U.S. Department of the Interior
Economic Report
FY 2021

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Prepared by the Department of the Interior, Office of Policy Analysis

Cover photo: Supermoon setting over the Centennial Mountains Wilderness Study Area in southwestern Montana. This 28,000-acre mountain range, which forms the boundary between southwest Montana and Idaho, is some of southwest Montana's wildest country. Designated as an Area of Critical Environmental Concern in 2006, it is considered an important corridor for wildlife movement, providing an east-west trending mountain range connecting the Yellowstone Ecosystem with the rest of the northern Rocky Mountains. Source: Bureau of Land Management. Photo by Bob Wick.

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List of Acronyms

ADF&G	Alaska Department of Fish and Game
AIRES	Artificial Intelligence for Environment & Sustainability
ANCSA	Alaska Native Claims Settlement Act of 1971
ANILCA	Alaska National Interest Lands Conservation Act of 1980
AUM	Animal unit month
BIA	Bureau of Indian Affairs
BIE	Bureau of Indian Education
BLM	Bureau of Land Management
BOEM	Bureau of Ocean Energy Management
BOR	Bureau of Reclamation
BSEE	Bureau of Safety and Environmental Enforcement
CVM	Contingent valuation method
COVID-19	Coronavirus disease 2019, caused by the virus named Severe Acute Respiratory Disease 2, or SARS-CoV-2
DOI	Department of the Interior
FAIR	Findable, Accessible, Interoperable, and Reusable Data Principles
FWS	U.S. Fish and Wildlife Service
GOMESA	Gulf of Mexico Energy Security Act
mbf	Thousand board-feet
M&I	Municipal and industrial
NEPA	National Environmental Policy Act
NP	National Park
NPS	National Park Service
NVS	National Visitor Survey
NCA	Natural Capital Accounting
NIPA	National Income and Product Accounts
OCS	Outer Continental Shelf
ONRR	Office of Natural Resources Revenue
OSMRE	Office of Surface Mining Reclamation and Enforcement
PILT	Payments in Lieu of Taxes
SEEA	System of Environmental Economic Accounting
SEM	Socioeconomic Monitoring
SFP	Special Forest Products
SNA	System of National Accounts
tcf	Trillion cubic feet
TWh	Terawatt-hours. One TWh is the amount of power generated by a one-terawatt generator running for one hour. One terawatt-hour equals one trillion watt-hours (10^{12} Wh), or one million megawatt-hours (10^{6} MWh)
TCM	Travel Cost Method
USGS	U.S. Geological Survey
WTP	Willingness to pay
VOI	Value of information

Preface

The Department of the Interior's programs, activities, and services support the well-being of Americans in every part of the Nation. The Department's bureaus and offices work together to manage America's natural resources to meet the demands of today, and to provide for future generations. The Department of the Interior (DOI) also has a unique mission to honor the Nation's trust responsibilities and commitments to Native American, Alaska Native, and affiliated island communities to help them prosper. It can be difficult to put an economic value on many of these activities. We can, however, evaluate how DOI lands and waters provide valuable ecosystem services, how DOI's actions support socioeconomic well-being, and how DOI's activities contribute to our Nation's economy.

This report presents case studies and estimates of economic contributions that demonstrate how DOI supports socioeconomic well-being and economic activity in communities around the country, from values of ecosystem services to the benefits and costs of energy production; the value of information; natural capital accounting; and contributions of DOI spending on economic activity. While the economic estimates in this report demonstrate the impact that DOI activities have on the national economy, they do not comprehensively represent the economic and societal benefits and costs associated with the extensive portfolio of DOI activities and programs. To address this limitation, this report includes six case studies that cover a diverse array of topics where Interior has significant management responsibilities and where market transactions do not fully reflect net economic values. The topic areas range from the values of recreation and forest products to subsistence harvest and others. Further, they demonstrate the broad scope of interdisciplinary research and activities performed by DOI economists in conjunction with other experts throughout the Department. The case studies reflect many of the Administration's priorities, such as the development of a national system of natural capital accounts and other initiatives. Although the economic effects associated with these priorities are not quantified in this report, they may be addressed in the future.

DOI's programs focus on adaptive management and increasing resilience to the changing climate; supporting economic development; using science to inform the management of natural resources; strengthening Tribal nations' self-determination; expanding inclusion of historically underrepresented communities; promoting environmental justice; delivering DOI's core services; and providing effective stewardship of America's national treasures. The contributors to this report hope the information contained herein demonstrates how DOI's programs contribute to the values of ecosystem services that sustain life on Earth, support socioeconomic well-being, and contribute to economic activity.

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Executive Summary

The lands and waters managed by the U.S. Department of the Interior (DOI, or the Department) are of profound ecological importance, but they are also of significant economic importance as well. The Department and its bureaus manage more than 480 million acres of surface lands, 700 million acres of subsurface mineral estate, and 760 million acres of submerged land in national monuments, and it has jurisdiction over more than 2.5 billion acres of the Outer Continental Shelf (DOI, 2022). These lands and waters encompass a range of biomes, from arid shrub-scrub landscapes to forests, wetlands, and others. The natural capital that comprises the vast area of these lands and waters provides valuable ecosystem services, supports socioeconomic well-being, and contributes to our Nation's economy in a range of ways that can be measured and quantified. This report provides some examples of applications of economic analysis to demonstrate the multiple ways the management and use of the lands and waters by the Department and its Bureaus generate economic value, contribute to economic production, and support jobs throughout the United States and beyond.

In this report we consider four questions related to the economic effects of DOI's resource management and other actions:

1) What is the value of ecosystem services supported by DOI-managed lands and waters?

To address this question, we use three case studies that demonstrate the economic value of ecosystem services in different contexts. Economic values (benefits and costs) measure changes in well-being. Ecosystem services are the direct and indirect contributions of ecosystems that support and sustain life on Earth. The first case study demonstrates how the contingent valuation method can be used to measure the benefits of recreation at Glacier National Park. Recreation is an example of a cultural ecosystem service, and visitors are willing to pay for the experiences of wildlife viewing, scenery, and opportunities for hiking and camping. However, unlike market goods, recreation has measurable economic value but is not traded in markets. Economists rely on non-market valuation techniques to quantify economic value for these resources. The net economic benefit, or difference between what a consumer is willing to pay and what they actually pay, is called consumer surplus. This consumer surplus provides a standard and consistent measure of the economic value of DOI resources. A study of the value of recreation at Glacier National Park yielded estimates of an average consumer surplus of $444 per person per trip, or $121 per day.

The second case study demonstrates the value of forest products through the Bureau of Land Management Special Forest Products Program. Harvesting resources for personal use from public lands is an example of DOI- managed ecosystems providing provisioning services. Access to these resources allows for a wide range of activities, from harvesting Christmas trees and recreational hunting and fishing to gathering fuel wood for home heating. The Bureau of Land Management (BLM) Special Forest Products Program issues permits for harvesting plant materials like seeds, berries, greenery, mushrooms, and seedlings, as well as wood products like fuelwood, biomass, fence posts and poles. These products may be harvested for recreation, personal use, or as a source of income. The case study estimates that nearly 55,000 Christmas trees were harvested between 2017 and 2021 through the BLM Special Forest Products Program, an average of approximately 2,683 per year, with about half of the harvest occurring in the state of Nevada.

Case Study 3 focuses on the value of subsistence harvest in Alaska. Subsistence harvest on public lands is another example of a provisioning service of ecosystems managed by DOI. Alaska is the only state with a legal priority for subsistence use on Federal lands under law. There are clear economic and human well-being implications of subsistence harvest, particularly for rural Alaskans who may live in areas where limited access can result in high food costs or the absence of commercial food markets altogether. However, the importance of subsistence harvest extends beyond monetary cost, as these activities are often intertwined with cultural practices and local customs in ways that are difficult, if not impossible, to fully quantify. In the upper Yukon River, Chinook and fall chum salmon have historically been locally abundant. However, severe declines and crashes in salmon populations have occurred over the past two decades, leading to unprecedented fishery closures in recent years. Total Chinook and chum salmon harvested fell from more than 10,000 pounds in 2011 to only about 3,800 pounds in 2018, based on surveys of households in Beaver, Alaska. In both 2021 and 2022, this stretch of the river was closed entirely to harvest of Chinook, summer chum, and fall chum due to the forecasted runs being too low, and the economic and socio-cultural effects of these declines have been substantial.

Lahontan cutthroat trout with floy tag. In continuing its work on Lake Tahoe restoration, Interior will deploy $17 million in Bipartisan Infrastructure Law funding to provide important capacity to control aquatic invasive species for the benefit of Lahontan cutthroat trout and other native species. The trout is a threatened species under the Endangered Species Act and is a recovery priority for the Service, Washoe Tribe, Pyramid Lake Paiute Tribe, and other federal and non-federal partners in the Lake Tahoe basin. Source: Department of the Interior Photo Galleries. Photo by Joanna Gilkeson.

2) In addition to ecosystem services, how do DOI's actions contribute to socioeconomic well-being?

To address this question, we use three case studies that demonstrate how DOI's actions contribute to socioeconomic well-being in different contexts. Case Study 4 discusses the benefits and costs of energy production. Public lands and waters support energy production from both fossil fuels and renewable resources that benefit socioeconomic well-being through the provision of energy services. There are also costs to energy production. Most notable are the environmental impacts associated with energy development, as all energy production impacts land, water, and air resources. Combustion of fossil fuels also generates greenhouse gas emissions that contribute to climate change. In addition, location of infrastructure can impact views, noise levels, and other aspects of well-being. Evaluating the costs and

benefits of energy production from DOI lands requires modeling the role Federal production plays in global energy markets. DOI economists are developing models that can be used to more completely and robustly estimate the benefits and costs associated with Federal energy production.

Case Study 5 discusses the value of information generated by research and data products. Research and development activities provide a range of societal benefits, supporting economic growth and innovation and DOI's management of natural resources and ecosystems. Interior's bureaus engage in a variety of activities that provide basic and applied research, scientific and technical information, and technology transfer. This case study provides several examples of DOI research on the value of information related to topics such as risk of radon exposure, advance warning system for cyanobacteria blooms, and volcanic eruption evacuations.

Case Study 6 discusses tracking the quantity and value of natural assets via natural capital accounting. Natural capital accounting is an accounting and statistical framework for comprehensive, internally consistent measurement and reporting on stocks and flows of natural capital. It provides statistical timeseries data representing relationships between the environment, the economy, and human well-being. A draft National Strategy to Develop Statistics for Environmental-Economic Decisions was released in August 2022. Despite the data abundance that underpins the development of many new accounts, several challenges exist as the U.S. is at an earlier stage of accounts development than much of the world.

In order for DOI to transition from a case-based analysis to an agency-wide model of comprehensive reporting, DOI must (i) prioritize data collection processes that are timely, comprehensive, and consistent, which allows for cross-geography and cross-time comparison of a range of sites and activities; (ii) conduct samples that are large and diverse enough to be able to statistically infer across all DOI activities; and continue to expand existing data collection and survey efforts.

Cebolla Wilderness, located within the El Malpais National Conservation Area, includes 61,600 acres of rimrock country in New Mexico. Sandstone mesas, canyons and grassy valleys characterize the area. The Mesas and canyons are clad with juniper, piñon, and ponderosa pine. Vertical escarpments provide excellent nesting habitat for golden eagles, prairie falcons, red-tail hawks, and great horned owls. Source: Bureau of Land Management. Photo by Bob Wick.

3) How does DOI spending contribute to economic activity?

To address this question, we examine the economic contributions of DOI spending across three categories, including DOI grants, payments to states, and payroll. Economic contributions describe how DOI spending affects overall economic activity in a defined geographic area. DOI spending becomes income for businesses or households, and other spending on DOI lands becomes revenue for industries. These businesses or households in turn spend this income at other businesses leading to a chain of economic contributions that extends well beyond DOI. In FY 2021, DOI expenditures across these three categories totaled $16.3 billion, and that spending generated $19.2 billion in value added (or contribution to the U.S. gross domestic product) and supported more than 203,000 jobs.

4) How do market transactions generated from activity on DOI lands contribute to economic activity?

Rainbow over the Bodie Hills Wilderness Study Area. The Bodie Hills region totals 121,500 acres of BLM lands, adjacent to Forest Service and privately owned land in California. From the pinyon pine and juniper rising out of rocky canyon walls, to the aspen and willow stands growing alongside streams, the Bodie WSA provides optimal habitat for many eastern Sierran fauna and wildlife. Source: Bureau of Land Management. Photo by Benjamin Cossel.

To address this question, we examine the economic contributions of spending related to activities that occur on DOI lands and waters. DOI's management of natural resources facilitates private sector activities and spending that result in economic contributions. For example, the use of public land by households and businesses for activities such as recreation, energy development, grazing, and irrigation facilitates spending which supports local economic activity and jobs. In FY 2021, spending on activities on DOI lands and waters generated more than $200 billion in value added and supported approximately 1.9 million jobs.

The estimates of economic values and contributions provided in this report reveal a partial depiction of the comprehensive economic effects of DOI programs. Where the current data collection allows for site specific valuation estimates, DOI has an opportunity to collect and estimate the societal value of economic benefits across all DOI lands and waters - that is, at the bureau- or DOI-wide level. In order to generate more comprehensive economic analyses, DOI must prioritize data collection processes that are timely, comprehensive, and consistent, allowing for cross-geography and cross-time comparison of a range of landscapes and activities with large and diverse samples that allow for statistical inference across DOI activities.

Introduction

This report is the 13th in a series produced by the Department of the Interior (DOI) focused on the economics of DOI's managed resources and management actions. The last report that was released was the DOI Economic Contributions Report: Fiscal Year 2019.[1] Historically, these reports were titled "DOI Economic Contributions Report" as they primarily focused on the specific economic effects described by an economic contribution analysis. While economic contributions are one useful metric for understanding the role of DOI actions and resources in supporting economic activity in formal markets, they are not measures of the value of these resources (Watson et al., 2007). Economists measure value, or benefits and costs, in terms of the effect on social welfare. This is a fundamentally different question from economic contributions. Both economic contributions and economic benefits can be useful in the decision-making process and can inform different aspects of DOI policy. The current report is the first step in expanding the analytical scope to more comprehensively report the economic effects of DOI's resource management and other actions, and to including both economic contributions and economic values. As such, this and future reports will be titled "DOI Economic Report".

The report, as well as the effort to expand its scope, directly supports the Department's mission to protect and manage the Nation's natural resources and cultural heritage and provide scientific information about those resources. Further, the FY 2022 – 2026 DOI Strategic Plan emphasizes the need to use the best available science to guide stewardship of public lands and waters for the benefit of current and future generations; to balance the use of resources while supporting communities and the economy; and to ensure people, communities, and organizations benefit from DOI data, science, and information (DOI, 2022). Information about how DOI's management and policy decisions affect economic activity and socioeconomic well-being are essential to carrying out the Plan. We must understand how people use, value, and appreciate the public lands, waters, and other natural resources[2] to properly balance these needs.

It is not currently possible to fully assess the economic effects of DOI's resource management and other actions in a comprehensive way, given data limitations, methodological constraints, and resource requirements. In many cases, data representing some benefits and costs do not exist, and employing methods for their estimation would be prohibitively costly. As evident in the content of this report, describing the economic benefits and costs associated with many aspects of DOI's resource management and other actions require data that do not currently exist and analytical expertise from resource specialists and economists to improve methods. As such, this year's report does not present a full assessment of the economic values of DOI's resource management and other actions. Rather, it assesses several components of the total value to demonstrate the possible direction that the economic report may take in the future. Over the next several years, DOI economists will lead work across bureaus and collaborate with other natural and social science experts to improve the Department's understanding of the economic value DOI provides to the public.

[1] The Fiscal Year 2020 Report was not released.

[2] Throughout this report, references to DOI's "lands and waters" include other natural resources for which DOI has some regulatory authority or other responsibility, such as migratory birds, endangered species, and others.

Big sagebrush is perhaps the most important shrub on western rangelands. Evergreen leaves provide an excellent winter food source to numerous species of large mammals, including mule deer, elk, and pronghorn. Source: U.S. Department of the Interior Photo Galleries. Photo by Tom Koerner, U.S. Fish and Wildlife Service.

Scope of this report

In this report, we consider four questions related to the economic effects of DOI's resource management and other actions:

1) What is the value of ecosystem services supported by DOI lands and waters?
2) In addition to ecosystem services, how do DOI's actions contribute to socioeconomic well-being?
3) How does DOI spending contribute to economic activity?
4) How do market transactions generated from activity on DOI lands contribute to economic activity?

The first two questions ask about economic value, or the benefits and costs associated with DOI's management and policy decisions. This year, we present several examples of how DOI can measure the values of some ecosystem services, conceptualize the economic benefits and costs associated with some of DOI's actions, or illustrate how these could be measured in future reports based on the currently available data. Future reports will seek to improve on these examples and expand into other areas covered by DOI's actions.

Renewable energy development in the California desert. Source: Bureau of Land Management.

The third and fourth questions continue the economic contribution analyses that this report has presented in previous years. These measures provide a snapshot of the jobs supported and value added associated with DOI's management, policies, and activities. The third question considers economic contributions from DOI's labor and non-labor spending. It includes spending on salaried employees as well as grants and payments made to states, but it does not include other components of non-labor spending such as capital expenditures.[3] The fourth question considers economic contributions from market transactions associated with spending or production that occurs because of DOI management, policies, and activities. For example, these include contributions from energy and non-energy mineral extraction, production of renewable energy and timber, and access to grazing and recreation.

Economic effects of DOI resource management and other actions

DOI is responsible for managing a large and diverse portfolio of resources and fulfilling trust responsibilities to American Indians, Alaskan Natives, Native Hawaiians, and affiliated Island communities. DOI manages 480 million acres of surface lands, 700 million acres of subsurface mineral estate, and 760 million acres of submerged land in national monuments, and it has jurisdiction over more than 2.5 billion acres of the Outer Continental Shelf (OCS) (DOI, 2022).[4] Collectively, these resources include working lands, recreation areas, and wilderness. DOI and its bureaus also engage in basic and applied research activities across a variety of topics, including science in support of the management of water, biological, energy, and mineral resources; the economic values of ecosystem services; wildland fire management; and the value of information, along with many other areas of research. DOI also participates in interagency research initiatives such as the U.S. Global Change Research Program, the National Interagency Fire Program, social costs of greenhouse gas emissions, and many others.

DOI and its bureaus manage more than 400 million acres of lands and waters spanning numerous biomes. An overview of these biomes by bureau is presented in Table 1 for the Bureau of Land

[3] DOI activities in the insular areas of the U.S. territories of American Samoa, Guam, the U.S. Virgin Islands, and the Commonwealth of the Northern Mariana Islands, as well as the sovereign nations of the Federated States of Micronesia, the Republic of the Marshal Islands, and the Republic of Palau, are excluded from National contributions in this report because these geographies are not included in the National economic statistics that underlie the economic contributions.

[4] In 2022, the Inflation Reduction Act of 2022 (Pub. L. 117–169) expanded DOI's jurisdiction over OCS offshore of U.S. territories.

Management (BLM), U.S. Fish and Wildlife Service (FWS), National Park Service (NPS), and the Bureau of Reclamation (BOR).

Table 1. DOI land and water biome extents, by bureau (thousands of acres)

Biome / Bureau	BLM	FWS	NPS	BOR	TOTALS
Open Water	947.4	3,244.1	1,987.3	432.9	6,611.8
Perennial Snow/Ice	1,197.9	1,417.4	7,251.8	-	9,867.2
Barren Land	8,496.8	7,318.7	12,792.4	177.7	28,785.7
Forest[1]	29,599.4	13,224.6	12,410.1	102.9	55,337.0
Shrub-Scrub	158,621.9	41,489.0	36,943.0	1,022.7	238,076.6
Herbaceous[2]	38,556.2	6,786.8	3,012.8	385.2	48,741.0
Planted/Cultivated[3]	668.7	1,451.0	47.3	139.7	2,306.6
Wetlands[4]	4,223.7	13,145.5	3,335.4	118.2	20,822.8
Development Intensity (High, Med, Low)	302.0	126.8	67.3	30.7	526.9
Development Intensity (Open Space)	529.0	125.0	92.0	23.5	769.0
Unclassified	0.8	0.6	4.6	0.3	6.4
TOTALS	243,143.8	88,329.2	77,944.1	2,433.7	411,850.7

Notes to Table 1

[1] The Forest category includes deciduous forest, evergreen forest, and mixed forest biomes.

[2] The Herbaceous category includes herbaceous and moss biomes.

[3] The Planted/Cultivated category includes hay-pasture and cultivated crops biomes.

[4] The Wetlands category includes woody wetlands, emergent herbaceous wetlands, and shrub/scrub wetlands biomes.

Note: Classifications are derived from the National Land Cover Database Class Legend and Description, Multi-Resolution Land Characteristics (MRLC) consortium. The sources of land cover and surface management data are the National Land Cover Dataset (2019, 2016, 2010), BLM, and ArcGIS Online Living Atlas.

In addition to the acreage identified in Table 1 where Reclamation recreation and hydropower exist, water is provided to contractors that utilize Reclamation provided water on private lands. Irrigation water available from Reclamation can be applied to approximately 49 million acres through existing water contracts.

Note some bureaus (e.g., Bureau of Indian Affairs (BIA), Bureau of Indian Education (BIE), Bureau of Ocean Energy Management (BOEM), Bureau of Safety and Environmental Enforcement (BSEE)) do not manage lands and waters *per se* and are thus not represented in Table 1. For example, the mission of the BOEM involves managing "development of U.S. Outer Continental Shelf energy and mineral resources". Given DOI's jurisdiction over more than 2.5 billion acres of the OCS, the energy and mineral resources that come from the OCS are factored into the analyses in this report (DOI, 2022).

Graphical depictions of the extent of DOI land and water biomes by bureau are presented in Figure 1 and Figure 2.

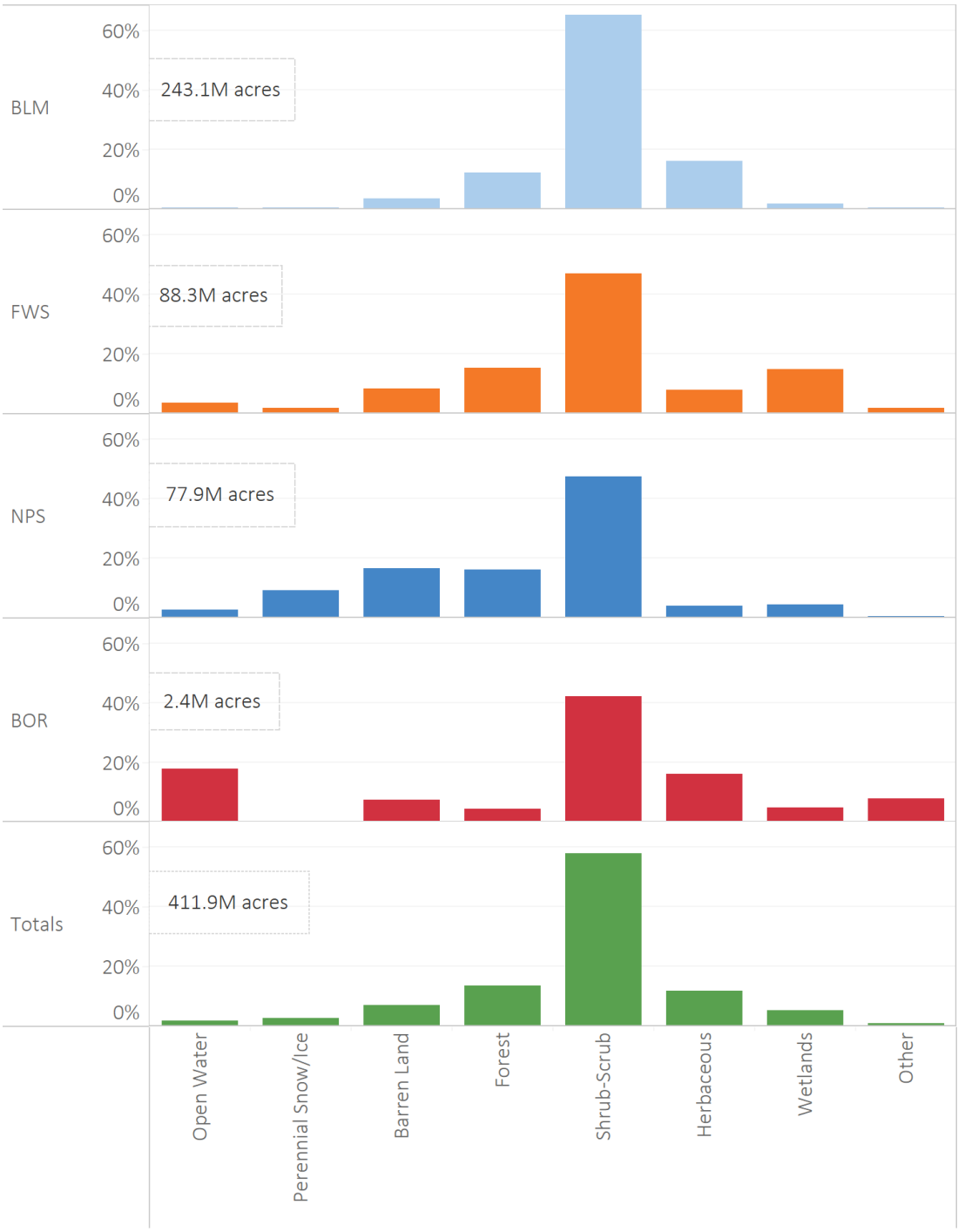


Figure 1. DOI land and water biome extents, by bureau (percent of bureau land cover acreage). 'Other' includes developed land, cultivated crops, hay-pasture, and unclassified areas.

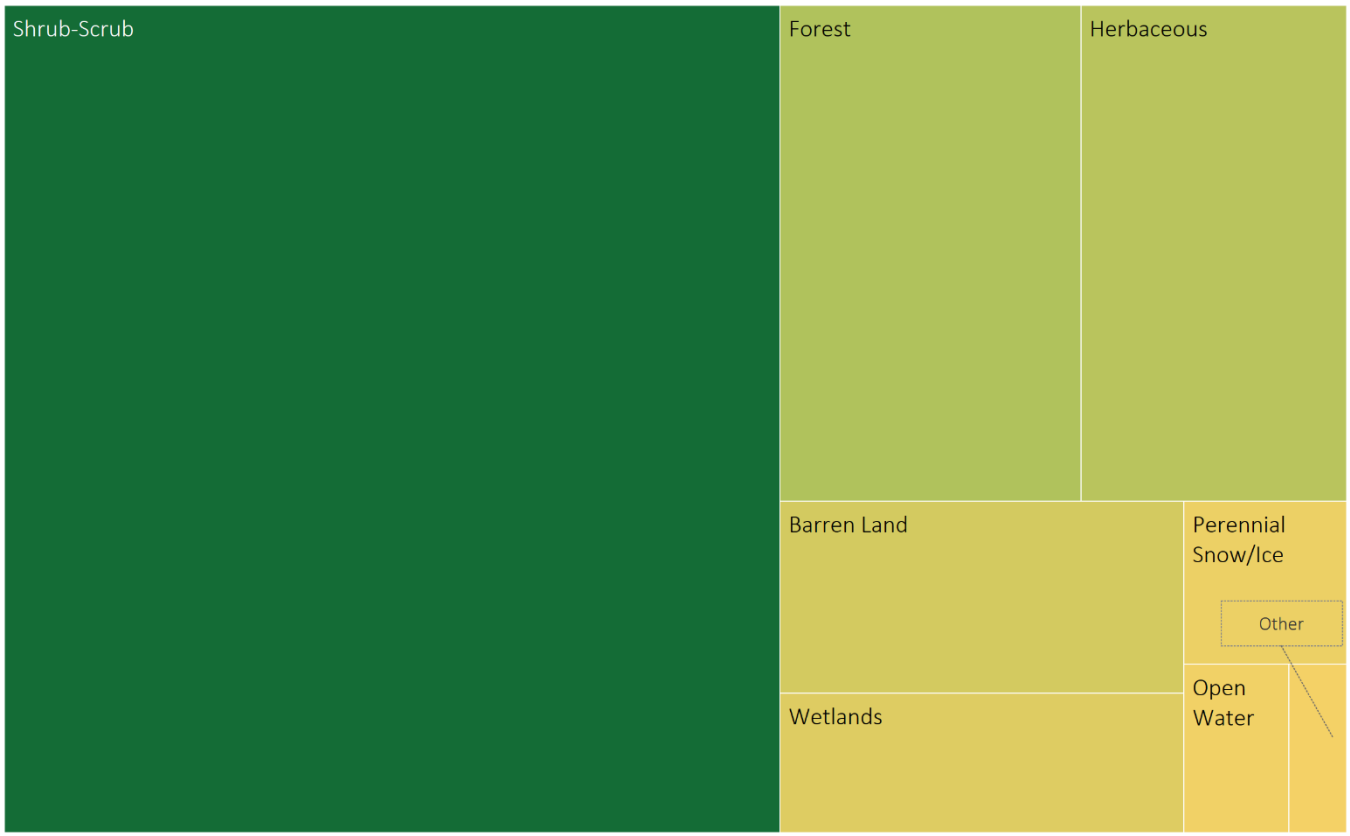


Figure 2. DOI land and water, relative coverage by biome. 'Other' includes developed land, cultivated crops, hay-pasture, and unclassified areas.

Some DOI-managed lands and waters and DOI research contribute to economic activity and affect socioeconomic well-being. An important step to estimating these contributions and values is to understand the quantity or quality of resources and resource use. This might be the volume of minerals produced (onshore and offshore), the number of visitors, or the ecological health of a wetland ecosystem. As an example, an overview of DOI-managed resources in terms of production quantities and values from FY 2017 to FY 2021 is presented in Table 2.

Table 2. Interior-Managed Resources: Production Quantities and Values, FY 2017-2021

Activity	Measure	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021
Recreation [a]	*Visits to DOI sites (millions)*	483	486	501	378	494
Crude Oil [b]	*DOI production (millions of barrels)*	875	932	1,083	1,058	1,084
Natural Gas [b]	*DOI production (trillions of cubic feet)*	4.7	4.7	4.9	4.6	4.4
Coal [b]	*DOI production (millions of short tons)*	348	322	317	253	258
Forage [c]	*BLM, AUMs billed (millions)*	8.7	8.9	8.8	8.4	9.2
Timber [d]	*BLM, commercial sawtimber harvested (mbf)*	227,216	184,960	201,191	249,130	255,569
	BIA harvested timber (mbf)	384,246	388,002	342,197	392,860	395,425
	Total for BLM and BIA (mbf)	611,462	572,963	543,388	641,990	650,994
Hydroelectric	*Net generation, TWh*	43.7	40.9	36.5	38.8	34.7
Geothermal [e]	*Generation, TWh*	-	-	15.9	14.5	15.0
Wind [e]	*Generation, TWh*	-	-	3.3	3.3	4.4
Solar [e]	*Generation, TWh*	-	-	5.8	5.7	8.1
Irrigation and M&I water (estimated deliveries) [f]	*Million acre-feet*	26.1	27.3	28.0	26.5	26.6

Notes to Table 2

[a] Currently available datasets do not track visitors' activities.

[b] Production is based on ONRR production volumes. Includes production on Tribal land, on other onshore areas, and the OCS. Production data from ONRR (https://revenuedata.doi.gov/) is updated regularly and may not match what is presented in this table.

[c] BLM AUMs billed are per grazing fee year, not fiscal year. For FY 2021, BIA billed an estimated 1.5 million AUMs.

[d] Source: BLM Data. Data include sawtimber yarded under sales contracts. Additional sawtimber is harvested from BLM managed lands under the Stewardship Program and Special Forest Products Program. These volumes represent a relatively small proportion of the volume and are not shown in this table. Other wood-based forest products not included in these volumes include biomass, posts, poles, fuelwood, and "other."

[e] Source: unpublished BLM analysis Generation information prior to FY 2019 is not available for these resources.

[f] Some Reclamation-supplied water (not reported) provides benefits for other uses, such as supporting instream flows or National Wildlife Refuges.

The Hoover Dam and the Mike O'Callaghan-Pat Tillman Memorial Bridge lit up at night as the last light of day lingers in the pink clouds. Source: Department of the Interior Photo Galleries. Photo by Michael McCook.

DOI's mission areas and responsibilities extend beyond the management of natural resources. The Bureau of Indian Education (BIE) provides students at BIE-funded schools with a culturally relevant, high-quality education that prepares them for a successful future while preserving their unique cultural identities. Education, more generally, provides benefits to society by raising productivity and creativity, as well as stimulating entrepreneurship and technological breakthroughs. By funding these educational opportunities, DOI helps to support economic development on Tribal lands.

Data provided by the BIE on graduation and enrollment rates are shown in Table 3. It is important to note the challenges inherent in collecting and interpreting any data from BIE-funded schools. Historically, data collection and the infrastructure to support it across BIE-funded schools have not always been consistent. This has prevented the bureau from being able to accurately assess and adjust performance in many cases. In addition, the COVID-19 pandemic severely impacted attendance and performance across BIE-funded schools. Therefore, the data presented in Table 3 should be interpreted cautiously, as they cannot be compared directly with national averages. Current efforts are underway to upgrade and add to BIE's data collection infrastructure and performance measurement capabilities, which should lead to improved performance and outcomes over time.

Table 3. Bureau of Indian Education Graduation and Attendance/Enrollment Rates

	Metric	FY 2018	FY 2019	FY 2020	FY 2021
Graduation Rate	Target	65.0%	67.0%	67.0%	67.5%
	Actuals	63.6%	65.5%	65.5%	65.6%
Attendance and Enrollment Rate	Target	53.0%	53.0%	55.0%	55.0%
	Actuals	42.8%	53.0%	54.0%	43.0%

Source: DOI (2020); BIE

Adult loggerhead sea turtle on the sand by the shore with cliff rocks in the background. Source: U.S. Fish and Wildlife Service. Photo by Dionysisa303.

Economic Values

Economic values (benefits and costs) measure changes in well-being. When a visitor goes to a National Park, the value of the visit to the visitor is not their expenditure, or what they had to pay to make the trip to visit the Park. Their value for the visit is revealed by what they would have been *willing* to pay to make the visit. This reflects the change in the visitor's well-being the visit generates (or is expected to generate). Economic values are not limited to activities or commodities with market value. For example, it is difficult to find a market price for scenic views, though many people are willing to spend time and money to enjoy such views.

Economists do not consistently distinguish between economic contributions and economic benefits/costs in their analyses (Watson et al., 2007) which can lead to confusion for both them and the

policymakers such economic analysis is meant to inform. Economic contributions and economic benefits/costs are distinct, complementary metrics that measure different types of economic effects.

Milky Way over the park, Arches National Park, 2014. Source: National Park Service.

While DOI economists understand the importance of measuring and presenting economic benefits and costs to present a complete picture of DOI's economic effects, the data and methods needed to accurately produce these metrics are generally more difficult to gather and costlier to implement than those used to create economic contribution analyses. The difficulty in producing estimates of economic benefits and costs across all DOI lands and waters is a major reason why they have not been included in prior versions of this economic report. The case studies in this year's report are examples of where and how we are starting to lower these barriers (e.g., with data and methods) and gain a more complete picture of the effects of DOI's activities.

Question 1: What is the value of ecosystem services supported by DOI lands and waters?

Key Concepts

Ecosystem services are the direct and indirect contributions of ecosystems that support and sustain life on Earth (MEA, 2005). The Millennium Ecosystem Assessment uses the following categorization of ecosystem services:

- Provisioning services, including goods and services obtained from ecosystems, such as food, fiber, fuel, and fresh water.

- Regulating services, including services received from the regulation of ecosystem processes. Services such as flood protection, water purification, disease regulation, pollination, and climate regulation are examples of regulating services that contribute to human well-being.
- Cultural services, including services that contribute to the cultural, spiritual, and aesthetic dimensions of human life and well-being. Ecosystem services such as opportunities for outdoor recreation, artistic inspiration, and spiritual enrichment are examples of cultural services that contribute to human well-being.
- Supporting services, including services that maintain the basic ecosystem processes and functions, such as soil formation, primary production, and habitat. Supporting services contribute to human well-being by supporting the processes necessary for provisioning, regulating, and cultural services.

Economic benefits and costs measure changes in socioeconomic well-being resulting from an action or policy. In short, how much better off (or worse off) society is due to an action or policy. As with economic contributions, economic benefits and costs can be monetized. But here, the fundamental idea is to measure how beneficial a good, service, or action is for improving human lives. With economic contributions, an analysis can show the total income and production resulting from an event or policy, but it cannot show how socioeconomic well-being changes as a result.

In principle, measuring economic benefits starts with understanding the value that an individual places on that good, service, or action. Economists refer to this estimation as the individual's willingness to pay (WTP) to have something (or, conversely, to avoid it). The economic benefit/cost to all of society is an aggregation of WTP across all individuals. The valuation of economic benefits and costs should theoretically encompass all types of goods, services, or actions that enhance human life and well-being. This includes but is not limited to food, shelter, health, environment, entertainment, and social/cultural knowledge.

One focus of economic research and practice centers on how to estimate WTP. At one level, economists distinguish between values where underlying goods and services are actively traded and available through markets, versus goods and services for which there are no active markets. These two categories of values are broadly referred to as market and non-market values, respectively. Economists can infer WTP for actively traded goods and services by observing the quantities bought and sold at different prices. For the things that are not traded in markets, economists must rely on other methods (e.g., observations from related markets, hypothetical markets, or direct solicitation) to estimate WTP. For example, oil, natural gas, timber, livestock, dining out, and airline travel are all goods or services traded in markets. In contrast, clean air, ecosystem services, or ecological knowledge are non-market goods, so economists do not have the same opportunity to observe how people make tradeoffs about these goods.

Ecosystem services play a key role in the evaluation of policies that affect ecosystems because of their contribution to human well-being (EPA, 2009). This characteristic implies that ecosystem services have value. Sometimes, these values are manifested as moral, aesthetic, or spiritual values. Only a few of these ecosystem services involve goods traded in markets (e.g., provision of food, fiber, and fuel), and their economic value is manifested through market prices. Economists have developed several methods for estimating non-market values of ecosystem services. In some cases, particularly where there is an observable interaction between the individual and the environment, observation of that use in different

contexts can be used to estimate value (so-called "use value"). For example, if an individual is willing to travel farther to reach higher quality recreation areas, or purchase technology to access improved water quality, this reflects WTP for those items. In other instances, particularly where values do not require any actual interaction between the individual and the environment ("non-use values"), direct solicitation of values through hypothetical scenarios is necessary. Examples of non-use values include "existence value" and "bequest value." Many people place a value on the existence of a certain species or place, such as with endangered wolves or the Arctic National Wildlife Refuge, even though they may never plan to see a wolf or visit Alaska in person.

Economic values depend on both the resource characteristics and the socioeconomic context in which the resources or activity exist. For example, the water filtration value of a wetland that supplies drinking water to a community is different than a wetland in a recreation context. Methods for estimating non-market values can be expensive to develop, complicated to implement, and often require years to produce results. A common alternative to conducting a primary study is the "benefits transfer" approach. In the benefits transfer approach, economists take the values estimated by analysts in other related contexts or applicable studies and apply them in their own analysis. This method has the advantage of saving time and expense associated with planning and implementing primary data collection. The results of many primary analyses are specific to a region, amenity, or research question and should not be simply generalized to other situations without following specific parameters which limits that transferability of existing studies.

These practical limitations are a hurdle to comprehensive assessment of the benefits and costs of DOI management and policy decisions. DOI has the technical knowledge but lacks the capacity and data to implement a full valuation at this time. As such, the following case studies are provided to illustrate some of the benefits that might be included in such an analysis.

Examples of economic value of ecosystem services

Case Study 1: Benefits of Recreation in Glacier National Park

A core element of DOI's mission is to protect and manage the Nation's natural resources and cultural heritage. In order to guide this mission with evidence-based decision making, DOI must be able to quantify how the public values DOI resources. Many DOI resources are not bought and sold in markets and do not have a market price. For example, outdoor recreation, considered a cultural ecosystem service, involves economic tradeoffs regarding leisure time that are not fully considered in markets. Participants in recreation on public lands likely value their experience more than the price of entry, especially for sites with no entrance fee. As such, we rely on non-market valuation techniques to quantify economic value for these resources. These techniques rely on the same concept used to value marketed goods—they measure consumer demand based on the public's WTP. When willingness to pay for a DOI resource (a day of hiking in a national park, for example) exceeds the cost incurred to use that resource, users benefit from the fact that they can enjoy the resource at a price less than they are willing to pay for it.[5] This benefit, or difference between what a consumer is willing to pay and what they

[5] Although visitors to DOI lands do not pay a market price to use DOI resources, they do often incur expenses on their trips. Money spent on food and lodging in gateway communities does not measure the value of recreation opportunities, but does provide a benefit to local businesses, captured by the economic contribution estimates in this report.

actually pay, is called consumer surplus. This consumer surplus provides a standard and consistent measure of the economic value of DOI resources.

Within non-market valuation, two approaches are commonly used to quantify the consumer surplus supported by DOI recreation resources. The first is the travel cost method (TCM).[6] This method is based on the concept that when an individual chooses to visit a recreation site, they reveal that the recreation experience is worth at least the cost incurred to make the trip possible, including the cost of transportation, travel time, and any entrance fees paid. A visitor will continue to take trips as long as the benefit from the recreational experience exceeds the associated travel cost. By gathering data on the number of trips different users take at various trip costs, demand for the recreation site can be estimated and the average consumer surplus per recreation trip can be calculated. A second approach is the contingent valuation method (CVM), which relies on carefully designed survey questions to gather information on people's WTP for the consumption of an ecosystem service such as a DOI resource.[7] Figure 3 shows a CVM question where respondents are asked to select the maximum amount of money they would be willing to pay in order to make their most recent trip possible. Some park visitors may feel that the amount they paid on their most recent visit was the right amount and they would not have been willing to pay any more (i.e., $0) to make the trip possible. Others may view their most recent visit as a bargain and would be willing to pay the maximum price option shown ($2,000), if not more. Evaluating responses across all visitors reveals the average consumer surplus per recreation visit.

As you know, some of the costs of travel such as gasoline, hotels, rental cars, and airline tickets often increase. If your share of the total trip costs were to increase, what is the maximum extra amount you personally would be willing to pay for this most recent trip to Glacier NP? Please mark (●) one.

O $0	O $5	O $15	O $30
O $50	O $75	O $100	O $150
O $200	O $250	O $350	O $500
O $750	O $1,000	O $1,500	O $2,000

Figure 3. Example Contingent Valuation Method Questionnaire

This case study uses the contingent valuation method to measure the monetary value of recreational resources at Glacier National Park (NP). In a visitor survey, a sample of visitors to the park in the summer of 2016 were asked the question in Figure 3, and the responses were used to estimate the value (i.e., WTP) accrued to visitors from recreation.[8] Visitors were also asked which recreation activities they participated in on their current trip, and of those activities, which was their primary activity. The average WTP per visitor can be multiplied by the total number of relevant visitors in 2021 to determine the societal value of recreation opportunities at Glacier NP in 2021, as shown in Table 4.

[6] The TCM, first suggested by Hotelling (1949), is one of several "revealed preference" approaches. These methods rely on observed market transactions to infer a value for a non-market resource; for instance, homeowners are often willing to pay more for a house near a national park or national wildlife refuge (Mueller et al., 2021; Liu et al., 2013).

[7] The CVM is one of several "stated preference" approaches. In addition to CVM, attribute-based methods such as discrete choice experiments can be used to determine the value of different attributes of a DOI resource (e.g., Mansfield et al., 2008, Hanemann, 1994).

[8] This analysis uses a Turnbull estimator, which reveals a lower bound estimate of expected WTP (Haab and McConnell, 2002). An alternative approach is to statistically model the responses using an interval regression (Cameron and Huppert, 1989; Welsh and Poe, 1998).

Table 4. Value of Recreation Use Estimated from Glacier National Park Visitor Survey (2021 $)

Recreational Activity	N[9]	Average WTP per visitor	Total Value for Glacier NP Visitation
All Recreation	538	$444/trip; $121/day	$372,197,095
Viewing wildlife, scenery, natural features	130	$371/trip; $115/day	$87,921,325
Driving for pleasure	50	$375/trip; $144/day	$42,297,836
Walking/short hike (<1 hour)	16	$590/trip; $205/day	$19,282,111
Day hike (>1 hour)	194	$496/trip; $104/day	$119,026,205
Water travel (motorized or non-motorized)	15	$466/trip; $192/day	$16,945,280
Camping (developed sites or backpacking)	21	$524/trip; $110/day	$13,583,382
Other (e.g., creative arts, nature study, fishing, picnicking)	35	$484/trip; $171/day	$35,365,310

DOI bureaus are responsible for providing a wide range of recreational opportunities, while also managing and conserving the resources that support these recreation opportunities for current and future generations. Land managers face complex challenges, balancing issues such as increased visitation, competing demands on recreation sites, and evolving interests in new recreation activities. The monetary values such as those shown in Table 4 are used for (i) benefit-cost analyses of proposed regulations and other management actions;[10] (ii) determining compensation for resource injuries that affect recreation opportunities;[11] (iii) designing effective visitor use management strategies; (iv) evaluating tradeoffs associated with investing in competing recreation uses; (v) determining whether investments in facilities and maintenance of recreation sites provide benefits to the public that justify the cost; and (vi) complementing regional economic contribution estimates to provide a holistic understanding of the economic benefits national parks provide to local economies and society. That is, consideration of the economic value of non-market DOI resources is a critical part of DOI's evidence-based decision making.

[9] "All Recreation" reflects total respondents. For specific recreation activities, this is the number of survey respondents indicating that was the primary activity they participated in on their visit to the park. Activities with a sample size less than 10 were combined in the 'Other' category. Respondents who did not select a primary activity are not reflected in the specific recreation activity counts.

[10] Improved valuation of recreation and other ecosystem services is consistent with the President's Executive Order on Strengthening the Nation's Forests, Communities, and Local Economies and Memorandum on Modernizing Regulatory Review.

[11] For more information about DOI's Office of Damage Assessment and Restoration, see https://www.doi.gov/restoration.

Lake McDonald Public Dock in Glacier National Park. Source: National Park Service. Photo by Jacob W. Frank.

The U.S. Fish and Wildlife Service (USFWS) National Visitor Survey (NVS) and the National Park Service (NPS) Socioeconomic Monitoring (SEM) Program are annual surveys providing data that is the underlying component of quality consumer surplus estimates for recreation. The information from these surveys provides the input to understand:

- Visitor demographics
- Trip experiences
- Participation in activities, programs, and services provided by the recreation site
- Motivations for experiencing the recreation site
- Visitor satisfaction with the current services and facilities
- Economic contributions to local economies from visitor spending
- Economic value of recreation opportunities on DOI lands and water
- Inputs to estimating total visitation

Where the current data collection allows for site specific recreation valuation estimates, DOI also has an opportunity to calculate the societal value of recreation opportunities across all DOI lands and water — that is, at the bureau- or DOI-wide level. This approach assumes that if existing surveys capture a diverse enough range of scenarios, the data from the sample surveys can be used to make a statistical inference about the value of DOI recreation on the whole. In order for DOI to transition from a case-based analysis to an agency-wide model, DOI must:

- Prioritize data collection processes that are timely, comprehensive, and consistent, which allows for cross-geography and cross-time comparison of a range of recreation sites and experiences;
- Conduct samples that are large and diverse enough to be able to statistically infer across all DOI recreation activities; and
- Continue to expand existing data collection and survey efforts. For example, collecting visitation by recreational activity or conducting surveys across seasons to ensure that a comprehensive list of recreational activities is captured, including emerging activities (e.g., stand up paddle-boarding, geocaching).

The monitoring of outcomes and continued prioritization of data collection investments, such as the NPS's SEM effort and the USFWS NVS effort, will facilitate opportunities for DOI to develop and advance quantitative information that supports the objectives of evidence-based decision making.

Case Study 2: Personal Harvest: BLM Special Forest Products

Resources harvested from public lands for personal use are examples of provisioning ecosystem services provided on DOI lands.[12] Access to these resources allows for a wide range of activities, from harvesting Christmas trees and recreational hunting and fishing to gathering fuel wood for home heating. Many of these activities provide important social and cultural connections for local populations where traditions around using these resources have been cultivated for generations. Thus, provisioning services can be closely connected to cultural services. In addition, there can be financial benefits to an individual or household, such as situations where the harvested resources can be resold and thus provide a source of income, or where a commercially available alternative is more expensive.

However, unlike activities that interact with commercial markets where production or harvested quantities are tracked and market prices can provide some information for quantifying value, data related to harvesting resources for personal use is much more limited. In addition, the value of these resources is dependent on a range of site-specific factors, including ecological characteristics (which determines what is available to harvest and in what abundance), socioeconomic and demographic characteristics of the local population (which determines whether there is cultural relevance to the available resources and economic drivers to invest the time and money in harvesting), and management decisions (which determines access, levels of use, and permitting costs).

One example is the BLM Special Forest Products (SFP) Program which issues permits for harvesting plant materials like seeds, berries, greenery, mushrooms, and seedlings, as well as wood products like fuelwood, biomass, fence posts and poles.[13] These products may be harvested for recreation, personal use, or as a source of income. Permitting programs for harvesting SFPs are managed by BLM state offices and vary by state and field office but overall, the program helps to meet local and rural community economic needs, as well as supporting cultural traditions such as Christmas tree cutting or collecting pinyon pine nuts. Table 5 shows the number of Christmas trees cut using SFP permits and average unit cost, [14] by State, for FY 2017-2021 (annual average, 5-year total, and average unit cost).

[12] In some situations, these resources may extend beyond harvest for personal use. For example, the BLM also issues commercial permits, which allow for harvested Special Forest Products resources up to a certain amount to be resold.
[13] https://www.blm.gov/programs/natural-resources/forests-and-woodlands/forest-product-permits
[14] Average unit cost is calculated as the total State fiscal year SFP receipts for a given category divided by the quantity harvested. SFP permit costs can vary across field offices, even within the same category. For more information on permit purchases, see https://www.blm.gov/programs/natural-resources/forests-and-woodlands/forest-product-permits.

Upper Missouri Wild and Scenic River, Montana. The Missouri is the longest river in the United States, flowing more than 2,500 miles from its source on the eastern slope of the Rockies near Three Forks, Montana, to its confluence with the Mississippi River at St. Louis, Missouri. The public lands of the Upper Missouri River Breaks National Monument, both under federal and state management, make a significant contribution to the local lifestyle and the regional economy. Source: Bureau of Land Management. Photo by Bob Wick.

Figure 4 presents the annual average number of Christmas trees harvested under the BLM's SFP Program in FY 2017-2021. Table 6 shows the (average/total) units of SFPs harvested in the State of Oregon for FY 2017-2021, along with the average unit cost within each SFP category.

Not all SFP harvests require permits and permit sales do not necessarily reflect the full harvest of SFPs.

Table 5. Christmas Trees Harvested under the BLM's SFP Program, FY 2017–2021 5-year total, average unit cost)

State	Trees Harvested (2017-2021)	Average unit cost
Alaska	256	$ -
Arizona	42	$ 10.0
California	905	$ 4.5
Colorado	5,577	$ 6.8
Idaho	3,728	$ 8.2
Montana	1,666	$ 4.9
Nevada	25,782	$ 3.4
New Mexico	2,542	$ 5.2
Oregon	3,422	$ 5.9
Utah	7,976	$ 9.2
Wyoming	2,678	$ 6.0

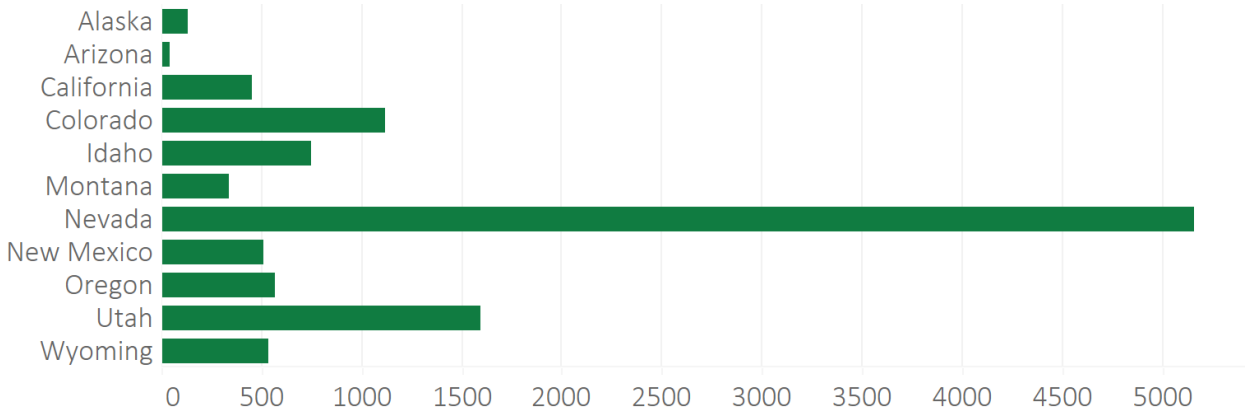


Figure 4. Christmas trees harvested under the BLM's SFP Program (FY 2017-2021 annual average)

Table 6. Non-wood Special Forest Products in Oregon, Quantities Harvested and Average Unit Costs (FY 2017 – 2021)

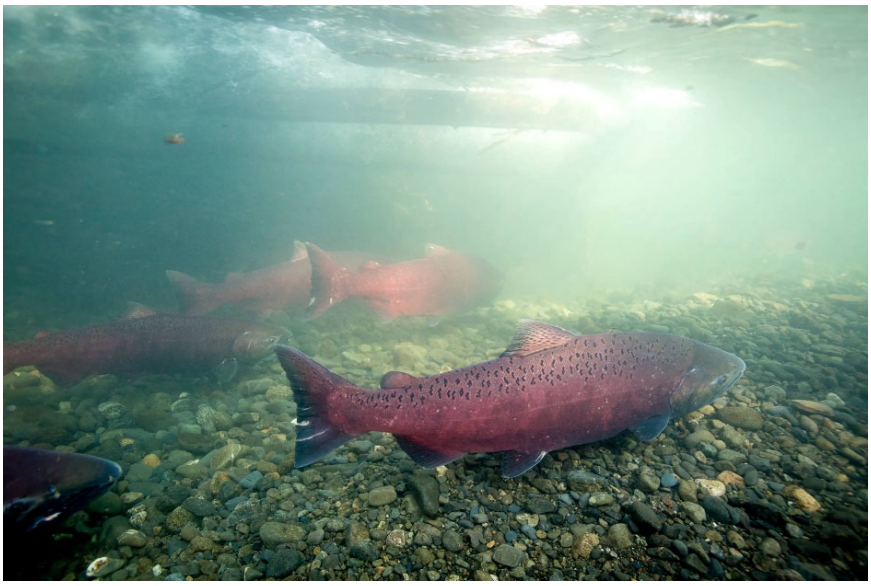
Category	Units	Average annual harvest	Total harvest (2017-2021)	Average unit cost
Boughs - Coniferous	Pounds	277,107	1,385,537	$ 0.1
Burls & Miscellaneous	Pounds	14,834	74,170	$ 0.1
Christmas Trees	Each	684	3,422	$ 5.9
Edibles & Medicinals	Pounds	13,796	68,982	$ 0.1
Floral & Greenery	Pounds	730,722	3,653,608	$ 0.1
Mosses - Bryophytes	Pounds	463	1,390	$ 0.1
Mushrooms - Fungi	Gallons	710	1,420	$ 0.3
	Pounds	229,925	1,149,624	$ 0.2
Native Seed - Misc.	Pounds	4,190	20,948	$ 0.2
Ornamentals	Each	147	440	$ 0.2
Seed & Seed Cones	Bushels	1,045	5,227	$ 0.5
	Pounds	352	704	$ 0.1
Transplants	Each	1,465	7,323	$ 0.7

Case Study 3: Subsistence Harvest in Alaska

Access to public lands for subsistence harvest is another example of a provisioning service of ecosystems managed by DOI. There are many ways in which Alaska differs from the Lower 48 states, and subsistence harvesting is one of them. Subsistence is defined by Federal law as "the customary and traditional uses by rural Alaska residents of wild, renewable resources for direct personal or family consumption as food, shelter, fuel, clothing, tools or transportation; for the making and selling of handicraft articles out of nonedible by-products of fish and wildlife resources taken for personal or family consumption; and for the customary trade, barter or sharing for personal or family consumption." A shorter definition that distinguishes subsistence from other forms of personal harvest is that subsistence is "life-enabling." Alaska is the only state with a legal priority for subsistence use on Federal lands, stemming from two Federal laws: the Alaska Native Claims Settlement Act (ANCSA) of 1971 and the Alaska National Interest Lands Conservation Act (ANILCA) of 1980. Title VIII of ANILCA gave rural Alaskans priority for subsistence harvest of fish and wildlife on Federal lands, which account for about 60% of the state's land area. The rural preference provision does not align with state law and is currently not implemented by the State of Alaska. Therefore, the Secretaries of the Interior and Agriculture created the Federal Subsistence Management Program (FSMP) and delegated authority to the Federal Subsistence Board (FSB)[15] to

[15] The FSMP is a multi-agency effort to provide the opportunity for a subsistence way of life by rural Alaskans on Federal public lands and waters while maintaining healthy populations of fish and wildlife. The public plays a vital role in proposing changes to subsistence fishing, hunting, and trapping regulations and making comments on proposed changes to ensure regulations are meeting the needs of subsistence users while conserving healthy populations of fish and wildlife. ANILCA established the grounds for the public to provide this feedback via subsistence Regional Advisory Councils (RACs; currently 10 in place across Alaska) and 7 Subsistence Resource Commissions (SRCs). RACs and SRCs meet twice, and the FSB at least twice per year, providing a forum for public involvement in the FSMP. Three Regional directors of DOI agencies are members of the FSB: NPS, BLM and USFWS. For more information see https://www.doi.gov/subsistence/osm.

manage the harvest and use by rural Alaskan residents of land mammals taken on Federal public lands and harvest and use of fish taken from waters within and adjacent to Federal public lands.[16]



Chinook salmon swim upstream to spawn in Alaska. Harvests are an integral part of culture, providing a critical food source for subsistence communities. Source: U.S. Fish and Wildlife Service. Photo by Ryan Hagerty.

There are undeniable economic and well-being implications of subsistence harvest, particularly for rural Alaskans who may live in areas where limited access can result in extremely high food costs or even the absence of commercial food markets altogether. However, the importance of subsistence harvest extends far beyond cost, as these activities are often deeply intertwined with cultural practices and local customs in ways that are difficult, if not impossible, to fully quantify. In that sense, subsistence harvest can be considered as both a provisioning and a cultural ecosystem service in that the activity is associated with the provision of a good (i.e., food) and the preservation of cultural values (i.e., traditions). Furthermore, the management of the resources (and information collected on the harvest of those resources) can vary across the State depending on land jurisdiction.[17] For these reasons, analyzing subsistence in Alaska is extremely complex and any analysis of its value would require accounting for the varying nature of it both across the geography and over time. This would likely mean engaging at a jurisdiction, unit, or possibly a more localized level, to understand the resource use and available information.[18]

One example that illustrates some of these complexities is a study by the Alaska Department of Fish and Game (ADF&G) Division of Subsistence (Trainor et al., 2021). This study employed the participation of residents from three rural Yukon River communities where salmon is a critical staple resource. One of those communities, Beaver, or *Ts'aahudaaneekk'onh Denh*, is located on the north bank of the Yukon River, within the Yukon Flats National Wildlife Refuge. There is no local grocery store in Beaver, so any store-bought food is flown in which is expensive and unreliable due to weather conditions.

[16] The authority to manage take for subsistence use in Alaska on Federal lands is delegated to the Federal Subsistence Board, which oversees the Federal Subsistence Management Program. The board is made up of the regional directors or designees of USFWS, the BLM, NPS, BIA, and USFS.

[17] Resources on Federal land are managed at a regional level through a public process and conservation is the utmost priority; regulations are reviewed and updated every two years to ensure the maintenance of healthy resource populations.

[18] One source of information is the Community Subsistence Information System (CSIS), an online repository of Alaska community harvest information collected by the Alaska Department of Fish and Game (ADF&G, 2022). The estimates in this database are based on data collected in systematic, comprehensive household surveys. See http://www.adfg.alaska.gov/sb/CSIS/

Access to wild foods is not only necessary for survival, but the harvest and use of these foods is an integral part of the community fabric, with extended families and households working together to harvest and process salmon. In addition, sharing of harvested resources is a quintessential aspect of wild food use. One Beaver resident described this: "We don't only ever fish for ourselves. We don't only ever hunt for ourselves. We fish knowing that we're going to give a certain amount away to our family. So when we can't give that amount away even if we're feeding ourselves, then it's not okay. Then that means that our needs have not been met. Our need to give has not been met…it's not necessarily reciprocal but it's an important part of our culture to give things away. *That's how we distribute wealth and how our economy works; that's what the subsistence economy is*" (Trainor et al., 2021, p158, emphasis added).

> *"We fish knowing that we're going to give a certain amount away to our family. So when we can't give that amount away even if we're feeding ourselves, then it's not okay…it's an important part of our culture to give things away. That's how we distribute wealth and how our economy works; that's what the subsistence economy is." (Source: Trainor et al., 2021)*

In addition to its importance to the health of the community, harvesting wild foods provides individuals with deep and meaningful connections to their community's cultural practices and heritage. One Beaver resident explained this as: "Fishing is almost a religion. You know? That's when I feel closest to God, is when I'm out on my country doing what my ancestors did before me" (Trainor et al., p. 140).

The Yukon River is home to several types of salmon; in the upper Yukon where Beaver is located, Chinook and fall chum salmon have historically been locally abundant.[19] However, severe declines and crashes in salmon populations have occurred over the past two decades, leading to unprecedented fishery closures in recent years. Table 7 shows pounds of Chinook and chum salmon harvested in 2011 and 2018, based on surveys of households in Beaver. In both 2021 and 2022 this stretch of the river was closed entirely to harvest of Chinook, summer chum,[20] and fall chum[21] due to the forecasted runs being too low with "little to no harvestable surplus available for subsistence use".

Table 7. Chinook and chum salmon harvests in Beaver, AK (by weight, in pounds)

	2011	2018	2021	2022
Chum salmon	4,289	691	0	0
Chinook salmon	5,736	3,106	0	0

Sources: ADF&G Community Subsistence Information System (2011), Trainor et. al, Table 5-10 (2018). 2021 and 2022 harvest values are presumably zero due to subsistence harvest closures.

The socioeconomic and socio-cultural effects of these declines have been substantial. Trainor et al. (2021) report that since the Chinook salmon decline in 2009, subsistence users need to expend much more effort, fishing longer than required in the past to try to harvest the amount needed and frequently ending up with smaller harvests that do not meet their needs. One Beaver resident described the

[19] This abundance is in reference to subsistence use; there have been no commercial fishing opportunities in this subdistrict of the river since 1997.

[20] https://www.doi.gov/subsistence/news/fishing/federal-waters-subdistrict-5-d-yukon-river-closed-subsistence-salmon

[21] https://doi.gov/subsistence/news/fishing/federal-waters-yukon-river-subdistricts-5d-lower-middle-and-upper-closed

impacts on well-being from fishing restrictions preventing local people from being able to carry out their traditions: "It's such a negative effect on a peoples' culture. And that's why you see suicide rates rising, or like domestic violence rising when those fishing crashes happen. Like that particular year of the salmon crash, there were like two or three really well-known adult males that committed suicide that year. That was just horrific. You know, they were providers for their family and like that kind of thing. It's just, that's horrific…Because people don't fish for themselves alone" (Trainor et al., p141).

Question 2: In addition to ecosystem services, how do DOI's actions contribute to socioeconomic well-being?

Key Concepts

In addition to managing resources that provide valuable ecosystem services, DOI engages in many other activities that contribute to socioeconomic well-being. As with ecosystem services, the economic value of these activities includes both market and non-market values, as well as use and non-use values. DOI and its bureaus manage a wide range of activities that contribute to socioeconomic well-being. Examples include:

- conserving and protecting resources on DOI lands and waters;
- safely producing energy and minerals, accounting for revenues, and reclaiming mined lands;
- managing trust responsibilities, and work related to insular affairs;
- funding or supporting education, youth outreach, and volunteer positions; and
- producing data, conducting research; etc.

A thorough and comprehensive accounting of net benefits associated with DOI activities is not currently possible due to data and methodological limitations. Addressing these limitations will be a priority in future reporting. For the FY 2021 report, we developed three examples of how DOI actions contribute to socioeconomic well-being: Case Study 4 discusses the benefits and costs of energy production; Case Study 5 discusses the value of information generated by research and data products; and Case Study 6 discusses tracking the quantity and value of natural assets via natural capital accounting.

There are numerous challenges associated with measuring how DOI actions contribute to socioeconomic well-being using the tools of economic analysis. For example, there is no single metric that could be used to measure socioeconomic well-being itself. These practical limitations are a hurdle to comprehensive assessment of the contributions of DOI management and policy decisions to socioeconomic well-being. DOI has the technical knowledge but lacks the capacity to implement a full analysis of well-being at this time. As such, the following case studies are provided to illustrate some of the benefits that might be included in such an analysis.

Examples of how DOI contributes to socioeconomic well-being

Case Study 4: Benefits and Costs of Energy Production

Many of the activities that occur on DOI lands and waters have both benefits and costs, and these effects may accrue differently to different groups of people. One example is the benefits and costs of energy production. Public lands and waters support energy production from both fossil fuels and

renewable resources. Table 8 shows how energy-resource production on DOI lands compared to total U.S. production in FY 2021.

DOI-managed lands and waters provide access to dependable energy production, with an associated range of benefits, costs, and economic contributions, including economic activity and employment (Stern, 2018).[22] It is important to remember that economic contributions are not direct measures of economic benefits (Watson et al., 2007).[23] Nevertheless, these economic contributions are often emphasized by industry groups, public comments, and state and local governments. Contributions to economic activity are described and analyzed under Question 4, "How do market transactions generated from activity on DOI lands contribute to economic activity?".

Beyond the economic activity supported directly or indirectly from energy production, almost every aspect of modern life, from work, to school, to leisure, relies on energy from some source. Further, if the alternative to domestic energy production is increased imports, there may be additional benefits of production from DOI resources related to political conflict and national security.

Table 8. Energy production from DOI-managed sources

Energy Source	Production from DOI Managed Resources[x]	Total U.S. Production[y]
Crude Oil	1,084 million barrels	4,041 million barrels
Natural Gas	4.4 tcf	36.4 tcf
Coal	258 million short tons	565.23 million short tons
Wind	4.4 TWh	364.6 TWh
Solar	8.1 TWh	156.7 TWh
Geothermal	15.0 TWh	16.2 TWh
Hydropower	34.7 TWh	257.3 TWh

[x]See sources from Table 2

[y]US EIA. FY 2021 production for crude oil, coal, natural gas marketed production (wet), and net electricity generation scale wind, geothermal, and conventional hydroelectric; and all (utility and small scale) solar

There are also costs to energy production. Most notably are the environmental impacts associated with energy development. All energy production, including both fossil fuel and renewable energy, impacts land, water, and air resources. In addition, location of infrastructure can impact views, noise levels, and other aspects of socioeconomic well-being. Combustion of fossil fuels also generates greenhouse gas emissions which contribute to climate change.

[22] See for example 2023 Second Quarter Competitive Lease Sale Environmental Assessment (DOI-BLM-WY-0000-2023-0001-EA), p. 49. https://eplanning.blm.gov/public_projects/2021772/200534737/20071765/250077947/WY%202023-06%20Draft%20Lease%20Sale%20EA.pdf

[23] While an individual job is neither a cost nor a benefit to society, a well-functioning and diverse economy does provide benefits related to economic opportunity and resilience. In any case, economic benefits associated with energy development (as part of the broader economy) are not measured by counting jobs.

The Bureau of Ocean Energy Management is responsible for offshore renewable energy development in Federal waters and is paving the way for the future of this innovative industry. Offshore wind is an abundant domestic energy resource. Offshore wind energy projects open new opportunities for accessing stronger winds, building larger-scale projects, creating domestic jobs and revitalizing ports. Source: Department of the Interior Photo Galleries. Photo by Bureau of Ocean Energy Management.

The social cost of greenhouse gasses (GHGs) refers to the net costs to society of adding GHGs to the atmosphere. The Interagency Working Group on the Social Cost of GHGs (IWG, 2021) estimates that one metric ton of carbon dioxide (CO_2) emitted in 2025 will have a median estimate of net harm to society of $17 to $83, depending on the discount rate used.[24] Similar costs from methane and nitrous oxide are $800 to $2,200, and $6,800 to $30,000, respectively. The IWG also reports costs associated with the high end of potential damages, that is the 95th percentile of estimates (based on a 3 percent discount rate). These are $169, $4,450, and $54,000, for one metric ton of carbon dioxide, methane, and nitrous oxide, respectively.

[24] The Environmental Protection Agency (EPA) reported higher mean costs per ton in 2022, relying on a lower (1.5 percent) discount rate and new approach to future uncertainty. The costs associated with CO_2 were estimated between $130 and $360 per ton; costs for methane were $1,590 to $2,737 per ton; costs for N_2O were $39,972 to $95,210. For more information, see Supplementary Material for the Regulatory Impact Analysis for the Supplemental Proposed Rulemaking, "Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review," EPA External Review Draft of Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances". EPA, September 2022). https://www.epa.gov/system/files/documents/2022-11/epa_scghg_report_draft_0.pdf

Evaluating the costs and benefits of energy production from DOI lands requires modeling the role Federal production plays in global energy markets. Reducing emissions from Federal lands will not reduce global emissions by the same amount, as other non-Federal domestic and international sources may increase to meet demand. DOI economists are developing models that can be used to estimate this substitution, and more completely and robustly estimate the benefits and costs associated with Federal energy production.

The U.S. Energy Information Administration produces the Annual Energy Outlook which includes projections of energy production in the U.S. (U.S. EIA, 2023). It is not feasible to estimate projections of energy production from Federal lands into the future, in part, because production decisions lie with the holders of leases and permits and are impacted by complex regional supply and demand factors. However, projections of total energy production in the U.S. reveal overall expected trends. Table 8 provides the projections of total energy production in the U.S. by source.

Table 9. Projections of energy production in the U.S., by source, 2023-2030

Energy Source[z]	Unit	2023	2024	2025	2026	2027	2028	2029	2030
Crude Oil	million barrels	4,606	4,735	4,808	4,875	4,914	4,980	4,973	4,982
Natural Gas	tcf	45	44	45	45	45	45	45	46
Coal	tons	399	435	408	374	335	301	269	256
Wind	Twh	463	466	506	575	663	771	865	935
Solar	Twh	176	250	368	503	626	702	745	773
Geothermal	Twh	15	16	17	18	18	19	20	21
Hydropower	Twh	281	290	298	299	299	297	296	295

[z]US EIA.

Case Study 5: The Value of Information: DOI Research and Data Products[25]

Research and development activities provide a range of societal benefits, supporting economic growth and innovation and DOI's management of natural resources and ecosystems. Interior's bureaus engage in a variety of activities that provide basic and applied research, scientific and technical information, and technology transfer. In particular, the U.S. Geological Survey (USGS) serves the Nation by providing reliable science, data, information, and models to describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect quality of life. USGS science informs public and private decisions, operations, and risk management in all major U.S. economic sectors, and provides critical information for natural resource and natural hazard management and stewardship decisions at the National and State or regional levels.

USGS economists, social scientists, and physical scientists are engaged in collaborative efforts to advance methods to estimate the Value of Information (VOI) produced by USGS. Understanding the value of scientific information supports the application of USGS science in land and water management decisions, and better informs the public about the return on investment in USGS programs. The work

[25] Adapted from E. Pindilli, S. Chiavacci, and C. Straub (2022) USGS Factsheet: Value of Information (forthcoming).

involves collaborating with an international community on methods and establishing best practices, developing a study repository, and conducting projects to assess the VOI of specific information products and their applications. This section focuses on economic valuation at USGS, though the methodology is broadly applicable to other DOI bureaus (there is also a range of non-economic valuation techniques for assessing benefits).[26]

Approximately $167 million in Bipartisan Infrastructure Law funding will support the design, construction and tenant build out of a state-of-the-art U.S. Geological Survey-owned facility for energy and minerals research through a cooperative agreement with an academic partner. Source: Department of the Interior Photo Galleries. Photo by U.S. Geological Survey.

Information has value when it is used to improve decision-making, often by reducing uncertainty in the resulting possible outcomes. To estimate VOI, economists consider the difference in economic value between outcomes (real or hypothetical) with and without the additional information. As with other commodities, the value of each additional unit of information typically decreases as the supply of similar information (i.e., knowledge) increases.

USGS has developed estimates of the value of a few information products (see Table 10). For example, Straub et al. (2019) surveyed direct users of Landsat (satellite) imagery to estimate that these images provided direct users with $3.45 billion in benefits in 2017, of which $2.06 billion was for U.S.-based users (equivalent to $2.28 billion in 2021). The total estimated value has increased over time, the estimate for 2017 was $2.19 billion higher than for 2011 (though with a lower value per image). Values were highest among users that download a small number of images and have used Landsat imagery for many years, as well as users in private business and Federal government (relative to users in academia, State and local governments, and nonprofit organizations).

[26] See https://www.usgs.gov/programs/science-and-decisions-center for information on VOI research.

Chiavacci et al. (2020) estimated that improving public, map-based information on the risk of radon exposure in Kentucky homes would avoid exposure to harmful radon levels for 75 people in one year, a change valued at $3.4 million to $8.5 million (2016 dollars, equivalent to $3.8 million to $9.6 million in 2021 dollars). Radon is responsible for about 21,000 lung cancer deaths every year (EPA, 2022). Public health officials could use geologic map data to help people avoid exposure to harmful radon levels via increased testing and mitigation rates.

Pindilli and Loftin (2022) estimated the annual value of a two-day advance warning system for cyanobacteria blooms in Kansas lakes and reservoirs like the Cyanobacteria Assessment Network, an interagency effort by EPA, NASA, NOAA, and USGS. Such a system could help managers close beaches before bathers were exposed to harmful blooms. The system could also help managers avoid closing beaches during harmless blooms, thus avoiding unnecessary recreational losses. Pindilli and Loftin (2022) estimated the combined value of these two effects at $0.6 million to $2.3 million (2018 dollars, equivalent to $0.6 million to $2.5 million in 2021). The 17 Kansas lakes and reservoirs managed by the U.S. Army Corps of Engineers hosted 1.1 million swimmer-days in 2021 (USACE, 2022). Kansas recreationalists may also visit seven reservoirs managed by the Bureau of Reclamation, and dozens of State and locally managed lakes. Managers use a system like CyAN to determine when to post a water contact advisory, balancing the benefits of avoided health effects against the costs of foregone recreation. This lower bound does not include potential costs related to drinking water, irrigation, and power generation.

Pindilli and Avery (2018) estimated that the value of information from the USGS Hawaiian Volcano Observatory on lava flow modeling is at least $2.8 million in avoided costs. This includes evacuation costs, sheltering costs, and opportunity costs. These avoided evacuation costs can be compared to property damages from lava flows, such as the Kīlauea eruptions of 1955 ($3.7 million in 2021 dollars); 1983-1991 ($121.4 million in 2021 dollars) (OSU, 2022); and 2018 (about $863 million in 2021 dollars) (Dayton, 2018). The evacuation cost savings stem from the ability to better size an evacuation with more current information. Evacuation officials can use the information to determine the areas to evacuate, balancing the benefits of avoided health effects against the costs of (unnecessary) evacuations.

Additional foundational research on VOI has focused on hazards and weather events (including evacuations related to wildland fire and hurricanes), and agriculture (e.g., water quality for irrigation). Table 10 provides estimates of the VOI by information domain.

Table 10. USGS Estimates of the Value of Information (VOI) by Information Domain

Information domain	Specific example	Geography	VOI Estimate	Next steps for expanding to National scale
Data products (inputs to other products)	Landsat images	U.S. users	$2,060 million (2017)	Repeat user survey for additional years
Hazards	Radon exposure	Kentucky	$3-$8 million (2016)	Develop data and maps for other areas across the US
	Volcanic eruption evacuations	Hawai`i	$3 million (2018)	Develop data and maps for other volcanic areas
	Harmful algal blooms	Kansas	$1-$2 million (2018)	Develop data and maps for other areas across the US; include impacts to drinking water, irrigation, hydropower

In conclusion, information and data generated through DOI research are used in both the private and public sectors for a variety of end-uses that may generate significant societal benefits. Evaluating these benefits by estimating the VOI is a unique topic within the field of economics, particularly for information that is provided as a public good because there is little likelihood that it will be traded in markets. The research requires multidisciplinary science to understand the role and use of information and may be best assessed by economists and social scientists in coordination with information providers, users of the information, and other stakeholders. The research draws on a base of foundational decision science theory and welfare economics. USGS has ongoing research related to the Landsat program, cyanobacteria blooms information, and volcano science. At DOI, there are many opportunities to initiate VOI studies going forward to support decision-making and prioritization on research and data collection efforts. Some of the key areas include water availability and use information, energy and mineral availability and use, natural hazards science, and climate change information broadly and as it applies to DOI lands and natural resources.

Case Study 6: Natural Capital Accounting

The United States depends on *natural capital* assets such as forests, fish stocks, and clean air for our prosperity, health, and sustainable development (World Bank, 2021). Many of the resources managed by DOI can be thought of as natural capital and as an important part of the Nation's wealth. Yet, the System of National Accounts (SNA)[27] and the National Income and Product Accounts (NIPA), in tracking U.S. economic performance with metrics like Gross Domestic Product (GDP), do not track how changes in the amount and quality of these natural capital assets influence economic output or the well-being of Americans[28,29] (Bagstad et al, 2021; Stiglitz et al., 2018; Fenichel et al., 2016; Muller, 2014). This

[27] The SNA is an internationally accepted set of statistical and accounting guidelines for the compilation of national accounts. https://www.bea.gov/national/sna-and-nipas

[28] A new chapter in the 2025 SNA is planned to begin to address this disconnect. https://unstats.un.org/unsd/nationalaccount/aeg/2020/M14_6_5_Well-being_Sustainability_Framework.pdf

[29] https://apps.bea.gov/well-being/

information remains disconnected from core statistical measurements of the economy that drive long-term national and regional planning.

Natural capital accounting (NCA), or environmental-economic statistics, is an accounting and statistical framework for comprehensive, internally consistent measurement and reporting on stocks and flows of natural capital.[30] It provides statistical timeseries and representing relationships between the environment, the economy, and human well-being (Bagstad et al., 2021). Building environmental-economic accounts compatible with and in parallel to the NIPA will inform policy to improve management of the U.S. asset portfolio. NCA can help decision makers and resource managers at Interior address critical issues, such as:

- The contribution of DOI-managed terrestrial and aquatic ecosystems and their services to the economy, social well-being, and livelihoods
- Providing a comprehensive and systematic framework to improve consistency in ecosystem services evaluation metrics across DOI bureaus and management units[31]
- Informing analyses done for National Environmental Policy Act (NEPA) compliance.[32] Continuing to develop NCA requires increased emphasis on valuing resources not typically bought and sold in markets (e.g., ecosystem services)
- Addressing administration policy priorities, such as:
    - Climate change and green infrastructure. NCA can track changes in the capacity of the Nation's ecosystems to sequester atmospheric carbon, buffer coastal communities from storm surges, and supply adequate water as climate change impacts unfold (Agarwala et al., 2014; Pizarro, 2020). NCAs can be coupled with scenario analysis to evaluate the effects of proposed policy alternatives more comprehensively.
    - Diversity, equity, and distributional issues related to environmental and economic justice. NCA can help track and identify how specific communities benefit from ecosystem services to better ensure that public and private investment can protect and enhance these values (Atkinson & Ovando, 2022).
    - America the Beautiful.[33] NCA can systematically track restoration and conservation efforts so natural resources and ecosystems are best managed by Interior to ensure continued services and benefits such as energy, water supply, flood control, carbon storage, and recreational opportunities (Farrell et al., 2021).
    - Sustainability Planning. NCA can provide consistent measurements to help identify the trade-offs among different DOI-managed land uses (e.g., for agriculture, mining, housing development, habitat conservation, recreation) to achieve long-term sustainability.

Much of the work to date related to NCA in the U.S. was completed by an interagency working group led by DOI. In 2020 and 2021, U.S. Geological Survey (USGS)-led publications[34] provided land, water, and ecosystem accounts for the United States (Heris et al., 2021; Bagstad et al., 2020; Warnell et al., 2020; Wentland et al., 2020). Interior's involvement in this effort is of vital importance given the scientific

[30] The UN Glossary of Environmental Statistics defines it as "natural assets in their role of providing natural resource inputs and environmental services for economic production." https://unstats.un.org/unsd/publication/SeriesF/SeriesF_67E.pdf
[31] https://www.doi.gov/sites/doi.gov/files/elips/documents/707_dm_.pdf
[32] https://www.law.cornell.edu/uscode/text/42/4332
[33] https://www.doi.gov/priorities/america-the-beautiful
[34] https://www.usgs.gov/centers/geosciences-and-environmental-change-science-center/science/accounting-natural-capital#overview

expertise of DOI bureaus and offices, and the value NCA can provide to the Department's decision making. Executive Order 14072 and Memorandum 22-15 directed that a system of accounts for tracking the status and value of nature and the environment be established, and the White House's Office of Science and Technology Policy convened an Interagency Policy Working Group (IPWG) to establish and develop strategic and implementation plans to guide the system from research-grade pilot accounts to production-grade core statistical products by 2036.[35] The National Strategy to Develop Statistics for Environmental-Economic Decisions was released by the White House Office of Science and Technology Policy in January 2023.

The U.N. System of Environmental Economic Accounting (SEEA)[36] is the accepted international statistical standard for environmental-economic accounting. SEEA's Central Framework (SEEA-CF) tracks environmental assets (and their interconnections, flows, and economic activity related to the environment) and Ecosystem Accounting (SEEA-EA) (to measure and value "ecosystem services"[37]) brings together economic and environmental information definitions and accounting rules to produce statistics consistent with the SNA. Consequently, the SEEA allows for the integration of environmental information (often measured in physical terms) with economic information (often measured in monetary terms) in a single framework. SEEA-EA includes accounts on ecosystem extent and condition; and supply and use accounts (i.e., ecosystems supply services for the use of various economic sectors) (Figure 5). Ecosystem accounting can provide both physical and monetary accounts; while monetary information can be extremely useful, organizing information in physical terms can facilitate comparisons with economic data even without monetary valuation (Brandon et al., 2021).

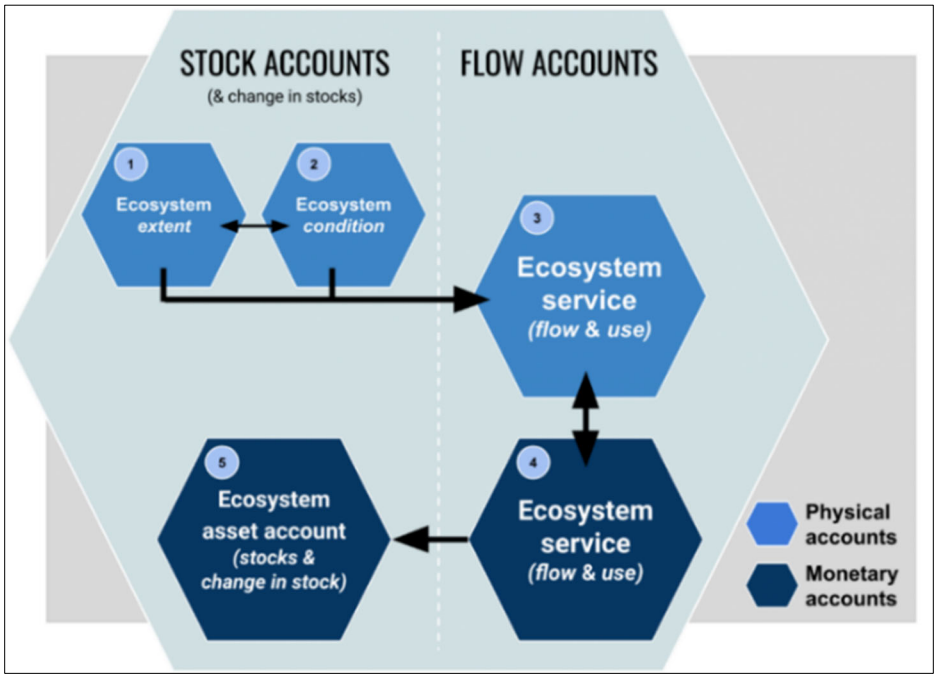


Figure 5. SEEA-EA related accounts. Source: United Nations (2021)

[35] https://www.whitehouse.gov/wp-content/uploads/2022/08/Natural-Capital-Accounting-Strategy.pdf
[36] https://seea.un.org/
[37] In SEEA Ecosystem Accounting, ecosystem services are defined as "the contributions of ecosystems to the benefits that are used in economic and other human activity." https://seea.un.org/ecosystem-accounting

Linville Falls, Blue Ridge Parkway. The Linville River flows from its headwaters high on the steep slopes of Grandfather Mountain and cascades through two falls as it begins a nearly 2,000-foot descent through this rugged and spectacularly beautiful gorge. Known by the Cherokee as "the river of many cliffs," Linville Gorge was the nation's first officially designated wilderness area. Source: National Park Service. Photo by Bill Bake.

As an example, physical and economic data about water in many nations are becoming more widely integrated through application of the System of Environmental-Economic Accounts for Water (SEEA-Water), which enables the tracking of linkages between water and the economy. Bagstad et al. (2020) presented the first national and subnational SEEA-Water accounts for the United States. The authors compiled accounts for water, including: (1) physical supply and use, (2) productivity, (3) quality, and (4) emissions for roughly the years 2000 to 2015 at the national scale organized by economic activity as defined by the North American Industry Classification System. They found that total water use declined nationally by 22% from 2000 to 2015 across numerous sectors and users, which reveals the continuation of a longer-term trend. Total water use declined in 44 states, largely due to reduced thermoelectric power water use. In addition to water use, accounts were also established to measure water productivity, water quality, and water emissions. With mature water accounts, water resource planners would be able to fully evaluate tradeoffs across multiple water uses at multiple spatial and temporal scales. Future efforts in support of this initiative will include the development of other natural capital accounts and a transition from research grade environmental-economic statistics and natural capital accounts to Core Statistical Products.

Despite the data abundance that underpins the development of many new accounts, a number of challenges exist as the U.S. is at an earlier stage of accounts development than much of the world. NCA demand will likely increase as accounts are consolidated and clear examples emerge of how NCA improves policymaking (Bagstad et al., 2021). First-generation U.S. accounts need to improve their timeliness, completeness, and quality across various dimensions. The need for wider dissemination of the accounts to build public awareness and their use in decision making is also generally noted in NCA U.S. literature (Jackson et al., 2016).

To meet the goal of ecosystem accounting to measure the supply and use of ecosystem services at large landscape scales (e.g., the national level) over a series of accounting periods, ecosystem services data must be available for multiple periods and at a broad spatial scale[38] (United Nations, 2021). Since environmental data have rarely been collected for the specific purpose of building ecosystem accounts, creating the accounts often highlights gaps where data do not exist or are inadequate for accounting purposes (Warnell et al., 2020; Olander et al., 2016). More work is needed to expand Nationwide coverage of ecosystem accounting data, especially for Western States with more DOI-managed lands and waters. Future work can focus on updating NCA data. These values will ideally form time series capable of providing more complete and consistent ecosystem accounts (e.g., including more final ecosystem services and their monetary values), supporting more complete evaluation of economic benefits and tradeoffs than is currently possible.

DOI will play an increasingly important role in expanding National capacity to produce accurate, timely, regularly updated, and decision-relevant natural capital accounts, supporting their use in the management and conservation of natural resources.

Economic Contributions

Economic contributions describe how DOI's actions and spending affect overall economic activity in a defined geographic area. This type of analysis is focused on activities and resources that have market value: producing commodities, supply-chain spending, or visitor or government spending. The metrics estimated in a contribution analysis (i.e., output, employment, and value added) provide information on how these actions affect economic activity, but they do not represent full benefits and costs in an economic sense. For example, the number of jobs provides no information about the "quality" of those jobs; visitor spending information represents an expense for the visitor but revenue for the local communities. Economic contributions do not measure changes in human living standards and well-being (Kapoor and Debroy, 2019).

Contribution analyses model the various linkages between individuals and companies in an area to simulate how spending moves through the economy. At each stage of spending, individuals and companies add another layer of value to the transaction. This produces a "multiplier effect" where each dollar of spending at the beginning of the chain of linkages results in more than a dollar in total value by the end of the chain. Economic contribution analyses provide a "snapshot" of this total economic activity in an area at a given point in time and can be thought of as an accounting exercise to track this flow of dollars through a region's economy.

[38] Given Interior's broad geographical responsibilities, it is important to highlight the need for coverage of Alaska, Hawaii, and U.S. territories, as many datasets are often limited to the contiguous United States.

Figure 6 provides a conceptual example created by the National Park Service (NPS) of an economic contributions analysis for recreation. The goal is to measure the economic contribution to the economy provided by visitors to NPS managed sites. This analysis can take place at the individual park unit level (e.g., Yellowstone National Park) or at the level of the entire United States. The analysis begins with spending by visitors at the locations of interest, and then traces that spending as it moves through the regional economy.

Figure 6. NPS Illustration of Visitor Spending and Resulting Economic Contributions (Illustrations by Shepherd Wolfe).

The economic contribution analysis presented in this report captures the gross economic activity associated with DOI spending and spending on DOI lands.[39] Here, DOI spending becomes income for businesses or households, and other spending on DOI lands becomes revenue for industries. These business or households in turn spend this income at other businesses leading to a chain of economic contributions that extends well beyond DOI. As such, total economic contributions are comprised of direct, indirect, and induced effects.

- Direct effects are the original amount of spending by DOI and spending on DOI lands.
- Indirect effects represent the subsequent purchases from businesses to other businesses in response to DOI's original spending.
- Induced effects represent the spending by the employees of businesses.
- Total effects represent the sum of direct, indirect, and induced effects.

[39] Contributions from some economic activities are not included due to lack of data or methods. For example, linear projects such as transmission lines or pipelines are not included due to methodology constraints. Economic activity from some specific hardrock mining in the western U.S. is not included because production data is not available.

These selected economic contributions can be summarized using a variety of metrics. In this report, we report the estimated contributions as value added and jobs supported.

- Value added measures the contribution of DOI spending to the U.S. Gross Domestic Product (GDP). This approach calculates the additional income that is accrued at each stage of the production process as the money cycles through the economy.
- Jobs supported measure the total number of annualized full and part time jobs that result from the DOI spending, both directly and through the chain of linkages as that money is repeatedly spent in the business and household sectors.

Question 3: How does DOI spending contribute to economic activity?

Key Concepts

This question focuses on the contributions of DOI spending to economic activity, measured in terms of value added and jobs supported, which is neither a benefit nor a cost to society (Watson et al., 2007). DOI's spending includes bureau-administered grants, payments, and payroll.[40] Grants go to states and other entities to fund different activities such as maintenance, conservation, restoration of lands and water, and research. "Payments to state and local governments" refers to expenditures such as Payments in Lieu of Taxes (PILT) and Refuge Revenue Sharing. These payments are made in recognition of the fact that Federal ownership of certain lands results in a loss of tax revenues that would otherwise be available to state and local governments. Payroll spending is simply the money that DOI pays to the staff and workforce across the Department's various bureaus and offices.

The total economic contributions reported are the sum of the original spending by DOI, plus the indirect and induced effects that eventually result from that original spending. The exception is for payroll, where total estimated contributions are based on only induced effects since the spending is ultimately being done by DOI employees or other workers. In this case, the estimated value added and jobs supported are external to DOI.

DOI's spending also includes many non-labor components, such as spending on buildings, materials, travel, and miscellaneous services. However, current data and methodological limitations prevent us from capturing this spending and translating the Department's full financial information into the framework for economic contributions analysis. Total spending on certain programs and activities conducted by DOI is also not comprehensively recorded. For example, spending in support of restoration activities across the Department is not reflected in this report. Addressing these limitations will be a priority for future analysis.

[40] Grants and payments to insular areas of the U.S. territories of American Samoa, Guam, the U.S. Virgin Islands, and the Commonwealth of the Northern Mariana Islands, as well as the sovereign nations of the Federated States of Micronesia, the Republic of the Marshall Islands, and the Republic of Palau, are excluded from national contributions in this report because these geographies are not included in the National economic statistics that underlie the economic contributions.

Abandoned mine land site after Reclamation. The Bipartisan Infrastructure Law invests billions in the clean-up of legacy pollution sites including plugging orphaned oil and gas wells and reclamation of abandoned mine lands. The Stineman Refuse Pile in Pennsylvania was hazardous to surrounding areas due to acid mine drainage that polluted groundwater and the Conemaugh River. This project reclaimed over 600,000 cubic yards of refuse and installed vegetation to buffer nearby waterways. A safer walking trail was created and expanded recreation opportunities along the river. Source: Department of the Interior Photo Galleries. Photo by the Office of Surface Mining Reclamation and Enforcement.

Results

Table 11 below presents the results of our IMPLAN analysis of the economic contributions of DOI spending to the United States.[41] Grants administered by DOI totaled $8.4 billion in FY 2021 and resulted in $12.3 billion of value added and supported 137,000 jobs nationwide. Payments to state and local governments totaled $600 million and resulted in $900 million of value added, as well as supporting 8,000 jobs. Finally, DOI's payroll spending totaled $7.3 billion, which led to $6.1 billion of value added and 58,000 jobs supported outside of DOI. As noted previously, payroll contributions are based on the induced effects only, so the total value added is less than the original payroll spending.

[41] For more information on economic contributions analysis using IMPLAN, please see the Supplementary Information section.

Table 11. Estimated Economic Contributions to the Nation by Spending Category (FY 2021) [42]

DOI Spending Category	Amount (billions, $2021)	Value added (billions, $2021)	Jobs supported (thousands of jobs)
DOI grants	8.4	12.3	137
Payments to state and local governments	0.6	0.9	8
Payroll	7.3	6.1	58
Total	16.3	19.2	203

Question 4: How do market transactions generated from activity on DOI lands contribute to economic activity?

Key Concepts

Like the previous section, this section focuses on economic activity, often measured in terms of value added or jobs supported, which is neither a benefit nor a cost to society (Watson et al., 2007). For a discussion of the net societal benefits for DOI's activities, please see Question 2, "How do DOI's actions contribute to socioeconomic well-being?".

DOI's management of natural resources facilitates private sector activities that result in economic contributions. For example, the use of public land by households and businesses for activities such as recreation, energy development, grazing, and irrigation facilitates spending which supports local economic activity and jobs.[43]

[42] Table 11 excludes grants, payments, and payroll spending in U.S. insular areas of the U.S. territories of American Samoa, Guam, the U.S. Virgin Islands, and the Commonwealth of the Northern Mariana Islands, as well as the sovereign nations of the Federated States of Micronesia, the Republic of the Marshall Islands, and the Republic of Palau. In FY 2021 DOI spent $379.7 million in grants, $369.8 million in fiscal payments to U.S. Treasury, $0.1 million in payments and $14.7 million in payroll in insular areas.

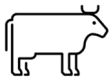
[43] In addition to this private sector activity, Federal law requires that all monies derived from mineral leasing and production activities on Federal and American Indian lands be collected, properly accounted for, and distributed. For Federal onshore lands, these mineral revenues are generally shared between the States in which the Federal lands are located and the Federal government. In most cases, States receive about 50 percent of the revenues associated with mineral production on Federal public lands within their borders. In the case of American Indian lands, all monies collected from mineral production are returned to the Indian Tribes or individual Indian mineral lease owners. Revenues associated with Federal offshore lands are distributed to the U.S. Treasury, States, counties/parishes, and the Land and Water Conservation Fund in accordance with the provisions of the relevant laws, including the Gulf of Mexico Energy Security Act (GOMESA) , the National Historic Preservation Act of 1966 (P.L. 114–289 reauthorized for the Historic Preservation Fund through 2023), the Great American Outdoors Act of 2020 (fully and permanently fund the LWCF), and Section 8(g) of the Outer Continental Shelf Lands Act.

Recreation: DOI's lands host millions of visitors each year. These recreation activities promote spending in nearby communities for food, lodging, equipment, and other goods and services.

Renewable Energy: DOI lands and facilities host renewable power projects for hydropower, solar, wind, and geothermal energy. Together, these power projects produce more than 60 terawatt-hours (TWh) each year. Economic contributions are estimated for facility construction, electricity production, and planning efforts (offshore wind only).

Fossil Fuel Energy: Oil, gas, and coal are all produced from the mineral estate administered by DOI. Economic contributions are estimated based on the market value of the commodity produced. In addition, for onshore oil production, economic activity supported by drilling activity is included.

Non-energy Minerals: DOI lands also produce a wide variety of minerals. Examples of these non-energy minerals include precious metals like gold, silver, and copper, and construction material like sand, gravel, and crushed stone. As with fossil fuel energy, contributions are estimated based on the market value of production.



Forage and Grazing: DOI lands managed by BLM and BIA provide access for cattle, sheep, and goat grazing. This management enables private operators to produce animal unit months (AUMs) which can be sold at market.

Timber: Sawtimber may be harvested from BLM and Tribal lands, providing a source of raw materials for the lumber industry. In addition to traditional sawtimber, DOI forestry lands provide biomass, fuelwood, poles, posts, and a variety of other products (e.g., seeds, Christmas trees, and mushrooms). The economic contributions supported by some of these products have not been explicitly analyzed (see example under *Question 1* for additional information).

Water: DOI stores and delivers water for irrigation, municipal and industrial (M&I) uses, and other uses. The value of water varies widely according to location, type of use, and climatic conditions. DOI also delivers water to support in-stream flows, wildlife refuges, and other environmental uses that are difficult to value fully and are not typically reflected in economic contribution estimates.

The economic contributions from these household- and business-sector activities associated with DOI resources can be estimated with similar methods used to measure contributions from direct DOI spending. In these cases, the estimated direct effects equal private-sector spending on activities utilizing natural resources managed by DOI.[44] Such an analysis recognizes that these activities could not take place without DOI's management of these resources.

[44] For some activities, public revenue raised from DOI-managed resource is an alternative to private-sector spending. Direct effects can be given by the value of production.

The Bipartisan Infrastructure Law provides $1.5 billion for the Department of the Interior to invest in preparedness, fuels management, post-fire restoration, and fire science. $245 million is invested in wildfire preparedness, including workforce reforms such as compensation improvements, mental health resources, improved physical safety, hiring, and additional training; purchasing and maintaining equipment and improving fire detection methods. This funding improves pay for wildland firefighters in areas of the nation where it has been difficult to recruit and retain wildland firefights, establishing a series that recognizes wildland firefighting as a federal career and developing programs that support firefighter mental health and well-being. Source: Department of the Interior Photo Galleries.

Results

In FY 2021, production and activities on DOI lands contributed approximately $200 billion to the Nation's GDP and supported about 1.9 million jobs (see Table 12).

Table 12. Estimated Economic Contributions by Activity, by Bureau (FY 2021)[45]

Activity			Value added (billions, $2021)	Jobs supported (thousands of jobs)
Recreation			**37.9**	**484**
		BLM	6.2	76.2
		BOR	3.2	38.2
		FWS	4.1	46.9
		NPS	24.3	322.6
Energy and minerals			**124.1**	**868.1**
	Wind energy		*4.4*	*23.5*
		BIA	0.0	0.0
		BLM	0.2	0.8
		BOEM	0.6	5.3
	Solar energy		*0.8*	*4.1*
		BIA	0.1	0.7
		BLM	0.7	3.4
	Geothermal energy		1.5	7.4
		BLM	1.5	7.4
	Hydropower		*1.4*	*5.9*
		BIA	0.0	0.4
		BOR	1.4	5.6
	Fossil fuel energy		95.6	680.5
	Oil and gas		*0.7*	*6.1*
		BIA	0.0	0.0
		BLM	0.2	0.8
		BOEM	0.6	5.3
	Coal		*0.8*	*4.1*
		BIA	0.1	0.7
		BLM	0.7	3.4
	Non-energy minerals		*24.1*	*164.1*
		BIA	0.2	0.7
		BLM	23.9	162.4
Grazing and timber			**2.0**	**46.2**
	Grazing		*1.4*	*39.4*
		BIA	0.1	0.9
		BLM	1.3	38.5
	Timber		*0.6*	*6.8*
		BIA	0.1	1.1
		BLM	0.5	5.7
Irrigation and M&I water			**31.2**	**438.7**
	Irrigation		*24.9*	*395.0*
		BIA	1.7	31.8
		BOR	23.2	363.2

(continued)

[45] Table 12 excludes recreation activities in U.S. insular areas of the U.S. territories of American Samoa, Guam, the U.S. Virgin Islands, and the Commonwealth of the Northern Mariana Islands.

Activity			Value added (billions, $2021)	Jobs supported (thousands of jobs)
	M&I water		*6.3*	*43.7*
		BOR	6.3	43.7
Revenue sharing			**5.0**	**47.7**
	Mineral revenue sharing		*5.0*	*47.7*
TOTAL			**200.1**	**1,484.7**

Other Considerations

Equity

A shortcoming common to both economic contribution and economic valuation (benefits and costs) analyses is that they typically do not reflect disparities in equity or distribution (Bockstael et al., 2000). Economic contributions can show how much a country's income and production have increased or decreased, while economic values can show how society is made better or worse off after a policy change, but neither of these sets of measures addresses how these changes are distributed and experienced by different groups in a society.

For example, drilling oil wells or coal mines could increase jobs and income in local communities, while also providing net benefits to society through newly available energy. However, any new jobs and income created might only be concentrated among a small group of individuals and companies, and not be evenly distributed across the local community. Moreover, if the energy resources are exported from the region, the benefits could go primarily to users who live far away while the costs in terms of pollution and health effects would be borne most heavily by nearby residents.

Similarly, consider investments in recreational sites. It is possible that a benefit-cost analysis would show that locating recreation facilities near wealthier communities maximizes net benefits to society, since people living in these communities would be expected to place a higher value on such amenities (expressed as net WTP). It is important to reiterate, however, that economists' ability to measure how much value a person places on an amenity is constrained by the individual's ability to pay. This can create an appearance that individuals from less wealthy communities value recreational amenities less than individuals from wealthy communities when the difference is at least partially due to limits in the way that economists measure value.

Economic contribution and benefit-cost analyses typically do not consider the distributional or equity implications of the policies being studied (Robinson et al., 2020). The primary concern of benefit-cost analyses is to understand the net benefits to society, without worry how those benefits are allocated. Economic contribution analyses may be able to reveal some of the distributional consequences of a policy since they allow an analyst to trace regional spending patterns through different industries and sectors of the economy. However, additional data and methods outside of these analyses would still be needed to understand how different groups within society may be impacted.

In addition, some decisions made today may have implications for *intergenerational* equity (Howarth & Norgaard, 1993). For example, action (or inaction) towards reducing greenhouse gas emissions to

mitigate the effects of climate change will almost certainly affect future generations. When dealing with benefits and costs that span long-term time horizons, economists use a discount rate to calculate the present value of future benefits and costs. The use of a discount rate assumes of a time preference for economic benefits in the near-term, and on the assumption that future generations may likely be wealthier and have the capacity to develop and employ technologies that would potentially reduce costs and harm. However, even low discount rates still shift the costs of environmental degradation to future generations and reduce incentives for long-term environmental conservation projects.

These shortcomings of both economic contribution and economic valuation analyses should be considered when examining the economic contribution of spending and the values of ecosystem services.

California Condor at Grand Canyon National Park. With a wingspan of 9.5 feet and weighing up to 25 pounds, the California condor is the largest land bird in North America. By the mid-20th century, condor populations had dropped dramatically, and by 1967 the California condor was listed as endangered by the federal government. In 1982, only 23 condors survived world-wide. By 1987, all remaining wild condors were placed into a captive breeding program in an effort to save the species from extinction. Since 1992, when the U.S. Fish and Wildlife Service began reintroducing captive-bred condors to the wild, the bureau and its public and private partners have grown the total free-flying and captive population to more than 500 condors. Source: U.S. Fish and Wildlife Service. Photo by Mark Lellouch, National Park Service.

Conclusion

The U.S. Department of the Interior and its bureaus manage more than 480 million acres of surface lands, 700 million acres of subsurface mineral estate, 760 million acres of submerged land in national monuments, and over 2.5 billion acres of the Outer Continental Shelf. These lands and waters encompass numerous biomes and multiple ecosystems. DOI plays a vital role in conserving America's natural resources and heritage, honoring our cultures and Tribal communities, and supplying the energy to power the Nation. DOI's people, programs, and activities affect Americans across all 50 states and insular areas. DOI is the steward of a significant portion of the Nation's lands, managing national parks, national wildlife refuges, and other public lands, and assisting states, tribes, and others in the management of natural and cultural resources.

As the Department carries out its unique mission, managing Federal lands and waters, and making investments that conserve and restore natural landscapes and the cultural heritage of the Nation, it also generates value in the form of ecosystem services, supports socioeconomic well-being, and contributes

to economic activity. Management of DOI's lands and waters also facilitates private sector activities that result in economic contributions. These economic values and contributions support the well-being of the people of the Nation that the Department serves.

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Supplementary Information

Value of Information

a. Methods

USGS scientific information is provided free of charge. It has characteristics of a "public good": consumption of USGS information is *non-rival* (multiple users can access the same information at the same time), and widely distributed USGS information is *non-excludable* (any user can access the information whenever they want). Scientific information is often a "non-market good" (not available for purchase in public markets), so its value must be estimated using non-market valuation techniques.[46]

Measuring the effects of the additional information (i.e., reduced uncertainty in potential outcomes) gives an estimate of the societal benefits of the information. When assessing VOI, we rely on basic principles of economics like estimating *marginal values* (based on how much a consumer would be willing to pay for an additional "unit" of information); and changes from *baseline* (comparing the value of additional information to the next best alternative, i.e., older information). Approaches used to estimate VOI include:

- Evaluation of gains in output or productivity;
- Hedonic pricing studies (valuations based on attributes of other goods);
- Stated preference approaches (i.e., contingent valuation surveys); and
- Bayesian analysis (decision tree) approaches.[47]

Survey-based methods such as the stated preference approach provide perspective on the change in value from broad uses of information. However, understanding how use of information changes outcomes (and resulting societal benefits) may require developing conceptual or mathematical models of socio-ecological systems. A specific method used to estimate VOI is the Bayesian analysis decision tree approach, which directly connects the use of information with decisions. The approach relies on decision pathways and assumptions about actions taken with and without additional information. This method is most relevant for case studies: specific applications of additional information, the decision points altered by that information, and monetized benefits or savings (where possible). The Bayesian approach considers the full benefits of the information including direct, indirect, and ancillary benefits.

The Bayesian approach examines the probability that a decision-maker will make a given decision under two scenarios: "with" and "without" the additional information. The "without" scenarios (relying on the next-best information) are also referred to as *counterfactuals*.[48] VOI is calculated as the difference in (monetized) benefits between the outcome under the "with additional information" scenario and the outcome of the counterfactual. To derive the VOI for a specific piece of information, the analyst

[46]There are many types of information that are traded in markets and their value can be approximated via market prices; however, the scientific information provided by USGS is provided for free so monetizing the societal benefits requires non-market valuation techniques.

[47] Macauley, Molly and Ramanan Laxminarayan. 2010. Conference Summary: The Value of Information - Methodological Frontiers and New Applications for Realizing Social Benefit. Resources for the Future.

[48] As noted above, the "without additional information" scenario represents the outcome using the next-best information. It is unlikely that the decision maker has no information at all, so to avoid overestimating the value of additional information, it is important to fully describe the counterfactual scenarios and information available under these.

considers all the decision points that use the information, estimates the probability of decision pathways with and without the information, and monetizes the benefits of each decision pathway.[49]

Economic Contributions

This is the thirteenth economic report produced by DOI. While all of the reports relied on the best available data and sound methods, there are changes across years as improved data, methods, and models are identified or become available. When making comparisons of DOI's economic contribution estimates across years, it is important to identify all of the factors that might contribute to estimates changing from one year to the next. These factors can include:

- Changes in land use. These might be due to changes in resource demand or management decisions, or reflect a natural progression in a project's life cycle, such as a shift from construction to operational status.
- Changes in the data describing a resource's annual economic output. These might be due to actual changes in the quantity or price of a good produced, or changes in data sources, collection, and assumptions.
- Changes in the economic models that describe the underlying structure of local economies. For most sectors, these models are developed independent of this report. In some cases, new models that better describe individual sectors have replaced models used in prior reports. In other cases, the assumptions and data within the models have changed significantly from year to year.

a. IMPLAN

This analysis primarily employs the widely used IMPLAN software and data system for estimating the economic contribution of DOI activities in terms of output, value added, and jobs supported. The underlying data drawn upon by the IMPLAN state and national-level data is collected by IMPLAN from multiple Federal and state sources including the Bureau of Economic Analysis (BEA), Bureau of Labor Statistics (BLS), and the U.S. Census Bureau. Additional information about the IMPLAN modeling software can be found at: http://www.implan.com.

In the FY 2021 report, a hybrid methodology was introduced to account for the uncertain impacts of COVID-19 during the period of analysis. In this hybrid approach two models were constructed. One model used data from calendar year 2019, a proxy for the pre-COVID-19 economy. The other model used data for calendar year 2020 during which many of the primary economic impacts from the COVID-19 pandemic were seen. Both models were then applied to the same FY 2021 DOI economic input. This choice was based on evidence from economic indicators reflecting a mix of pre-pandemic and pandemic economic activity in 2021. This creates an uncertainty in identifying a single dataset that is the best economic proxy for that year.

A 50-50 split was used to weight the results. The 50-50 split reflects the uncertainty around how COVID-19 may have impacted the economy during the Fiscal Year. While some sectors showed significant recovery following the 2020 recession, indicators for other sectors showed mixed or

[49] Additional details on decision trees is available in Pearlman and others, 2019, Demonstrating the Value of Earth Observations—Methods, Practical Applications, and Solutions—Group on Earth Observations Side Event Proceedings. Open-File Report. Accessed August 9, 2021, at https://doi.org/10.3133/ofr20191033.

negative results. Exceptions to this hybrid methodology include BOEM wind energy, oil, and gas models, as well as some recreation and agriculture models. In these models a mix of calendar year 2017 and calendar year 2019 data were used based on availability. For most DOI activities it is assumed that this hybrid methodology more accurately reflects the economic environment of FY 2020.

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