was developed collaboratively with DOI and USDA.

Supporting recommendation: Consider two options for hosting data on natural capital accounts and environmental-economic statistics.

- First, based on the interagency collaboration and funding necessary to produce natural capital accounts and environmental-economic statistics, data could be hosted by the multiple agencies involved - with each agency's data drawn from a common back-end database or using a data mesh network.
- Second, all data could be hosted on BEA's website as a centralized site with no data hosted on other partner agencies' websites, but with links from those websites to the BEA website. BEA is one possible candidate agency for this role. Such multi-agency statistical activities are new and the best singular agency to provide this role is still being decided.

Engagement

This Strategic Plan was developed with robust public engagement, including public presentations, listening sessions and roundtables, and a 60-day public comment period. The Federal Government intends for this robust public engagement to continue. It is important for the Chief Statistician of the United States' office and any bodies coordinating environmental-economic accounts to coordinate and cooperate internationally and with state, local, territorial,

[227] Burwell, S. (2014, Feb. 14). *Memorandum for the Heads of Executive Departments and Agencies: Guidance for Providing and Using Administrative Data for Statistical Purposes [M-14-06]*. Office of Management and Budget. https://www.whitehouse.gov/wp-content/uploads/legacy_drupal_files/omb/memoranda/2014/m-14-06.pdf.

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and Tribal governments. These governments may have important sources of data and knowledge and benefit from use guidance and information sharing. It is also important that the Chief Statistician's office and any other cooperating agencies engage with the private sector, nongovernmental organizations, academia, and the general public, as feasible and appropriate.

International

As with many engagements that touch on statistical measurement on the international level, coordination is necessary among the Chief Statistician of the United States,[228] the Department of State, and the agencies that staff the relevant topical tracks—in this case, EPA and Treasury, among others. There is growing interest in environmental-economic statistics in the G7, the G20, and other multilateral forums, in particular in the environment and finance tracks. For the United States to be an international leader in natural capital accounting and environmental-economic statistics, engagements in this area should expand.

Supporting recommendation: The Federal Government should continue to expand engagements that raise high-level ambition, technical capacity, or both for natural capital accounts and environmental-economic statistics. Experts within the Federal Government already engage with and, in many instances, provide leadership within international groups to advance natural capital accounting and environmental-economic statistics. These include forums such as Earth Observations for Ecosystem Accounting (EO4EA) and the London Group on Environmental Accounting. The Working Group recommends expanding these collaborations to include similar groups, such as the Global Ocean Accounting Partnership, when feasible and helpful. The Working Group also recommends creating or joining bilateral and multilateral cooperations related to high-level ambition and technical coordination.[229] Finally, the Working Group recommends continued or expanded collaboration with through G7, G20, OECD, U.N., and multilateral development banks and other international financial institutions on initiatives related to natural capital accounting or environmental-economic statistics.

State, Territorial, and Local Governments

Many states, territories, and some local governments maintain their own statistics. These subnational systems often use or feed into national statistics.

Supporting recommendation: Build on existing relationships with state and local governments to ensure interoperability and that the system address state, territory, and local needs to the extent possible. Cooperation related to data is one reason to engage with state, territorial, and local governments. These governments are also often the owners or trustees of natural capital, and it is important that they are engaged as the measurement process develops. State, territorial, and local governments may also be good research partners in the development phases of *Statistics for Environmental-Economic Decisions*.

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[228] One of the functions carried out by the Chief Statistician of the United States under the PRA is to "coordinate the participation of the United States in international statistical activities, including the development of comparable statistics."

[229] For example, the Joint Statement of the Government of the United States of America and the Government of Australia on Cooperation on Natural Capital Accounting, Environmental-Economic Accounting, and Related Statistics (12/15/2022, Montreal, Canada), https://www.whitehouse.gov/ostp/news-updates/2022/12/15/joint-statement-of-the-government-of-the-united-states-of-america-and-the-government-of-australia-on-cooperation-on-natural-capital-accounting-environmental-economic-accounting-and-related-statisti/.

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Tribal Governments and Indigenous Organizations

The United States is committed to strengthening nation-to-nation relationships with Tribal Nations.[230] As noted in the section "Natural Capital Accounting and Resilient State, Territorial, Local, Tribal, and Indigenous Communities," international standards do not provide guidance on engagement and inclusion of Indigenous Peoples or Indigenous Knowledge in environmental-economic statistics. Tribal Governments and Indigenous Organizations are often the caretakers or owners of natural assets.

Supporting recommendation: Conduct robust Tribal consultation and engagement around the development of the natural capital accounts and environmental-economic statistics, consistent with Executive Order 13175 and the Memorandum on Indigenous Knowledge.[231] Tribes and Indigenous Communities may require, and Federal Government should anticipate the need to provide, technical assistance to assess resource portfolios, contribute data, and make use of natural capital accounts for planning, credit enhancement, and other economic purposes. One important focus of Tribal consultation and other Indigenous Peoples engagement is to clearly identify accounting partitions and natural asset classifications that are important for ensuring that these groups are included and reflected in the natural capital accounts and environmental-economic statistics.

Private Sector, Natural Resource Stewards, Non-Governmental Sector, Academia, and the General Public

A large number of private sector and non-governmental natural capital accounting and environmental statistics initiatives exist. This Strategic Plan mentions some of these. Public comments and roundtables[232] related to this Strategic Plan revealed others. These sectors are important users of national statistics. They have strong interests in the international comparability of environmental-economic statistics and the rigor with which the natural capital accounts and environmental-economic statistics are compiled. Statistics are ultimately used to inform decisions, and business, non-profits, and the general public should understand how environmental-economic statistics are derived and compiled.

Supporting recommendation: The Office of the Chief Statistician of the United States, with implementing agencies, should continue robust public engagement related to the development, implementation, and updating of natural capital accounts and environmental-economic statistics. This engagement should involve two-way dialogue, issuing Requests for Information, and accepting public comments, peer-review, or both as appropriate and feasible. Furthermore,

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[230] The White House. (2021, Jan. 26). *Memorandum on Tribal Consultation and Strengthening Nation-to-Nation Relationships*. https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/26/memorandum-on-tribal-consultation-and-strengthening-nation-to-nation-relationships/.

[231] Prabhakar, A., & Mallory, B. (2022, Nov. 30). *Memorandum for the Heads of Departments and Agencies: Guidance for Federal Departments and Agencies on Indigenous Knowledge*. Office of Science and Technology Policy & Council on Environmental Quality. https://www.whitehouse.gov/wp-content/uploads/2022/12/OSTP-CEQ-IK-Guidance.pdf. Prabhakar, A., & Mallory, B. (2022, Nov. 30). *Memorandum for the Heads of Departments and Agencies: Implementation of Guidance for Federal Departments and Agencies on Indigenous Knowledge*. Office of Science and Technology Policy & Council on Environmental Quality. https://www.whitehouse.gov/wp-content/uploads/2022/12/OSTP-CEQ-IK-Guidance.pdf.

[232] Office of Science and Technology Policy. (2022, Aug. 18). *Readout: OSTP Initial Engagement on Developing Natural Capital Accounts*. https://www.whitehouse.gov/ostp/news-updates/2022/08/18/readout-ostp-initial-engagement-on-developing-natural-capital-accounts/.

the Federal Government should maintain a diverse partner network and, as appropriate and feasible, cooperate on research and data collection with experts outside the Federal Government. Especially for environmental sectors in which substantial shares of the natural assets are privately owned, such as forests, cropland, and rangeland, it is important to engage with resource owners and stewards in the development phase of environmental-economic statistics.

The Federal Government needs to engage meaningfully and with clarity given there are high expectations domestically and internationally, some of which may be unrealistic, for the U.S. natural capital accounts. It is important that the Federal Government manage expectations about the timing of natural capital accounts and what they can and cannot do. As a national accounting program, natural capital accounts will not provide bespoke information for every project or provide ready-made outputs for benefit-cost analysis for policy makers, investors, or businesses. The public comments received on this Strategic Plan reinforced the need to set clear expectations.

Effective engagement and expectation management requires maintaining steady progress so that products are available early in the 15-year time horizon. This will promote learning to use these accounts.[233] For example, in the European Union there are dedicated resources for outreach to users of the natural capital accounts. Furthermore, natural capital accounts, like all accounts, become more useful the longer the time period they cover. This Strategic Plan lays out a 15-year plan to establish natural capital accounts as core statistical products, and it recognizes that the accounts will likely continue to evolve after that—much like the national economic accounts have continued to evolve over the past century.

Within the Federal Government, there are many accounting programs. This initiative will seek to align environmental-economic statistics and the natural capital accounts with national economic accounts. These differ from the Federal Government's fiscal and budgetary accounts and the Working Group will continue to communicate the difference. The economic accounts are useful for strategic decision making and framing national conversations. They also help set standards for what is considered part of the economy and budget planning. By contrast, the fiscal and budget accounts track what resources the Federal Government has at its disposal at a given point in time. Over the long term, natural capital accounts could influence tax policies and revenue and resources available to the Federal Government, but these will only appear in Federal fiscal and budget accounts after the fact.

[233] SELINA Project. (n.d.). *About*. https://www.selina-project.eu/about.

VI. Conclusion

The draft Strategic Plan, *Statistics for Environmental-Economic Decisions*, serves to guide the Federal Government in establishing natural capital accounts and associated environmental-economic statistics as core statistical products over the next 15 years. This is part of the natural and decades-long evolution of U.S. national economic accounts and anticipates the direction that international standards for national accounts are moving. By 2036, there is high expectation, both domestically and internationally, that the United States will incorporate the environment and nature into economic decision making. This Strategic Plan aims to ensure that the United States is ready to lead in the future evolution of national economic accounts that connect to the environment. It has long been acknowledged that current economic measures do not adequately summarize economic growth for natural resource-dependent economies,[234] but today—given economic challenges stemming from climate change, biodiversity loss, and other environmental threats—we must recognize that our natural assets function as an essential pillar upon which our economy stands.

[234] Kuznets, S. (1973). Modern Economic Growth: Findings and Reflections. *The American Economic Review*, *63*(3), 247–258. https://www.jstor.org/stable/pdf/1914358.pdf.

List of Acronyms

Abbreviation	Definition
API	Application Programming Interface
ARIES	ARtificial Intelligence for Ecosystem Services
BEA	U.S. Bureau of Economic Analysis
BLM	U.S. Bureau of Land Management
BLS	U.S. Bureau of Labor Statistics
BOEM	U.S. Bureau of Ocean Energy Management
CEA	Council of Economic Advisers
CEQ	Council on Environmental Quality
CFO	Act Chief Financial Officers Act
CIPSEA	Confidential Information Protection and Statistical Efficiency Act
CMAQ	Community Multiscale Air Quality Modeling System
CPO	Domestic Climate Policy Office
CSOTUS	Chief Statistician of the United States
DOC	U.S. Department of Commerce
DOE	U.S. Department of Energy
DOI	U.S. Department of the Interior
DOL	U.S. Department of Labor
ECPC	Economic Classification Policy Committee
EGSS	Environmental Goods and Services Sector
EIA	U.S. Energy Information Administration
ENOW	Economics: National Ocean Watch
EOP	Executive Office of the President
EPA	U.S. Environmental Protection Agency
EPE	Environmental Protection and Expenditure
EQUATES	EPA's Air QUAlity TimE Series
EROS	Earth Resources Observation and Science
ERS	Economic Research Service
ESG	Environmental, Social, and Governance
FIA	Forest Inventory and Analysis
FTC	Federal Trade Commission
GDP	Gross Domestic Product
GHGI	Greenhouse Gas Inventory
ICSP	Interagency Council on Statistical Policy
IEESA	Integrated Environmental and Economic Satellite Accounts
IIJA	Bipartisan Infrastructure Investment and Jobs Act of 2021
IMF	International Monetary Fund
LCMAP	Land Change Monitoring, Assessment, and Projection
LULC	Land Use-Land Cover
MESA	Marine Economy Satellite Account
NAICS	North American Industry Classification System
NAPCS	North American Product Classification System

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Abbreviation	Definition
NASA	The National Aeronautics and Space Administration
NASS	National Agricultural Statistics Service
NAWQA	National Water-Quality Assessment
NBER-CRIW	National Bureau of Economic Research Conference on Research on Income and Wealth
NDP	Net Domestic Product
NEC	National Economic Council
NEI	National Emissions Inventory
NEPA	National Environmental Policy Act
NGWOS	Next Generation Water Observing System
NIPA	National Income and Product Accounts
NLCD	National Land Cover Database
NNI	Net National Income
NOAA	National Oceanic and Atmospheric Administration
NPV	Net Present Value
NRCS	Natural Resources Conservation Service
NSC	National Security Council
NSF	National Science Foundation
OECD	Organization for Economic Co-operation and Development
OIRA	Office of Information and Regulatory Affairs
OMB	Office of Management and Budget
OSTP	Office of Science and Technology Policy
PCS-ICIS	Permit Compliance System and Integrated Compliance Information System
PRA	Paperwork Reduction Act of 1995
RPA	Resources Planning Act
SEEA	System of Environmental-Economic Accounting
SEEA CF	System of Environmental-Economic Accounting Central Framework
SEEA EA	System of Environmental-Economic Accounting Ecosystem Accounting
SNA	System of National Accounts
U.N.	United Nations
UNSD	U.N. Statistics Division
USDA	U.S. Department of Agriculture
USEEIO	U.S. Environmentally-Extended Input-Output
USFS	U.S. Forest Service
USGS	U.S. Geological Survey

Appendices

Appendix A. The Development of Environmental-Economic Statistics

American success in the post-World War II period is built in part on our national economic accounting system.[235] That system, however, did not always exist. At the dawn of the Great Depression, economic planners used a variety of disassociated measures, such as rail car loadings, to try to understand the state of the national economy. Post-Depression American prosperity is built on accurate measurement of sectors for economic production and the assets that support the economy. History tells us that omitting measurement of important asset classes, in terms of quantities and prices, puts economic prosperity at risk. The Soviet Union made the mistake of omitting prices and values from their original national accounting system. This led the Soviet Union to ultimately abandon its own accounting system, which gave the West a strong economic advantage during the Cold War.

U.S. Federal agencies have a long history, substantial strength, and the know-how required to develop natural capital accounts and environmental-economic statistics. Its experts were early leaders in this area and continue to develop methodology and data, supported by outside experts from academia and research institutions.

The modern incarnation of these ideas began in the United States in Nobel laureates William Nordhaus and James Tobin's 1973 seminal piece which noted "serious consequences of treating as free things which are not really free. This practice gives the wrong signals for the directions of economic growth."[236] After years of research, the BEA initiated the Integrated Environmental and Economic Satellite Accounts (IEESA) in 1992, published in 1994.[237] At that point, the United States was a global leader and pioneer in this area until the Commerce Department was directed by law to suspend further work in this area until an independent entity analyzed the Commerce Department's proposed methodology.[238] A review panel working under the National Research Council's Committee on National Statistics examined "the objectivity, methodology, and application of integrated environmental and economic accounting in the context of

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[235] Landefeld, J.S. (2000, Jan.). GDP: One of the Great Inventions of the 20th Century. *Survey of Current Business*, *80*(1), 6–14. https://apps.bea.gov/scb/account_articles/general/0100od/maintext.htm.

[236] Nordhaus, W. D., & Tobin, J. (2018). Is Growth Obsolete? In *Green Accounting*. *Routledge*, 49–72. http://doi.org/10.4324/9781315197715-3.

[237] A satellite account uses the same principles as the core national accounts but offers more flexibility and is generally not additive with the core account.

[238] U.S. House of Representatives. (n.d.). *H. Rept. 103-708 (Conference Report) accompanying the Departments of Commerce, Justice, and State, the Judiciary and Related Agencies Appropriations Act, 1995 (Pub. L. 103-317)*. U.S. Government Publishing Office, 61;
U.S. House of Representatives. (n.d.). *H. Rept. 103-552 (Committee Report) accompanying Departments of Commerce, Justice, and State, the Judiciary and Related Agencies Appropriations Act, 1995 (Pub. L. 103-317)*. U.S. Government Publishing Office, 64.

broadening the national economic accounts."[239] The panel was chaired by William Nordhaus and published its findings under the title "Nature's Numbers: Expanding the National Economic Accounts to Include the Environment."[240] The report made many recommendations, chief among them was the importance of environmental-economic accounting and that BEA should resume its work.[241] This was followed by a series of reports by the National Research Council in 2005,[242] the National Bureau of Economic Research in 2006,[243] and the Government Accountability Office in 2007[244] (see also Appendix D on legal developments, which include the Paperwork Reduction Act of 1995 and the Foundations for Evidence-Based Policymaking Act of 2018). While this was happening in the United States, international experience was catching up. In 2012, the United Nations Statistical Commission adopted the System of Environmental Economic Accounting Central Framework (SEEA CF) as an international standard.[245] The SEEA CF addresses accounting for traditional natural resources (e.g., land, water, energy, minerals, timber, and harvested fish). The SEEA system expanded to include ecosystems and their services in 2021.

Today's focus has shifted beyond statistical and environmental agency engagement, with natural capital accounting now drawing the global attention of treasury departments and central banks. The United Kingdom's Treasury published "The Economics of Biodiversity: The Dasgupta Review," the Network for Greening the Financial System published "Central Banking and Supervision in the Biosphere: An Agenda for Action on Biodiversity Loss, Financial Risk and System Stability," and the Banque of France's Silent Spring report.[246] In September of 2022, the Governor of the Banque de France declared, "These biodiversity losses pose significant risks to economic growth and the financial system."[247] These international developments illustrate the importance of Federal Government consultation and outreach with other governments to ensure

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[239] Nordhaus, W. D. (1999, Nov.). *The Future of Environmental and Augmented National Accounts: An Overview. U.S. Bureau of Economic Analysis*. *Survey of Current Business*, *79*(11), 45–50. https://apps.bea.gov/scb/account_articles/national/1199od/nordhaus.htm.

[240] Nordhaus, W. D. (1999, Nov.). *The Future of Environmental and Augmented National Accounts: An Overview. U.S. Bureau of Economic Analysis*. *Survey of Current Business*, *79*(11), 45–50. https://apps.bea.gov/scb/account_articles/national/1199od/nordhaus.htm.

[241] Nordhaus, W. D., & Kokkelenberg, E. C. (1999). *Nature's Numbers: Expanding the National Economic Accounts to Include the Environment*. National Academies Press, Washington, D.C. https://doi.org/10.17226/6374.

[242] National Research Council. (2005). *Beyond the Market: Designing Nonmarket Accounts for the United States*. National Academies Press. Washington, DC. http://doi.org/10.17226/11181.

[243] Jorgenson, D., Landefeld, J. S., & Nordhaus, W. D. (2006). *A New Architecture for the U.S. National Accounts.* University of Chicago Press.

[244] U.S. Government Accountability Office. (2007). *Measuring our Nation's Natural Resources and Environmental Sustainability*. https://www.gao.gov/assets/gao-08-127sp.pdf.

[245] United Nations. (2014). *System of Environmental-Economic Accounting 2012 — Central Framework.* https://seea.un.org/sites/seea.un.org/files/seea_cf_final_en.pdf.

[246] Dasgupta, P. (2021). *The Economics of Biodiversity: The Dasgupta Review*. HM Treasury;
NGFS-INSPIRE Study Group on Biodiversity and Financial Stability. (2022). *Central Banking and Supervision in the Biosphere: An Agenda for Action on Biodiversity Loss, Financial Risk and System Stability.* https://www.ngfs.net/sites/default/files/medias/documents/central_banking_and_supervision_in_the_biosphere.pdf;
Svartzman, R., Espagne, E., Julien, G., Paul, H.L., Mathilde, S., Allen, T., Berger, J., Calas, J., Godin, A., & Vallier, A., 2021. A 'Silent Spring' for the Financial System? Exploring Biodiversity-Related Financial Risks in France. *Banque de France,* Working Paper 826. https://doi.org/10.2139/ssrn.4028442.

[247] Villeroy de Galhau, F. (2022, Sept. 29). *Speech at the DNB-OMFIF Conference on Biodiversity in Amsterdam. Biodiversity, macroeconomics, and finance: what we do know, what we don't know yet, and what we have to do.* Banque de France. https://www.banque-france.fr/en/intervention/biodiversity-macroeconomics-and-finance-what-we-do-know-what-we-dont-know-yet-and-what-we-have-do.

consistency of approach within sovereign frameworks for the sake of maintaining the coherent global system of methodology that we currently enjoy.

Finally, technological and methodological advances of the last decade or so have made assembling natural capital accounts technologically and methodologically feasible. This sentiment was expressed frequently throughout the public comment and engagement process.

Appendix B. Connecting Natural Capital and Environmental-Economic Statistics with National Economic Accounts.

Stocks and Flows

The concepts of stocks and flows are used throughout the Strategic Plan. Stocks are durable, physical elements of nature that can provide services either through harvest or through their regular functioning in the natural environment. When the services convey production, income, in-kind or implicit income, or future opportunities, then the stocks are capital or assets. Physical flows are the creation, destruction, or movement of material. For example, the generation of particulate matter through combustion or the harvest of timber from a forest are physical flows. The process creating income is also a flow. The relationship between flows and stocks is similar to the relationship between kinetic and potential energy – flows reflect changes in stocks. This creates accounting identities that are used in natural capital accounting and environmental-economic statistics.

Supply-Use Tables and Input-Output Tables

In the SNA, the most fundamental accounting identity is the supply-use identity, which requires that the supply of goods and services in an economy equals the uses of those goods and services. Supply comes from either domestic production, which is referred to as output, or imports from foreign economies. In the case of natural assets, domestic production needs to be carefully considered when production can occur through natural generation (in the case of renewable resources and many ecosystem services) or discovery (in the case of nonrenewable resources, particularly energy and minerals). There may also be special cases of accumulation through migration, especially in the case of migratory fish and wildlife or transboundary water resources.

Uses include intermediate consumption by business, final consumption by households and government, capital formation (including changes in inventories), and exports to foreign economies. The supply-use identity holds for monetary and physical flows of products, and assigning a monetary value to products facilitates the aggregation of many types of products that would not otherwise be possible.

In practice, the SNA supply-use identity is embodied in monetary supply-use tables that are detailed elaborations of the production account that serve as the starting point for national accounts. A supply table is arranged as a rectangular matrix with rows corresponding to products available in an economy and columns corresponding to the supply of products from domestic industries, imports, and various valuation adjustments. A use table is also arranged as a rectangular matrix with rows corresponding to the same products as the matching supply table,

and columns summarizing the disposition of products to intermediate and final uses (including exports) in the supply-use identity.

Monetary supply-use tables can be synthesized to compile value-added by industry and a breakdown of value-added into income components, including compensation of employees, taxes less subsidies on production and imports, and operating surplus. This synthesis along with proper balancing, which is facilitated by the internal consistency of the supply-use framework, yields an input-output table that articulates the three approaches to compiling a single measure of GDP—i.e., production, expenditure, and income approaches. The input-output table also yields "technical coefficients" that are useful for inter-industry types of economic analysis designed to understand how changes in economic activity of one industry may impact economic activity of other industries, or to observe how production and consumption patterns change over time.

In the SEEA CF, physical supply-use tables play a key role in linking environmental flows of natural inputs and residuals to economic activity in the SNA monetary supply-use tables. The structure of the physical supply-use tables extends the SNA monetary supply-use tables to incorporate a column for the environment and rows for natural inputs and residuals.

"The [SEEA] Central Framework looks at individual environmental assets, such as [land,] water, [mineral and] energy, forests and fisheries [and other biological] resources and how those assets are extracted from the environment, used within the economy and returned back to the environment in the form of emissions into air, water and waste."[248] The supply-use identity that applies to products in SNA monetary supply-use tables also applies to natural inputs and residuals in SEEA CF physical supply-use tables. In addition to the supply-use identity, an input-output identity for physical supply-use tables requires that total flows into the economy during an accounting period are either returned to the environment or accumulate in the economy. Both identities—supply-use and input-output—are integral parts of the SEEA CF accounting system. As explained in the SEEA CF, the identities are based on the laws of conservation of mass and energy.[249] The implication for environmental-economic accounting is that mass and energy flows must balance across natural inputs, products, and residuals.

Since different types of physical flows, e.g., extraction of mineral ores for use in production, gross fisheries catch, abstracted water, or timber felling residues as a residual—are measured in different units that cannot be aggregated, separate subsystems of physical supply-use tables can be developed with different measurement units for each individual environmental asset or residual. The scope of all subsystems can then include: (1) physical flows of natural inputs from the environment to the economy; (2) physical flows of products or residuals within the economy; and (3) physical flows of residuals back to the environment, so each subsystem can include a complete and balanced system of flows.

In contrast to the SEEA CF and EA with their express goal of expanding the boundary of what the SNA measures, the EPA's U.S. Environmentally-Extended Input-Output (USEEIO) models

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[248] United Nations. (n.d.). *The SEEA at a Glance*. Retrieved August 16, 2022, from https://seea.un.org/sites/seea.un.org/files/seea_one_pager_final_nov_18.pdf), supplemented with information from United Nations. (2014). *System of Environmental-Economic Accounting 2012 — Central Framework.* https://seea.un.org/sites/seea.un.org/files/seea_cf_final_en.pdf.

[249] This is only an approximation in the biosphere.

use BEA input-output tables with the intention of creating life-cycle assessment models, not to link back to expand U.S. measures of economic stocks and flows.[250]

Other Summaries and Indicators

Organized natural capital accounts and environmental-economic statistics can be useful for a wide range of potentially useful broader societal indicators. Sustainable development and economic and environmental policy are not lacking for indicators.[251] Hoekstra estimates that over 900 such indicators have been developed.[252] Many of these include, but extend beyond, changes in natural assets. For example, the United Kingdom's Office of National Statistics is pursuing Gross and Net Inclusive Income measures, which include implicit income generated by natural capital and other forms of non-market income.[253] Organizing natural asset data is a necessary step to considering many indicators, and could contribute to U.S. Measures of Economic Well-Being and Growth.[254] Public commenters also suggested several alternative indicators deriving from Nordhaus and Tobin's Measure of Economic Welfare or Capital-based approaches—for example, Adjusted Net National Savings, Genuine Progress Indicator; Inclusive, Genuine, and Comprehensive Wealth Indices; and Gross Environmental Product. The environmental and natural capital elements of many of these indicators could be supported through supply-use and other underlying statistical organizations laid out in this Strategic Plan.[255] SEEA compliant natural capital accounts increasingly play an important role in tracking progress on the U.N. Sustainable Development Goals (SDG). Other social progress measures, such as those based on subjective well-being or "happiness," would require separate statistical efforts. Furthermore, purely biological or ecological indicators could be appropriately covered by other initiatives, such as the National Nature Assessment.

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[250] Ingwersen, W. W., Li, M., Young, B., Vendries, J., & Birney, C. (2022). USEEIO v2.0, The US Environmentally-Extended Input-Output Model v2.0. *Scientific Data, 9*, Article 194. https://doi.org/10.1038/s41597-022-01293-7; Yang, Y., Ingwersen, W. W., Hawkins, T. R., Srocka, M., & Meyer, D. E. (2017). USEEIO: A New and Transparent United States Environmentally-Extended Input-Output Model. *Journal of Cleaner Production, 158*, 308–318. https://doi.org/10.1016/j.jclepro.2017.04.150.

[251] Fleurbaey, M., & Blanchet, D. (2013). Beyond GDP: Measuring welfare and assessing sustainability. *Economics and Philosophy, 31*(1), 181–187. https://doi.org/10.1017/S0266267114000479.

[252] Hoekstra, R. (2019). *Replacing GDP by 2030: Towards a Common Language for the Well-being and Sustainability Community*. Cambridge University Press. http://doi.org/10.1017/9781108608558.

[253] U.K. Office for National Statistics. (2022). *New Beyond GDP measures for the UK: a workplan for measuring inclusive income*. https://www.ons.gov.uk/economy/economicoutputandproductivity/output/articles/newbeyondgdpmeasuresfortheukaworkplanformeasuringinclusiveincome/2022-05-12.

[254] U.S. Bureau of Economic Analysis. (2022). *Prototype Measures for Economic Well-Being and Growth*. https://apps.bea.gov/well-being/.

[255] Fleurbaey, M., & Blanchet, D. (2013). Beyond GDP: Measuring welfare and assessing sustainability. *Oxford University Press*.

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Appendix C. Pathway to Production Grade Accounts and Core Statistical Products

Research

Products begin as research-based products**.** These include professional papers, working papers, technical reports, research presentations to external audiences, and other informational products that explore new ideas and are not connected to core or experimental products. These research products are often supported as one-off products with no commitment of ongoing funding. These products seldom have their own dedicated funding (aside from grants or specific research funding), and these research products may be developed within the Federal Government or as jointly-developed products of the Federal Government and external partners, such as with academia. The resulting publications generally include a disclaimer that they are not official Federal Government products.

Experimental Statistics

Experimental statistics occupy the second tier. These statistical products are developed to satisfy emerging data-user needs. They generally have a reasonable expectation of producing relevant and useful statistics, but they may benefit from user feedback and be subject to methodological changes. They may also be used to gauge user demand to determine if more resources should be invested to create a recurring standard statistical product. The products may be new or innovative in some respect, but they are typically supported by existing research. In cases where key data gaps persist or a methodological consensus has not been reached, parallel research may be conducted to resolve these issues. Experimental statistics can involve novel data sources or methodologies, where quality is still to be assessed. Transparency is important, and users need to be informed of the relevant research and processes involved in the development of the statistics and any quality issues that may arise with each revision. These products typically have some future resource commitment, but that commitment may not be open-ended. Experimental statistics may or may not be disseminated through a dedicated webpage.[256]

There is a continuum within the experimental statistics stage. Early-stage experimental statistics or late-stage research statistics are generally called “Pilot Projects.” Pilot stage statistics build on prior research, and are the step where one-off research begins to be organized into a system amenable to later production. This is an important, and sometimes difficult, step in going from a one-off research project to a statistical series. It may involve research in how to best make this transition and include development of a more formalized, longer-term working relationship among agencies on specific topics. This is a critical step because it is when Government interactions are required beyond those directly involved with the specific project.

Late-stage experimental statistics may be referred to as “Beta Versions” or “Prototype Statistical Series.” By this stage in the experimental account development process, there is a clear signal that the product is likely to become a Core Statistical Product or Production Grade Product. This includes having a dedicated website for its dissemination, and dedicated resource support.

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[256] For example, BEA uses www.bea.gov/data/special-topics to communicate such products.

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Prototypes may still carry clear disclaimers, and there still may be room for advancement in their methodology. However, the production process, including needed interagency relationships, is generally worked out by this stage. The pilot and prototype stage may result in some types of products needing to be modified in the future; this is especially true of some summary products.

Production Grade or Core Statistical Products

The goal is to have environmental-economic statistics that are Core Statistical Products or Production Grade Statistical Products. These become a core part of the statistical information produced by the Federal Government and must meet certain quality standards, guided by OMB Statistical Policy Directives and agency-specific requirements. They are produced using reliable resources, including funding and data. These statistical products are disseminated via a dedicated website. Methodological changes occur as needed, but must go through a formal review process.[257] No disclaimer is included with these products.

The initial development of national accounts for market sectors took about ten years.[258] Developing national accounts for the environmental sectors of the economy will also take time. The United Kingdom, which has produced experimental natural capital accounts since 2014, has shown how natural capital accounts can support decision making even in the experimental stage.[259]

[257] These products prioritize using robust data, science, and analysis, that is reliable and can be repeated. These products may not use the most cutting-edge methods. Methods used may also not be the most current, given the requirements to ensure robustness, reliability, and repeatability.

[258] Coyle, D. (2015). *GDP: A Brief but Affectionate History - Revised and Expanded Edition*. Princeton University Press. https://www.jstor.org/stable/j.ctvc77mfx.

[259] U.K. Office for National Statistics. (2021). *UK Natural Capital Accounts: 2021.* https://www.ons.gov.uk/economy/environmentalaccounts/bulletins/uknaturalcapitalaccounts/2021; Schwab, N., & Khatri, A. (2022). *Davos 2022: A Key Milestone in a Pivotal Year for Nature Action*. World Economic Forum. https://www.weforum.org/agenda/2022/05/davos-2022-a-key-milestone-in-a-pivotal-year-for-nature-action-f8d852f23e/.

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Appendix D. Authority and Applicable Guidelines for Developing Natural Capital Accounts and Associated Environmental-Economic Statistics within the United States

International systems, such as SEEA, implicitly envision a singular statistical agency with broad authority overseeing natural capital accounts. In the United States, none of the 13 principal statistical agencies has explicit responsibility over the management of environmental statistics, but there is broad authority, specific direction, and agency expertise to develop natural capital accounts and environmental-economic statistics. Therefore, developing practices and measurements related to natural capital accounting will require coordinated efforts from many statistical agencies and units within the Executive Branch. At the all-of-government level, the Chief Statistician of the United States (Chief Statistician) coordinates the statistical system with authorities from the Paperwork Reduction Act of 1995 (PRA) and Foundations for Evidence-Based Policymaking Act of 2018 (Evidence Act). The Evidence Act specifically calls for statistics related to "the economy, society, [and] the natural environment."

The Paperwork Reduction Act of 1995

The PRA requires the Director of OMB, through the Administrator of the Office of Information and Regulatory Affairs (OIRA) and carried out by the Chief Statistician, to "coordinate the activities of the Federal statistical system to ensure . . . efficiency and effectiveness" and "integrity, objectivity, impartiality, utility, and confidentiality."[260] The Chief Statistician oversees the Federal statistical system, which includes 13 principal statistical agencies and about 100 statistical units across the Executive Branch.[261] Therefore, this coordination authority could be used to coordinate across the Federal statistical system to develop statistics related to natural capital accounting, and further to promote the objectivity and utility of the statistics developed.

The PRA also requires the Director, through OIRA and the Chief Statistician, to "develop and oversee the implementation of Governmentwide policies, principles, standards, and guidelines" related to statistics.[262] OMB, through the Chief Statistician, could similarly use this authority to promote development of statistics related to natural capital accounting, and to help ensure their rigor and quality. Under this authority, OMB has issued a number of Statistical Policy Directives to promote comparable and robust Federal statistics, including policies that outline minimum quality and transparency standards for published statistical series, such as principal Federal economic indicators.[263]

The PRA also requires the Director, through the Chief Statistician, to "coordinate the participation of the United States in international statistical activities, including the development

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[260] 44 U.S.C. § 3504(e)(1).
[261] Office of Management and Budget. (2022). *Leveraging Federal Statistics to Strengthen Evidence-Based Decision-Making.* https://www.whitehouse.gov/wp-content/uploads/2022/03/ap_15_statistics_fy2023.pdf.
[262] 44 U.S.C. § 3504(e)(3).
[263] Office of Management and Budget. (1985, Sept. 25). *Statistical Policy Directive on Compilation, Release, and Evaluation of Principal Federal Economic Indicators, 50 Fed. Reg. 38932.* U.S. National Archives — Federal Register. https://www.whitehouse.gov/wp-content/uploads/legacy_drupal_files/omb/assets/OMB/inforeg/statpolicy/dir_3_fr_09251985.pdf.

of comparable statistics."[264] This responsibility applies to many kinds of topical measurement, such as efforts to develop internationally comparable industry classifications.[265] This could also apply to natural capital accounts, which are well underway in many other countries. The PRA thus allows for the Chief Statistician to coordinate U.S. efforts to participate in, and develop accounts that are compatible with, such efforts.

Foundations for Evidence-Based Policymaking Act of 2018

The Evidence Act establishes a series of policies designed to improve evidence-based policymaking. In support of this, Title III establishes four responsibilities for statistical agencies: they must "produce and disseminate relevant and timely statistical information," "conduct credible and accurate statistical activities," "conduct objective statistical activities," and ensure the "confidentiality and exclusive statistical use" of information providers' responses.[266] These "statistical agencies"—i.e., agencies whose efforts primarily involve generating or analyzing statistics[267]—must adopt best practices consistent with these principles and coordinate with other agencies as relevant.[268] Building on the PRA, the Evidence Act charges the Director of OMB and designees with a strong coordination and implementation role relating to these policies.[269] To best comply with the Evidence Act's requirement that final statistics be "relevant and timely," "credible and accurate," and "objective," strong involvement by statistical agencies (which are held to this standard), and coordination by OMB, in natural-capital-accounting efforts is important.

In particular, statistical agencies' mandate to "produce . . . relevant . . . statistical information" supports producing natural capital accounts. The statute defines "relevant" as "processes, activities, and other such matters likely to be useful to policymakers and public and private sector data users."[270] Natural capital accounts are highly "likely to be useful to" these actors, as outlined earlier in this document. Moreover, the statistical agencies are instructed to conduct "statistical activities" consistent with the above standards. "Statistical activities" includes both "the collection, compilation, processing, or analysis of data for the purpose of describing or making estimates concerning the whole, or relevant groups or components within, the *economy, society, or the natural environment*" and "the development of methods or resources that support those activities, such as measurement methods, models, statistical classifications, or sampling frames."[271] This further supports statistical agencies' involvement in natural capital accounting, which involves collecting, compiling, processing, and analyzing data relevant to "the economy, society, [and] the natural environment," along with methods and resources for doing so.

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[264] 44 U.S.C. § 3504(e)(6).
[265] White House Office of Management and Budget. (2021, Dec. 21). *North American Industry Classification System—Revision for 2022; Update of Statistical Policy Directive No. 8, North American Industry Classification System: Classification of Establishments; and Elimination of Statistical Policy Directive No. 9, Standard Industrial Classification of Enterprises, 86 Fed. Reg. 72277*. U.S. National Archives — Federal Register. https://www.govinfo.gov/content/pkg/FR-2021-12-21/pdf/2021-27536.pdf.
[266] 44 U.S.C. § 3563(a)(1).
[267] *Id*. § 3561(11).
[268] *Id*. § 3563(a)–(b).
[269] *Id*. § 3562(a).
[270] *Id*. § 3563(d)(4).
[271] *Id*. § 3561(10)(A)–(B) (emphasis added).

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In addition, Title I of the Evidence Act establishes that statistical experts within agencies across the Executive Branch coordinate their efforts through the Interagency Council on Statistical Policy, which is Chaired by the Chief Statistician.[272] While that body was initially chartered in 1989, the PRA provided its governing legislative mandates in 1995, and the Evidence Act updated its membership.[273] The interagency aspects of natural capital accounting would likely benefit from such a parallel interagency group of statistical experts.

Other Authorities

In addition to the PRA and the Evidence Act, which provide clear and broad authorities for agency experts to coordinate in developing natural capital accounts and environmental-economic statistics, various other legal authorities may further bolster this endeavor. One notable example is the National Environmental Policy Act (NEPA). NEPA mandates that "all agencies of the Federal Government" "utilize a systematic, interdisciplinary approach which will insure [sic] the integrated use of the natural and social sciences and the environmental design arts in planning and in decision-making which may have an impact on man's environment."[274] It also mandates that agencies "identify and develop methods and procedures . . . which will insure [sic] that presently unquantified environmental amenities and values may be given appropriate consideration in decision-making along with economic and technical considerations."[275] Because natural capital accounting involves a "systemic, interdisciplinary approach" to quantifying environmental effects, and because it could facilitate more precise accounting for "presently unquantified environmental amenities and values," such efforts are well in line with NEPA's mandates.

Applicable Guidelines

Several Federal statistical guidelines and directives apply to the work described in this Strategic Plan.[276] These include OMB memoranda M-14-06 on sharing administrative data,[277] M-15-15 on interagency collaboration,[278] and M-19-23 on implementing the Evidence Act.[279] They also include OMB Statistical Policy Directive 1 on fundamental responsibilities for Federal statistical

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[272] 5 U.S.C. § 314.
[273] 44 U.S.C. § 3504(e)(8).
[274] 42 U.S.C. § 4332(2)(A).
[275] 42 U.S.C. § 4332(2)(B).
[276] For an overview of important statistical guidelines and directives, see the Office of Management and Budget's Statistical Programs & Standards: https://www.whitehouse.gov/omb/information-regulatory-affairs/statistical-programs-standards/.
[277] Burwell, S. (2014, Feb. 14). *Memorandum for the Heads of Executive Departments and Agencies: Guidance for Providing and Using Administrative Data for Statistical Purposes [M-14-06]*. Office of Management and Budget. https://www.whitehouse.gov/wp-content/uploads/legacy_drupal_files/omb/memoranda/2014/m-14-06.pdf.
[278] Shelanski, H. (2015, July 8). *Memorandum for the Heads of Selected Executive Departments and Agencies: Improving Statistical Activities through Interagency Collaboration [M-15-15]*. Office of Management and Budget. https://www.whitehouse.gov/wp-content/uploads/legacy_drupal_files/omb/memoranda/2015/m-15-15.pdf.
[279] Vought, R. (2019, July 10). *Memorandum for the Heads of Executive Departments and Agencies: Phase 1 Implementation of the Foundations for Evidence-Based Policymaking Act of 2018: Learning Agendas, Personnel, and Planning Guidance [M-19-23]*. https://www.whitehouse.gov/wp-content/uploads/2019/07/M-19-23.pdf.

agencies and units[280] and Directive 4 on release and dissemination of statistical products.[281] The Working Group intends to follow all applicable internal guidelines and best practices.

Appendix E. Themes from Public Comment

This section reflects general, high-level themes from the public comments the Working Group received on the draft Strategic Plan. It is included as a high-level synthesis rather than a comprehensive summary of all comments. Each comment was read and considered in its entirety, and many changes to the Strategic Plan resulted, even if not reflected directly below.

The timeline: There were many comments related to the 15-year planning horizon, most asking to accelerate the timeline because of the urgency of responding to crises like climate change and declining natural capital and biodiversity. The Working Group understands the urgency of responding to these crises. Work on Phase I and research into Phase II and III are already underway. Implementation of the Strategic Plan will result in products being released well before 15 years, with updates on phase I pilot accounts planned for later this year. Fifteen years reflects the Federal Government's commitment to long-term planning for the statistical system and a desire for the natural capital accounts to be robust. This aligns with another desire of commenters that the natural capital accounts and environmental-economic statistics be produced with scientific integrity and following existing statistical standards and policies for information quality.

Priorities and relationships: Commenters made suggestions on relationships among environmental sectors and their connection to traditional economic sectors and on the sequencing of the environmental sections, including some suggestions for additional sectors or summary outputs. Discussion on the connections among and between environmental sectors and traditional economic sectors has been expanded. The marine natural capital accounts are accelerated in the Strategic Plan. The Working Group adjusted and clarified plans for reports on hazards and extreme weather events, biodiversity, greenhouse gases, and other topics raised in these comments.

Use cases, examples, need, and concerns about misuse: Many commenters expressed the need for this Strategic Plan, often including use cases and examples. We have included several of these in the Strategic Plan: human health, macroeconomic policy and financial stability, private sector applications and initiatives, recreation and tourism, biodiversity, and applications of nearly every environmental topic covered by the Strategic Plan. Some commenters expressed concern about potential applications of the data that will be generated under this Strategic Plan, suggesting that such data could be used to support undesirable Federal policies. Particular applications of such data to particular future policy decisions are beyond the Strategic Plan's scope. Those commenters are invited to engage in any future Federal policymaking processes that apply these data to decision making.

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[280] Office of Management and Budget. (2014, Dec. 2). *Statistical Policy Directive No. 1: Fundamental Responsibilities of Federal Statistical Agencies and Recognized Statistical Units, 79 Fed. Reg. 71610*. U.S. National Archives — Federal Register. https://www.govinfo.gov/content/pkg/FR-2014-12-02/pdf/2014-28326.pdf.

[281] Office of Management and Budget. (2008, March 7). *Statistical Policy Directive No. 4: Release and Dissemination of Statistical Products Produced by Federal Statistical Agencies, 73 Fed. Reg. 12622*. U.S. National Archives — Federal Register. https://www.govinfo.gov/content/pkg/FR-2008-03-07/pdf/E8-4570.pdf.

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Equity, inclusion, environmental justice, and Indigenous Knowledge and Indigenous Peoples: Commenters asked that the Strategic Plan clarify contributions to addressing Administration priorities related to advancing equity, inclusion, and environmental justice, with specific references to Indigenous Knowledge and Peoples. The revised Strategic Plan provides greater clarity on these topics, explains the connections and commitments to related ongoing Administration initiatives, and places the Strategic Plan's statements on these topics in the context of global standards. The revised Strategic Plan acknowledges that natural capital accounts and environmental-economic statistics are one tool that can help address these long-standing needs, in concert with many other initiatives.

Engagement and process: Commenters expressed strong interest in continued public engagement throughout the processes outlined in the Strategic Plan. This included suggestions of engagement with the public; state, local, territorial, and Tribal governments; the international community; the business and non-profit sectors; and academia. There was also a recognition that use of public comment to create a national strategy for natural capital accounts is globally unique. In response, the Working Group expanded the Strategic Plan's section on engagement. Related to comments on engagement were comments asking for inclusion of additional Federal agencies. Since the draft Strategic Plan was released, more Federal agencies have joined the Working Group. Those agencies, and their views, are reflected in this revised draft.

Technical comments: The Working Group received numerous technical comments on a wide range of topics, including data management, classification systems, application to GDP and other statistical summaries, remote sensing and other data sources, physical measurement and valuation of natural capital, accounting boundaries, and the treatment of uncertainty. Some of these comments led to adjustments and clarification in the Strategic Plan. Others have been passed to the teams working on technical implementation, where they will be integrated as appropriate.

Resources: Some commenters acknowledged the importance of resources and funding for developing natural capital accounts and environmental-economic statistics. These commenters generally suggested providing sufficient resources for the initiative overall as well as for specific ongoing programs that will feed information into the natural capital accounts, such as the USFS's Forest Inventory and Analysis and EPA's National Aquatic Resource Survey.