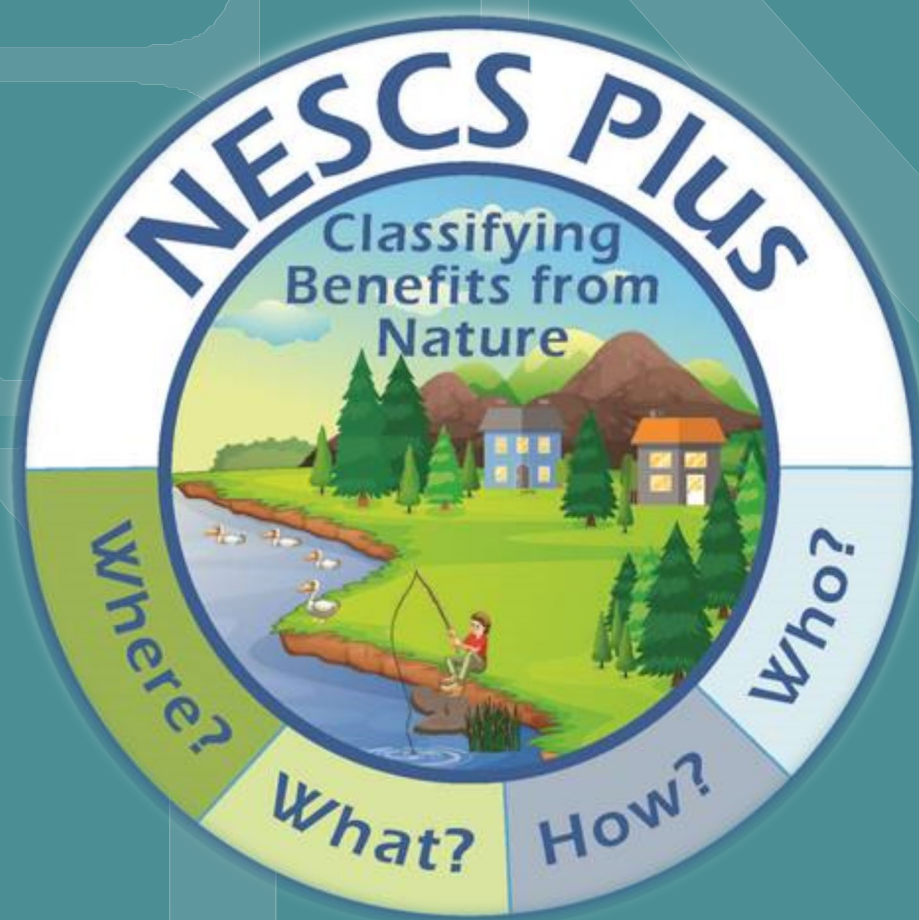


# National Ecosystem Services Classification System (NESCO) Plus



# **National Ecosystem Services Classification System (NESCS) Plus**

By

Tammy Newcomer-Johnson<sup>1</sup>, Faye Andrews<sup>2</sup>, Joel Corona<sup>3</sup>, Theodore H. DeWitt<sup>4</sup>, Matthew C. Harwell<sup>5</sup>, Charles Rhodes<sup>6</sup>, Paul Ringold<sup>7</sup>, Marc J. Russell<sup>8</sup>, Paramita Sinha<sup>9</sup>, George Van Houtven<sup>9</sup>

1. USEPA, Watershed & Ecosystem Characterization Division, Center for Environmental Measurement and Modeling, Cincinnati, OH
2. ORAU Student Services Contractor at USEPA, Pacific Ecology Division, Center for Public Health & Environmental Assessment, Corvallis, OR
3. USEPA, Office of Water, Washington, DC
4. USEPA, Pacific Ecological Systems Division, Center for Public Health & Environmental Assessment, Newport, OR
5. USEPA, Gulf Ecosystem Measurement & Modeling Division, Center for Environmental Measurement and Modeling, Gulf Breeze, FL
6. Former ORISE participant at USEPA, Office of Water and Office of Research and Development, Washington, DC; presently US Geological Survey, Reston, VA
7. USEPA, Pacific Ecological Systems Division, Center for Public Health & Environmental Assessment, Corvallis, OR
8. USEPA, Center for Computational Toxicology and Exposure, Gulf Breeze, FL
9. RTI International

# Notice/Disclaimer Statement

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An important disclaimer is that NESCO Plus is a classification system for identification and classification of ecosystem services. Individual users of NESCO Plus are responsible for evaluating the uncertainties associated with the original datasets feeding into NESCO Plus and characterizing NESCO Plus results for applicability, precision, accuracy, uncertainty, and other data qualifications associated with usability of results.

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The NESCO Plus webtool is available here:

<https://www.epa.gov/eco-research/nescs-plus>

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# Acronyms and Abbreviations

BCA	Benefit-Cost Analysis
CICES	Common International Classification of Ecosystem Services
EEP	Ecological End-Product
EPA	U.S. Environmental Protection Agency
EPF	Ecological Production Function
ES	Ecosystem Services
ESML	EcoService Models Library; <a href="https://esml.epa.gov/">https://esml.epa.gov/</a>
EVRI	Environmental Valuation Resource Inventory
FEG	Final Ecosystem Good
FEGS	Final Ecosystem Goods and Services
FEGS-CS	FEGS Classification System – a precursor to NESCS Plus
FES	Final Ecosystem Services
GDIT	General Dynamics Information Technology
GDP	Gross Domestic Product
ILK	Indigenous and Local Knowledge
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
ITIS	Integrated Taxonomic Information System (ITIS); <a href="https://www.itis.gov/">https://www.itis.gov/</a>
MA	Millennium Ecosystem Assessment
NESCS	National Ecosystem Services Classification System – a precursor to NESCS Plus
NESCS Plus	National Ecosystem Services Classification System Plus
NAICS	North American Industrial Classification System
NAPCS	North American Product Classification System
NARS	USEPA’s National Aquatic Resource Surveys
NCP	Nature’s contributions to people
NERRS	National Estuarine Research Reserve System
NEP	National Estuary Program
NEPA	National Environmental Policy Act
NIPA	National Income and Product Accounts
NLCD	National Land Cover Database
NO <sub>x</sub>	Nitrogen Oxides
OW	Office of Water
RIBs	Rapid Injection Basins
SAV	Submerged Aquatic Vegetation
STEPS	Stressor–Ecological Production function–final ecosystem Services Framework
TEV	Total Economic Value
TSN	ITIS Taxonomic Serial Number
USEPA	U.S. Environmental Protection Agency

# 1.0 Purpose

Understanding how ecosystems contribute to human well-being is critical to public- and private-sector decision making. Broadly speaking, when humans receive contributions from ecosystems those interactions are referred to as “ecosystem services.” As the importance of these services to society receives increasing attention, there is also growing awareness about the complexity and diversity of these connections between ecosystems and human systems. The need to understand and ultimately to quantify the value of these connections to humans has been one of the main motivating forces behind the large and rapidly growing literature focused on defining, classifying, and measuring ecosystem services.

To support continuing efforts in this area, this document introduces, defines, and describes the National Ecosystem Services Classification System (NESCS Plus, pronounced “nex-us plus”). It is named “NESCS Plus” because it includes the original NESCS 4-component framework (USEPA, 2015) “plus” a 5<sup>th</sup> component, the Beneficiary list from the Final Ecosystem Goods and Services Classification System (FEGS-CS; Landers and Nahlik, 2013). A key feature of this classification system is that it focuses on “Final Ecosystem Services,” which are described below, as well as Final ecosystem goods (FEGs, or ecological end-products, EEPs) that are critical precursors of these services.

This document is intended to help a diverse audience of natural and social sciences professionals understand and apply NESCS Plus. The main purpose of NESCS Plus is to serve as a framework for analyzing how changes to ecosystems impact human welfare. This system can aid in the analysis of different types of environmental management actions, policies, and

## **Final Ecosystem Services**

Final ES are specifically defined as the services from nature that are “*directly* [emphasis added] enjoyed, consumed, or used to yield human well-being” (Boyd and Banzhaf, 2007). This separates them from ecosystem characteristics and processes that help produce final ecosystem goods.

## **Goods vs. Services**

Natural scientists generally use “ecosystem services” as a term to cover both goods and services. Final ecosystem goods (FEGs, or ecological end-products, EEPs) are the biophysical components of nature that humans directly use or appreciate in final ES. The NESCS Plus is useful for classifying both final ecosystem goods and final ES. In a general way, the term final ES encompasses both the final ecosystem goods and the final ES concepts.

regulations. Quantifying and (as feasible) valuing how changes in ecosystems affect human well-being first requires identification of the relevant final ES by answering the following four questions shown in **Table 1.1**: “Where,” “What,” “How,” and “Who?”

**Table 1.1** NESCS Plus Classification Questions and Components

<p><b>Where?</b>  <u>Component 1: <i>Environment</i></u> classes and subclasses are the spatial environments where each Ecological End-Product is located when used or appreciated by humans.</p>	
<p><b>What?</b>  <u>Component 2: <i>Ecological End-Product</i></u> (EEP) classes are the relevant biophysical components of nature that are directly used or appreciated by humans.</p>	
<p><b>How?</b>  <u>Component 3: <i>Direct Use</i></u> classes and subclasses are the ways each Ecological End-Product is directly used or appreciated by humans.</p>	<p><b>How?</b>  <u>Component 5: <i>Beneficiary</i></u> classes and subclasses are the interests of individuals, groups of people, or organizations that drive their use or appreciation of Ecological End-Products. This component of the system is from the FECS-CS system and can be a simpler option than the Use/User classes for those unfamiliar with NAICS.</p>
<p><b>Who?</b>  <u>Component 4: <i>Direct User</i></u> classes and subclasses are the sector(s) of the economy that make direct use of each Ecological End-Product. These are linked to the North American Industrial Classification System (NAICS).</p>	

Answering these questions enables comprehensive identification of final ecosystem services, ensuring that all beneficiaries are considered from the earliest stages of project scoping to completion so that there is a full recognition of the ways people benefit from nature. Identifying a comprehensive list of NESCS Plus codes sets a foundation for tracking quantification and valuation. Potential applications include but are not limited to cost-benefit analyses of environmental programs and natural capital accounting. Though NESCS Plus is not an accounting system, it is designed to support systematic and comprehensive accounting of changes in final ecosystem services.

The intended audience for this document includes individuals, communities, private and public-sector firms, as well as non-profit organizations that may wish to measure, quantify, map, model, and/or value a standard, but complete, set of ecosystem services anywhere on the Earth. Technical practitioners (e.g., social scientists, economists, landscape architects, natural scientists,

decision-makers, etc.) of ecosystem services will also likely appreciate the relatively fine separation of ecosystem services achieved in this classification system and the common language established in this document to efficiently communicate within and across disciplines and to the public.

The classification system provides a common architecture, and it has been integrated into several other EPA products aimed at supported standardized approaches to classifying and assessing ecosystem services. For example, there is a companion FEGS Community Scoping Tool for community engagement (Sharpe and Jenkins, 2018; Sharpe et al., 2020) and a report that aids in the identification of metrics and indicators that matter most to people (Ringold et al. 2020). NESCS Plus has been integrated into the EcoService Models Library to aid in finding models for estimating the production of ecosystem services and its components have been cross walked to data layers in the EnviroAtlas which includes spatial datasets and visualizations (Tashie and Ringold 2019). To date, components of the classification system have been included in over a dozen publications (e.g., Angradi et al. 2019; Bell et al. 2017; Clark et al. 2017; Bolgrien et al. 2018; Boyd et al. 2016; Harwell and Jackson 2018; 2019; Harwell and Moleda 2018; Irvine et al. 2017; Littles et al. 2018; Ringold et al. 2013; Warnell et al. 2020; Yee et al. 2019) including a new International textbook on “Ecosystem-Based Management, Ecosystem Services and Aquatic Biodiversity,” which includes multiple case studies demonstrating ORD tools (DeWitt et al., 2020; Flood et al., 2020; Russell et al., 2020; Sharpe et al., 2020).

The NESCS Plus webtool is available here:

<https://www.epa.gov/eco-research/nescs-plus>

## 1.1 Why Focus on “Final” Ecosystem Services?

An important distinction has been drawn between “final” (direct) versus “intermediate” (indirect) ecosystem services to improve the understanding and measurement of ecosystem services (DeWitt et al. 2020). Ecosystems depend on and perform a wide variety of intermediate processes and functions, which contribute to final ecosystem services. For simplicity, “intermediate ecosystem services” as used in this report,<sup>1</sup> are ecosystem characteristics or processes that precede and support Ecological End-Products (also referred to as FEGs). Final ES are outputs from nature that are directly used or appreciated by humans in diverse ways. For example, water flowing in a stream is used for kayaking; this water provides a final ES to recreational users. The water for kayaking final ES is supported by multiple intermediate ecosystem services (plant transpiration, cloud formation, precipitation, etc.). Plant transpiration is a process through which plants use soil moisture as an input and release water to the atmosphere as an output. Ecosystems perform a wide variety of processes and functions that influence the quantity and/or quality of final ES but do not themselves qualify as final ES (because they are not directly enjoyed, consumed, or used). NESCS Plus refers to these processes and functions as intermediate ecosystem services.

The distinction between final and intermediate services is important for several reasons:

1. *Recognition of connections from ecosystems to human well-being.* Final ES play a unique role in the steps of identifying connections from ecological changes to effects on humans. To fully understand any specific connection, it is often necessary to trace out a sequence of input-output relationships, connecting ecological inputs to those outputs that people directly use. These can vary in length and complexity, involving multiple intermediate ecosystem services and they can be quantified using ecological production functions as demonstrated in USEPA’s EcoService Models Library (ESML; <https://esml.epa.gov/>). In the end, however, each individual chain must eventually lead to and contain a final ES connection, where the output from nature represents a direct value to humans.
2. *Useful way of communicating to the public how ecosystems contribute to human well-being.* A focus on final ES highlights the features of ecosystems that are most likely to matter to humans, which are also often the features that are most familiar to them.
3. *Help identify environmental metrics and indicators that matter most to people.* By focusing on the components of nature that are most tangible to the public (Boyd et al.

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<sup>1</sup> The United Nations Statistics Division uses “intermediate ecosystem services” in a more limited way to refer to services that flow between environment classes (UNSD 2012). Here the term is used more broadly to refer to services the flow both within and between environment classes.

2016; USEPA, 2017; Ringold et al. 2020), it can therefore improve efforts to monitor and measure changes in environmental conditions. These advantages of using final ES for communicating and quantifying ecosystem changes also extend to economic valuation methods for ecosystem services. Whether eliciting preferences through surveys (a “stated preference” approach) or deducing preferences through observed behaviors (a “revealed preference” approach), it is helpful to use indicators that are most relevant to humans (Sinha et al. 2018).

4. *Systems approaches help identify the full set of ecosystem services.* A focus on final ES can help address the potential problem of undercounting ecosystem services, i.e., not identifying, quantifying or assigning values to the full set of benefits. This can happen because of a limited number of biophysical models or metrics (e.g., Chestnut and Mills 2005), a limited ability to assign a value to a predicted biophysical change, or an oversight in identifying the full range of benefits or challenges associated with an environmental change. The classification system is expected to assist in addressing this problem by providing a complete list of the ways in which people benefit from ecosystem change and, in the long run, encouraging the development of a broader set of biophysical models, metrics, and indicators (Ringold et al. 2020). Additionally, the companion FECS Community Scoping Tool can help users identify the components of NESCS Plus using a structured, transparent, repeatable process (Sharpe and Jenkins, 2018; Sharpe et al., 2020).
5. *Avoid double counting in environmental accounting.* Several studies have noted (Boyd and Banzhaf, 2007; Wainger and Mazzotta, 2011), the distinction between intermediate and final services is critical for many types of environmental accounting, such as cost-benefit analysis of environmental programs, natural capital accounting, and measurement of “green” gross domestic product (green GDP). A fundamental best-practice for any accounting process is to avoid double counting of constituent parts. Because an intermediate ecosystem service is an input to a final ecosystem service, it is embedded within the value calculated for that final service. Therefore, to avoid duplication (i.e., double counting) when adding up environmental values, the value of an intermediate service should not be added to that of a final service. Importantly, this focus on final ES for environmental accounting does not mean that intermediate ecosystems services are of secondary importance. On the contrary, it recognizes that their contribution to human well-being is a major contributor to the value of final ES. It is also worth noting,

however, that double counting of ecosystem service values is not a main concern for all types of ecosystem service analyses and applications.

For NESCS Plus, the focus on final ES should also not be interpreted as a decision to ignore or minimize the importance of ecosystem characteristics and processes, and elements of ecosystem condition such as biodiversity. Rather, it reflects a decision about where to draw boundaries on the scope of this classification system. In no way does it limit or preclude the development of complementary classification systems for intermediate ecosystem services. Moreover, a classification system focused on final ES is not expected to address the needs of all ecosystem service analyses. Rather, NESCS Plus will need to be applied in combination with other tools, data, and methods, especially those used to describe and quantify ecological and economic production processes and human preferences. For example, the FEGS Community Scoping Tool (Sharpe and Jenkins, 2018; Sharpe et al., 2020), EcoService Models Library (ESML; <https://www.epa.gov/eco-research/ecoservice-models-library>), and EnviroAtlas (<https://www.epa.gov/enviroatlas>), and the Ringold et al. (2020) Metrics Report can be used together. **Table 1.2** outlines four general principles for identifying and quantifying final ES.

**Table 1.2** Final ES General Approach (Adapted from Landers and Nahlik 2013).

<b>Final ES Conceptual Principles</b>
Defining, measuring, quantifying, valuing, and/or accounting for final ES requires a wholly collaborative effort among natural scientists and social scientists.
Environmental processes and functions produce potential final ES, while people, groups, or firms enjoy, use, or consume final ES.
Defining, identifying, and classifying a complete, but non-duplicative, set of final ES is the foundation that can be used as a transdisciplinary approach to measure, quantify, map, model, and value ecosystem services.
Because individuals enjoy, use, or consume final ES, an understanding of how they directly use or appreciate Ecological End-Products is crucial to identify final ES and contribute to the framing of the research and implementation plan.

## 1.2 Why Have a Classification System for Final Ecosystem Services?

In general, classification systems (or taxonomies) are used for a wide range of scientific applications, including for living organisms, land cover, human diseases, and economic sectors, to name a few. Many of the main objectives of these systems (Sokal, 1974; Bruno and Richmond, 2003) are also relevant for classifying final ecosystem services. Finisdore et al. (2020) described 18 benefits of ecosystem services classification systems such as enabling final ES to be more easily and precisely defined, simplifying knowledge transfer between studies, and avoiding the redundancy and work of re-creating final ES identification systems.

The main objectives of NESCS Plus as a classification system are the following:

1. Provide a common language and framework for describing and visualizing final ES. Establishing a common language is particularly important for facilitating communication within the inherently interdisciplinary field of ecosystem services research. Ecologists, economists, and other disciplines all gain from having a common system that is clearly defined and structured. To address this objective, NESCS Plus provides a conceptual framework that describes key terms and concepts, and a classification structure for final ES that is directly based on this framework. Together, these two features aim to clearly define what ecosystem services are and how they can be grouped according to key characteristics.
2. Provide a structure for identifying and comprehensively listing distinct final ES. In general, classification systems help to define, organize, and clarify the relationship between and among specific items, so that those with similar characteristics can be grouped together. This function is particularly important for systems involving large numbers of components. In the case of NESCS Plus, classification can help users to develop lists of the distinct types of final ES that flow from specific environments and ecosystems to different sectors and beneficiaries. Classification can also be used to organize analyses that require identifying the different “causal chains” pathways through which a management or policy action is expected to propagate through linked ecosystems and human systems to ultimately affect human well-being. NESCS Plus can play an important role in these analyses because each pathway must include a distinct “point of hand-off” (i.e., final ES flow) from ecosystems to human systems.
3. Provide a structure that helps to organize the measurement of final ES and goods. For example, NESCS Plus can be used to organize the development of final ES and goods **metrics and indicators**, especially those that focus on the biophysical features of ecosystems that are most relevant for specific human uses or beneficiaries, such as waterfowl abundance for hunters or water quantity and salinity for agricultural irrigators (Ringold et al. 2009, 2013, 2020).



4. Provide a structure that helps to organize the accounting and aggregation of final ES and goods. In addition to measuring an individual final ES, there is often a need to add up values (or changes) across multiple final ES, as a way of measuring the combined contributions of multiple ecosystem services. For example, economic accounting practices such as cost-benefit analysis of environmental programs or natural capital accounting, typically require some aggregation of ecosystem service benefits. Similar to the economic classification systems (e.g., NAICS) that provide an essential foundation for national income accounting, NESCS Plus can provide a foundational structure for the systematic accounting of ecosystem service benefits.
5. Provide a structure that helps to organize, catalogue, and retrieve information about final ES, similar to a library, filing, or meta-data system. This function can include organizing information on:
  - a. The different types of ecosystem services addressed by existing empirical analyses.
  - b. The different types of metrics and indicators used to quantify ecosystem services, including monetary (e.g., willingness-to-pay estimates) and non-monetary (e.g., number of wildlife sightings per visit) metrics.
  - c. The different empirical estimates of ecosystem services generated in these analyses, including monetary values and non-monetary values.
  - d. The different types of models used to quantify ecosystem services (e.g., fish population dynamics or economic valuation models).

Additional explanations with examples of how NESCS Plus can be used to address these objectives are provided in the “4.0 NESCS Plus: Example Applications” section.

### **1.3 Why Do We Need a New Ecosystem Services Classification System?**

Existing literature on ecosystem services proposes various definitions and classification approaches for ecosystem services (Flood et al. 2020; Finisdore et al. 2020). Although there is broad consensus that ecosystems are natural assets that support human welfare, a convergence of views has not been reached on the best conceptual approach for describing and classifying the diverse processes, functions, stocks, flows, goods, services, and benefits embedded within or provided by ecosystems. This lack of consensus can create confusion in the application of the term ecosystem services (Nahlik et al, 2012), which makes it more difficult to organize a wide array of information in support of policy analyses.

The widely cited Millennium Ecosystem Assessment (MA, 2003, 2005) divides ecosystem services into supporting, provisioning, cultural, and regulating service. However, the MA report emphasizes that “the purpose [of these categories] is not to establish a taxonomy but rather to ensure that the [MA] analysis addresses the entire range of services” (p. 38 MA 2003).

A more fully developed classification system is the Common International Classification of Ecosystem Services (CICES; Haines-Young and Potschin, 2013, 2018). The CICES adapts and expands the MA approach to provide a more detailed classification system. It includes more attention to the differentiation between ecosystem services and the ecological processes that contribute to those services. The CICES does not include supporting services as an ecosystem service category. However, overlaps still exist among the three remaining categories of ecosystem services (regulating, provisioning and cultural). A lack of explicit partitioning between final and intermediate services in CICES limits its usefulness as a foundation for accounting or for benefits analysis.

The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) has also developed a framework centered around the concept of “Nature’s contributions to people” (NCP). The stated objective of this framework is to include a “wider range of values (e.g., relational and intrinsic values), valuation methods (e.g., socio-cultural methods), and worldviews [e.g., indigenous and local knowledge (ILK) systems]” and provide an approach for assessing the value of NCPs (Christie, et al (2019), IPBES (2018)). The IPBES approach includes two different perspectives, one more typical of biophysical and economic sciences and the other typical of local and indigenous knowledge. The first (“generalizable”) perspective identifies eighteen categories of NCPs that are organized into three partially overlapping groups: regulating, material and non- material services. Under the second (“contextual”) perspective, NCPs are not classified. Therefore, although the concept of NCPs is like ecosystem services, IPBES does not attempt to distinguish between final and intermediate; rather, it explicitly includes overlapping categories.

Several key themes and implications for ecosystem service classification emerge from the existing literature. First, if one wishes to support ecosystem service accounting or benefits analysis at local, regional and national levels, it is important to distinguish between final ecosystem goods, final ecosystem services, and the multitude of ecological processes that contribute to them (i.e., intermediate services). As previously noted, failing to make a clear distinction between intermediate and final ecosystem services can be particularly problematic for

ecosystem service valuation and accounting because it increases the likelihood of either incomplete or double-counting. Duplication can occur because the value of the intermediate ecological processes is embedded within the value for final ES. This potential for double-counting is a well-recognized and demonstrated drawback of the MA framework (Ojea et al., 2012; Fu et al., 2011). For example, MA includes both regulating services, such as the process of water purification, and provisioning services, such as freshwater supplies. The problem is that if both regulating and provisioning services are valued, and then those values are added up, the value of water regulation to water provisioning would be double counted. Similarly, IPBES includes regulating NCPs (e.g., regulation of air quality, climate, freshwater quantity and quality and soil) as well as material NCPs (e.g., food and feed, medicinal resources). If these NCPs are all added up, this would result in double-counting. Despite distinguishing between intermediate and final services in its documentation, the CICES classification also includes regulating and provisioning services that are potentially overlap between intermediate and final services groupings. For example, CICES includes categories for seed dispersal and control of erosion rates. The value of these services is at least partly embedded within the value of other final service categories such as wild plants used for nutrition.

Second, to reduce the risk of double counting it is also important to distinguish between ecosystem goods and services and economic goods and services. If economic goods (e.g., the amount of cotton harvested) are confused with ecosystem goods (e.g., the health of our soils), decision makers may draw inappropriate conclusions about the environment's capacity to sustain services on which people rely. For instance, MA and CICES include categories describing goods that are typically produced by humans (using human labor, capital, and ecological inputs) and often sold in markets, such as food (MA, 2005) and "Cultivated terrestrial plants (including fungi, algae) grown for nutritional purposes" (Haines-Young and Potschin, 2018). Treating these types of economic goods as ecosystem goods or services again runs the risk of double counting, because ecosystem service values (e.g., from water inputs to agricultural production) are embedded within the value of the economic goods.

Two recent efforts initiated by the U.S Environmental Protection Agency (USEPA) to develop classification systems that address these issues include the Final Ecosystem Goods and Services Classification System (FEGS-CS; Landers and Nahlik, 2013) and the National Ecosystem Services Classification System (NESCS; USEPA, 2015). To avoid double counting ecosystem goods and services, both FEGS-CS and NESCS focus on final ecosystem goods and services. Although conceptually and structurally similar, the two systems have different features and advantages. For example, FEGS-CS defines ecosystem goods and services as "components

of nature,” which implies they are countable stocks in nature (such as quantities of water at specific times, fish abundance, water clarity and soil health that can be measured at a specific point in time). In contrast, drawing mainly on economic approaches, NESCS treats services as flows, which move over time from an origin to a destination. The FECS-CS and NESCS also use different approaches for categorizing the different ways humans benefit from these services. Finally, whereas FECS-CS provides a ready-to-use and finite list of final ecosystem goods and services, NESCS provides lists for the components of final ES. The NESCS leaves it to the user of the system to define how these components are combined to identify distinct final ES.

Therefore, the aim of NESCS Plus is to provide a new system that: (1) improves on existing classification approaches; and (2) combines the desirable features of FECS-CS and NESCS. Key features of NESCS Plus are summarized in Text Box 1.3.

### Text Box 1.3. Key Features of NESCS Plus

Key features designed to support ecosystem service assessments are:

- (1) **Flexible and comprehensive:** NESCS Plus provides a broad and flexible modular structure intended to, as comprehensively as possible, capture potential pathways from ecosystems to human beings, thus avoiding any omission of ecosystem service categories (including those that may become important in the future).
- (2) **Minimizes double counting of ecosystem services:** While supporting a comprehensive accounting of ecosystem services, it avoids duplication by distinguishing between intermediate and final ecosystem services, and by distinguishing between: (1) *economic* goods and services; and (2) *ecosystem* goods and services. It also does this by striving to define categories of final ecosystem goods and services that are mutually exclusive (i.e., non-overlapping).

NESCS Plus can also be characterized in part by what it does not do or include:

- (1) **Does not provide a system for identifying or classifying intermediate ecosystem services, ecological production functions, or economic production functions.** The user must rely on other tools and sources of information to create these parts of the causal chains from changes in the environment to changes in human well-being.
- (2) **Does not conduct valuation of ecosystem services:** The NESCS Plus does not attempt to conduct quantification or valuation. The goal is to support *identification* of pathways between ecological and human systems, which can then be used as a basis or starting point for quantification (e.g., metric identification) or valuation.
- (3) **Is not a macro-accounting system:** The NESCS Plus draws from certain elements of macro-accounting structures such as the North American Industry Classification System (NAICS), the North American Product Classification System (NAPCS), and the National Income and Product Accounts (NIPA). It might prove to be a useful tool for green Gross Domestic Product accounting, although this is not the fundamental purpose of NESCS Plus.
- (4) **Does not define or categorize feedbacks from human systems to ecosystems:** The NESCS Plus defines flows *from* ecosystems *to* human systems and not feedback effects from human to ecosystems. It is important to note that this is by design and does not limit consideration of these dynamic and feedback effects when quantifying and valuing ecosystem services. Feedbacks may generate more flows through the NESCS Plus system and require that more of the existing final ecosystem goods pathways be considered. However, considering these feedbacks does not imply that new pathways will need to be *defined* and *classified*.
- (5) **Does not include a separate class for human health effects, but instead includes multiple categories involving dimensions of human health and safety:** Rather than separating human health and safety into a single separate category, it includes multiple human use categories for ecosystems that have health and safety implications, including extractive uses for subsistence, recreation, and production of economic goods and services.

## 2.0 What Is NESCS Plus?

The NESCS Plus provides two main tools for identifying final ES – a conceptual framework and a classification structure.

### 2.1 NESCS Plus Conceptual Framework

The conceptual framework provides a way to systematically link *ecological systems* that produce ecosystem services with *human systems* that directly use these services (i.e., market production systems and households) in specific and diverse ways.

The NESCS Plus conceptual framework is shown in **Figure 2**. The green half of the figure includes a simplified representation of the “ecological production” processes in the environment. These processes produce the biophysical components of nature (a “good”) that are directly beneficial to or directly valued or used by humans, more specifically, as “Ecological End-Products” (EEPs). The blue half of the figure provides a simplified representation of human production and consumption of economic goods and services and their contribution to human well-being.

As previously discussed, the conceptual framework also distinguishes between *stock* and *flow* concepts. In Figure 1, flows are represented as arrows and stocks are represented as boxes. Circles represent processes (e.g., production). The Ecological End-Products are therefore represented as the stocks in nature – e.g., wildlife (fauna), trees (flora), water – that are the direct source of all final ES flows<sup>2</sup>.

Final ecosystem services occur at the point of hand-off between the ecological systems and human systems. They are flows that contribute to human production or consumption processes. In some cases, they may be thought of as flowing directly to human well-being, which is a summary concept representing the overall condition and quality of life of humans and society. Whether directly or indirectly, all final ES flows eventually contribute to human well-being.

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<sup>2</sup> In NESCS Plus, final ecosystem goods and EEPs are not treated as physical flows (to humans) because the process of generating those flows – e.g., withdrawing water from a stream, catching fish, or harvesting wild mushrooms – generally requires human input (i.e., labor), which implies that the flows are *economic* goods. A similar argument about the distinction between ecosystem and economic goods is made by Boyd and Banzhaf (2007).

In contrast to final ES flows, which are intangible and usually cannot be directly observed, Ecological End-Product stocks are typically observable and measurable.<sup>3</sup> As a result, Ecological End-Product measures are critically important as *indicators* or *metrics* (indirect biophysical measures) of final ES flows, particularly when these measures have meaning and relevance for the humans that receive the final ES (Ringold et al. 2020). For example, the abundance of adult deer population in a forest preserve (Ecological End-Product stock measure) can be an important indicator of the final ES flow provided by forest wildlife to recreational hunters.<sup>4</sup> The number of deer killed and harvested (a flow measure) could also be used as an indicator, but it is not a *direct* measure of the final ES flow, because it also measures the labor and skill used by the hunter (i.e., it is a direct measure of the economic good produced by the hunting activity).<sup>5</sup>

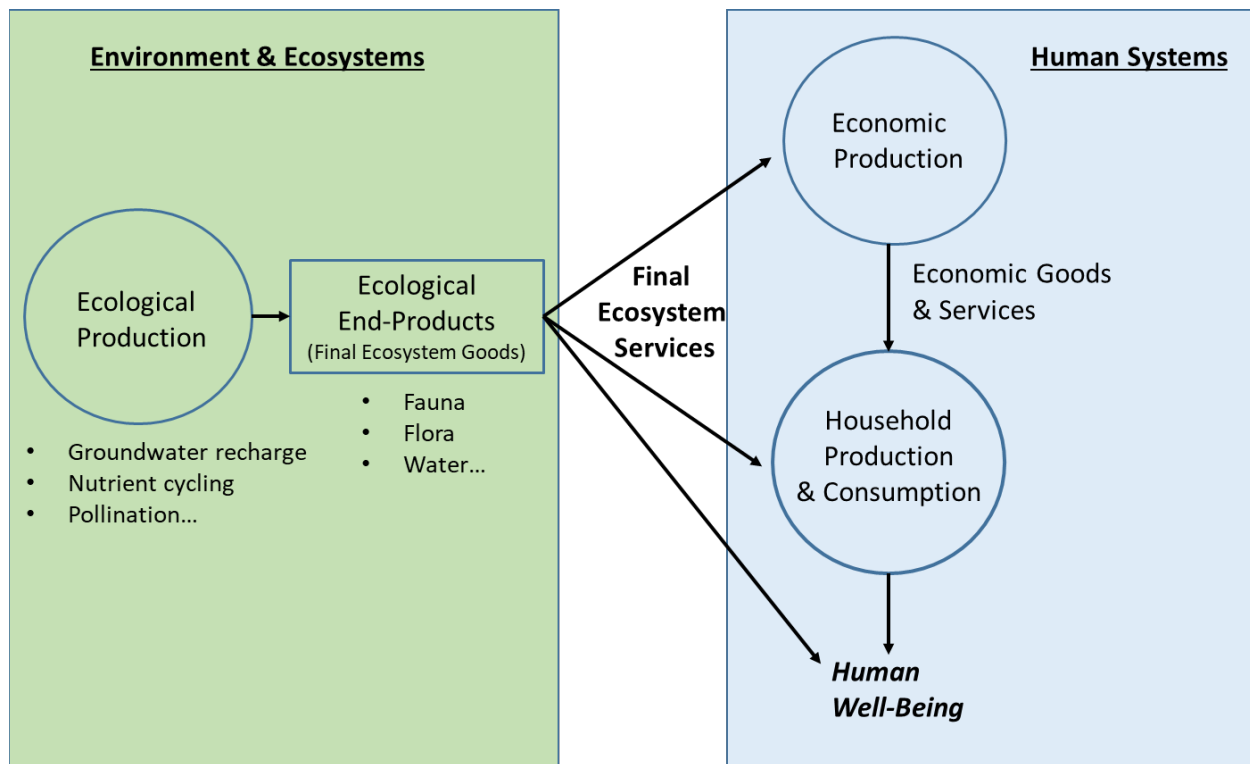
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<sup>3</sup> Like services produced in the economy – e.g., storage space rental, financial advice, automobile repair – the service flows themselves cannot be directly observed. Instead, input or outcome indicators such as number of storage units rented, number of financial reports produced, or number of labor hours provided can be used.

<sup>4</sup> Depending on the context, additional information (for example about the hunters' access to or preferences for the deer) may be needed to develop a more complete, and precise estimate of final ES.

<sup>5</sup> A direct measure of the final ES from the deer population to the hunters could, for example, be the hunter's willingness to pay for access to the forest reserve for hunting. As an analogy, if one wanted to measure the economic services (also intangible) provided by a musical performance, one could use the price of the ticket as a direct measure, or one could use measures of the musicians' experience and awards as an indirect indicator.

**Figure 2** Conceptual framework that shows how final ecosystem services flow from the environment to human systems. Final ecosystem services occur when Ecological End-Products are directly used or appreciated by humans<sup>6</sup>



For clarity and simplicity, the NESCS Plus framework separates ecological systems and human systems; however, in practice it must be acknowledged that there are overlapping or “gray” areas. For example, in heavily managed environments like urban cities, suburban parks, or agroecosystems, identifying the relevant Ecological End-Product and corresponding “final” ecosystem service flow can be challenging and requires both correct application of the tool and use of relevant and appropriate judgment by the NESCS Plus user since the boundary between ecosystems and human modified systems is often not clear.

In NESCS Plus, things produced using intentionally applied human inputs and sold in a market<sup>7</sup> are generally considered economic goods or services rather than final ES.<sup>8</sup> However,

<sup>6</sup> Although not shown explicitly on the diagram, the characteristics and attributes of the EEPs (e.g., water quality, size of wildlife populations) are key determinants of the magnitude of final ES flows. Biophysical metrics or indicators can be used to represent these magnitudes.

<sup>7</sup> Not including regulatory-based environmental (i.e., cap-and-trade) markets.

<sup>8</sup> For example, agricultural landscapes are produced using human inputs and humans may have aesthetic appreciation for such landscapes. However, the view of these landscapes is not sold in the market, and it may be considered a positive final ES externality that results from agricultural production systems.



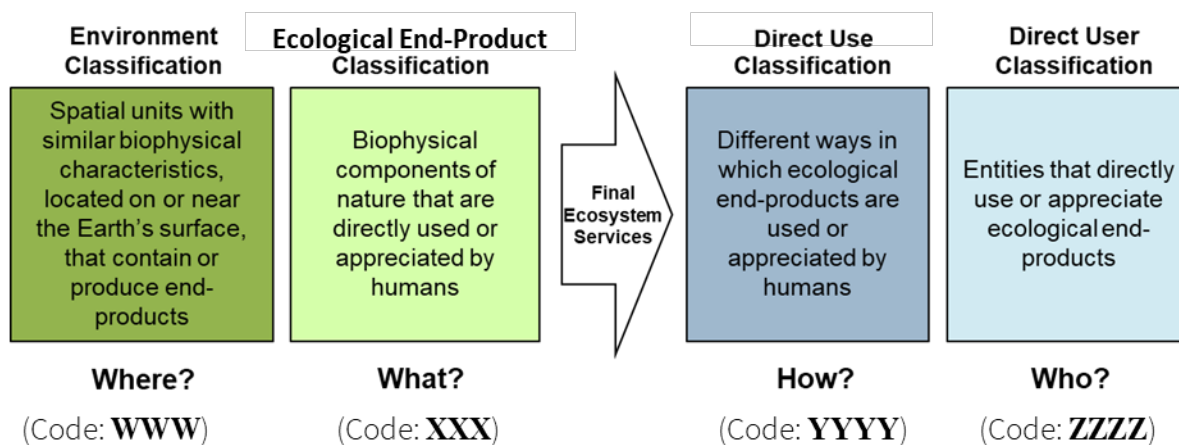
even in these cases, determining where to draw the line between ecosystems and human systems may depend on the context and require user judgment. For example, if a private landowner creates a nature park on his land, which users can access by paying a fee, it may require appropriate judgment to determine what aspects of the park offer human-produced economic services as opposed to ecosystem services.

### 3. NESCS Plus Classification Structure

The NESCS Plus classification structure defines classes and subclasses, which are each assigned a numeric code designed to identify and classify flows of services from ecosystems to human beings in a comprehensive and mutually exclusive way. It consists of four main components (**Figure 3.1**):

1. Environment classes (code: **WWW**)
2. Ecological End-Product classes (code: **XXX**)
3. Direct Use classes (code: **YYYY**)
4. Direct User classes (code: **ZZZZ**)

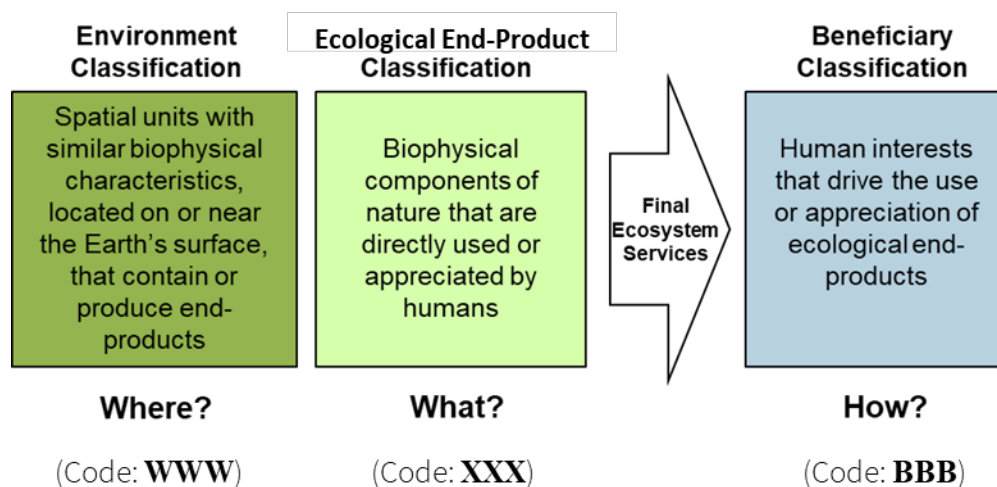
**Figure 3.1** The NESCS Plus “Use/User” structure (four components)



The NESCS Plus also offers an alternative three-component structure, where the last two components representing human systems (i.e., the Direct Use/User classes) are replaced with a single classification component for ‘**Beneficiaries**.’ Beneficiaries are defined as the interests of individuals, groups of people, or organizations that drive their direct use or appreciation of Ecological End-Products. This alternative NESCS Plus structure, has the following three components (**Figure 3.2**):

1. Environment classes (code: **WWW**)
2. Ecological End-Product classes (code: **XXX**)
3. Beneficiary classes (code: **BBB**)

**Figure 3.2** Alternative NESCS Plus “Beneficiary” structure (three components)



For all the classification components, NESCS Plus employs a nested hierarchical structure so that each component can be represented at multiple levels of aggregation or detail (an illustration of this hierarchy is shown later in **Table 3.5**). Tradeoffs exist between adding more detail and keeping the system tractable--existing levels of detail in NESCS Plus attempt to balance the two. To maintain flexibility for the future, additional levels of detail can be added to any class or subclass. Also, other existing classification systems for specific categories in NESCS Plus (e.g., for wetlands or fauna) can be used to expand or complement the NESCS Plus structure, depending on the user’s needs.

### 3.1 NESCS Plus Use/User Classification Structure (Four Components)

#### 3.1.1 Environment Classification (Code: WWW)

The first component of NESCS Plus is the **Environment** classification, which spatially divides the earth into areas with similar biophysical characteristics. **Table 3.1** shows the 3-level classification hierarchy for this component. It also includes a numeric coding structure, which provides a short-hand notation for the hierarchy and a numeric identifier for each element. The top level (single-digit) indicates two mutually exclusive environment classes – aquatic and terrestrial – each of which is further subdivided into 2-digit (level I) sub-classes. These subclasses are then further subdivided into 3-digit (level II) subclasses. The Terrestrial Environment classes match the National Land Cover Database (NLCD)<sup>9</sup>, which is commonly used by other tools and systems (e.g., USEPA’s EnviroAtlas; <https://www.epa.gov/enviroatlas>).

When used to classify a final ES, the environment classes and subclasses *specifically refer to the environment in which the relevant Ecological End-Product is located when it is used or appreciated by humans*. This location is not necessarily the same as the location of the Direct Use, User, or Beneficiary. Specific definitions of these classes and subclasses are in **Appendix B**.

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<sup>9</sup> Disclaimer: Individual users of NESCS Plus are responsible for evaluating the uncertainties associated with the original datasets feeding into NESCS Plus, including the NLCD, and characterizing NESCS Plus results for applicability, precision, accuracy, uncertainty, and other data qualifications associated with usability of results. Users should particularly note that many sources of information that may be used to quantify EEPs are built on spatial frameworks not congruent with the NLCD. This lack of congruence may need to be accounted for in quantitative representations.

**Table 3.1** The Environment Classification (Code: *WWW*) addresses the question of where EEPs are located when they are used, enjoyed, or appreciated.

Environment Class	Subclass I	Subclass II
1. Aquatic	11. Open Water	111. Rivers and Streams
		112. Lakes and Ponds
		113. Near Coastal Marine/Estuarine
		114. Open Oceans and Seas
	12. Wetlands	121. Woody Wetlands
		122. Emergent Herbaceous Wetlands
2. Terrestrial	21. Forests	211. Deciduous Forest
		212. Evergreen Forest
		213. Mixed Forest
	22. Agroecosystems	221. Pasture/Hay
		222. Cultivated Crops
	23. Grasslands	231. Grassland/Herbaceous
	24. Scrubland/Shrubland	241. Shrub/Scrub
	25. Tundra	251. Lichens
		252. Moss
		253. Dwarf Scrub
		254. Sedge/Herbaceous
	26. Ice and snow	261. Perennial Ice/Snow
	27. Urban/suburban	271. Developed Open Space
		272. Developed Low Intensity
		273. Developed Medium Intensity
		274. Developed High Intensity
	28. Barren/rock and sand	281. Barren Land (Rock/Sand/Clay)

### 3.1.2 Ecological End-Product (EEP) Classification (Code: XXX)

The second component of NESCS Plus is the **Ecological End-Product (EEP)** classification. Ecological End-Products represent the biophysical components in nature that humans most directly use or appreciate. In this capacity, they can also be described as final ecosystem goods. **Table 3.2** shows the proposed single-level classification and coding system for this component. It also provides definitions for the eight main classes of end-products<sup>10</sup>, and examples for elements in the sub-class groupings.

One of the challenges in constructing this end-product classification is defining mutually exclusive categories while also recognizing that there can be substantial complexity in what people use appreciate or enjoy directly in nature. In addition to individual end-products, people often care about combinations of them. For example, people may value an entire landscape in addition to individual flora, fauna, water, etc., that are parts of the landscape. To account for this issue, a class called “Composite” is included. Examples of end-products included in this class are the different types of natural features or phenomena that directly matter to humans but can be thought of as combinations of the other end-products.

It is important to emphasize that most biophysical components in nature that are the direct source of final ES can also, in other settings, be the source of intermediate ecosystem services. In other words, whether a specific biophysical component is identified and classified as an Ecological End-Product depends on the Beneficiary or Use/User combination. For example, when salmon are harvested by recreational anglers, they can be thought of as Ecological End-Products classified as Fauna. However, when the salmon are consumed by bears, who are later appreciated by wildlife viewers, they are one step removed from being an Ecological End-Product.

Though not part of the formal classification system, an attributes table has been created to support identification of metrics and indicators (available in **Appendix C**). These attributes have been integrated into the FEGS Community Scoping Tool (Sharpe et al. 2020) and the FEGS Metrics Report (Ringold et al. 2020).

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<sup>10</sup> There are 8 EEP categories identified in Table 4, including Fauna, Flora, and Fungi. It is important to recognize that the Integrated Taxonomic Information System (ITIS; <https://www.itis.gov/>) classifies seven taxonomic Kingdoms: Archaea, Bacteria, Protozoa, Chromista, Fungi, Plantae, Animalia); see Table 4.

**Table 3.2** Ecological End-Product Classification (Code: XXX) addresses the question of what in nature is directly used or appreciated by humans.

<b>Ecological End-Product Class</b>	<b>Definition</b>
1. Atmosphere	Atmospheric conditions (e.g., wind, sunlight, cloud cover, air temperature, and humidity) and components of the atmosphere (e.g., precipitation, water vapor, oxygen, carbon dioxide, helium, nitrogen, and hydrogen). This class excludes weather events (which are included under “Composite”).
2. Soil	The unconsolidated mineral or organic matter on the surface of the Earth, including for example mud, clay, loam, stones, rocks. This class excludes materials suspended or dissolved in water (those are included under “Water”).
3. Water	Liquid and solid forms of water surface water and ground water including components suspended or dissolved in water, which are indicators of water quality. This class excludes water vapor and precipitation (which are included under “Atmosphere”). This class excludes extreme events (which are included under “Composite”).
4. Fauna	All animal life (for example, mammals, fish, shellfish, birds, reptiles, amphibians, insects). The Fauna class includes everything in the Kingdom Animalia. Subclasses should use an Integrated Taxonomic Information System (ITIS) Taxonomic Serial Number (TSN*).
5. Flora	All plant and unicellular life (for example trees, shrubs, herbs, grasses, ferns, mosses, viruses, bacteria.) This class excludes fungal life (which is included under “Fungi.”). The Flora class includes everything in the Kingdoms Plantae, Chromista, Protozoa, Bacteria, and Archaea. Subclasses should use an Integrated Taxonomic Information System (ITIS) Taxonomic Serial Number (TSN*).
6. Fungi	All fungal life including for example lichens and mushrooms. The Fungi class includes everything in the Kingdom Fungi. Subclasses should use an Integrated Taxonomic Information System (ITIS) Taxonomic Serial Number (TSN*).
7. Other Natural Components	All other biota or biotic material that are not part of / attached to currently living floral / faunal source, including for example driftwood not attached to currently living tree, shells not attached to currently living clams.
8. Composite	A combination of elements and components of single or multiple environmental classes, including for example: (1) site appeal (e.g., views, sounds, scents; (2) extreme events and natural phenomenon (e.g., fire, hot springs, geysers); and (3) integrated ecosystems.

\* A TSN is a unique, persistent, non-intelligent identifier for a scientific name in the context of the Integrated Taxonomic Information System (ITIS; <https://www.itis.gov/>). The ITIS provides a unique TSN for every level in the taxonomic hierarchy.

### 3.1.3 Direct Use Classification (Code: YYYY)

The Direct Use classification describes distinct ways in which end-products can be directly used or appreciated by humans (**Table 3.3**). Consistent with the total economic value (TEV) framework often used by economists (see for example Pearce and Pretty, 1993), this classification component includes separate classes for “use” and “non-use.” Many of the direct use subclasses are then further subdivided into second level subclasses, according to whether they involve extractive or in-situ use of the Ecological End-Product in question. Specific definitions of these classes and subclasses are in **Appendix D**.

**Table 3.3.** Direct Use Classification (Code: YYYY) addresses the question of how Ecological End-Products are directly used or appreciated by humans

Direct Use	Subclass I	Subclass II
1. Direct Use	101. Raw material for transformation	1011. Extractive use
	102. Distribution to other users	1021. Extractive use
	103. Industrial processing	1031. Extractive use
	104. Transportation medium	1042. In-situ use
	105. Waste disposal/assimilation	1052. In-situ use
	106. Aesthetic appreciation	1062. In-situ use
	107. Fuel/energy	1071. Extractive use
		1072. In-situ use
	108. Support of plant or animal cultivation	1081. Extractive use
		1082. In-situ use
	109. Support or protection of human health and life or subsistence	1091. Extractive use
		1092. In-situ use
	110. Support for protection of human property	1101. Extractive use
		1102. In-situ use
	111. Recreation/tourism	1111. Extractive use
		1112. In-situ use
	112. Cultural/spiritual activities	1121. Extractive use
		1122. In-situ use
	113. Information, science, education, and research	1131. Extractive use
		1132. In-situ use
	114. Other direct use	1141. Extractive use
		1142. In-situ use
2. Non-use	201. Existence	1102. In-situ use
	202. Bequest	1102. In-situ use
	203. Other non-use	1102. In-situ use



### 3.1.4 Direct User Classification (Code: ZZZZ)

The fourth component is the **Direct Users** classification (**Table 3.4**). This component defines the separate economic sectors through which people directly use or appreciate end-products. Following established classification structures adopted by the U.S. Census Bureau and The United Nations, the first level includes broad sectors of the economy – Industry, Households, and Government. To further subdivide the industry class, the existing North American Industrial Classification System (NAICS) and coding system has been adopted in NESCS Plus, which is the standard used by U.S. federal statistical agencies in classifying business establishments.<sup>11</sup> The NAICS coding system contains six digits (with four levels of sub-classification), with details and definitions available at <https://www.census.gov/cgi-bin/sssd/naics/naicsrch?chart=2017>; however, **Table 3.4** only shows the top level (2-digit) classes.<sup>12</sup> Specific definitions and a more detailed classification using 3-digit NAICS codes is available in **Appendix E**.

Unlike commercial establishments, which tend to specialize in certain productive activities and can therefore be assigned to individual NAICS categories, households do not specialize in the same way and are therefore not divided into sub-classes. However, the diverse ways in which households experience nature are captured in the myriad listings of direct uses (in **Table 3.3**).

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<sup>11</sup> Note, NAICS 814 (Private Households) are omitted. See <https://www.census.gov/cgi-bin/sssd/naics/naicsrch?chart=2012> for definitions. Separate categories for households and government were included to ensure the capture a broader range of uses than that implied by the NAICS definition.

<sup>12</sup> Some categories such as manufacturing and retail trade span more than one 2-digit class.

**Table 3.4** Direct User Classification and Codes (Code: ZZZZ) addresses the question of who direct uses each Ecological End-Product

Direct User Class	Subclass I
1. Industry	111. Agriculture, Forestry, Fishing, and Hunting
	121. Mining
	122. Utilities
	123. Construction
	131. Manufacturing - 31
	132. Manufacturing - 32
	133. Manufacturing - 33
	142. Wholesale Trade
	144. Retail Trade - 44
	145. Retail Trade - 55
	148. Transportation and Warehousing - 48
	149. Transportation and Warehousing - 49
	151. Information
	152. Finance and Insurance
	153. Real Estate Rental and Leasing
	154. Professional, Scientific, and Technical Services
	155. Management of Companies and Enterprises
	161. Educational Services
	162. Health Care and Social Assistance
	171. Arts, Entertainment, and Recreation
	172. Accommodation and Food Services
	181. Other Services (except Public Administration)
2. Households	211. Households
3. Government	392. Public Administration
	399. Other Government

Taken together, these four classification components can be used to identify individual final ES. More specifically, each unique combination – with a single element drawn from each of the four components – defines a separate potential final ES. The ability to define different combinations allows the NESCS Plus structure to be flexible and comprehensive. For example, the same Ecological End-Product class may be used in multiple ways (e.g., water can be used to support human life as drinking water and as an energy source through hydropower production). It also recognizes that a single use class or subclass can be linked to multiple different user

categories. For example, water used to support plant cultivation is relevant both for the agricultural sector and for households (e.g., lawn watering).

In total, there are over 120,000 possible combinations for the four components.<sup>13</sup> The NESCS Plus offers users the flexibility to define the combinations of the four components that are relevant for their specific needs. However, it is worth noting that not every combination necessarily represents a plausible ecosystem service. For example, it is difficult to envision a combination that links the Ecological End-Product class Fungi with the Direct Use subclass of Transportation Medium.

Each unique final ecosystem service can be easily identified using the NESCS Plus codes shown in **Tables 3.1-3.4**. The coding system is summarized in **Table 3.5**. The general format of the code is **WWW.X.YYYY.ZZZZZZZ**, where the first three digits (**WWW**) refer to the Environment class and subclasses, the next digit (**XXX**) refers to the Ecological End-Product class, the next four digits (**YYYY**) refer to the Direct Use class and subclasses, and the final seven digits (**ZZZZZZZ**) refer to the Direct User classes and subclasses.

**Table 3.5** NESCS Plus Coding System with 4-Components

Component	Environment	Ecological End-Product	Direct Use	Direct User
	<b>WWW</b>	<b>. XXX</b>	<b>. YYYY</b>	<b>. ZZZZZZZ</b>
Class	<b>W</b>	WWW.X	WWW.X.Y	WW.X.YYYY.Z
Subclass I	<b>WW</b>	WWW.XX	WWW.X.YYY	WW.X.YYYY.ZZZ
Subclass II	<b>WWW</b>	WWW.XXX	WWW.X.YYYY	WW.X.YYYY.ZZZZZZZ
Example	<b>112</b> <i>Aquatic—Open Water—Lakes and Ponds</i>	<b>112.3</b> <i>Water</i>	<b>112.3.1081</b> <i>Direct Use—Support of plant or animal cultivation—Extractive Use</i>	<b>112.3.1081.1111333</b> <i>Industry—Agriculture, Forestry, Fishing, and Hunting—Grape Vineyards</i>

Because of the hierarchical structure of each classification component, the NESCS Plus code can be used at various levels of detail, depending on the desired level of granularity or

<sup>13</sup> With 24 Environment subclasses (level II), 8 EEP classes, 25 Direct Use subclasses (level II), and 25 Direct User subclasses (level, I, assuming a 3-digit level of detail for this component), the total number of possible combinations is 120,000. If a 4-digit level of detail is used for the Direct User component (i.e., using a 3-digit NAICS code), then the number of combinations increases to over 600,000.

aggregation for the specific context being considered. In its simplest form, it can be used to only specify the top-level class for each component. For example, the combination of: (1) Environment class = *Terrestrial*; (2) Ecological End-Product class = *Fauna*; (3) Direct Use class = *Direct Use*; and (4) Direct User class = *Industry* can be represented by the code 2.4.1.1 (or using all the digits: 2WW.4XX.1YYY.1ZZZZZZ).

At its most detailed level, it can make use of all 15 digits. For example, the combination of: (1) Environment class = *Aquatic—Open Water--Lakes and Ponds*; (2) Ecological End-Product class = *Water*; (3) Direct Use class = *Direct Use—Support of plant or animal cultivation—Extractive Use*; and (4) Direct User class = *Industry—Agriculture, Forestry, Fishing, and Hunting—Grape Vineyards* can be represented by the code 112.3.1081.1111333. In this case, the last six digits are the same as the 6-digit NAICS code for the Grape and Vineyards industrial subclass.

### 3.2 NESCS Plus “Beneficiary” Classification Structure (Three Components)

As indicated at the beginning of this section, NESCS Plus also offers an alternative three-component structure as previously shown in **Figure 3**. In this case, the last two components representing human systems (i.e., the Direct Use Classes and Direct User Classes) are replaced with a single classification component for human Beneficiaries (**Table 3.6**).

Unlike the Direct User and Direct Use concepts, the Beneficiary concept does not specifically separate the questions (1) *Who* benefits from nature? and (2) *How* do they benefit? Therefore, it can be thought of as a combination of the two concepts. In some cases, the Beneficiary definition also identifies connections to specific Ecological End-Products. For example, the Agricultural Processors subclass is defined as “This beneficiary primarily consumes water for washing edible products.” Specific definitions of these classes and subclasses are in **Appendix F**.

**Table 3.6** Beneficiary Classification and Codes (Code: *BBB*)

Beneficiary Class	Beneficiary Subclass I
01. Agricultural	011. Livestock Grazers
	012. Agricultural Processors
	013. Aquaculturists
	014. Farmers
	015. Foresters
	016. Other Agricultural Beneficiaries
02. Commercial/Industrial	021. Food Extractors
	022. Timber, Fiber, and Ornamental Extractors
	023. Industrial Processors
	024. Private Energy Generators
	025. Pharmaceutical and Food Supplement Suppliers
	026. Fur / Hide Trappers and Hunters
	027. Private Drinking Water Plant Operators
	028. Commercial/Industrial Property Owner
	029. Other Commercial/Industrial
03. Government, Municipal, and Residential	031. Municipal Drinking Water Plant Operators
	032. Residential Property Owners
	033. Public Sector Property Owners
	034. Military / Coast Guard
	035. Public Energy Generators
	036. Other Government, Municipal, and Residential
04. Commercial/Military Transportation	041. Transporters of Goods
	042. Transporters of People
	043. Other Commercial/Military Transportation
05. Subsistence	051. Water Subsisters
	052. Food and Medical Subsisters
	053. Timber, Fiber, and Fur / Hide Subsisters
	054. Building Material Subsisters
	055. Other Subsistence
06. Recreational	061. Experiencers and Viewers
	062. Food Pickers and Gatherers
	063. Hunters
	064. Anglers
	065. Waders, Swimmers, and Divers
	066. Boaters
	067. Other Recreational

Beneficiary Class	Beneficiary Subclass I
07. Inspirational	071. Spiritual and Ceremonial Participants and Participants of Celebration
	072. Artists
	073. Other Inspirational
08. Learning	081. Educators and Students
	082. Researchers
	083. Other Learning
09. Non-Use	091. People Who Care (Existence)
	092. People Who Care (Option /Bequest)
	093. Other Non-Use
10. Humanity	101. All Humans

Therefore, one advantage of the Beneficiary approach is that it simplifies final ES classification by constraining the combinations of uses and users (and in some cases Ecological End-Products too) through a pre-defined list of beneficiaries. The downside of this approach, however, is that it limits the flexibility to consider other combinations.

In contrast, one of the benefits of the Direct Use classes is that they are defined “generically” so that they can be linked to multiple Direct User classes and Ecological End-Product classes. For example, the subclass “Support of plant or animal cultivation” can apply to households, multiple agricultural sectors, and potentially other sectors. It can also be linked to multiple Ecological End-Product classes (as inputs) including soil, water, and flora. A possible disadvantage of this flexibility is that it can result in a long and, in some cases, unwieldy list of potential combinations to be considered.

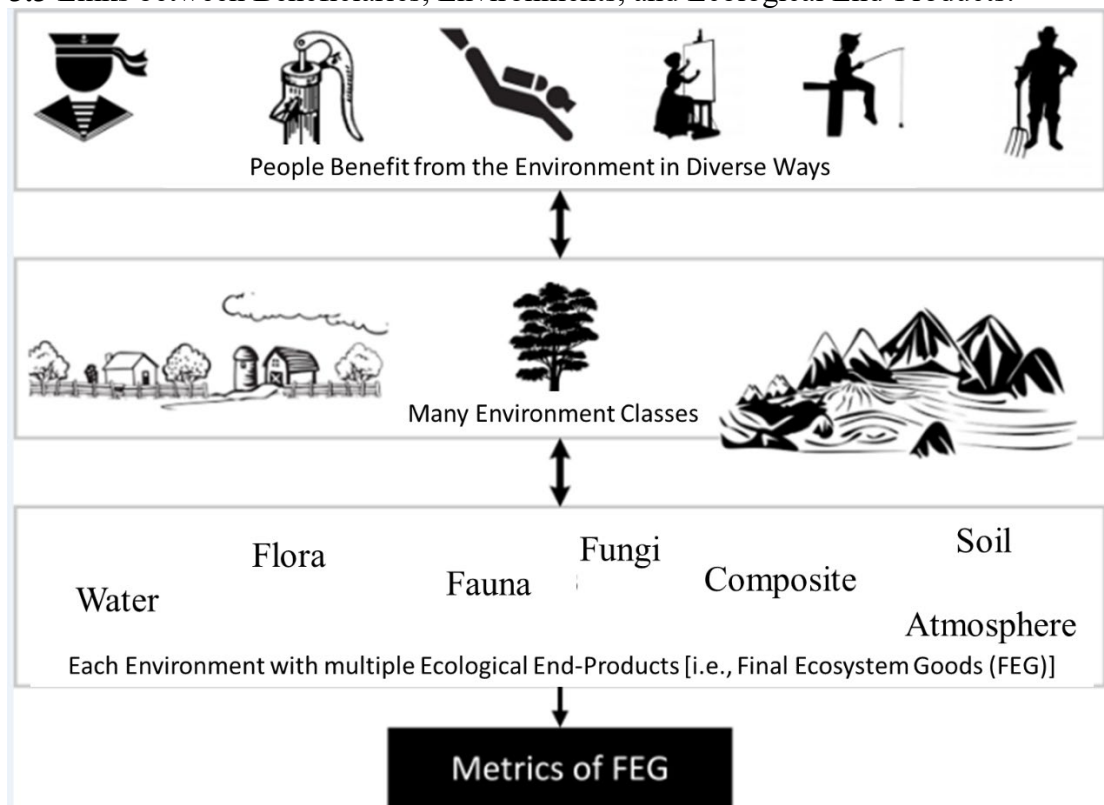
In this case, the general format of the code is **WWW.XXX.BBB**, where the first three digits (**WWW**) refer to the Environment class and subclasses, the next digit (**XXX**) refers to the Ecological End-Product class, the three final digits (**BBB**) refer to the Beneficiary classes and subclasses (**Table 3.7**).

**Table 3.7** NESCS Plus Coding System with 3 Components

Component	Environment	Ecological End-Product	Beneficiary
	WW W	. XXX	. BBB
Class	W	WWW.XXX	WWW.X.BB
Subclass I	WW		WWW.X.BBB
Subclass II	WWW		

Beneficiaries directly value one or more attributes of one or more ecosystems. These combinations, produced by the final ecosystem goods, produce the final ES that people directly value (**Figure 3.3**). Based on the attributes that directly matter to people identify metrics that directly matter to each of the many ways in which people benefit from ecosystems can be identified.

**Figure 3.3** Links between Beneficiaries, Environments, and Ecological End-Products.



### 3.3 “Core” Final ES Combinations

Although NESCS Plus provides users with the flexibility to select the 4-component or 3-component final ES combinations that are most relevant for their applications, it is recognized that, for some users, working with a more limited set of options may be preferable. Therefore, NESCS Plus also offers a simpler, pre-defined, “core” set of final ES combinations (available online at <https://www.epa.gov/eco-research/nescs-plus>).

The objective in defining this core set was to select the combinations that represent the most common or recognizable final ES. This selection obviously entails making judgments, and it is not intended to imply that combinations outside the core are unimportant or infeasible. The core was initially defined by linking to work by Landers and Nahlik (2013), who conducted a similar selection process using the FECS-CS and NAICS classification systems.<sup>14</sup> By adapting their list to fit the NESCS Plus classification structure and then refining, modifying, and adding based on inputs from our own experts and reviewers, a core set of 1,078 final ES combinations for NESCS Plus was identified. This core set provides a relatively simple alternative to the over 600,000 total possible combinations using the 4-component NESCS Plus structure.

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<sup>14</sup> Landers and Nahlik (2013) started with a list of 589 combinations of environment, beneficiary, and final ecosystem goods type. They then identified one or more “potentially relevant” 3-digit NAICS codes for many of these combinations, creating a total of 1,260 combinations of environment, end-product, beneficiary, and NAICS code. This is the list of combinations adapted for the “core” NESCS Plus list.



## 4.0 Recent Publications that Apply NESCS Plus Components

This section includes some examples of recent publications that use components of NESCS Plus.

### 4.01 Piloting Ecosystem Accounts for the Southeastern U.S.



USEPA researcher Dr. Marc Russell and collaborators have used NESCS Plus in the first effort to develop Ecosystem Accounts for the U.S. at a broad scale. The team has explored the potential for U.S. ecosystem accounting and explain their pilot accounts for a 10-state region in the Southeast. The pilot accounts address air quality, water quality, biodiversity, carbon storage, recreation, and pollination for selected years from 2001 to 2015. In their study, [Testing ecosystem accounting in the United States: A case study for the Southeast](#), they explain how results can contribute to policy and decision making. For example, in Atlanta they show how ecosystem accounts can help give a more complete picture of a local area's environmental-economic trends.

Source: Warnell, K.J., M. Russell, C. Rhodes, K.J. Bagstad, L.P. Olander, D.J. Nowak, R. Poudel, P.D. Glynn, J.L. Hass, and S. Hirabayashi. (2020). Testing ecosystem accounting in the United States: A case study for the Southeast. *Ecosystem Services*. 43:101099.

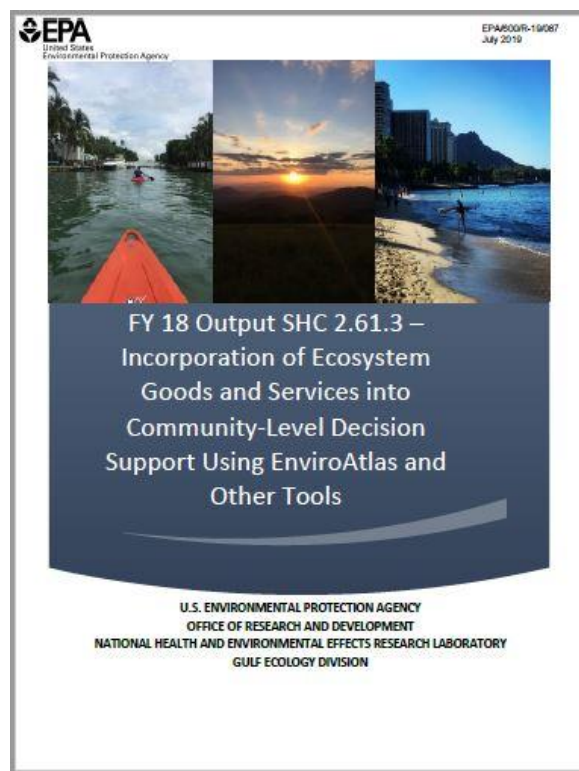
#### 4.02 Who are the Beneficiaries of Great Lakes Waterfront Revitalization?



Cleanup of Great Lakes Areas of Concern (AOCs) and other waterfront areas restores environmental benefits to waterfront communities and is essential for revitalization. In the study, [Goals, beneficiaries, and indicators of waterfront revitalization in Great Lakes Areas of Concern and coastal communities](#), multidisciplinary USEPA researchers crosswalk waterfront revitalization goals with NESCS Plus Beneficiaries. The also compiled indicators for tracking these goals that that can be used in planning, for comparing alternative designs, and for tracking revitalization progress.

Source: Angradi, T.R., K.C. Williams, J.C. Hoffman, and D.W. Bolgrien. (2019). Goals, beneficiaries, and indicators of waterfront revitalization in Great Lakes Areas of Concern and coastal communities. *Journal of Great Lakes Research*. 45(5):851–863.  
<https://doi.org/10.1016/j.jglr.2019.07.001>

#### 4.03 How Can Recently Developed USEPA Tools Help Communities Include Ecosystem Services in Decision Making?



This synthesis report presents a suite of USEPA Sustainable and Healthy Communities research on ecosystem services. The studies summarized in [FY18 Output - Incorporation of Ecosystem Goods and Services into Community-Level Decision Support Using EnviroAtlas and Other Tools](#) represent efforts to support community-level decision making by incorporating quantitative information on ecosystem goods and services. This report discusses research to evaluate the utility of decision support tools such as the FEGS-CS classification system (the predecessor to NESCS Plus), the EcoService Models Library (ESML), the EnviroAtlas, Eco-Health Relationship Browser and the FEGS Community Scoping Tool.

Source: Harwell, M.C., and Jackson, C. (2019). FY18 Output—SHC 2.61.3—Incorporation of Ecosystem Goods and Services into Community-Level Decision Support Using EnviroAtlas and Other Tools. U.S. Environmental Protection Agency. EPA/600/R-19/087.



#### 4.04 Mapping and Identifying Linkages in USEPA's EnviroAtlas



USEPA Researcher Dr. Paul Ringold and his postdoc Arik Tashie searched the USEPA's EnviroAtlas for useful metrics for final ES. They selected the EnviroAtlas because it contains a large fraction of the existing ecological data that is available at a national scale. The researchers investigated linkages between NESCS Plus Environment and Beneficiary classifications and EnviroAtlas data layers. In [\*A critical assessment of available ecosystem services data according to the Final Ecosystem Goods and Services framework\*](#), they created a database of over 14,000 linkages between 255 EnviroAtlas data layers. These linkages were classified as intermediate ecosystem goods and services, final ecosystem goods and services, and social or economic outcomes.

Source: Tashie, A., and P. Ringold. (2019). A critical assessment of available ecosystem services data according to the Final Ecosystem Goods and Services framework. *Ecosphere*. 10(3): e02665.

#### 4.05 Who Benefits from National Estuaries? Using an Ecosystem Services Classification System to Identify Beneficiaries



USEPA researchers conducted a document analysis of national estuary management plans using the final ecosystem goods and services (FEGS) Classification System (recently updated as NESCS Plus). In [\*Who Benefits from National Estuaries? Applying the FEGS Classification System to Identify Ecosystem Services and their Beneficiaries\*](#), they present a suite of ecosystem services relevant to management of National Estuary Programs (NEP) and the National Estuarine Research Reserve System (NERRS), and explicitly link them to the beneficiaries who use them.

Source: Yee, S., A. Sullivan, K. Williams, and K. Winters. (2019). Who benefits from national Estuaries? Applying the FEGS Classification System to identify ecosystem services and their beneficiaries. *International Journal of Environmental Research and Public Health*. 16:2351.



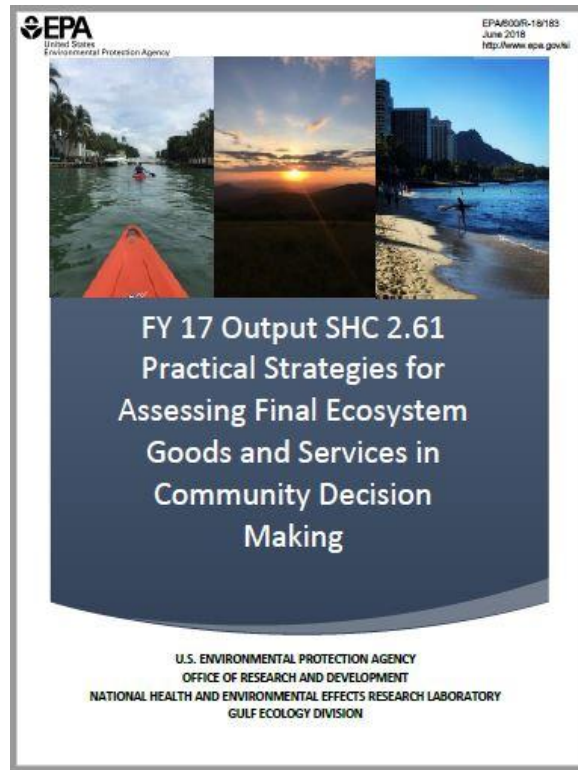
#### 4.06 How can EnviroAtlas and the Eco-Health Relationship Browser connect decision makers to scientific data?



Dr. David W. Bolgrien and other USEPA researchers use community case studies to demonstrate how the EnviroAtlas and the Eco-Health Relationship Browser serve as gateways between scientific data and decision makers. Successful community problem solving depends on such gateways that facilitate effective communication among partners and make data accessible to establish robust and mutually understandable decisions. In [Ecosystem Goods and Services Case Studies and Models Support Community Decision Making using the EnviroAtlas and the Eco-Health Relationship Browser](#) summarizes multiple lines of evidence, analytical tools, models, and data for using ecosystems goods and services in community decision making. Particular emphasis is put on using USEPA's publicly available, web-based EnviroAtlas and Eco-Health Relationship Browser to access ecosystem goods and services data at national and community scales.

Source: Bolgrien, D.W., T.R. Angradi, J. Bousquin, T.J. Canfield, T.H. Dewitt, R.S. Fulford, M.C. Harwell, M. J.C. Hoffman, J. C., T.P. Hollenhorst, T. P., J.M. Johnston, J.J. Launspach, J. J., Lovette, J., R.B. McKane, T.A. Newcomer-Johnson, M.J. Russell, M. J., L.S. Sharpe, L. S., A. Tashie, A., K. Williams, K., and S.H. Yee, S. H. (2018). Ecosystem Goods and Services Case Studies and Models Support Community Decision Making using the EnviroAtlas and the Eco-Health Relationship Browser. U.S. Environmental Protection Agency, EPA/600/R-18/167. <https://doi.org/10.13140/RG.2.2.31113.29286>.

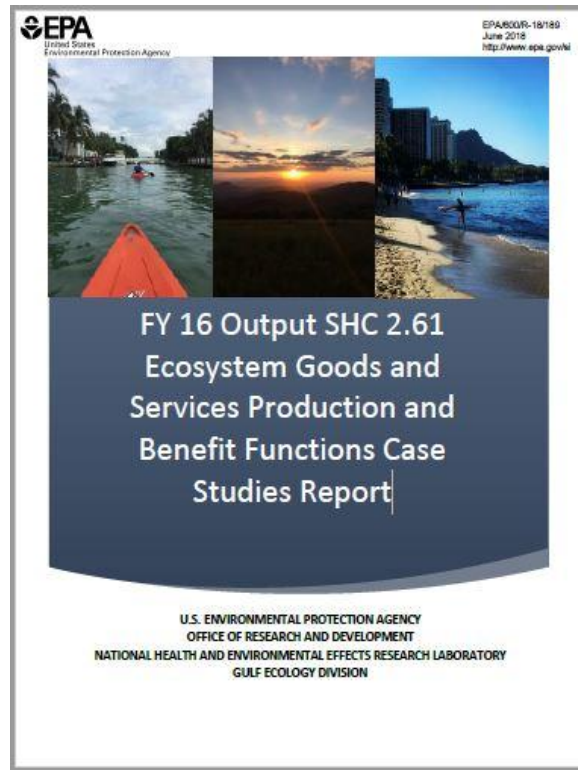
#### 4.07 What are some Practical Strategies for Assessing Final Ecosystem Goods and Services for Community Decision Making?



This synthesis report describes the USEPA’s Office of Research and Development’s (ORD) research to incorporate the sustainability of final ecosystem goods and services (FEGS) production and benefits into community-scale decisions across the U.S. In [FY17 Output SHC 2.61 Practical Strategies for Assessing Final Ecosystem Goods and Services in Community Decision Making](#), the reader can learn how community-based studies have previously utilized ecosystem services to inform aspects of their decision making, to identify best practices that may be transferred to other communities, and to identify gaps in those practices that need to be addressed. This report builds upon “Practical Strategies for Integrating Final Ecosystem Goods and Services into Community Decision Making” by Yee et al. (2017) and a number of other deliverables in ORD’s Sustainable Healthy Communities Research Portfolio covering work through FY 17.

Source: Harwell, M.C., and C. Jackson. (2018). FY17 Output SHC 2.61.3 Practical Strategies for Assessing Final Ecosystem Goods and Services in Community Decision Making. U.S. Environmental Protection Agency. EPA/600/R-18/083.

#### 4.08 What Can We Learn from Coordinated Case Studies Across the United States?



This synthesis report describes the USEPA's Office of Research and Development's research to incorporate the sustainability of final ecosystem goods and services production and benefits into community-scale decision-making at several study sites around the U.S. The five case study locations are San Juan, Puerto Rico, Great Lakes Region, Coastal Gulf of Mexico, Pacific Northwest, and Southern Plains Watersheds. The [FY16 Output SHC 2.61- Ecosystem Goods and Services Production and Benefit Functions Case Studies Report](http://www.epa.gov/rl) addresses: (1) how to estimate the production of ecosystem goods and services, given the type and condition of ecosystems; (2) how ecosystem services contribute to human health and well-being; and (3) how the production and benefits of these ecosystem services may change under various decision scenarios and in response to regional conditions.

Source: Harwell, M.C., and J. Molleda. (2018). FY16 Output SHC 2.61- Ecosystem Goods and Services Production and Benefit Functions Case Studies Report. U.S. Environmental Protection Agency. EPA/600/R-18/189.



#### 4.09 Who Benefits from Coastal Habitats?



To support coastal communities in land-use planning and prioritization efforts, university scientists and USEPA researchers, Theodore DeWitt and Matthew Harwell, examined the state of the science for final ecosystem goods and services (FEGS) in coastal ecosystems. They reviewed ~2,800 studies and documented how various human beneficiaries rely on coastal habitats in [Linking people to coastal habitats: A meta-analysis of final ecosystem goods and services on the coast](#). Recreational (83%) and industrial (35%) users were most cited in literature, with experiential-users/hikers and commercial fishermen most prominent in each class, respectively. This work highlights the intricate relationship between healthy coastal environments and the socio-economic systems they support. The authors hope communities and other stakeholders will couple results from this study with other tools, such as USEPA's EnviroAtlas, to recognize and protect existing FEGS, and plan for future ecosystem service delivery.

Source: Littles, C.J., C.A. Jackson, T.H. DeWitt, and M.C. Harwell. (2018). Linking people to coastal habitats: A meta-analysis of final ecosystem goods and services on the coast. *Ocean and Coastal Management*. 165: 356–369. <https://doi.org/10.1016/j.ocecoaman.2018.09.009>.

#### 4.10 How Does Air Pollution Impact Ecosystem Services?

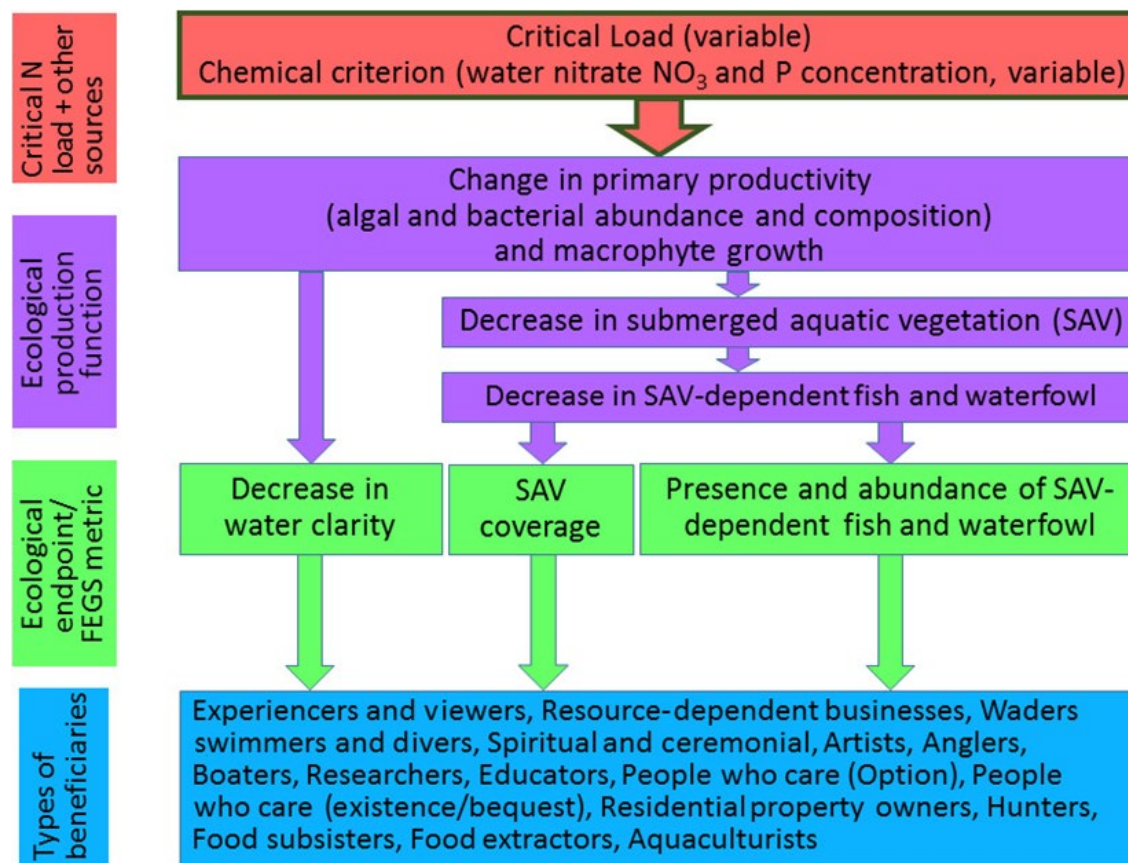


USEPA ORD researchers, Dixon Landers, Amanda Nahlik, and Chris Clark, worked together with a team including USEPA's Office of Air and Radiation and Office of Water in a workshop to introduce the STEPS (Stressor–Ecological Production function–final ecosystem Services) Framework, a novel way to apply FECS-CS as the foundation for identifying difficult and unknown linkages between humans and components of the environment that may lead to human well-being. In [A framework to quantify the strength of ecological links between an environmental stressor and final ecosystem services](#), the examine the ecological impacts of nitrogen and sulfur pollutant emissions and deposition to changes in final ecosystem services. This application is a means of defining a common approach to identify the potential beneficiaries and possible metrics and indicators.

Source: Bell, M.D., J. Phelan, T.F. Blett, D. Landers, A.M. Nahlik, G. Van Houtven, C. Davis, C.M. Clark, and J. Hewitt. (2017). A framework to quantify the strength of ecological links between an environmental stressor and final ecosystem services. *Ecosphere*. 8(5): e01806. <https://doi.org/10.1002/ecs2.1806>.



#### 4.11 How can Nitrogen Loading in Freshwater Systems Impact Final ES?



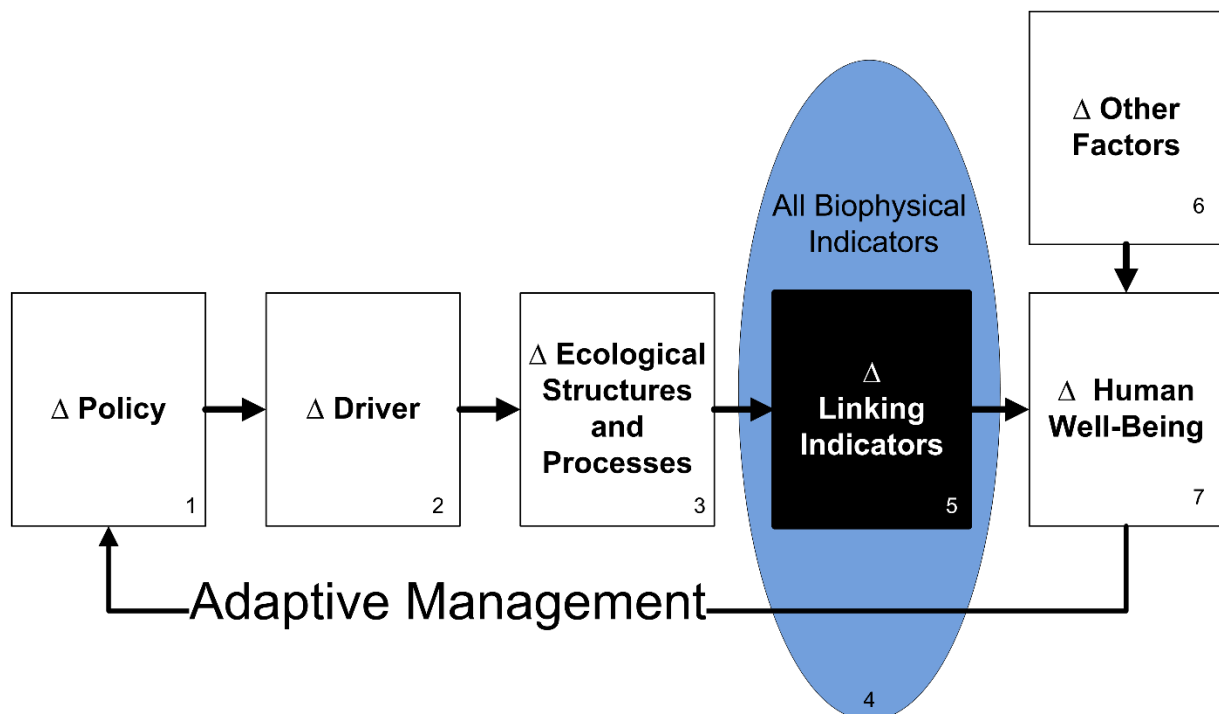
*Ecosphere*, Volume: 8, Issue: 7, First published: 24 July 2017, DOI: (10.1002/ecs2.1858)

USEPA ORISE post-doctoral research fellow Charles Rhodes, and USEPA researchers Jason Lynch and Randall Waite, along with USEPA Office of Water economist Julie Hewitt, worked together with three members from the US National Park Service, following a workshop to introduce the STEPS (Stressor–Ecological Production function–final ecosystem Services) Framework, a novel way to apply ecosystem services classification as the foundation for identifying difficult and unknown links between humans and components of the environment that may lead to human well-being. In [Diatoms to human uses: linking nitrogen deposition, aquatic eutrophication, and ecosystem services](#), the authors examine the ecological impacts of air-based nitrogen deposition in freshwater ecosystems as effects may propagate to changes important in final ecosystem services. This application focused on 154 of the 589 originally proposed chains from air-based nitrogen deposition to final ecosystem services, and was one of five focused papers out of the workshop to apply the STEPS framework ([Ecosphere Special Feature: Air Quality and Ecosystem Services](#)).

Source: Rhodes, C., Bingham, A., Heard, A.M., Hewitt, J., Lynch, J., Waite, R., Bell, M.D. (2017). Diatoms to human uses: linking nitrogen deposition, aquatic eutrophication, and ecosystem services. *Ecosphere*. 8(7): e01858. <https://doi.org/10.1002/ecs2.1858>.

#### 4.12 Improving the Linkage between Biophysical and Economic Analyses

A team of natural and social scientists examined the ways in which ecosystems link to human wellbeing and the way biophysical metrics and indicators should be defined to strengthen that linkage. The paper develops principles to guide the identification of Final Ecosystem Goods and Services (which it refers to as linking indicators); compares their features with those of more commonly collected data from the point of view of conducting monetary valuation of ecological outcomes ecological measures; and reviews empirical evidence pertinent to their identification, definition, and performance. The first section introduces the issue. Section 2 articulates two broad goals that the team argues can help frame the identification of linking indicators. The more obvious of these is the desire for biophysical outcomes that lay audiences can relate clearly to their own well-being. The second goal is to choose indicators that enhance the accuracy of social evaluations. The authors show how both goals are related to the concept of ecological production. Section 3 describes the deployment of linking indicators in various policy applications. Section 4 identifies research questions pertinent to identification and evaluation of linking indicators and reviews pertinent existing research. Section 5 summarizes the primary findings of the evaluation and offers recommendations for indicator development. This strategy should facilitate collaboration between natural and social scientists; improved understanding, specification, and measurement of linking indicators; and more accurate and powerful environmental policy analysis.



Source: Boyd, J., P. Ringold, A. Krupnick, R.J. Johnston, M.A. Weber, and K. Hall. (2016). Ecosystem services indicators: Improving the linkage between biophysical and economic analyses. *International Review of Environmental and Resource Economics*. 8:359-443.

#### 4.13 What Data Should We Collect?



A team of natural and social scientists applied the Final Ecosystem Goods and Services (FEGS) framework to identify metrics and indicators to link changes in policies to changes in human well-being when that linkage is mediated by ecosystems. The six-step process presented enabled the authors to propose metrics associated with streams that can be used in the analysis of human well-being. The team illustrates these steps with data from a regional stream survey. Continued refinement and application of this framework will require ongoing collaboration between natural and social scientists. Application of this framework could result in more useful and relevant data, leading to more informed decisions in the management of ecosystems.

Source: Ringold, P., J. Boyd, D. Landers, and M. Weber. (2013). What data should we collect? A framework for identifying indicators of ecosystem contributions to human well-being. *Frontiers in Ecology and the Environment*. 11:98-105.

# 5.0 Example Applications

## 5.1 Example 1: Ecological restoration at a Superfund landfill site

The purpose of this section is to provide a relatively simple example illustrating how NESCS Plus can be used as a tool to support decisions affecting ecosystem services. Please note that applying NESCS Plus to support an ecological revitalization project could certainly be much more detailed and complex than what is described here. This example is kept simple strictly for illustrative purposes.

In this example, a Superfund site has a landfill that was capped three decades ago in a way that is protective of human health and the environment. Weeds and non-native species dominate the landfill site. In its current condition, the site provides negligible value to the local community and nearby area. Federal, state, and local officials are collaborating on an ecological restoration project aimed at promoting the well-being of the local community by broadly enhancing the ecosystem services offered by the site.

The restoration project will primarily involve revegetation of the landfill cap with sustainable and low maintenance native grasses and flowers. In completing the project design, the team needs to evaluate available restoration options, based on current site conditions and constraints. Using input from the community, they are also interested in identifying and assessing which types of ecosystem services potentially offered by the project would be most relevant to, and favored by, the community. They will use NESCS Plus to identify the ecosystem services of interest and to communicate about them to diverse stakeholders.

The project involves two parts: (1) physical removal of non-native plants, by digging and pulling them from the soil; and (2) planting and maintenance of native grasses and flowers.

To understand and evaluate the ecosystem services affected by these actions, the project team wishes to identify the different environmental and societal pathways through which human well-being may be affected. These pathways are represented through a conceptual model (flow diagram; in **Figure 5.1** and **Figure 5.2**; Olander et al., 2015).

The two connected figures show how NESCS Plus can be used in conjunction with conceptual models to identify and list the distinct types of final ES potentially affected by a policy action. Importantly, NESCS Plus is not by itself a tool for developing these conceptual models. Constructing these flow diagrams may require the analyst to draw from a substantial body of scientific knowledge and evidence that is not contained in NESCS Plus (Bell et al., 2017; Clark et al., 2017; Irvine et al. 2017). However, when combined with this knowledge and evidence, NESCS Plus provides a framework that can help to identify and articulate relevant pathways. More specifically, it can help to identify those points in the pathways where natural systems are directly used by human systems.

In **Figure 5.1**, the model begins on the left side by showing the grassland restoration activities under consideration. In the figure, each green oval represents an “ecological production function” (EPF) that transforms inputs from nature into outputs, and these outputs can then be used by other processes. Arrows are used to represent flows in and out of these processes, and boxes represent stocks in nature.

Flows of final ES occur at the point where these ecological production processes connect to human processes. Examples of different types of final ES that are potentially affected by the restoration actions are listed in the table on the right side of the diagram. Each of the eight rows in this table represents and provides a unique four-part code representing different types of final ES flows.

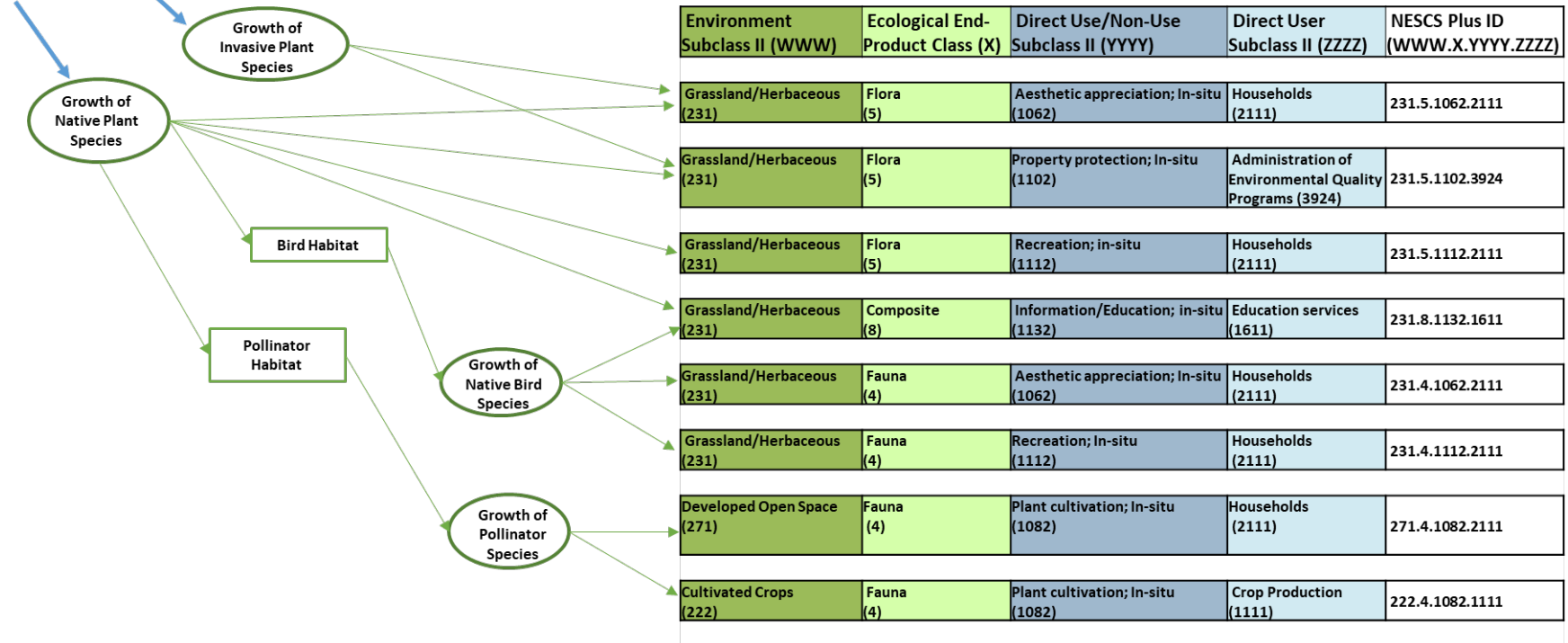
Specifically, each final ES row is represented by a different combination of the four components – Environment (*WWW*), Ecological End-Product (*XXX*), Direct Use (*YYYY*) and Direct User (*ZZZZ*) – shown in the columns. Each row represents a final ES and includes the NESCS Plus code for each component. The final column contains the complete NESCS Plus code for each final ES example.

In this example, the first action – removal of invasive plants – directly affects the ecological production process described as “growth of invasive plant species.” In this case, it completely halts and removes this process. The growth of invasive plant species is shown to be directly connected to two main types of final ES. The first is the flow of final ES provided by the invasive plants (Environment = Grassland; EEP = Flora) to aesthetic enjoyment by people in the community (Direct Use = Aesthetic appreciation; Direct User = Households). The final ES code corresponding to this four-component description is 231.5.1062.2111.



### Grassland Restoration

- Removal of invasive plants
- Planting of native species

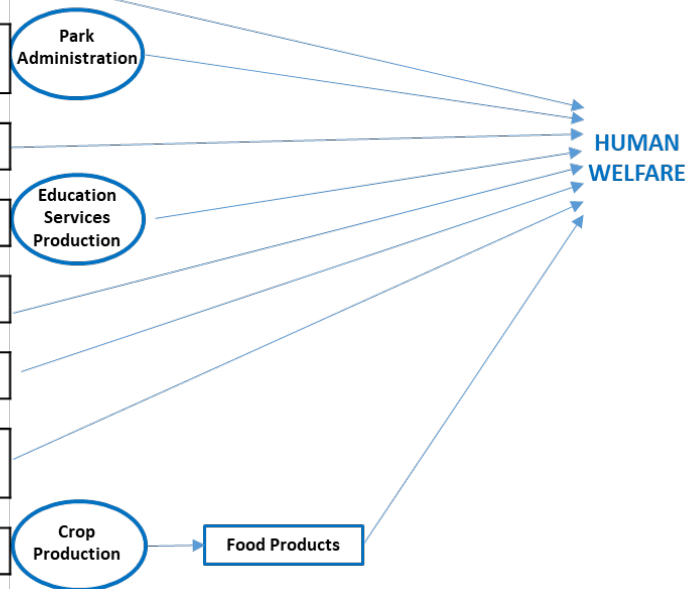


**Figure 5.1** Example 1: Landfill restoration conceptual model linking the environment to a tabular list of final ES. Components of ecosystems are represented in green and human systems in blue. In the flow diagram, boxes represent stocks, arrows represent flows, and circles represent processes.



### LIST OF AFFECTED FINAL ECOSYSTEM SERVICES (FES)

Environment Subclass II (WWW)	Ecological End-Product Class (X)	Direct Use/Non-Use Subclass II (YYYY)	Direct User Subclass II (ZZZZ)	NESCS Plus ID (WWW.X.YYYY.ZZZZ)
Grassland/Herbaceous (231)	Flora (5)	Aesthetic appreciation; In-situ (1062)	Households (2111)	231.5.1062.2111
Grassland/Herbaceous (231)	Flora (5)	Property protection; In-situ (1102)	Administration of Environmental Quality Programs (3924)	231.5.1102.3924
Grassland/Herbaceous (231)	Flora (5)	Recreation; in-situ (1112)	Households (2111)	231.5.1112.2111
Grassland/Herbaceous (231)	Composite (8)	Information/Education; in-situ (1132)	Education services (1611)	231.8.1132.1611
Grassland/Herbaceous (231)	Fauna (4)	Aesthetic appreciation; In-situ (1062)	Households (2111)	231.4.1062.2111
Grassland/Herbaceous (231)	Fauna (4)	Recreation; In-situ (1112)	Households (2111)	231.4.1112.2111
Developed Open Space (271)	Fauna (4)	Plant cultivation; In-situ (1082)	Households (2111)	271.4.1082.2111
Cultivated Crops (222)	Fauna (4)	Plant cultivation; In-situ (1082)	Crop Production (1111)	222.4.1082.1111



**Figure 5.2** Example 1: Landfill restoration conceptual model linking the tabular list of final ES to human well-being. Components of ecosystems are represented in green and human systems in blue. In the flow diagram, boxes represent stocks, arrows represent flows, and circles represent processes.

The second action – planting of native species – directly affects the ecological production process described as “growth of native plant species.” This production process is connected to multiple final ES via several pathways. Like the growth of invasive species, it is directly connected to several final ES categories, including the two described in the previous paragraph. However, in this case, the final ES flows for aesthetic appreciation are likely to have a positive value, and those for property protection may be greater than for invasive grasses. The growth of native grasses is also directly connected to two other types of final ES. The first flows from the plants themselves (Environment = Grassland; EEP = Flora) to those enjoying the native grasses for recreational purposes (Direct Use = Recreation; in-situ) such as nature walks. The second type of final ES flows to those who use the site to provide educational opportunities for others (Direct Use = Information/education; in-situ; Direct User = Educational Services).

The growth of native plant species is also connected *indirectly* to several more final ES types. These indirect pathways are shown in **Figure 5.1** by the flows from this ecological production process to two types of stocks – Bird Habitat and Pollinator Habitat – which then serve as inputs to other ecological production processes – growth in native bird species and growth in pollinator species. In other words, the growth of native plants increases the land area suitable for native birds, which is a critical input for growth in native bird populations.

The native bird and pollinator processes are then *directly* connected to several types of final ES. For example, the combination of native plant species, native bird species, and pollinators together provide a “Composite” EEP category, which is used for educational purposes. The native bird species are also directly linked to a final ES class that flows from the birds themselves (Environment = Grassland; EEP = Fauna) to birdwatchers who visit the new grassland (Direct User = Recreation; in-situ). The growth in pollinator species is linked to final ES categories provided by other nearby environments. In the Urban/Suburban environment category, the pollinator species (EEP = Fauna) support the growth of home gardens (Direct Use = Plant cultivation; in-situ; Direct User = Households), and in the Agroecosystems environment they support the growth of crops by local farmers (Direct User = Agricultural Sector).

The example shown in **Figure 5.1** illustrates another important feature of EEP and final ES, which is that many components of nature, such a flora and fauna, can provide both final and intermediate ecosystem services. Whether the services they provide are final or intermediate depends on whether they are being used directly and/or indirectly by humans. In this example, the grassland flora is categorized as an EEP and a source of final ES for recreational users of the park who directly view and appreciate their plant life. In addition, and at the same time, they provide habitat for birds, which are then directly used by recreational birdwatchers. In this second indirect role, the grassland flora are the source intermediate ecosystem services.

**Figure 5.2** represents the continuation of the flow diagram in **Figure 5.1** into human systems. Therefore, the left side of this diagram contains the same list of FES combinations as are shown on the right side of **Figure 5.1**. In **Figure 5.2**, each blue oval represents an “economic production” process, where inputs from nature or from other economic production processes are

converted into economic outputs. As in **Figure 5.1**, the input-output production processes can be linked together through distinct pathways, and developing these parts of the pathways may require users to draw on their own specialized knowledge of the case study context or on other expert knowledge (in this case of human and economic systems) to develop them.

In **Figure 5.2**, all the final ES types including Households as the Direct User classes flow directly to human welfare. In the other cases, however, the FES are inputs to production processes. For example, the fourth row represents the flow of final ES from the grassland ecosystem (Environment = Grassland; EEP = Composite) to those who use the ecosystem to provide educational experiences for others (Direct Use = Information/Education; in-situ; Direct User = Educational Services). In this case, the education providers use the composite inputs from the environment to produce education services. This flow of education services is represented by the arrow from the Education Services Production process to Human Welfare. Another example is shown in the last row, which represents the flow of FES from pollinators (Environment = Agroecosystems; EEP = Fauna) to farmers (Direct Use = Plant cultivation; in-situ; Direct User = Agriculture). In this case, crop production is the directly affected economic production process. However, the outputs from this process do not flow directly to households. Instead, they are inputs to another production process (Food Manufacturing) which then produces outputs that flow directly to human welfare.

## 5.2 Example 2: Benefits Analysis of an Environmental Policy Action – Proposed Revisions to an Air Quality Standard for Nitrogen Oxides

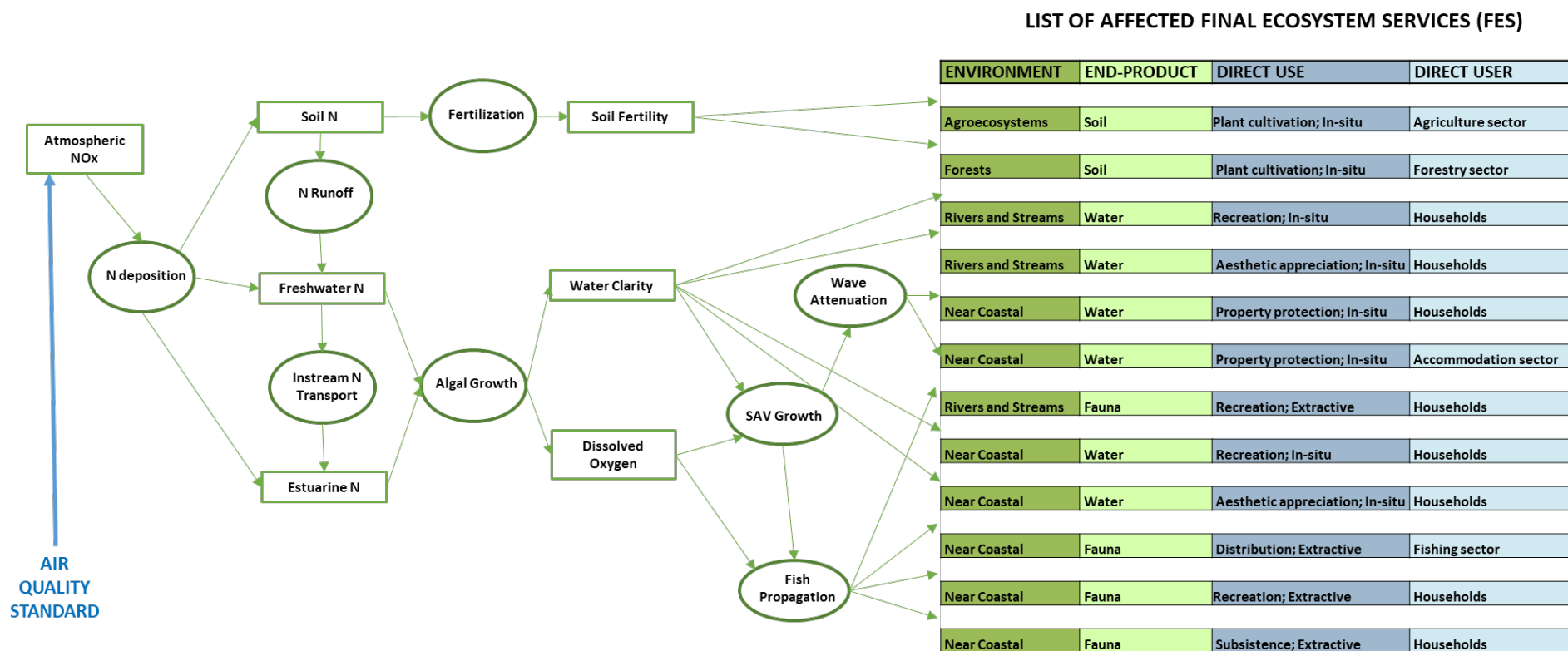
In this example, an air quality regulator is interested in estimating the benefits of a proposed action to lower the allowable ambient concentration of nitrogen oxides (NO<sub>x</sub>) in the US to protect potentially vulnerable ecosystems. Although this type of action is expected to provide several benefits to humans, including direct human health benefits from reduced respiratory exposures to airborne pollutants, for simplicity it is assumed that the specific focus of this benefits analysis is on the changes in human well-being resulting from reductions in nitrogen (N) deposition and its contribution to nutrient enrichment of soils and aquatic systems. In other words, how will reductions in N deposition and nutrient enrichment alter the environment and the ecosystem services that are ultimately received by humans?

It is also assumed the analysis will be part of a larger benefit-cost analysis (BCA) of the proposed action. Therefore, to the extent feasible, the benefits need to be quantified in monetary terms, so that they can be combined with other benefit estimates and directly compared to the economic costs.

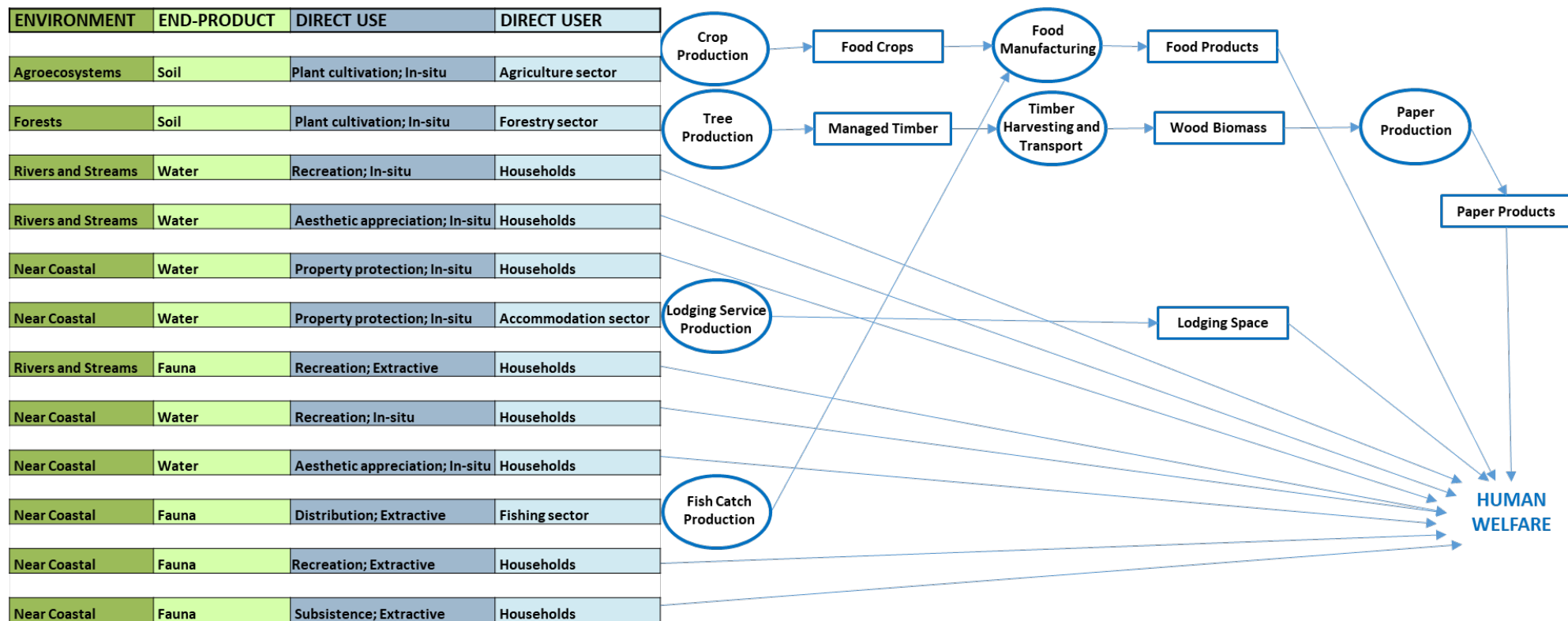
As a first step in this analysis, it will help to begin by identifying the pathways through which human well-being may be affected by the proposed action. The conceptual model in **Figure 5.3** and **Figure 5.4** depicts the pathways for this example.

The model begins on the left side of the diagram with the proposed action under consideration (air quality standard setting). In the diagram, the ecological stocks provide flows of inputs to the ecological processes, and the processes generate output flows that alter the stocks. It is assumed that the analyst builds these connections by drawing on evidence from the scientific literature regarding the potentially affected environments and ecological processes. In this example, the proposed action most directly affects the stock (concentration) of NO<sub>x</sub> in the atmosphere. From there, the process of N deposition transforms these NO<sub>x</sub> inputs into stocks of N in soils and in surface waters. These stocks then become the source of flows into other natural processes including nutrient runoff, in-stream transport, and algae production (Rhodes et al. 2017).

Flows of FES occur at the point where these ecological production processes connect to human processes. Examples of different FES categories that are potentially affected by the proposed action (through the pathways) are listed in the table on the right side of the diagram. Each of the 12 rows in this table represents a different type of FES. Specifically, each FES row is represented by a different combination of the four components shown in the columns. To simplify the diagram, the table uses abbreviated terminology for many of the classes and subclasses of the four components. To conserve on space, the NESCS Plus codes are not included in the diagrams for this example (or the next one).



**Figure 5.3** Example 2: Air quality standard conceptual model linking the environment to a tabular list of final ES. Components of ecosystems are represented in green and human systems in blue. In the flow diagram, boxes represent stocks, arrows represent flows, and circles represent processes.



**Figure 5.4** Example 2: Air quality standard conceptual model linking the tabular list of FES to human welfare. Components of ecosystems are represented in green and human systems in blue. In the flow diagram, boxes represent stocks, arrows represent flows, and circles represent processes.

Several examples of pathways linking the proposed action (air quality standard) to individual FES are shown in **Figure 5.3**. In this case, all the chains begin by affecting the nitrogen deposition process, but from there they diverge. For example, one output from reducing nitrogen deposition is that it reduces the stock (level) of N in freshwater. From there, changes in this N stock are inputs to the instream algal production process, and one of the effects of limiting the algal growth process in streams is that it increases the clarity of the water. Since this water clarity in nature can be directly appreciated by humans, it can be linked to one or more FES combinations. To apply NESCS Plus at this point, water clarity must first be categorized (on the natural system “supply” side) into: (1) one of the NESCS Plus Ecological End-Product classes (in this case, Water); and (2) the Environmental class in which this end-product is located (Rivers and Streams).

To complete the FES classification for this pathway, the Environment/Ecological End-Product combination must be linked to the human system “demand” side. In the example shown in **Figure 5.4**, this means linking the combination to at least one Direct Use class and one Direct User class (an example using the alternative Beneficiary classification is offered in **Figures 5.5** and **5.6**). The diagram includes two such connections – one involving in-situ recreational use by households and another involving in-situ aesthetic appreciation by households.

Water clarity can also be on the part of a pathway that does not directly connect to human processes, in which case it does not provide or directly contribute to a final ES. For example, higher water clarity can promote the process of submerged aquatic vegetation (SAV) growth. Assuming there are no direct human uses of SAV, additional connections are needed to identify the affected final ES. One way is through SAV’s contribution to the growth and propagation of fish, which are directly used and valued by humans. Therefore, on the natural system “supply” side, fish must be categorized into one of the NESCS Plus Ecological End-Product classes (in this case, Fauna) and into the Environmental class in which this Ecological End-Product is located (for example, Near Coastal Marine/Estuarine). Once again, to complete the FES classification, each Environment-End-product combination must be linked to a human system “demand” side combination. One example is commercial fish harvest, which in the NESCS Plus system is a Direct Use of Distribution-Extractive and a Direct User class of Industry-Fishing.

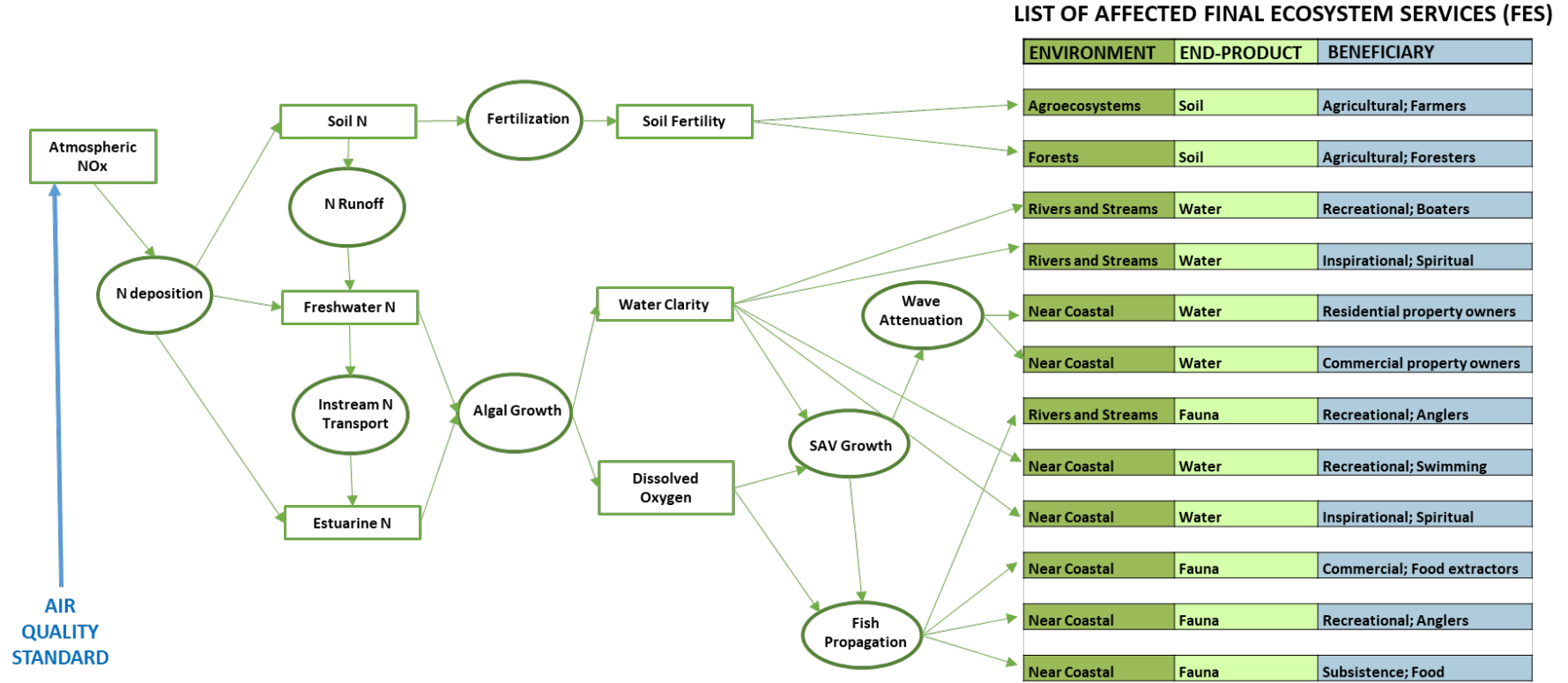
In the end, each distinct FES combination identified and listed in the conceptual model can be linked back to the proposed action through at least one modeled pathway. The length of these pathways (i.e., the number of input-output processes) can vary widely depending on the context.

**Figure 5.5** represents the continuation of the flow diagram in **Figure 5.4** into human systems. Therefore, the left side of this diagram contains the same list of final ES combinations as are shown on the right side of **Figure 5.4**. In **Figure 5.5**, each blue oval represents an “economic production” process, where inputs from nature or from other economic production processes are converted into outputs. As in **Figure 5.4**, the input-output production processes can be linked together through distinct pathways, and the user may need to draw on expert or scientific knowledge (in this case of human and economic systems) to develop them. For example, the FES

combination involving commercial fishing (Direct Use of Extractive-Distribution and a Direct User class of Industry-Fishing) is directly associated with a fish catch production process. In this example, the output of this process is landed fish, with the fishermen benefiting directly from the FES. These fish are bought and sold in transactions between industries and households. In this case, the fish caught by commercial fishermen enter as inputs into the food manufacturing process. The food products that result from this second process are the economic goods that are generally available for household consumption.

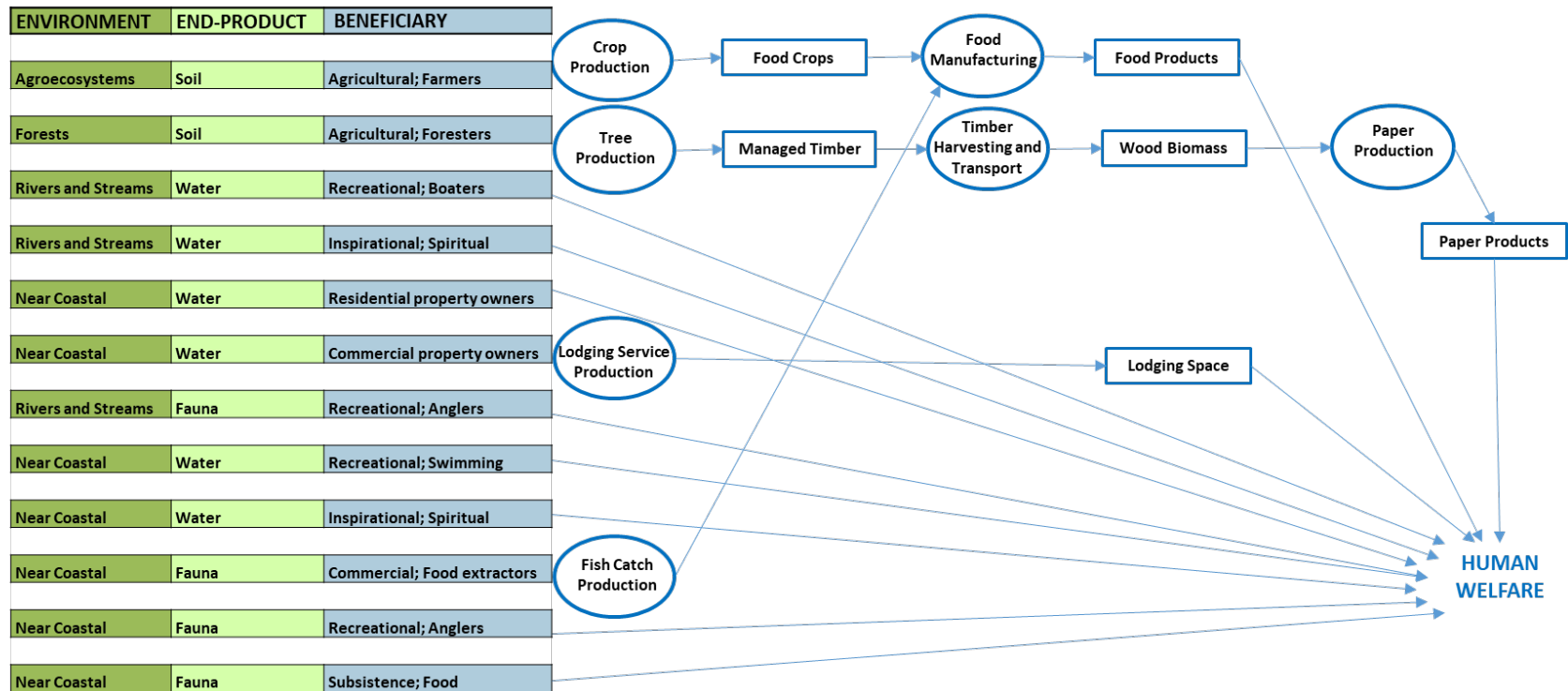
**Figures 5.5 and 5.6** show how the same process of listing FES for this NO<sub>x</sub> application can be done using the Beneficiary classification component instead of the Direct Use and Direct User classification components. Therefore, the FES tables in these diagrams contain three columns (components) rather than four.





**Figure 5.5** Example 2: Conceptual model linking a proposed action (air quality standard) to a tabular list of FES (with the Beneficiary classification). Components of ecosystems are represented in green and human systems in blue. In the flow diagram, boxes represent stocks, arrows represent flows, and circles represent processes.

### LIST OF AFFECTED FINAL ECOSYSTEM SERVICES (FES)



**Figure 5.6** Example 2: Conceptual model linking the tabular list of FES (with the Beneficiary classification) to human welfare. Components of ecosystems are represented in green and human systems in blue. In the flow diagram, boxes represent stocks, arrows represent flows, and circles represent processes.

### **5.3 Example 3: Analysis for a surface mine expansion project under the National Environmental Policy Act (NEPA)**

In this example, a federal agency is conducting a NEPA-required environmental impact assessment for a proposed expansion of a surface gold mine on federal lands. This assessment includes an evaluation of the socioeconomic effects of the proposed mine expansion. Three main alternatives are under consideration, including a No-Action alternative and two action alternatives. Although not specifically required under NEPA, analysts for the agency wish to include an assessment of impacted ecosystem services under the action alternatives (compare to the No Action alternative) as part of the socioeconomic analysis.

The mine expansion site being evaluated is in a predominantly sagebrush shrubland environment. The area provides habitat for birds that forage and/or nest on the ground, and it is occasionally used for hunting by nearby residents. The area drains to a river that is one mile away. The area directly surrounding the mine includes a small number of ephemeral streams and wetlands fed by groundwater. The proposed expansion of the mine would involve clearing vegetation and regrading lands for roads, disposal areas, and for new excavation in a 1 million ft<sup>2</sup> area (92,903 m<sup>2</sup>). It would also create a new pit lake fed by deep groundwater. Operating in this expanded area will require pit dewatering.

Under the No-Action alternative, the mine site would not be expanded and would remain within its current boundaries. To keep the example simple, conditions under the No-Action alternative are assumed to be the same as current conditions. The main difference between the two action alternatives is the destination of the water removed from the pit. To summarize, the three alternatives are as follows:

#### Alternative 1 – No Action

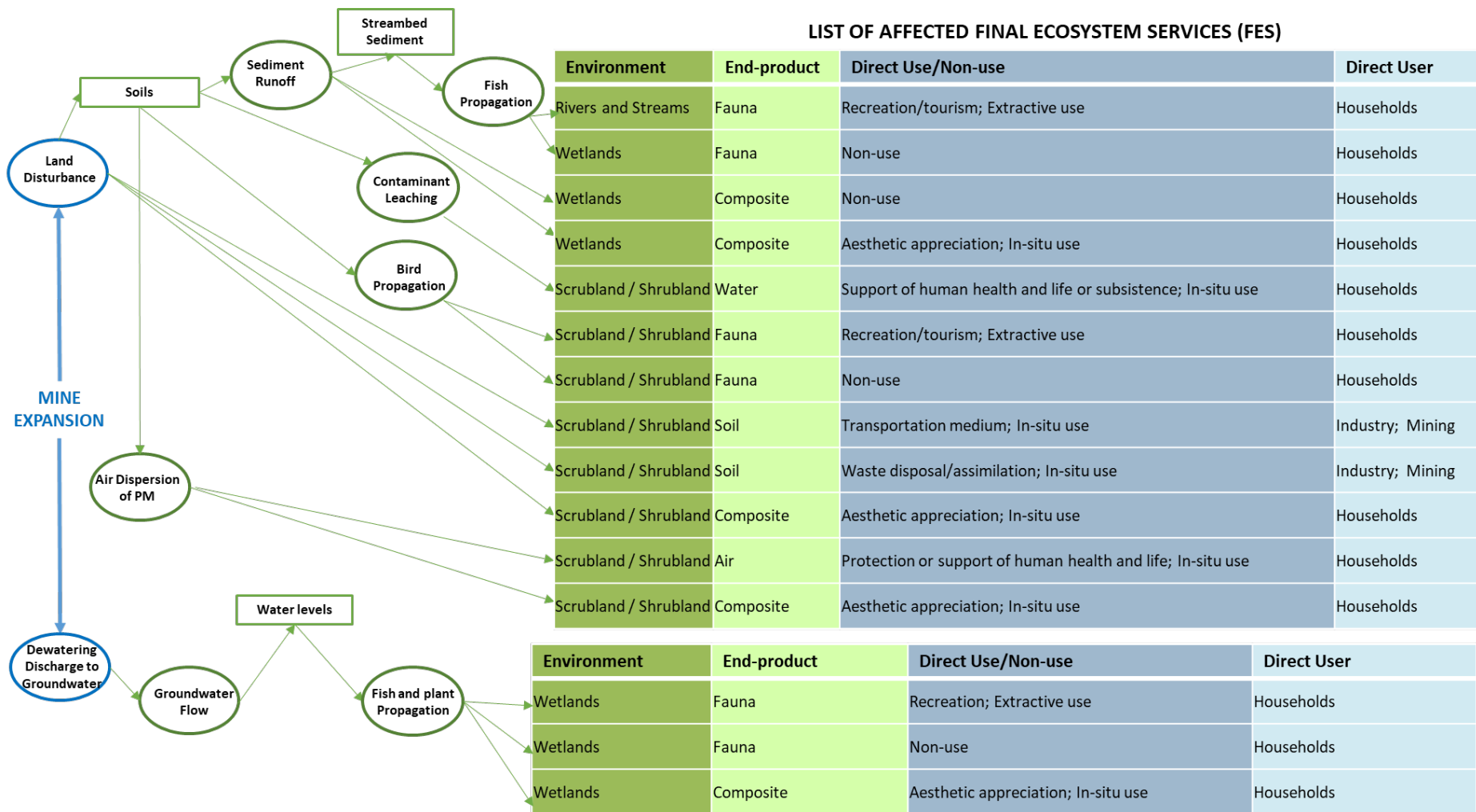
- No mine expansion and no change from current conditions

#### Alternative 2 – Mining + Dewater deep groundwater and infiltrate excess to alluvium

- Treat and discharge water to alluvial aquifer via Rapid Injection Basins (RIBs) during mining

#### Alternative 3 – Mining + Dewater deep groundwater and discharge to stream

- Treat and discharge water to ephemeral stream during mining

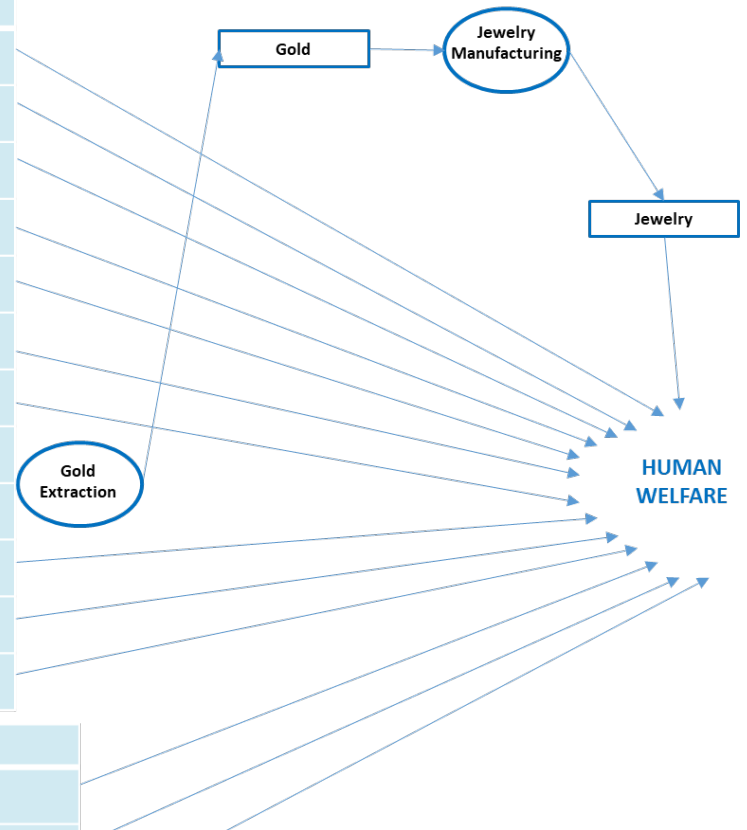


**Figure 5.7 Example 3: Conceptual model for Alternative 1 – Mining + Dewater deep groundwater and infiltrate excess to alluvium.** Components of ecosystems are represented in green and human systems in blue. In the flow diagram, boxes represent stocks, arrows represent flows, and circles represent processes.

### LIST OF AFFECTED FINAL ECOSYSTEM SERVICES (FES)

Environment	End-product	Direct Use/Non-use	Direct User
Rivers and Streams	Fauna	Recreation/tourism; Extractive use	Households
Wetlands	Fauna	Non-use	Households
Wetlands	Composite	Non-use	Households
Wetlands	Composite	Aesthetic appreciation; In-situ use	Households
Scrubland / Shrubland	Water	Support of human health and life or subsistence; In-situ use	Households
Scrubland / Shrubland	Fauna	Recreation/tourism; Extractive use	Households
Scrubland / Shrubland	Fauna	Non-use	Households
Scrubland / Shrubland	Soil	Transportation medium; In-situ use	Industry; Mining
Scrubland / Shrubland	Soil	Waste disposal/assimilation; In-situ use	Industry; Mining
Scrubland / Shrubland	Composite	Aesthetic appreciation; In-situ use	Households
Scrubland / Shrubland	Air	Protection or support of human health and life; In-situ use	Households
Scrubland / Shrubland	Composite	Aesthetic appreciation; In-situ use	Households

Environment	End-product	Direct Use/Non-use	Direct User
Wetlands	Fauna	Recreation; Extractive use	Households
Wetlands	Fauna	Non-use	Households
Wetlands	Composite	Aesthetic appreciation; In-situ use	Households



**Figure 5.8** Example 3: Conceptual model for Alternative 2 – Mining + Dewater deep groundwater and discharge to stream. Components of ecosystems are represented in green and human systems in blue. In the flow diagram, boxes represent stocks, arrows represent flows, and circles represent processes.

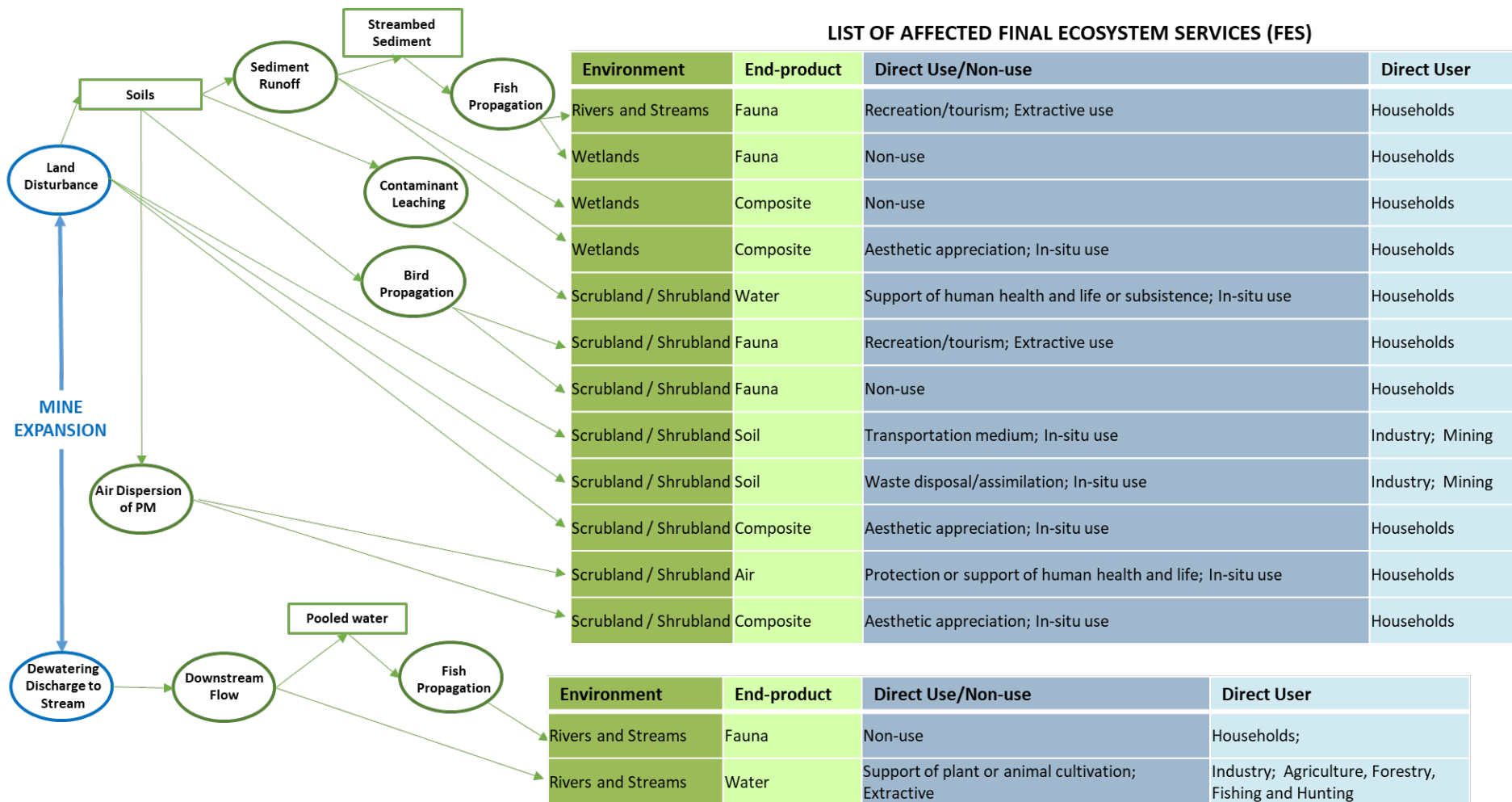
**Figures 5.7 and 5.8** present diagrams and lists of FES affected by the two action alternatives (relative to the no-action alternative). In both cases, the main action is the proposed mine expansion, and in both cases, one result of this expansion is land disturbance for building access roads. The main differences between the two diagrams are the types of disposal of excess dewatering water linked to the mine expansion and the ecological processes and FES affected by these alternative approaches.

For both action alternatives, the land disturbance caused by the mine expansion is linked through pathways to 12 different FES. Three of these chains link directly to FES provided by the Scrubland/shrubland Environmental class in which the mine is located. For two of these FES, the Ecological End-Product is the soil provided by the shrubland, and the Direct User class for this soil is the mining sector. In one case the Direct Use of this soil is as a medium of transportation for mine vehicles, and in the other case it is used as a medium for mine waste disposal and assimilation. In both cases, the soils in the mine expansion area would be altered to provide a new ecosystem service, which did not previously exist at the site and therefore would not exist under a no-action alternative. For the third FES, the Ecological End-Product is the Composite class, which in this case refers to the overall landscape provided by the shrubland environment. The Direct Users of this Ecological End-Product are households who use this shrubland environment for aesthetic appreciation.

For the other nine FES affected by land disturbance, their pathways involve one or two ecological production processes. In four cases, the soil disturbance increases the sediment runoff process, which affects the nearby Wetland and River-and-Stream Environments. The pathways for the other FES involve processes such as contaminant leaching to groundwater (under the Scrubland/Shrubland Environment) that is potentially used for drinking water and dispersion of particulate matter (PM) into the Atmosphere.

The difference between the two alternatives regarding their effects on FES stems from their different dewatering processes. In Alternative 1, the water is discharged to groundwater, which feeds nearby wetlands. The resulting increase level of water in these wetlands improves the habitats for grasses and fish, which enhances the three types of FES for households shown in Figure 6. In Alternative 2, the water is discharged to a stream which feeds a nearby river. The increased water flow supports two FES. In one case it improves habitat for fish with non-use value for households, and in the other it makes more water available for irrigated agriculture.

**Figures 5.9 and 5.10** repeat the example 2 conceptual diagrams using the Beneficiary classification. For all the FES in these diagrams that include Households as the Direct User class, the chains connect directly to human welfare (i.e., welfare benefits are realized by individuals in households). For the FES that include an industry as the Direct User, the chains include one or more economic production processes. For example, when the mining sector is the Direct User component of the FES, the corresponding Ecological End-Product component (i.e., soils) is treated as an input to the gold mine production process. The output of this production process is gold which, in this example, becomes an input into the jewelry production process.

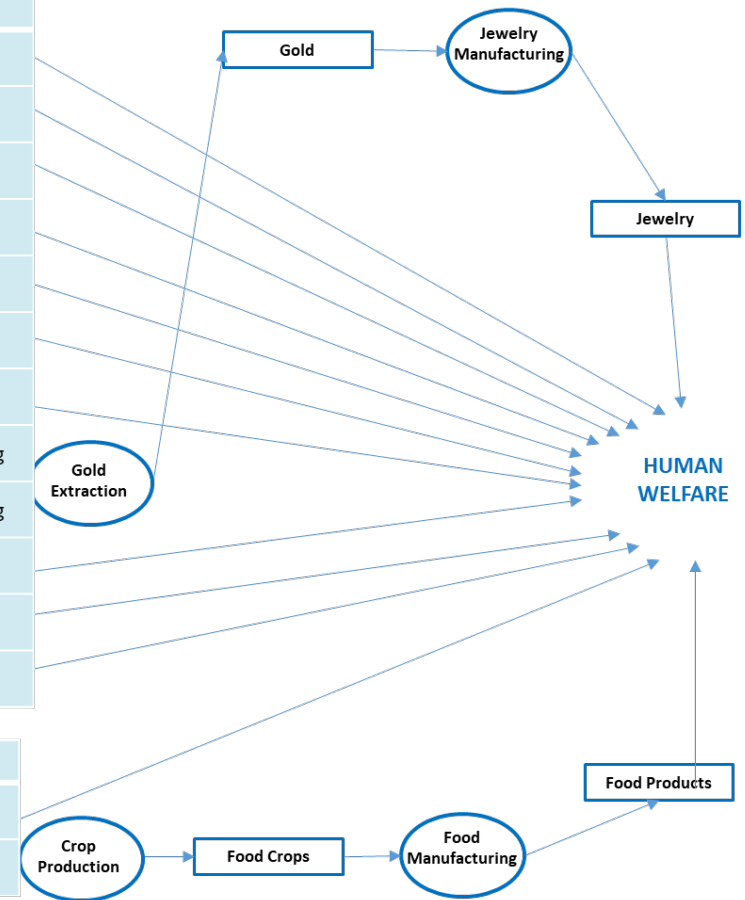


**Figure 5.9** Example 3: Second part of conceptual model for Alternative 1 – Mining + Dewater deep groundwater and infiltrate excess to alluvium. Components of ecosystems are represented in green and human systems in blue. In the flow diagram, boxes represent stocks, arrows represent flows, and circles represent processes.

### LIST OF AFFECTED FINAL ECOSYSTEM SERVICES (FES)

Environment	End-product	Direct Use/Non-use	Direct User
Rivers and Streams	Fauna	Recreation/tourism; Extractive use	Households
Wetlands	Fauna	Non-use	Households
Wetlands	Composite	Non-use	Households
Wetlands	Composite	Aesthetic appreciation; In-situ use	Households
Scrubland / Shrubland	Water	Support of human health and life or subsistence; In-situ use	Households
Scrubland / Shrubland	Fauna	Recreation/tourism; Extractive use	Households
Scrubland / Shrubland	Fauna	Non-use	Households
Scrubland / Shrubland	Soil	Transportation medium; In-situ use	Industry; Mining
Scrubland / Shrubland	Soil	Waste disposal/assimilation; In-situ use	Industry; Mining
Scrubland / Shrubland	Composite	Aesthetic appreciation; In-situ use	Households
Scrubland / Shrubland	Air	Protection or support of human health and life; In-situ use	Households
Scrubland / Shrubland	Composite	Aesthetic appreciation; In-situ use	Households

Environment	End-product	Direct Use/Non-use	Direct User
Rivers and Streams	Fauna	Non-use	Households;
Rivers and Streams	Water	Support of plant or animal cultivation; Extractive	Industry; Agriculture, Forestry, Fishing and Hunting



**Figure 5.10** Example Application 3: Second part of conceptual model for Alternative 2 – Mining + Dewater deep groundwater and discharge to stream). Components of ecosystems are represented in green and human systems in blue. In the flow diagram, boxes represent stocks, arrows represent flows, and circles represent processes.



## 5.4 Organizing final ES accounts

Once a list of potentially affected final ES has been identified with NESCS Plus (such as the one in **Figures 5.1-5.10**) the list can be used to organize the process of quantifying and/or monetizing changes in the identified final ES. Generating these types of estimates is particularly relevant for cost-benefit analyses, such as the one described in the first example (NO<sub>x</sub>). The NESCS Plus does not provide a system for quantifying or monetizing final ES, but it can serve as an organizing structure.

First, the analyst can use the list of final ES to prioritize which final ES are most easily and cost-effectively quantified and monetized. This process includes identifying and planning for which of the listed final ES can be captured by different valuation methods. For example, travel cost methods can potentially be used for all the final ES involving recreation as a Direct Use, whereas hedonic methods could be used for final ES involving aesthetic appreciation as a Direct Use. One can also use the list of final ES to evaluate which direct uses are likely to be competing against each other (e.g., an ecosystem good can only be used in a consumptive fashion once, while it might be used in a non-consumptive fashion by many users). In addition, the list can be combined with other tools, such as USEPA's EnviroAtlas (<https://www.epa.gov/enviroatlas>), to investigate which final ES are most likely to occur in particular areas due to proximity of populations or economic production capacity with available Ecological End-Products.

Importantly, using final ES to organize the quantification and monetization of final ES (e.g., accounts; Russell et al. 2020; Warnell et al. 2020) should not be interpreted to mean that the value of each final ES in the list needs to be or can be measured separately. For example, stated preference methods for valuing improvements in water quality may be used to estimate several final ES in a single value. In many cases, analyst judgment may be needed to determine which final ES are or are not included in value estimates generated with different valuation methods.

Second, the analyst can use the NESCS Plus final ES categories to systematically combine and aggregate the value estimates developed in the previous steps. These final ES categories are designed to be as mutually exclusive as possible; therefore, the analyst should be able to add benefits that are in different categories. For example, in the NO<sub>x</sub> application, the benefit estimates for final ES involving agricultural users due to soil fertility changes could be added to benefit estimates for final ES involving commercial fishing users due to increases in fish abundance. However, as discussed above, not all value estimates can be separated in this way. For example, a stated preference study could generate estimated values that overlap with recreation value estimates from travel cost methods. In these cases, NESCS Plus can at least help to identify where these types of overlaps may be occurring and to be explicit about which specific final ES are potentially being double counted. In a similar way, NESCS Plus can be used to identify and specify the final ES that are not being quantified or monetized in the benefits analysis.

## 5.5 Cataloguing and Retrieving Final ES Data

A third potential use of NESCS Plus is as an organizing structure for storing and retrieving final ES-related information from existing studies and applications. In other words, it can be used as a meta data system for organizing databases, libraries, or other collections of final ES-related information.

For the NO<sub>x</sub> application, this NESCS Plus feature could be used in several ways. For example, due to commonly encountered budgetary constraints for this type of analysis, it may require a “benefit transfer” approach. To apply this type of secondary data approach, analysts adapt and transfer benefit estimates from existing studies rather than developing new value estimates.

Thus, the first step in conducting a benefit transfer analysis is to identify studies that contain relevant and transferable benefit estimates. The relevance of existing studies can be determined in part by the specific types of final ES they address. If the features of existing studies were systematically classified or coded using NESCS Plus, then the resulting metadata would make it easier to conduct searches of the literature and to identify studies and final ES-related estimates that are suitable for benefit transfer. For instance, the NESCS Plus classification components could in principle be included in the contents and search criteria of existing benefit transfer databases, such as the Environmental Valuation Resource Inventory (EVRI) (<https://www.evri.ca/en/home>).

In addition to a benefit transfer approach, the analysis may require a process for searching and identifying existing quantitative measures of final ecosystem goods or final ES (e.g., indicators or metrics) or existing models of the ecological processes that generate final ES. Again, if existing measures and models were systematically classified or coded using NESCS Plus, then the resulting metadata could be used. For example, USEPA’s EcoService Models Library (ESML) (<https://esml.epa.gov/>), a searchable database of models for estimating the ecological production of ecosystem goods and services, includes NESCS components among its search criteria.

This metadata feature of NESCS Plus can also be used to store and catalogue the *results* of the NO<sub>x</sub> analysis. For future applications, such as cost-benefit analyses of other proposed air or water quality standards, this feature would allow analysts to more easily locate and make use of the methods, lessons, and findings from this analysis.

## 5.6 Key Issues and Considerations in Using NESCS Plus

When using NESCS Plus for this type of analysis, it is important to be aware of the inherent limits of the system. These limits (some of which have been mentioned above) include the following:

- NESCS Plus can help to organize and structure analyses of final ES, but it is not by itself a final ES quantification or valuation tool. It must be paired with final ES measurement or modeling methods to make it useful for further analysis.
- Using NESCS Plus to inform valuation does not imply that separate benefit estimates must or always can be estimated for each individual final ES code. Value estimates may often cover several final ES categories and disaggregation according to these categories may not always be possible.
- Identifying the individual final ES categories that are captured or excluded by certain benefit estimation methods is not always a straightforward process. Some interpretation and judgment are often needed.
- Using NESCS Plus in analyses where final ES values will be totaled, one must also recognize that different final ES categories may involve competing uses for the same Ecological End-Products – in particular those involving extractive Direct Uses – in which case increases extractive flows of final ES (picking all the flowers) may reduce other flows of FES, both extractive and non-extractive (no flowers left for picking or for viewing or painting).
- The spatial boundaries of the Direct Users or Beneficiaries may be different from the spatial boundaries of the Environments or Ecological End-Products considered. For example, the recreational Users of a specific lake may come from a long distance or through non-use would not need to visit the lake at all to value it. Therefore, the spatial extent of the lake environment and its Ecological End-Products is smaller than the spatial extent of households who are the Users of the lake. These potential types of spatial differences must be recognized and considered when applying NESCS Plus.

# 6.0 Frequently Asked Questions

## 6.1 Do human-managed ecosystems produce Ecological End-Products or economic goods?

One important feature of the system is the need to isolate the ecosystem products from products that combine ecosystem and non-ecosystem inputs (such as capital and labor). Thus, putting the concept of final ES and Ecological End-Products (i.e., FEGs) into practice requires drawing a line between what ecosystems produce (ecological production) and what humans produce (economic production). This line establishes where the “final” link from ecosystems to humans occurs. However, this line is often blurred, particularly when natural systems are heavily managed by humans but not intended for sale in markets. For example, publicly owned and managed natural systems such as reservoirs and renourished beaches can provide Ecological End-Products despite the human contribution to their existence or condition. Drawing the line between natural and human systems will therefore often require subjective judgment on the part of the user of NESCS Plus that should be clearly stated. The following principles are some examples that we have used and can help to clarify some of these issues in identifying Ecological End-Products and final ES.

1. If something is produced by humans for sale in a market, it is an economic good or service, not an Ecological End-Product. For example, agricultural crops, commercially produced Christmas trees, and maintained trails in a privately-owned nature park that charges an entrance fee are not Ecological End-Products. However, the soils and water necessary to grow the trees and the vistas enjoyed by trail users are Ecological End-Products.
2. If a natural feature is created by humans, but it is not connected to the lithosphere or hydrosphere and is isolated from more natural systems, then it is not an Ecological End-Product. For example, aquariums and indoor botanical gardens do not qualify as Ecological End-Products.
3. If human production of an economic good or service incidentally creates natural features that are non-marketed “public goods,” then these by-products may be Ecological End-Products. For example, if a farm creates an appealing vista then the resulting landscape can be considered an Ecological End-Product. If a tree plantation provides habitat for birds that are then enjoyed by birdwatchers, then the birds can be considered Ecological End-Products.

## 6.2 Why is there no EEP class for water quality, air quality, or other types of environmental quality?

Although environmental quality characteristics affect the *level* of ecosystem services provided by Ecological End-Products, they are not *categories* of Ecological End-Products. This same principle is applied when classifying economic goods and services. For example, safety and gas mileage are quality *characteristics* of motor vehicles, but they are not *categories* of motor vehicles. For this reason, NESCS Plus categorizes Environments and Ecological End-Products, but it does not treat quality as a type of Ecological End-Product. Arguably, the best way to address quality differences would be through the quantification (i.e., with indicators and metrics) and valuation of ecosystem services rather than through the classification system itself. For example, safety ratings and other scores (e.g., stars used for rating movies or restaurants) describe differences in quality of economic goods and services. Likewise for Ecological End-Products, metrics and indicators (e.g., Secchi disk depth for water clarity) can describe differences in Ecological End-Product quality (Ringold et al. 2020).<sup>15</sup> Similarly, just as the quality of marketed goods and services is often reflected in their market prices, quality differences in Ecological End-Products can be captured through differences in their estimated values (i.e., using non-market valuation methods).

## 6.3 Why is carbon sequestration not listed as a class of ecosystem service in NESCS Plus?

By providing a sink for greenhouse gasses and thus helping to limit climate change, carbon sequestration can be very beneficial to society. However, it is also a clear example of an “intermediate” ecological process that is several steps removed (along a pathway) from several Ecological End-Products and Direct Uses that define final ES. For example, it reduces acidifying deposition to oceans, which then reduces damage to coral reefs, which then improves habitat for fish, which are then “directly used” in recreational diving and commercial fishing. The relevant Ecological End-Product class in this case is fish (fauna) in the ocean environment, and the direct uses are for recreation by households and for extraction and distribution by commercial fishers. Although the act of sequestering carbon (or purchasing carbon offsets) may provide an individual with direct benefit, the ultimate final ES provided by the action is several steps “upstream.” Reports on the social cost of carbon do implicitly use final ES concepts. They develop a value for carbon on the basis of the value of final ES and the link between different levels of carbon sequestration and those final ES.

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<sup>15</sup> Some environmental quality characteristics, such as water clarity and air visibility, can also modify or be indicators of ecosystem services from other EEPs (e.g., aesthetic enjoyment of aquatic life or landscapes).

Nonetheless, a substantial portion of the ecosystem services community wants some version of carbon sequestration (or carbon stocks held in an ecosystem, or carbon retention) to be counted as an FES in cost-benefit analysis or ecosystem accounting. As a tool, if NESCS Plus has a large number of potential system users informing it that a particular EEP correlates with a final ES, then NESCS Plus – being an exhaustive and comprehensive classification for flows of final ES – must have a path and code for it. In this case, the EEP for carbon sequestration/carbon stocks/carbon retention would be under EEP = 7XX, Other Biotic and Natural Components. Single or multiple Environments may be on the left side of the NESCS Plus code, Direct Use would be “support or protection of human health or life” or “protection of property” (separate from “support of...cultivation,” which is a separate FES), and the User choice would be at the tool user’s discretion, where the area of benefit may be much larger than the particular Environment, because global climate is not bounded by land cover types. In such applications, NESCS Plus does not recommend naïve adding of “carbon” FES value with other FES values, to avoid double counting intermediate ES with final ES.

#### **6.4 Why is biodiversity not listed as an Ecological End-Product class in NESCS Plus?**

Protecting or increasing biodiversity can increase human well-being in several ways, including by providing more broad-based sources of nutrition and by contributing to the existence values held by some individuals. However, rather than being a *type* of Ecological End-Product, biodiversity is better described as a *characteristic* (similar to an environmental quality indicator) of an environment class (e.g., forests) or an Ecological End-Product (e.g., flora or fauna).

#### **6.5 How are the spatial and temporal scales of final ES addressed in NESCS Plus?**

NESCS Plus is intended to provide a system that is flexible and adaptable enough to classify any type of final ES, regardless of its spatial or temporal scale. For this reason, the classification structure does not specify or limit the spatial or temporal scale of any the final ES components (i.e., environments, Ecological End-Products, direct uses, etc.). Instead, it allows the system user to specify these dimensions, based on their own needs and context. For example, the NESCS Plus Environment classification divides the earth’s surface into areas with similar characteristics, such as Deciduous Forest, but it does not classify them according to the size or spatial extent of the areas covered. It is left to the system user to specify the Deciduous Forest areas that are of interest to him or her as a source of final ES.

## **6.6 How does NESCS Plus handle regulation of extreme events?**

Extreme events are rare and can cause loss of life, injuries, significant property damage, and/or disruption to commerce. Monier and Gao (2015) provide examples of values for extreme precipitation and temperatures across the United States. Ecological regulation offering some protection against extreme events such as flooding, fire, and extreme weather events are included under the Composite Ecological End-Product class. The extreme events Ecological End-Product class should be used, just as for any other Ecological End-Product, whenever humans directly experience or perceive the extreme event. In NESCS Plus, if a landowner directly perceives or experiences flooding the Ecological End-Product would be coded as Composite and not coded as water. As for other Ecological End-Products, factors that modify the frequency, duration, intensity, or distribution of extreme events are considered to be of great importance. However, they are intermediate goods and services and are not directly covered by NESCS Plus. One would expect them to be of great interest in research, monitoring, and assessment for many reasons, not the least of which would be for their inclusion on EPFs that predict the extreme event.



## 7.0 Summary

To summarize, NESCS Plus has been developed to standardize the identification of the flows of ecosystem services that are directly used or appreciated by human beings. It has been designed to meet the needs of a multidisciplinary community, including government agencies and private business for decision making. The NESCS Plus provides two tools to support identification. First, it provides a conceptual framework for systematically identifying and tracing unique pathways between ecological systems that supply final ecosystem services and human systems that benefit from them. Second, NESCS Plus applies best practices of classification systems to define categories and numeric codes that help analysts identify and reference flows from ecosystems to human beings in a consistent way. Specifically, NESCS Plus is designed to provide a flexible, modular structure that allows for comprehensive identification of flows of final ecosystem services, while minimizing the risk of double counting. The NESCS Plus codes also allow analysts to link flows of ecosystem services to long-established national accounting categories that are used by policy makers to track economy-wide effects.

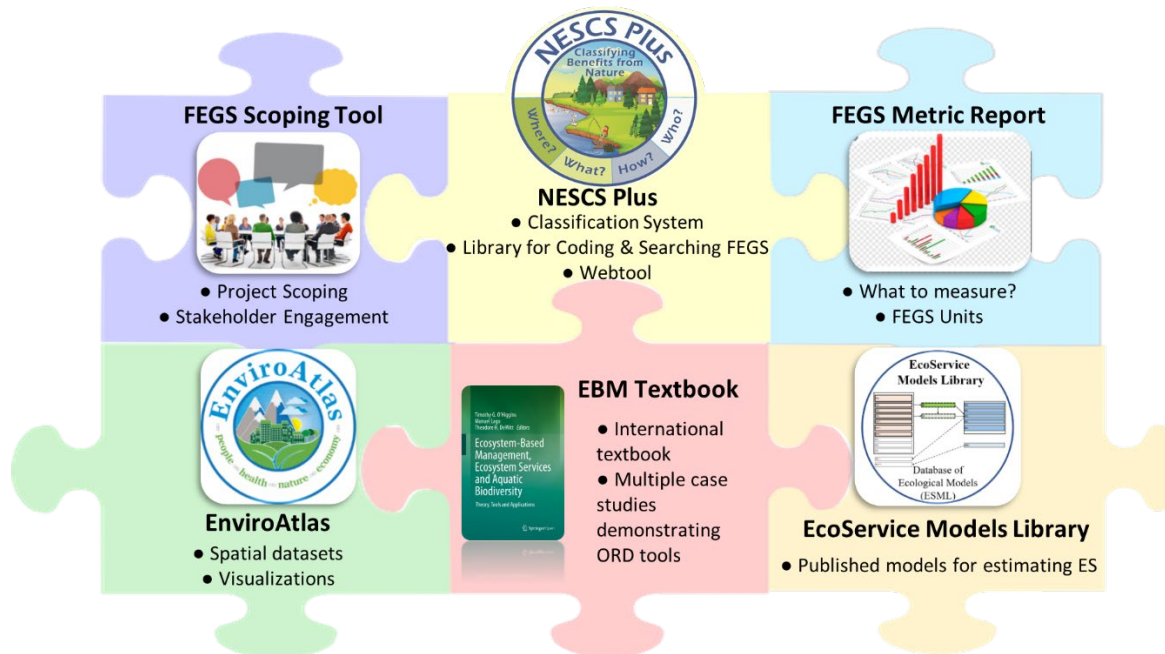
The NESCS Plus addresses a main area of disagreement in classification systems such as MA, CICES, and IPBES – where do “ecosystem services” occur along the continuum between ecosystems and human welfare? These classification approaches differ in whether natural processes or functions should themselves be considered services and whether services and benefits should be treated as synonymous. They also differ in whether ecosystem services should include items that involve input from humans (e.g., food production that requires human labor inputs) or whether these services must inherently be delivered from natural processes or components prior to human involvement (e.g., unmanaged pollination). Therefore, even though a consensus has emerged in the literature about the importance of differentiating “final” ecosystem services from the “intermediate” processes that contribute to them, there is less agreement about what constitutes a final service. For purposes of environmental accounting, not making these distinctions can result in double-counting of values.

The predecessors to NESCS Plus (NESCS and FEGS-CS) were designed to avoid such issues by: (a) distinguishing between intermediate ecological production functions/processes and final ecosystem services; (b) striving to define mutually exclusive use categories; and (c) distinguishing between direct (e.g., fruit growers) and indirect users (e.g., households that consume fruit from growers). The NESCS Plus leverages the most desirable features of these two systems. The modular four-component structure of NESCS Plus, is also designed to prevent undercounting of services by enabling users to develop a complete list of the ways in which people benefit from ecosystems.

The next steps for NESCS Plus will depend importantly on users' experience with and feedback on the system. As with almost any classification system, user experience will highlight areas where future changes to the classification structure are most needed or important. These changes may include adding classes or subclasses within the existing structure, to better identify categories that have either been overlooked or not adequately differentiated from existing categories in the system. It may also involve deleting classes or subclasses that are found to be unnecessary. The changes may also involve more substantial reorganizations of the structure, including adding or deleting entire subclass levels.

Moving forward, the USEPA plans to use NESCS Plus as a tool for organizing and connecting different ecosystem services research efforts and related projects. For example, NESCS Plus provides a common language, structure, and coding system that can be used to link USEPA tools (**Figure 7**), such as the FEGS Community Scoping Tool (Sharpe and Jenkins, 2018; Sharpe et al., 2020), EcoService Models Library (ESML; <https://www.epa.gov/ecoresearch/ecoservice-models-library>), and the EnviroAtlas (<https://www.epa.gov/enviroatlas>), and to support ongoing efforts to develop metrics and indicators for final ecosystem goods and services (USEPA, 2017).

**Figure 7** Example USEPA Tools that can used together with components of NESCS Plus.



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## Appendix A. Glossary of Key Terms

Term	Definitions
Beneficiary	<p>The interests of individuals, groups of people, or organizations that drive their direct use or appreciation of an Ecological End-Product, resulting in an impact (positive or negative) on their welfare. In this way a Beneficiary differs from a User where Users are the individuals or groups, and not their “interests.” <i>[Note the departure from common usage, in which a beneficiary is “a person who receives benefits,” to focus instead on the person’s awareness and interests, relative to final ecosystem services, rather than to the persons themselves, because a single person with multiple interests can benefit from ecosystems in multiple and distinct ways.]</i></p> <p><u>Example:</u> A farmer relies on their land (space and soil) for producing crops and uses water from a nearby stream to irrigate in the summer.</p>
Beneficiary Classification	<p><u>Definition:</u> Classification of the different types of interests individuals, groups of people, or organizations that drive direct use and/or appreciation of one or more Ecological End-Products, resulting in an impact on their welfare.</p> <p><u>Context:</u> This NESCS Plus classification component jointly addresses questions about <b>how</b> Ecological End-Products are used, enjoyed or appreciated and <b>who</b> uses, enjoys, or appreciates them.</p> <p><u>Example:</u> Agricultural, recreational, subsistence, and non-use beneficiaries are all examples of Beneficiary classes.</p>
Benefit transfers	<p>“[T]he use of research results from pre-existing primary studies at one or more sites or policy contexts (often called study sites) to predict [human] welfare estimates or related information for other, typically unstudied sites or policy contexts (often called policy sites)” (Rolfe, Johnston, et al. 2015).</p>
Bequest Value	<p>A type of non-use value for a good or service. It is derived from the benefits an individual receives solely from the knowledge that the good or service will continue to be present for the benefit and/or enjoyment of future generations</p>
Biophysical	<p>Pertaining to the biological, chemical, and physical attributes of an ecosystem or environment.</p>
Class	<p>A main subdivision of a classification component, located within the top level of the component's hierarchical structure.</p>
Classification Component	<p>The NESCS Plus uses five dimensions to classify final ecosystem services – Environment, Ecological End-Product, Direct Use, and Direct User, or Beneficiary instead of Direct Use and User – where each dimension is referred to as a classification component.</p>

Term	Definitions
Classification system	<p>1. An organized (and often hierarchical) structure that, through well-defined categories, allows one to group similar elements together and to separate others. Pre-determined criteria define what should be considered similar or different, and these criteria are driven by the specific purpose for developing the classification system.</p> <p>2. A method to group individual elements or features into collections similar in type, function, affiliation, behavior, response, or ontogeny.</p> <p>3. An organized structure for identifying and organizing ecosystem services into a coherent scheme.</p>
Cultural Services	The nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, and aesthetic experience, including, for example, knowledge systems, social relations, and aesthetic values.
Demand	<p><u>Definition:</u> As an economic concept, the amount of a economic good or service that potential buyers would be willing and able to purchase at any given price. The level of demand for a good or service is also determined by many other factors, such as the availability and price of substitute and complementary goods and services and the income of the potential buyers. Demand is not the same as economic value, but it is a key determinant of the economic value of a good or service. Although most ecosystem services are not bought and sold in markets – so, there are no market prices – the economic demand for an ecosystem service can nonetheless be thought of as the amount that people would be willing and able to buy of the service <b>if</b> they could acquire it through a market transaction.</p> <p><u>Context:</u> As an economic concept, demand can be influenced by, but is not the same thing as, a need, requirement, or desire. Like economic values, the demand for economic or ecosystem goods or services is a reflection of individuals’ preferences for them.</p>
Direct Use	Direct Use means that the User or Beneficiary is using or appreciating an Ecological End-Product in its Environment. Direct Use does not include ecosystem characteristics or processes that precede or help produce the Ecological End-Product. Direct Uses include extractive and consumptive uses (e.g., harvesting goods), non-consumptive uses (e.g., enjoyment of scenic beauty) and non-use classes where a User appreciates or values an Ecological End-Product without direct interaction. The boundary between Use and Non-use within Direct Use can be fuzzy, and their distinct values may be hard to disentangle.
Direct Use Classification	<u>Definition:</u> Classification of the different ways in which Ecological End-Products are directly used or appreciated by humans. Direct Uses may be either extractive or in-situ. Note that direct users may derive an increase in well-being from using Ecological End-Products as well as

Term	Definitions
	<p>from non-use (i.e., direct users such as households may appreciate end-products even if they do not see or use them).</p> <p><u>Context:</u> This NESCS Plus classification component addresses the question about <b>how</b> Ecological End-Products are used or appreciated.</p> <p><u>Example:</u> Direct Uses include extraction of natural resources for transformation into economic products, or non-extractive use associated with outdoor recreation.</p>
Direct User	<p>A direct user of an Ecological End-Product is a person or institution that directly extracts the Ecological End-Product or interacts with or physically senses the Ecological End-Product in its environment, or it is a person who holds a non-use value for the Ecological End-Product.</p>
Direct User Classification	<p><u>Definition:</u> Classification of the people or institutions that directly use or appreciate Ecological End-Products.</p> <p><u>Context:</u> This NESCS Plus classification component addresses <b>who</b> uses, enjoys, or appreciates the Ecological End-Products. Following established classification structures adopted by the U.S. Census Bureau and United Nations, the first level includes broad sectors of the economy: Industry, Households, and Government. To further subdivide the industry class, the existing North American Industrial Classification System (NAICS) and coding system was adopted, which is the standard used by U.S. federal statistical agencies in classifying business establishments.</p> <p><u>Example:</u> An example is the Manufacturing Industry sector which would have a 3-digit code, one digit for industry and two digits for the sector. Unlike commercial establishments, which tend to specialize in certain productive activities and can therefore be assigned to individual NAICS categories, households and governments do not specialize in the same way as industries and are therefore not divided into sub-classes by NAICS categories. They currently are presented as 1st-level hierarchical classes with further designation to subclasses remaining open to be filled out. One way to differentiate the many ways households and governments interact with nature is through the combination of the Household or Government Direct User class with different Direct Uses.</p>
Ecological End-Product	<p>The relevant biophysical components of nature that are directly used or appreciated by humans in Final Ecosystem Services.</p> <p><u>Example:</u> The Fauna present in forests, such as deer, are an example of an Ecological End-Product that provides Final Ecosystem Services to commercial and recreational hunters who harvest them, as well as to recreational wildlife viewers who enjoy them in a non-consumptive way. The forest ecosystem's production of the forage that supports the deer populations is an example of an intermediate ecosystem service</p>

Term	Definitions
	that contributes (as an input) to the deer, which is the Ecological End-Product used in the Final Ecosystem Service.
Ecological End-Product Classification	<p><u>Definition:</u> Classification of the biophysical components of nature that are directly used by humans to produce goods and services or directly enjoyed. They can also be referred to as Final Ecosystem Goods.</p> <p><u>Context:</u> This NESCS Plus classification component addresses <b>what</b> in nature is directly used or appreciated by humans. All flows of final ecosystems services originate from an Ecological End-Product. One might use biophysical metrics or indicators to quantify an Ecological End-Product.</p> <p><u>Example:</u> Different types of Flora and Fauna, such as maple trees and chinook salmon, are examples of Ecological End-Products that are directly used and appreciated by individuals.</p>
Ecological production functions	<p><u>Definition:</u> Usable expressions (i.e., models) of the processes by which ecosystems produce Ecological End-Products, often including external influences on those processes.</p> <p><u>Context:</u> The definition and specification of ecological production functions are used in modeling approaches to quantify how changes in one part of a natural system affect changes in another.</p> <p><u>Example:</u> The relationship between a plant's uptake of soil nutrients (as an input) and its rate of biomass growth (as an output) can be represented by an ecological production function that can include one or more factors (e.g., soil nutrients, precipitation, altitude, etc.).</p>
Economic production functions	A representation (often mathematical) of the input-output relationship involved in the production of an economic good or service by commercial/industrial establishments (i.e., firms) or non-commercial entities (e.g., households or individuals). Inputs typically include labor, physical capital (e.g., machinery), land, other natural resources (e.g., water) and raw materials, and other material supplies. Outputs are the goods or services produced by the process. The function also represents the technology, skill level, and methods that are embedded within the production process.
Economic valuation	Quantification of the benefits and increase in well-being experienced by individuals or society as a result of a change – typically measured and expressed in monetary terms. In the context of ecosystem services, it is the quantification of benefits derived from an increase in ecosystem services. In a monetized economic analysis, it is often the practice of measuring individuals', households', or firms' maximum willingness and ability to pay for the change.

Term	Definitions
Ecosystem Attributes	<p><u>Definition:</u> A biological, physical, or chemical characteristic or feature inherent to an ecosystem.</p> <p><u>Context:</u> In economic valuation studies, ecosystem attributes refer to the set of ecological features that individually or as a group contribute to the enjoyment of a valued experience, such as a recreational or aesthetic experience (e.g., a day of fishing).</p> <p><u>Example:</u> Surface water clarity (e.g., as measured by Secchi disk depth) is an attribute of water in its natural environment, which can affect recreational users' enjoyment of the environment. Surface water clarity is an example of a water quality attribute of the Water Ecological End-Product class.</p>
Environment Classification	<p><u>Definition:</u> Classification of spatial units, with similar biophysical characteristics, that are located on or near the Earth's surface and that contain Ecological End-Products. Environment classes spatially divide the Earth into qualitative non-overlapping areas with similar biophysical characteristics that, when taken together, can completely cover the surface of the Earth. The Environment is where the Ecological End-Product is located when it is used, enjoyed, or appreciated. Note, an "Environment class" is not synonymous with an "ecosystem."</p> <p><u>Context:</u> This NESCS Plus classification component addresses <b>where</b> Ecological End-Products are located when they are used, enjoyed, or appreciated.</p> <p><u>Example:</u> In its most highly aggregated form, the Earth can be separated into two mutually exclusive Environment classes corresponding to Terrestrial and Aquatic areas.</p>
Existence Value	<p><u>Definition:</u> The enjoyment people may experience simply by knowing that a resource exists even if they never expect to use that resource directly themselves.</p> <p><u>Context:</u> This is a component of "non-use value" from early literature in environmental economics.</p>
Final Ecosystem Good (FEG)	<p>Components of nature, directly enjoyed, consumed, or used to yield human well-being. The final ecosystem good (i.e., ecological end-product) is a biophysical quality or feature and needs minimal translation for relevance to human well-being. Furthermore, a final ecosystem good is the last step in an ecological production function before the user interacts with the ecosystem, either by enjoying, consuming, or using the good, or using it as an input in the human economy.</p>
Final Ecosystem Service (FES)	<p>The services from nature that are "<i>directly</i> [emphasis added] enjoyed, consumed, or used to yield human well-being" (Boyd and Banzhaf, 2007).</p>

Term	Definitions
Flow	<p><u>Definition:</u> A variable measured over an interval of time. Flow measures are typically expressed as a rate per unit of time—e.g., annual income (dollars/year), daily nutrient load to surface water (pounds/day).</p> <p><u>Context:</u> The distinction between "stocks" and "flows" is an essential concept for measuring natural capital (which is a stock concept) and the contributions of natural capital to human well-being (which is a flow concept).</p>
Goods	<p><u>Definition:</u> Tangible items that are created through a production process and that may be acquired, used, or consumed by people for use as inputs in another production process or to satisfy other needs or wants. Goods can be represented and measured as “flows,” such as the amount sold and transferred to new owners over the course of the year, or as “stocks,” such as the amount stored in an inventory at the end of the year.</p> <p><u>Context:</u> Two important features that distinguish goods from services are: (1) their tangible nature; and (2) their ability to be treated as stocks in certain contexts.</p>
Hedonic Analysis	<p>An economic valuation method that uses statistical methods to decompose the price of an asset by: (1) identifying a set of distinct and measurable attributes of the asset, each of which contributes to its value; and (2) estimating the portion of the total asset value that is attributable to each attribute (i.e., the implicit price of each attribute). Hedonic analysis of housing prices is often used to isolate and infer the economic value of ecosystem services provided by specific local environmental amenities to residents (e.g., from open space or good air quality). These amenities are treated as distinct attributes of the homes and separately priced using this method.</p>
Household production functions	<p>A representation of the various processes through which members of a household produce goods and services for their own consumption, using their own unpaid labor, capital, and other acquired goods or services. It is a type of economic production function, specifically involving households rather than commercial/industrial establishments.</p>
Human well-being	<p>A multidimensional description of the state of people’s lives, which encompasses personal relationships, strong and inclusive communities, meeting basic human needs, good health, financial and personal security, access to education, adequate free time, connectedness to the natural environment, rewarding employment, and the ability to achieve personal goals.</p>
Indicator	<p>1. An interpretable value or category describing trends in some measurable aspect, often used singularly or in combination to generate an index.</p>



Term	Definitions
	<p>2. A sign or signal that relays a complex message, potentially from numerous sources, in a simplified and useful manner.</p> <p>3. An interpretable summary value that reflects the state of, or change in, a system or point of interest that is being evaluated. Indicators are derived from measures or metrics that correspond to components of well-being. Example indicators are perceived safety, lifestyle and behavior, and wealth.</p> <p>4. A summary measure that provides information on the state of, or change in, the system that is being measured. Information based on measured data used to represent a particular attribute, characteristic, or property of a system.</p>
Intermediate ecosystem service	<p><u>Definition:</u> Attributes of ecological structure or ecosystem characteristics, processes, or functions that influence the quantity and/or quality of ecosystem services but do not themselves qualify as final ecosystem goods or services (because they are not directly enjoyed, consumed, or used).</p> <p><u>Context:</u> A good or service can be an intermediate good and service in one situation and a final good or service in another situation.</p> <p><u>Example:</u> Water in a river is an EEP used in a final ecosystem service by a kayaker, but the same river water is an intermediate good or service to a hiker who appreciates a deer that drinks from that water.</p>
Metrics and indicators	<p>Direct or indirect measurements of an ecological end-product or attributes. If a metric can be consistently and reliably related to an end-product and a beneficiary, it can potentially serve as an indicator of final ecosystem goods or services.</p>
National accounting	<p>A compilation of methods for tracking and measuring the level of economic activity, including total flows of goods and services, in a region or country, as well as the level of wealth and assets present. It included national income accounting, which focuses on the level of production and income generation within a country.</p>
Natural Capital	<p>An extension of the economic concept of physical capital – produced assets such as buildings, machinery, and equipment that are used in the production of economic goods and services – to ecosystem goods and services. Natural capital is the stock of natural ecosystems that yields a flow of valuable ecosystem goods or services into the future.</p>
Non-use values	<p><u>Definition:</u> Human preferences for goods or services that are not associated with or derived from direct use or contact with them. For instance, individuals may care about or appreciate Ecological End-Products, even if they never directly use or see them – i.e., they may have non-use values for the existence of things like tropical forests or pristine lakes, even if they never visit them. Sometimes referred to as “passive use value,” non-use values are theoretically distinct from “use values,” although the boundary between use and non-use values is not</p>

Term	Definitions
	<p>always definitive. Different types of non-use value include existence value, option value, and bequest value.</p> <p><u>Context:</u> The recognition that humans enjoy and benefit from ecosystems in ways that do not involve direct use is essential for developing a comprehensive accounting (e.g., economic valuation) of the total benefits provided by nature.</p> <p><u>Example:</u> Individuals often value the assurance that threatened and endangered species are being protected, even if they will never see them in the wild, reflecting a preference (benefit) from knowing that the species continues to exist.</p>
Option value	<p>The value for sustaining the existence of a good or service into the future so that one has the option to use it if needed or desired at a later date. Although option value is sometimes characterized as a non-use value, because it does not involve current use, it is more accurately described as a value associated with expected/uncertain future use.</p>
Services	<p>Actions or processes performed by people or nature that benefit people. Services are typically intangible and non-storable. In contrast to goods, which can be treated as “stocks” and measured at a specific point in time, services are “flows” from the service provider to the service consumer and are measured over a period of time (e.g., hourly access to and use of a gym facility). Unlike a good, which can exist (e.g., as part of an inventory) without being transferred to a consumer, the existence of a service requires that it be received by a human. The wants and needs of people are met through items (i.e., goods) and delivery of assistance (i.e., services). Economic, environmental, and social services reflect the three pillars of sustainability.</p>
Stock	<p><u>Definition:</u> A quantity existing at a point in time, which may have accumulated or been produced in the past. Units of measurement are typically expressed in levels – e.g., wealth (dollars), physical assets (number of machines), and nutrient concentration (milligrams per liter) – that are present in or over a period of time. Economic goods can be represented as a stock when they are accumulated, stored, or stockpiled – e.g., the stock of produce in a grocery store's inventory at the beginning of the year. Natural capital is partially a stock concept, representing the level of wealth (productive natural capacity through ecosystem characteristics and processes, as well as the ecosystem goods) embodied within Environments at a point in or span of time.</p> <p><u>Context:</u> The distinction between “stocks” and “flows” is an essential concept for measuring natural capital (which is a stock and capacity concept) and the contributions of natural capital to human well-being (which is a flow concept).</p>

Term	Definitions
Use values	<p><u>Definition:</u> The value received by individuals from goods or services, which is derived from direct contact with, use of, or enjoyment from the goods or services (as opposed to non-use values which do not involve or require direct contact, use, or enjoyment). Use values for ecosystem services can be derived from consumptive uses of the ecosystem, such as catch-and-keep fishing, as well as from non-consumptive uses such as birdwatching.</p> <p><u>Context:</u> For completeness in defining preferences for ecosystem services, use value must be distinguished from non-use value, where non-use value recognizes that humans can enjoy and benefit from ecosystems in ways that do not involve direct use.</p>

## Appendix B. Definitions of Environment Classes and Subclasses

Environment Class	Environment Subclass I	Environment Subclass II	Definition
1. Aquatic			Lakes, rivers, streams, wetlands, estuaries and the open ocean. These ecosystems may be covered with ice either permanently or seasonally.
	11. Open Water		Areas of open water, including areas that are intertidal, and including habitats dominated by rooted or attached vegetation that extends into subtidal or permanently submerged aquatic habitats (such as seagrasses, submerged aquatic vegetation, kelp beds).
		111. Rivers and Streams	All streams and rivers that have flowing water during the summer excluding tidal rivers with salinity greater than 0.5ppt. Run-of-the-river ponds and pools are included while reservoirs are excluded. Includes areas with submerged aquatic vegetation. Source: Adapted from USEPA National Aquatic Resource Surveys (NARS).
		112. Lakes and Ponds	All lakes, reservoirs, and ponds that are permanent water bodies. Lakes that are saline are excluded as are those used for aquaculture, disposal-tailings, sewage treatment, evaporation, or other unspecified disposal use. Includes areas with submerged aquatic vegetation. Source: Adapted from USEPA National Aquatic Resource Surveys (NARS).
		113. Near Coastal Marine/Estuarine	All coastal waters of the conterminous United States with salinity greater than 0.5ppt to confluence with the ocean, including inland waterways tidal rivers and creeks, lagoons, fjords, bays, and major embayments. The seaward boundary extends out to where an imaginary straight-line intersecting two land features would fully enclose a body of coastal water. All waters within the enclosed area are defined as estuarine, regardless of depth or salinity. Includes areas with submerged aquatic vegetation, such as seagrass beds, kelp beds, and algal mats. Source: Adapted from USEPA National Aquatic Resource Surveys (NARS).
		114. Open Oceans and Seas	All saline waters seaward of near coastal marine systems. These are generally deeper waters than the photic zone that supports submerged aquatic vegetation. Source: Adapted from USEPA National Aquatic Resource Surveys (NARS).
	12. Wetlands		Tidal and nontidal wetlands have rooted vegetation and, when present, open water less than 1 meter deep. Source: Adapted from USEPA National Aquatic Resource Surveys (NARS).

Environment Class	Environment Subclass I	Environment Subclass II	Definition
		121. Woody Wetlands	Areas where forest or shrubland vegetation accounts for greater than 20% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.
		122. Emergent Herbaceous Wetlands	Areas where perennial herbaceous vegetation accounts for greater than 80% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.
2. Terrestrial			Areas of the Earth's surface that are not Aquatic.
	21. Forests		Land that is at least 10 percent stocked by forest trees of any size, or land formerly having such tree cover, and is not currently developed for a nonforest use. The minimum area for classification as forest land is 1 acre (0.4 hectares). Roadside, streamside, and shelterbelt strips of timber must be at least 120 feet (37 meters) wide to qualify as forest land. Unimproved roads and trails, streams and other bodies of water, or natural clearings in forested areas shall be classified as forest, if <120 feet (37 meters) in width or 1.0 acre (0.4 hectares) in size.
		211. Deciduous Forest	Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species shed foliage simultaneously in response to seasonal change. This is a subclass of Forests.
		212. Evergreen Forest	Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species maintain their leaves all year. Canopy is never without green foliage. This is a subclass of Forests.
		213. Mixed Forest	Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. Neither deciduous nor evergreen species are greater than 75% of total tree cover. This is a subclass of Forests.
	22. Agroecosystems		The subset of Terrestrial Environments managed to grow crops. This includes Pasture/Hay and Cultivated Crops, but excludes areas managed to grow trees (those are included under "forests.")
		221. Pasture/Hay	Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay

Environment Class	Environment Subclass I	Environment Subclass II	Definition
			vegetation accounts for greater than 20% of total vegetation. This is a subclass of Agroecosystems.
		222. Cultivated Crops	Areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20% of total vegetation. This class also includes all land being actively tilled. This is a subclass of Agroecosystems.
	23. Grasslands		Areas dominated by graminoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensive management such as tilling but can be utilized for grazing. This is a Terrestrial Environment.
		231. Grassland/ Herbaceous	Areas dominated by graminoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensive management such as tilling but can be utilized for grazing. This is a Terrestrial Environment.
	24. Scrubland/ Shrubland		Areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions.
		241. Shrub/Scrub	Areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions.
	25. Tundra		Treeless regions in which the subsoil is permanently frozen.
		251. Lichens	Areas dominated by fruticose or foliose lichens generally greater than 80% of total vegetation. In the United States, this Terrestrial Environment only occurs in Alaska.
		252. Moss	Areas dominated by mosses, generally greater than 80% of total vegetation. In the United States, this Terrestrial Environment only occurs in Alaska.
		253. Dwarf Scrub	Areas dominated by shrubs less than 20 centimeters tall with shrub canopy typically greater than 20% of total vegetation. This type is often co-associated with grasses, sedges, herbs, and non-vascular vegetation. In the United States, this Terrestrial Environment only occurs in Alaska.

Environment Class	Environment Subclass I	Environment Subclass II	Definition
		254. Sedge/ Herbaceous	Areas dominated by sedges and forbs, generally greater than 80% of total vegetation. This type can occur with significant other grasses or other grass like plants, and includes sedge tundra, and sedge tussock tundra. In the United States, this Terrestrial Environment only occurs in Alaska.
	26. Ice and snow		Areas characterized by a perennial cover of ice and/or snow, generally greater than 25% of total cover.
		261. Perennial Ice/Snow	Areas characterized by a perennial cover of ice and/or snow, generally greater than 25% of total cover.
	27. Urban/suburban		Areas of intensive human use with much of the land covered by structures. Included in this class are cities, towns, villages, strip developments along highways, transportation, power, and communications facilities, and areas such as those occupied by mills, shopping centers, industrial and commercial complexes, and institutions that may, in some instances, be isolated from urban areas.
		271. Developed Open Space	Areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20% of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes. This is a Terrestrial Urban/Suburban Environment.
		272. Developed Low Intensity	Areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20% to 49% percent of total cover. These areas most commonly include single-family housing units. This is a Terrestrial Urban/Suburban Environment.
		273. Developed Medium Intensity	Areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50% to 79% of the total cover. These areas most commonly include single-family housing units. This is a Terrestrial Urban/Suburban Environment.
		274. Developed High Intensity	Highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses and commercial/industrial. Impervious



Environment Class	Environment Subclass I	Environment Subclass II	Definition
			surfaces account for 80% to 100% of the total cover. This is a Terrestrial Urban/Suburban Environment.
	28. Barren/rock and sand		Areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover.
		281. Barren Land (Rock/Sand/Clay)	Areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover.

## Appendix C. Ecosystem Attributes for Ecological End-Product Metrics and Indicators

Though not part of the formal classification system, a prioritized attributes table has been created to support identification of metrics and indicators. These attributes can be loosely associated with Ecological End-Product classes and have been integrated into the FEGS Community Scoping Tool (Sharpe et al. 2020) and the Metrics Report (Ringold et al. 2020). Attributes do not represent Ecological End-Product subclasses and have no associated NESCS code. While living things can be classified within the NESCS Ecological End-Product Classes of Fauna, Flora, and Fungi using Integrated Taxonomic Information System (ITIS; <https://www.itis.gov/>), Ecological End-Product subclasses for the other 5 Ecological End-Product Classes are not yet available.

Ecological End-Product Class	Ecosystem Attribute	Definition
1. Atmosphere	Air quality	The degree to which air is clean, clear, and pollution-free.
	Wind strength/speed	The speed and force of the wind.
	Precipitation	Weather in which something, including rain, snow, sleet, and/or hail, is falling from the sky.
	Sunlight	Light from the sun.
	Temperature	A measure of the warmth or coldness of the weather or climate.
2. Soil	Soil quantity	The amount of soil present, could be measured in terms of volume, depth, and/or extent.
	Soil quality	The suitability of soil for use based on physical, chemical, and/or biological characteristics.
	Substrate quantity	The amount of substrate present, could be measured in terms of volume, depth, and/or extent.
	Substrate quality	The suitability of substrate for use based on physical, chemical, and/or biological characteristics.
3. Water	Water quality	The suitability of water for use based on physical, chemical, and/or biological characteristics.
	Water quantity	The amount of water present, could be measured in terms of volume, depth, total yield, and/or peak flow.
	Water movement	The amount of water flowing per unit of time, includes aspects such as surface water movement through watersheds, wave action, etc.

Ecological End-Product Class	Ecosystem Attribute	Definition
4. Fauna	Fauna community	The interacting animal life present in the area.
	Edible fauna	Fauna fit to be eaten by humans.
	Medicinal fauna	Fauna that has healing properties as is or after processing.
	Keystone fauna	Fauna on which other species depend, its absence would significantly alter the ecosystem.
	Charismatic fauna	Fauna with symbolic value or widespread popular appeal.
	Rare fauna	Fauna that are uncommon or infrequently encountered.
	Pollinating fauna	Fauna that moves pollen from plant to plant.
	Pest predator/depredator fauna	Fauna that prey upon pest species.
	Commercially important fauna	Fauna that has importance for commerce.
	Spiritually/culturally important fauna	Fauna that has importance for spiritual or cultural practices or beliefs.
5. Flora	Flora community	The interacting plant life present in the area.
	Edible flora	Flora fit to be eaten by humans.
	Medicinal flora	Flora that has healing properties as is or after processing.
	Keystone flora	Flora on which other species depend, its absence would significantly alter the ecosystem.
	Charismatic flora	Flora with symbolic value or widespread popular appeal.
	Rare flora	Flora that are uncommon or infrequently encountered.
	Commercially important flora	Flora that has importance for commerce.
	Spiritually/culturally important flora	Flora that has importance for spiritual or cultural practices or beliefs.
6. Fungi	Fungal community	The interacting fungal life present in the area.
	Edible fungi	Fungi fit to be eaten by humans.
	Medicinal fungi	Fungi that has healing properties as is or after processing.
	Rare fungi	Fungi that are uncommon or infrequently encountered.

Ecological End-Product Class	Ecosystem Attribute		Definition
6. Fungi	Commercially important fungi		Fungi that has importance for commerce.
	Spiritually/culturally important fungi		Fungi that has importance for spiritual or cultural practices or beliefs.
7. Other Natural Components	Fuel quality		The suitability of material, based on physical, chemical, and/or biological characteristics, to produce heat or power through burning or other methods.
	Fuel quantity		The amount of fuel present, could be measured in terms of volume, mass, and/or extent.
	Fiber material quantity		The suitability of material, based on physical, chemical, and/or biological characteristics, to be used in production of textiles.
	Fiber material quality		The amount of fiber material present, could be measured in terms of volume, mass, and/or extent.
	Mineral/chemical quantity		The amount of material present, could be measured in terms of volume, mass, and/or extent.
	Mineral/chemical quality		The suitability of material for use based on physical, chemical, and/or biological characteristics.
	Presence of other natural materials for artistic use or consumption (e.g. shells, acorns, honey)		The presence and/or extent of materials suitable for artistic use or consumption.
8. Composite	Site Appeal	Sounds	The sounds or combination of sounds arising from the area.
		Scents	The scents or combination of scents arising from the area.
		Viewscapes	The views and vistas available in the area.
		Phenomena (e.g. sunsets, northern lights, etc)	Natural phenomena arising from a combination of environmental attributes.
	Ecological condition		The overall quality of the ecological system based on physical, chemical, and biological characteristics.

Ecological End-Product Class	Ecosystem Attribute		Definition
8. Composite	Open Space		Land that is undeveloped, but may be landscaped or otherwise in use, and is available for use.
	Extreme Events	Flooding	The likelihood the area will experience flooding and the likely severity of the flooding.
		Wildfire	The likelihood the area will experience wildfire and the likely severity of the fire.
		Extreme weather events	The likelihood the area will experience extreme weather events and the likely severity of the events.
		Earthquakes	The likelihood the area will experience earthquakes and the likely severity of the earthquakes.

## Appendix D. Definitions of Direct Use Classes and Subclasses

Direct Use Class	Definition
1. Direct Use	Direct Use of Ecological End-Product means that the Direct User or Beneficiary directly extracts, interacts with, or physically senses the Ecological End-Product in its Environment.
2. Non-use	Ecological End-Product is appreciated or valued by humans in a way that does not involve or require direct use or contact with the Ecological End-Product.

Direct Use Subclass I	Definition
101.Raw material for transformation	Ecological End-Product is extracted or harvested and transformed into other commercial products.
102.Distribution to other users	Ecological End-Product is extracted or harvested for distribution to other users.
103.Industrial processing	Ecological End-Product is extracted or harvested and directly used in other ways as a material in industrial processing.
104.Transportation medium	Ecological End-Product is used in situ as a medium for transporting goods or humans.
105.Waste disposal/assimilation	Ecological End-Product is used in situ as a sink for assimilating and disposing of waste.
106. Aesthetic appreciation	Ecological End-Product is used in situ for aesthetic (visual and other senses) appreciation, separate from outdoor/nature recreational, tourist, cultural or spiritual activities.
107. Fuel/energy	Ecological End-Product is directly used as an energy source for commercial production.
108. Support of plant or animal cultivation	Ecological End-Product is directly used to support human cultivation of plant or animal life.
109. Support or protection of human health and life or subsistence	Ecological End-Product is directly used by humans for subsistence, health, or other life support.

Direct Use Subclass I	Definition
110. Support for protection of human property	Ecological End-Product is directly used to protect human property from being damaged.
111. Recreation/tourism	Ecological End-Product is directly used as part of an outdoor recreational or nature tourist activity.
112. Cultural/spiritual activities	Ecological End-Product is directly used as part of a non-recreational cultural or spiritual activity.
113. Information, science, education, and research	Ecological End-Product is directly used to support scientific research or education.
114. Other direct use	Ecological End-Product is directly used for other purposes.
201. Existence	Ecological End-Product is of value to people simply because it exists. It is neither used nor directly experienced. People simply value the knowledge that it exists.
202. Bequest	Ecological End-Product is of value to people now, not because they use or experience it, but rather because of the value they place on ensuring that the resource can be used, enjoyed, or appreciated by future generations.
203. Other non-use	Ecological End-Product is appreciated or valued by humans for other reasons (without direct use or contact).

## Appendix E. Definitions of Direct User Classes and Subclasses

Direct User Class	Definition
1. Industry	Establishments involved in the production of goods and services.
2. Households	Households are social units, such as families, composed of individuals who share a dwelling.
3. Government	Public sector establishments conducting activities that are not performed by private establishments.

Direct User Subclass I	Definition (from NAICS: <a href="https://www.census.gov/eos/www/naics/">https://www.census.gov/eos/www/naics/</a> )
111. Agriculture, Forestry, Fishing and Hunting	The Agriculture, Forestry, Fishing and Hunting sector comprises establishments primarily engaged in growing crops, raising animals, harvesting timber, and harvesting fish and other animals from a farm, ranch, or their natural habitats.
121. Mining, Quarrying, and Oil and Gas Extraction	The Mining, Quarrying, and Oil and Gas Extraction sector comprises establishments that extract naturally occurring mineral solids, such as coal and ores; liquid minerals, such as crude petroleum; and gases, such as natural gas. The term mining is used in the broad sense to include quarrying, well operations, beneficiating (e.g., crushing, screening, washing, and flotation), and other preparation customarily performed at the mine site, or as a part of mining activity.
122. Utilities	The Utilities sector comprises establishments engaged in the provision of the following utility services: electric power, natural gas, steam supply, water supply, and sewage removal.
123. Construction	The Construction sector comprises establishments primarily engaged in the construction of buildings or engineering projects (e.g., highways and utility systems). Establishments primarily engaged in the preparation of sites for new construction and establishments primarily engaged in subdividing land for sale as building sites also are included in this sector.
131. Manufacturing-31	The Manufacturing sector comprises establishments engaged in the mechanical, physical, or chemical transformation of materials, substances, or components into new products. This Direct User Subclass only includes manufacturing establishments that are classified in NAICS under the 2-digit Manufacturing code equal to 31.
132. Manufacturing-32	The Manufacturing sector comprises establishments engaged in the mechanical, physical, or chemical transformation of materials, substances, or components into new products. This Direct User Subclass



Direct User Subclass I	Definition (from NAICS: <a href="https://www.census.gov/eos/www/naics/">https://www.census.gov/eos/www/naics/</a> )
	only includes manufacturing establishments that are classified in NAICS under the 2-digit Manufacturing code equal to 32.
133. Manufacturing-33	The Manufacturing sector comprises establishments engaged in the mechanical, physical, or chemical transformation of materials, substances, or components into new products. This Direct User Subclass only includes manufacturing establishments that are classified in NAICS under the 2-digit Manufacturing code equal to 33.
142. Wholesale Trade	The Wholesale Trade sector comprises establishments engaged in wholesaling merchandise, generally without transformation, and rendering services incidental to the sale of merchandise. The merchandise described in this sector includes the outputs of agriculture, mining, manufacturing, and certain information industries, such as publishing.
144. Retail Trade-44	The Retail Trade sector comprises establishments engaged in retailing merchandise, generally without transformation, and rendering services incidental to the sale of merchandise. This Direct User Subclass only includes retail trade establishments that are classified in NAICS under the 2-digit Retail Trade code equal to 45.
145. Retail Trade-45	The Retail Trade sector comprises establishments engaged in retailing merchandise, generally without transformation, and rendering services incidental to the sale of merchandise. This Direct User Subclass only includes retail trade establishments that are classified in NAICS under the 2-digit Retail Trade code equal to 44.
148. Transportation and Warehousing-48	The Transportation and Warehousing sector includes industries providing transportation of passengers and cargo, warehousing and storage for goods, scenic and sightseeing transportation, and support activities related to modes of transportation. Establishments in these industries use transportation equipment or transportation related facilities as a productive asset. This Direct User Subclass only includes transportation and warehousing establishments that are classified in NAICS under the 2-digit Transportation and Warehousing code equal to 49.
149. Transportation and Warehousing-49	The Transportation and Warehousing sector includes industries providing transportation of passengers and cargo, warehousing and storage for goods, scenic and sightseeing transportation, and support activities related to modes of transportation. Establishments in these industries use transportation equipment or transportation related facilities as a productive asset. This Direct User Subclass only includes transportation and warehousing establishments that are classified in NAICS under the 2-digit Transportation and Warehousing code equal to 48.

Direct User Subclass I	Definition (from NAICS: <a href="https://www.census.gov/eos/www/naics/">https://www.census.gov/eos/www/naics/</a> )
151. Information	The Information sector comprises establishments engaged in the following processes: (a) producing and distributing information and cultural products; (b) providing the means to transmit or distribute these products as well as data or communications; and (c) processing data.
152. Finance and Insurance	The Finance and Insurance sector comprises establishments primarily engaged in financial transactions (transactions involving the creation, liquidation, or change in ownership of financial assets) and/or in facilitating financial transactions.
153. Real Estate and Rental and Leasing	The Real Estate and Rental and Leasing sector comprises establishments primarily engaged in renting, leasing, or otherwise allowing the use of tangible or intangible assets, and establishments providing related services. The major portion of this sector comprises establishments that rent, lease, or otherwise allow the use of their own assets by others. The assets may be tangible, as is the case of real estate and equipment, or intangible, as is the case with patents and trademarks.
154. Professional, Scientific, and Technical Services	The Professional, Scientific, and Technical Services sector comprises establishments that specialize in performing professional, scientific, and technical activities for others. These activities require a high degree of expertise and training. The establishments in this sector specialize according to expertise and provide these services to clients in a variety of industries and, in some cases, to households.
155. Management of Companies and Enterprises	The Management of Companies and Enterprises sector comprises: (1) establishments that hold the securities of (or other equity interests in) companies and enterprises for the purpose of owning a controlling interest or influencing management decisions; or (2) establishments (except government establishments) that administer, oversee, and manage establishments of the company or enterprise and that normally undertake the strategic or organizational planning and decision-making role of the company or enterprise.
156. Administrative and Support and Waste Management and Remediation Services	The Administrative and Support and Waste Management and Remediation Services sector comprises establishments performing routine support activities for the day-to-day operations of other organizations. These essential activities are often undertaken in-house by establishments in many sectors of the economy.
161. Educational Services	The Educational Services sector comprises establishments that provide instruction and training in a wide variety of subjects. This instruction and training are provided by specialized establishments, such as schools, colleges, universities, and training centers. These establishments may be privately owned and operated for profit or not for profit, or they may be publicly owned and operated.

Direct User Subclass I	Definition (from NAICS: <a href="https://www.census.gov/eos/www/naics/">https://www.census.gov/eos/www/naics/</a> )
162. Health Care and Social Assistance	The Health Care and Social Assistance sector comprises establishments providing health care and social assistance for individuals. The sector includes both health care and social assistance because it is sometimes difficult to distinguish between the boundaries of these two activities.
171. Arts, Entertainment, and Recreation	The Arts, Entertainment, and Recreation sector includes a wide range of establishments that operate facilities or provide services to meet varied cultural, entertainment, and recreational interests of their patrons. This sector comprises: (1) establishments that are involved in producing, promoting, or participating in live performances, events, or exhibits intended for public viewing; (2) establishments that preserve and exhibit objects and sites of historical, cultural, or educational interest; and (3) establishments that operate facilities or provide services that enable patrons to participate in recreational activities or pursue amusement, hobby, and leisure-time interests.
172. Accommodation and Food Services	The Accommodation and Food Services sector comprises establishments providing customers with lodging and/or preparing meals, snacks, and beverages for immediate consumption.
181. Other Services (except Public Administration)	The Other Services (except Public Administration) sector comprises establishments engaged in providing services not specifically provided for elsewhere in the classification system. Establishments in this sector are primarily engaged in activities such as equipment and machinery repairing, promoting or administering religious activities, grantmaking, advocacy, and providing drycleaning and laundry services, personal care services, death care services, pet care services, photofinishing services, temporary parking services, and dating services.
392. Public Administration	The Public Administration sector consists of establishments of federal, state, and local government agencies that administer, oversee, and manage public programs and have executive, legislative, or judicial authority over other institutions within a given area. These agencies also set policy, create laws, adjudicate civil and criminal legal cases, and provide for public safety and for national defense. In general, government establishments in the Public Administration sector oversee governmental programs and activities that are not performed by private establishments. ... [G]overnment establishments engaged in the production of private-sector-like goods and services should be classified in the same industry as private-sector establishments engaged in similar activities.
399. Other Government	Other Government includes public sector establishments not included in the other NAICS categories.

<b>Direct User Subclass II</b>	<b>Definition</b> (from NAICS: <a href="https://www.census.gov/eos/www/naics/">https://www.census.gov/eos/www/naics/</a> )
1111. Crop Production	NAICS 3 digit code: 111 - Industries in the Crop Production subsector grow crops mainly for food and fiber. The subsector comprises establishments, such as farms, orchards, groves, greenhouses, and nurseries, primarily engaged in growing crops, plants, vines, or trees and their seeds.
1112. Animal Production and Aquaculture	NAICS 3 digit code: 112 - Industries in the Animal Production and Aquaculture subsector raise or fatten animals for the sale of animals or animal products and/or raise aquatic plants and animals in controlled or selected aquatic environments for the sale of aquatic plants, animals, or their products. The subsector includes establishments, such as ranches, farms, and feedlots, primarily engaged in keeping, grazing, breeding, or feeding animals. These animals are kept for the products they produce or for eventual sale. The animals are generally raised in various environments, from total confinement or captivity to feeding on an open range pasture.
1113. Forestry and Logging	NAICS 3 digit code: 113 - Industries in the Forestry and Logging subsector grow and harvest timber on a long production cycle (i.e., of 10 years or more). Long production cycles use different production processes than short production cycles, which require more horticultural interventions prior to harvest, resulting in processes more similar to those found in the Crop Production subsector. Consequently, Christmas tree production and other production involving production cycles of less than 10 years, are classified in the Crop Production subsector.
1114. Fishing, Hunting and Trapping	NAICS 3 digit code: 114 - Industries in the Fishing, Hunting and Trapping subsector harvest fish and other wild animals from their natural habitats and are dependent upon a continued supply of the natural resource. The harvesting of fish is the predominant economic activity of this subsector and it usually requires specialized vessels that, by the nature of their size, configuration and equipment, are not suitable for any other type of production, such as transportation.
1115. Support Activities for Agriculture and Forestry	NAICS 3 digit code: 115 - Industries in the Support Activities for Agriculture and Forestry subsector provide support services that are an essential part of agricultural and forestry production. These support activities may be performed by the agriculture or forestry producing establishment or conducted independently as an alternative source of inputs required for the production process for a given crop, animal, or forestry industry. Establishments that primarily perform these activities independent of the agriculture or forestry producing establishment are in this subsector.
1211. Oil and Gas Extraction	NAICS 3 digit code: 211 - Industries in the Oil and Gas Extraction subsector operate and/or develop oil and gas field properties.

<b>Direct User Subclass II</b>	<b>Definition</b> (from NAICS: <a href="https://www.census.gov/eos/www/naics/">https://www.census.gov/eos/www/naics/</a> )
1212. Mining (except Oil and Gas)	NAICS 3 digit code: 212 - Industries in the Mining (except Oil and Gas) subsector primarily engage in mining, mine site development, and beneficiating (i.e., preparing) metallic minerals and nonmetallic minerals, including coal.
1213. Support Activities for Mining	NAICS 3 digit code: 213 - Industries in the Support Activities for Mining subsector group establishments primarily providing support services, on a contract or fee basis, required for the mining and quarrying of minerals and for the extraction of oil and gas.
1221. Utilities	NAICS 3 digit code: 221 - Industries in the Utilities subsector provide electric power, natural gas, steam supply, water supply, and sewage removal through a permanent infrastructure of lines, mains, and pipes. Establishments are grouped together based on the utility service provided and the particular system or facilities required to perform the service.
1236. Construction of Buildings	NAICS 3 digit code: 236 - The Construction of Buildings subsector comprises establishments primarily responsible for the construction of buildings. The work performed may include new work, additions, alterations, or maintenance and repairs.
1237. Heavy and Civil Engineering Construction	NAICS 3 digit code: 237 - The Heavy and Civil Engineering Construction subsector comprises establishments whose primary activity is the construction of entire engineering projects (e.g., highways and dams), and specialty trade contractors, whose primary activity is the production of a specific component for such projects.
1238. Specialty Trade Contractors	NAICS 3 digit code: 238 - The Specialty Trade Contractors subsector comprises establishments whose primary activity is performing specific activities (e.g., pouring concrete, site preparation, plumbing, painting, and electrical work) involved in building construction or other activities that are similar for all types of construction, but that are not responsible for the entire project.
1311. Food Manufacturing	NAICS 3 digit code: 311 - Industries in the Food Manufacturing subsector transform livestock and agricultural products into products for intermediate or final consumption. The industry groups are distinguished by the raw materials (generally of animal or vegetable origin) processed into food products.
1312. Beverage and Tobacco Product Manufacturing	NAICS 3 digit code: 312 - Industries in the Beverage and Tobacco Product Manufacturing subsector manufacture beverages and tobacco products. The Beverage Manufacturing industry group includes three types of establishments: (1) those that manufacture nonalcoholic beverages; (2) those that manufacture alcoholic beverages through the fermentation process; and (3) those that produce

Direct User Subclass II	Definition (from NAICS: <a href="https://www.census.gov/eos/www/naics/">https://www.census.gov/eos/www/naics/</a> )
	distilled alcoholic beverages. Ice manufacturing, while not a beverage, is included with nonalcoholic beverage manufacturing because it uses the same production process as water purification.
1313. Textile Mills	NAICS 3 digit code: 313 - Industries in the Textile Mills subsector group establishments that transform a basic fiber (natural or synthetic) into a product, such as yarn or fabric that is further manufactured into usable items, such as apparel, sheets, towels, and textile bags for individual or industrial consumption. The further manufacturing may be performed in the same establishment and classified in this subsector, or it may be performed at a separate establishment and be classified elsewhere in manufacturing.
1314. Textile Product Mills	NAICS 3 digit code: 314 - Industries in the Textile Product Mills subsector group establishments that make textile products (except apparel). With a few exceptions, processes used by these establishments are generally cut and sew (i.e., purchasing fabric and cutting and sewing to make nonapparel textile products, such as sheets and towels).
1315. Apparel Manufacturing	NAICS 3 digit code: 315 - Industries in the Apparel Manufacturing subsector group establishments with two distinct manufacturing processes: (1) cut and sew (i.e., purchasing fabric and cutting and sewing to make a garment); and (2) the manufacture of garments in establishments that first knit fabric and then cut and sew the fabric into a garment.
1316. Leather and Allied Product Manufacturing	NAICS 3 digit code: 316 - Establishments in the Leather and Allied Product Manufacturing subsector transform hides into leather by tanning or curing and fabricating the leather into products for final consumption. This subsector also includes the manufacture of similar products from other materials, including products (except apparel) made from "leather substitutes," such as rubber, plastics, or textiles.
1321. Wood Product Manufacturing	NAICS 3 digit code: 321 - Establishments in the Wood Product Manufacturing subsector manufacture wood products, such as lumber, plywood, veneers, wood containers, wood flooring, wood trusses, manufactured homes (i.e., mobile homes), and prefabricated wood buildings.
1322. Paper Manufacturing	NAICS 3 digit code: 322 - Industries in the Paper Manufacturing subsector make pulp, paper, or converted paper products. The manufacturing of these products is grouped together because they constitute a series of vertically connected processes. More than one is often carried out in a single establishment.
1323. Printing and Related Support Activities	NAICS 3 digit code: 323 - Industries in the Printing and Related Support Activities subsector print products, such as newspapers, books, labels, business cards, stationery, business forms, and other



Direct User Subclass II	Definition (from NAICS: <a href="https://www.census.gov/eos/www/naics/">https://www.census.gov/eos/www/naics/</a> )
	materials, and perform support activities, such as data imaging, platemaking services, and bookbinding.
1324. Petroleum and Coal Products Manufacturing	NAICS 3 digit code: 324 - The Petroleum and Coal Products Manufacturing subsector is based on the transformation of crude petroleum and coal into usable products. The dominant process is petroleum refining that involves the separation of crude petroleum into component products through such techniques as cracking and distillation.
1325. Chemical Manufacturing	NAICS 3 digit code: 325 - The Chemical Manufacturing subsector is based on the transformation of organic and inorganic raw materials by a chemical process and the formulation of products.
1326. Plastics and Rubber Products Manufacturing	NAICS 3 digit code: 326 - Industries in the Plastics and Rubber Products Manufacturing subsector make goods by processing plastics materials and raw rubber.
1327. Nonmetallic Mineral Product Manufacturing	NAICS 3 digit code: 327 - The Nonmetallic Mineral Product Manufacturing subsector transforms mined or quarried nonmetallic minerals, such as sand, gravel, stone, clay, and refractory materials, into products for intermediate or final consumption
1331. Primary Metal Manufacturing	NAICS 3 digit code: 331 - Industries in the Primary Metal Manufacturing subsector smelt and/or refine ferrous and nonferrous metals from ore, pig or scrap, using electrometallurgical and other process metallurgical techniques. Establishments in this subsector also manufacture metal alloys and superalloys by introducing other chemical elements to pure metals.
1332. Fabricated Metal Product Manufacturing	NAICS 3 digit code: 332 - Industries in the Fabricated Metal Product Manufacturing subsector transform metal into intermediate or end products, other than machinery, computers and electronics, and metal furniture, or treat metals and metal formed products fabricated elsewhere.
1333. Machinery Manufacturing	NAICS 3 digit code: 333 - Industries in the Machinery Manufacturing subsector create end products that apply mechanical force, for example, the application of gears and levers, to perform work.
1334. Computer and Electronic Product Manufacturing	NAICS 3 digit code: 334 - Industries in the Computer and Electronic Product Manufacturing subsector group establishments that manufacture computers, computer peripherals, communications equipment, and similar electronic products, and establishments that manufacture components for such products.
1335. Electrical Equipment, Appliance, and Component Manufacturing	NAICS 3 digit code: 335 - Industries in the Electrical Equipment, Appliance, and Component Manufacturing subsector manufacture products that generate, distribute and use electrical power.

<b>Direct User Subclass II</b>	<b>Definition</b> (from NAICS: <a href="https://www.census.gov/eos/www/naics/">https://www.census.gov/eos/www/naics/</a> )
1336. Transportation Equipment Manufacturing	NAICS 3 digit code: 336 - Industries in the Transportation Equipment Manufacturing subsector produce equipment for transporting people and goods. Transportation equipment is a type of machinery. An entire subsector is devoted to this activity because of the significance of its economic size in all three North American countries.
1337. Furniture and Related Product Manufacturing	NAICS 3 digit code: 337 - Industries in the Furniture and Related Product Manufacturing subsector make furniture and related articles, such as mattresses, window blinds, cabinets, and fixtures. The processes used in the manufacture of furniture include the cutting, bending, molding, laminating, and assembly of such materials as wood, metal, glass, plastics, and rattan.
1339. Miscellaneous Manufacturing	NAICS 3 digit code: 339 - Industries in the Miscellaneous Manufacturing subsector make a wide range of products that cannot readily be classified in specific NAICS subsectors in manufacturing.
1423. Merchant Wholesalers, Durable Goods	NAICS 3 digit code: 423 - Industries in the Merchant Wholesalers, Durable Goods subsector sell capital or durable goods to other businesses. Merchant wholesalers generally take title to the goods that they sell; in other words, they buy and sell goods on their own account.
1424. Merchant Wholesalers, Nondurable Goods	NAICS 3 digit code: 424 - Industries in the Merchant Wholesalers, Nondurable Goods subsector sell nondurable goods to other businesses. Nondurable goods are items generally with a normal life expectancy of less than three years.
1425. Wholesale Electronic Markets and Agents and Brokers	NAICS 3 digit code: 425 - Industries in the Wholesale Electronic Markets and Agents and Brokers subsector arrange for the sale of goods owned by others, generally on a fee or commission basis. They act on behalf of the buyers and sellers of goods. This subsector contains agents and brokers as well as business-to-business electronic markets that facilitate wholesale trade.
1441. Motor Vehicle and Parts Dealers	NAICS 3 digit code: 441 - Industries in the Motor Vehicle and Parts Dealers subsector retail motor vehicles and parts from fixed point-of-sale locations. Establishments in this subsector typically operate from a showroom and/or an open lot where the vehicles are on display.
1442. Furniture and Home Furnishings Stores	NAICS 3 digit code: 442 - Industries in the Furniture and Home Furnishings Stores subsector retail new furniture and home furnishings from fixed point-of-sale locations. Establishments in this subsector usually operate from showrooms and have substantial areas for the presentation of their products. Many offer interior decorating services in addition to the sale of products.
1443. Electronics and Appliance Stores	NAICS 3 digit code: 443 - Industries in the Electronics and Appliance Stores subsector retail new electronics and appliances from point-of-sale locations.



<b>Direct User Subclass II</b>	<b>Definition</b> (from NAICS: <a href="https://www.census.gov/eos/www/naics/">https://www.census.gov/eos/www/naics/</a> )
1444. Building Material and Garden Equipment and Supplies Dealers	NAICS 3 digit code: 444 - Industries in the Building Material and Garden Equipment and Supplies Dealers subsector retail new building material and garden equipment and supplies from fixed point-of-sale locations.
1445. Food and Beverage Stores	NAICS 3 digit code: 445 - Industries in the Food and Beverage Stores subsector usually retail food and beverage merchandise from fixed point-of-sale locations.
1446. Health and Personal Care Stores	NAICS 3 digit code: 446 - Industries in the Health and Personal Care Stores subsector retail health and personal care merchandise from fixed point-of-sale locations.
1447. Gasoline Stations	NAICS 3 digit code: 447 - Industries in the Gasoline Stations subsector retail automotive fuels (e.g., gasoline, diesel fuel, gasohol, alternative fuels) and automotive oils or retail these products in combination with convenience store items. These establishments have specialized equipment for storing and dispensing automotive fuels.
1448. Clothing and Clothing Accessories Stores	NAICS 3 digit code: 448 - Industries in the Clothing and Clothing Accessories Stores subsector retail new clothing and clothing accessories from fixed point-of-sale locations. Establishments in this subsector have similar display equipment and staff that is knowledgeable regarding fashion trends and the proper match of styles, colors, and combinations of clothing and accessories to the characteristics and tastes of the customer.
1451. Sporting Goods, Hobby, Musical Instrument, and Book Stores	NAICS 3 digit code: 451 - Industries in the Sporting Goods, Hobby, Musical Instrument, and Book Stores subsector are engaged in retailing and providing expertise on the use of sporting equipment or supplies for other specific leisure activities, such as needlework and musical instruments. Book stores are also included in this subsector.
1452. General Merchandise Stores	NAICS 3 digit code: 452 - Industries in the General Merchandise Stores subsector retail new general merchandise from fixed point-of-sale locations.
1453. Miscellaneous Store Retailers	NAICS 3 digit code: 453 - Industries in the Miscellaneous Store Retailers subsector retail merchandise from fixed point-of-sale locations (except new or used motor vehicles and parts; new furniture and home furnishings; new appliances and electronic products; new building materials and garden equipment and supplies; food and beverages; health and personal care goods; gasoline; new clothing and accessories; and new sporting goods, hobby goods, books, and music).
1454. Nonstore Retailers	NAICS 3 digit code: 454 - Industries in the Nonstore Retailers subsector retail merchandise using methods, such as the broadcasting of infomercials, the broadcasting and publishing of direct-

<b>Direct User Subclass II</b>	<b>Definition</b> (from NAICS: <a href="https://www.census.gov/eos/www/naics/">https://www.census.gov/eos/www/naics/</a> )
	response advertising, the publishing of paper and electronic catalogs, door-to-door solicitation, in-home demonstration, selling from portable stalls, and distribution through vending machines.
1481. Air Transportation	NAICS 3 digit code: 481 - Industries in the Air Transportation subsector provide air transportation of passengers and/or cargo using aircraft, such as airplanes and helicopters. The subsector distinguishes scheduled from nonscheduled air transportation.
1482. Rail Transportation	NAICS 3 digit code: 482 - Industries in the Rail Transportation subsector provide rail transportation of passengers and/or cargo using railroad rolling stock. The railroads in this subsector primarily either operate on networks, with physical facilities, labor force, and equipment spread over an extensive geographic area, or operate over a short distance on a local rail line.
1483. Water Transportation	NAICS 3 digit code: 483 - Industries in the Water Transportation subsector provide water transportation of passengers and cargo using watercraft, such as ships, barges, and boats.
1484. Truck Transportation	NAICS 3 digit code: 484 - Industries in the Truck Transportation subsector provide over-the-road transportation of cargo using motor vehicles, such as trucks and tractor trailers.
1485. Transit and Ground Passenger Transportation	NAICS 3 digit code: 485 - Industries in the Transit and Ground Passenger Transportation subsector include a variety of passenger transportation activities, such as urban transit systems; chartered bus, school bus, and interurban bus transportation; and taxis.
1486. Pipeline Transportation	NAICS 3 digit code: 486 - Industries in the Pipeline Transportation subsector use transmission pipelines to transport products, such as crude oil, natural gas, refined petroleum products, and slurry. Industries are identified based on the products transported (i.e., pipeline transportation of crude oil, natural gas, refined petroleum products, and other products).
1487. Scenic and Sightseeing Transportation	NAICS 3 digit code: 487 - Industries in the Scenic and Sightseeing Transportation subsector utilize transportation equipment to provide recreation and entertainment. These activities have a production process distinct from passenger transportation carried out for the purpose of other types of for-hire transportation.
1488. Support Activities for Transportation	NAICS 3 digit code: 488 - Industries in the Support Activities for Transportation subsector provide services which support transportation. These services may be provided to transportation carrier establishments or to the general public. This subsector includes a wide array of establishments, including air traffic control services, marine cargo handling, and motor vehicle towing.

<b>Direct User Subclass II</b>	<b>Definition</b> (from NAICS: <a href="https://www.census.gov/eos/www/naics/">https://www.census.gov/eos/www/naics/</a> )
1491. Postal Service	NAICS 3 digit code: 491 - The Postal Service subsector includes the activities of the National Post Office and its subcontractors operating under a universal service obligation to provide mail services, and using the infrastructure required to fulfill that obligation.
1492. Couriers and Messengers	NAICS 3 digit code: 492 - Industries in the Couriers and Messengers subsector provide intercity, local, and/or international delivery of parcels and documents (including express delivery services) without operating under a universal service obligation.
1493. Warehousing and Storage	NAICS 3 digit code: 493 - Industries in the Warehousing and Storage subsector are primarily engaged in operating warehousing and storage facilities for general merchandise, refrigerated goods, and other warehouse products. These establishments provide facilities to store goods.
1511. Publishing Industries (except Internet)	NAICS 3 digit code: 511 - Industries in the Publishing Industries (except Internet) subsector group establishments engaged in the publishing of newspapers, magazines, other periodicals, and books, as well as directory and mailing list and software publishing. In general, these establishments, which are known as publishers, issue copies of works for which they usually possess copyright.
1512. Motion Picture and Sound Recording Industries	NAICS 3 digit code: 512 - Industries in the Motion Picture and Sound Recording Industries subsector group establishments involved in the production and distribution of motion pictures and sound recordings.
1515. Broadcasting (except Internet)	NAICS 3 digit code: 515 - Industries in the Broadcasting (except Internet) subsector include establishments that create content or acquire the right to distribute content and subsequently broadcast the content.
1517. Telecommunications	NAICS 3 digit code: 517 - Industries in the Telecommunications subsector group establishments that provide telecommunications and the services related to that activity (e.g., telephony, including Voice over Internet Protocol (VoIP); cable and satellite television distribution services; Internet access; telecommunications reselling services). The Telecommunications subsector is primarily engaged in operating and/or providing access to facilities for the transmission of voice, data, text, sound, and video.
1518. Data Processing, Hosting, and Related Services	NAICS 3 digit code: 518 - Industries in the Data Processing, Hosting, and Related Services subsector group establishments that provide the infrastructure for hosting and/or data processing services.
1519. Other Information Services	NAICS 3 digit code: 519 - Industries in the Other Information Services subsector group establishments supplying information, storing and providing access to information, searching and

Direct User Subclass II	Definition (from NAICS: <a href="https://www.census.gov/eos/www/naics/">https://www.census.gov/eos/www/naics/</a> )
	retrieving information, operating Web sites that use search engines to allow for searching information on the Internet, or publishing and/or broadcasting content exclusively on the Internet. The main components of the subsector are news syndicates, libraries, archives, exclusive Internet publishing and/or broadcasting, and Web search portals.
1521. Monetary Authorities-Central Bank	NAICS 3 digit code: 521 - The Monetary Authorities-Central Bank subsector groups establishments that engage in performing central banking functions, such as issuing currency, managing the Nation's money supply and international reserves, holding deposits that represent the reserves of other banks and other central banks, and acting as a fiscal agent for the central government.
1522. Credit Intermediation and Related Activities	NAICS 3 digit code: 522 - Industries in the Credit Intermediation and Related Activities subsector group establishments that: (1) lend funds raised from depositors; (2) lend funds raised from credit market borrowing; or (3) facilitate the lending of funds or issuance of credit by engaging in such activities as mortgage and loan brokerage, clearinghouse and reserve services, and check cashing services.
1523. Securities, Commodity Contracts, and Other Financial Investments and Related Activities	NAICS 3 digit code: 523 - Industries in the Securities, Commodity Contracts, and Other Financial Investments and Related Activities subsector group establishments that are primarily engaged in one of the following: (1) underwriting securities issues and/or making markets for securities and commodities; (2) acting as agents (i.e., brokers) between buyers and sellers of securities and commodities; (3) providing securities and commodity exchange services; and (4) providing other services, such as managing portfolios of assets; providing investment advice; and trust, fiduciary, and custody services.
1524. Insurance Carriers and Related Activities	NAICS 3 digit code: 524 - Industries in the Insurance Carriers and Related Activities subsector group establishments that are primarily engaged in one of the following: (1) underwriting (assuming the risk, assigning premiums, and so forth) annuities and insurance policies; or (2) facilitating such underwriting by selling insurance policies and by providing other insurance and employee benefit related services.
1525. Funds, Trusts, and Other Financial Vehicles	NAICS 3 digit code: 525 - Industries in the Funds, Trusts, and Other Financial Vehicles subsector group legal entities (i.e., funds, plans, and/or programs) organized to pool securities or other assets on behalf of shareholders or beneficiaries of employee benefit or other trust funds.
1531. Real Estate	NAICS 3 digit code: 531 - Industries in the Real Estate subsector group establishments primarily engaged in renting or leasing real estate to others; managing real estate for others; selling, buying, or

Direct User Subclass II	Definition (from NAICS: <a href="https://www.census.gov/eos/www/naics/">https://www.census.gov/eos/www/naics/</a> )
	renting real estate for others; and providing other real estate related services, such as appraisal services.
1532. Rental and Leasing Services	NAICS 3 digit code: 532 - Industries in the Rental and Leasing Services subsector include establishments that provide a wide array of tangible goods, such as automobiles, computers, consumer goods, and industrial machinery and equipment, to customers in return for a periodic rental or lease payment.
1533. Lessors of Nonfinancial Intangible Assets (except Copyrighted Works)	NAICS 3 digit code: 533 - Industries in the Lessors of Nonfinancial Intangible Assets (except Copyrighted Works) subsector include establishments primarily engaged in assigning rights to assets, such as patents, trademarks, brand names, and/or franchise agreements, for which a royalty payment or licensing fee is paid to the asset holder. Establishments in this subsector own the patents, trademarks, and/or franchise agreements that they allow others to use or reproduce for a fee and may or may not have created those assets.
1541. Professional, Scientific, and Technical Services	NAICS 3 digit code: 541 - Industries in the Professional, Scientific, and Technical Services subsector group establishments engaged in processes where human capital is the major input. These establishments make available the knowledge and skills of their employees, often on an assignment basis, where an individual or team is responsible for the delivery of services to the client. The individual industries of this subsector are defined on the basis of the particular expertise and training of the services provider.
1551. Management of Companies and Enterprises	NAICS 3 digit code: 551 - Industries in the Management of Companies and Enterprises subsector include three main types of establishments: (1) those that hold the securities of (or other equity interests in) companies and enterprises; (2) those (except government establishments) that administer, oversee, and manage other establishments of the company or enterprise but do not hold the securities of these establishments; and (3) those that both administer, oversee, and manage other establishments of the company or enterprise and hold the securities of (or other equity interests in) these establishments. Those establishments that administer, oversee, and manage normally undertake the strategic or organizational planning and decision-making role of the company or enterprise.
1561. Administrative and Support Services	NAICS 3 digit code: 561 - Industries in the Administrative and Support Services subsector group establishments engaged in activities that support the day-to-day operations of other organizations. The processes employed in this sector (e.g., general management, personnel administration, clerical

Direct User Subclass II	Definition (from NAICS: <a href="https://www.census.gov/eos/www/naics/">https://www.census.gov/eos/www/naics/</a> )
	activities, cleaning activities) are often integral parts of the activities of establishments found in all sectors of the economy.
1562. Waste Management and Remediation Services	NAICS 3 digit code: 562 - Industries in the Waste Management and Remediation Services subsector group establishments engaged in the collection, treatment, and disposal of waste materials. This includes establishments engaged in local hauling of waste materials; operating materials recovery facilities (i.e., those that sort recyclable materials from the trash stream); providing remediation services (i.e., those that provide for the cleanup of contaminated buildings, mine sites, soil, or ground water); and providing septic pumping and other miscellaneous waste management services.
1611. Educational Services	NAICS 3 digit code: 611 - Industries in the Educational Services subsector provide instruction and training in a wide variety of subjects. The instruction and training are provided by specialized establishments, such as schools, colleges, universities, and training centers.
1621. Ambulatory Health Care Services	NAICS 3 digit code: 621 - Industries in the Ambulatory Health Care Services subsector provide health care services directly or indirectly to ambulatory patients and do not usually provide inpatient services. Health practitioners in this subsector provide outpatient services, with the facilities and equipment not usually being the most significant part of the production process.
1622. Hospitals	NAICS 3 digit code: 622 - Industries in the Hospitals subsector provide medical, diagnostic, and treatment services that include physician, nursing, and other health services to inpatients and the specialized accommodation services required by inpatients. Hospitals may also provide outpatient services as a secondary activity. Establishments in the Hospitals subsector provide inpatient health services, many of which can only be provided using the specialized facilities and equipment that form a significant and integral part of the production process.
1623. Nursing and Residential Care Facilities	NAICS 3 digit code: 623 - Industries in the Nursing and Residential Care Facilities subsector provide residential care combined with either nursing, supervisory, or other types of care as required by the residents. In this subsector, the facilities are a significant part of the production process, and the care provided is a mix of health and social services with the health services being largely some level of nursing services.
1624. Social Assistance	NAICS 3 digit code: 624 - Industries in the Social Assistance subsector provide a wide variety of social assistance services directly to their clients. These services do not include residential or accommodation services, except on a short-stay basis.



Direct User Subclass II	Definition (from NAICS: <a href="https://www.census.gov/eos/www/naics/">https://www.census.gov/eos/www/naics/</a> )
1711. Performing Arts, Spectator Sports, and Related Industries	NAICS 3 digit code: 711 - Industries in the Performing Arts, Spectator Sports, and Related Industries subsector group establishments that produce or organize and promote live presentations involving the performances of actors and actresses, singers, dancers, musical groups and artists, athletes, and other entertainers, including independent (i.e., freelance) entertainers and the establishments that manage their careers
1712. Museums, Historical Sites, and Similar Institutions	NAICS 3 digit code: 712 - Industries in the Museums, Historical Sites, and Similar Institutions subsector engage in the preservation and exhibition of objects, sites, and natural wonders of historical, cultural, and/or educational value.
1713. Amusement, Gambling, and Recreation Industries	NAICS 3 digit code: 713 - Industries in the Amusement, Gambling, and Recreation Industries subsector: (1) operate facilities where patrons can primarily engage in sports, recreation, amusement, or gambling activities; and/or (2) provide other amusement and recreation services, such as supplying and servicing amusement devices in places of business operated by others; operating sports teams, clubs, or leagues engaged in playing games for recreational purposes; and guiding tours without using transportation equipment.
1721. Accommodation and Food Services	NAICS 3 digit code: 721 - Industries in the Accommodation subsector provide lodging or short-term accommodations for travelers, vacationers, and others. There is a wide range of establishments in these industries. Some provide lodging only, while others provide meals, laundry services, and recreational facilities, as well as lodging. Lodging establishments are classified in this subsector even if the provision of complementary services generates more revenue. The types of complementary services provided vary from establishment to establishment.
1722. Food Services and Drinking Places	NAICS 3 digit code: 722 - Industries in the Food Services and Drinking Places subsector prepare meals, snacks, and beverages to customer order for immediate on-premises and off-premises consumption. There is a wide range of establishments in these industries. Some provide food and drink only, while others provide various combinations of seating space, waiter/waitress services, and incidental amenities, such as limited entertainment.
1811. Repair and Maintenance	NAICS 3 digit code: 811 - Industries in the Repair and Maintenance subsector restore machinery, equipment, and other products to working order. These establishments also typically provide general or routine maintenance (i.e., servicing) on such products to ensure they work efficiently and to prevent breakdown and unnecessary repairs.

<b>Direct User Subclass II</b>	<b>Definition</b> (from NAICS: <a href="https://www.census.gov/eos/www/naics/">https://www.census.gov/eos/www/naics/</a> )
1812. Personal and Laundry Services	NAICS 3 digit code: 812 - Industries in the Personal and Laundry Services subsector group establishments that provide personal and laundry services to individuals, households, and businesses. Services performed include: personal care services; death care services; laundry and drycleaning services; and a wide range of other personal services, such as pet care (except veterinary) services, photofinishing services, temporary parking services, and dating services.
1813. Religious, Grantmaking, Civic, Professional, and Similar Organizations	NAICS 3 digit code: 813 - Industries in the Religious, Grantmaking, Civic, Professional, and Similar Organizations subsector group establishments that organize and promote religious activities; support various causes through grantmaking; advocate various social and political causes; and promote and defend the interests of their members.
3921. Executive, Legislative, and Other General Government Support	NAICS 3 digit code: 921 - The Executive, Legislative, and Other General Government Support subsector groups offices of government executives, legislative bodies, public finance, and general government support.
3922. Justice, Public Order, and Safety Activities	NAICS 3 digit code: 922 - The Justice, Public Order, and Safety Activities subsector groups government establishments engaged in the administration of justice, public order, and safety programs.
3923. Administration of Human Resource Programs	NAICS 3 digit code: 923 - The Administration of Human Resource Programs subsector groups government establishments primarily engaged in the administration of human resource programs.
3924. Administration of Environmental Quality Programs	NAICS 3 digit code: 924 - The Administration of Environmental Quality Programs subsector groups government establishments primarily engaged in the administration of environmental quality.
3925. Administration of Housing Programs, Urban Planning, and Community Development	NAICS 3 digit code: 925 - The Administration of Housing Programs, Urban Planning, and Community Development subsector groups government establishments primarily engaged in the administration of housing, urban planning, and community development.
3926. Administration of Economic Programs	NAICS 3 digit code: 926 - This subsector comprises government establishments primarily engaged in the administration of economic programs.
3927. Space Research and Technology	NAICS 3 digit code: 927 - This subsector comprises government establishments that conduct space research.
3928. National Security and International Affairs	NAICS 3 digit code: 928 - This subsector comprises government establishments primarily engaged in national security and international affairs.



## Appendix F. Definitions of Beneficiary Classes and Subclasses

Beneficiary Class	Definition
01. Agricultural	This class includes Beneficiaries who use Ecological End-Products (also known as FEGs) for agricultural or forest production activities.
02. Commercial/Industrial	This class includes Beneficiaries who use Ecological End-Products (also known as FEGs) for industrial or commercial production activities not included in the other classes or subclasses.
03. Government, Municipal, and Residential	This class includes governmental, military, and residential Beneficiaries who use Ecological End-Products (also known as FEGs) in ways not included in the other classes or subclasses.
04. Commercial/Military Transportation	This class includes military and commercial Beneficiaries who use Ecological End-Products (also known as FEGs) as a media to transport goods or people.
05. Subsistence	This class includes Beneficiaries who use Ecological End-Products (also known as FEGs) to support subsistence activities.
06. Recreational	This class includes Beneficiaries who use Ecological End-Products (also known as FEGs) to support recreational activities.
07. Inspirational	This class includes Beneficiaries who use or appreciate Ecological End-Products (also known as FEGs) as a source of inspiration.
08. Learning	This class includes Beneficiaries who use Ecological End-Products (also known as FEGs) for educational or scientific research activities.
09. Non-Use	This class includes Beneficiaries who benefit from Ecological End-Products (also known as FEGs) in ways that do not require or are not associated with direct use of or contact.
10. Humanity	This class includes everyone, regardless of whether they actively recognize or appreciate the Ecological End-Products (also known as FEGs), because the FEGs are available to everyone and used by everyone to live (e.g., air for breathing).

Beneficiary Subclass I	Definition
011. Livestock Grazers	This Beneficiary uses Ecological End-Products (also known as FEGs) to graze livestock.
012. Agricultural Processors	This Beneficiary primarily consumes Water for washing edible products.

<b>Beneficiary Subclass I</b>	<b>Definition</b>
013. Aquaculturists	This Beneficiary farms aquatic Fauna, such as fish, shrimp, oysters, etc. Those who cultivate aquatic Flora are accounted for under the Farmer Beneficiary subclass.
014. Farmers	This Beneficiary may plant annual crops (e.g., corn, soybeans, rice) or introduce cultivars that produce perennial, long-term crops (e.g., hay, grapes, cranberries, watercress).
015. Foresters	This Beneficiary introduces tree cultivars and nurtures those cultivars as they grow into trees, which are harvested. The rotation for the tree crops may be as short as 10 years or many decades.
016. Other Agricultural Beneficiaries	Agricultural Beneficiaries not captured in the other agricultural subclasses.
021. Food Extractors	This Beneficiary utilizes the wild abundance of edible organisms (i.e., non-cultivated or bred) for commercial use or sale. Includes commercial fishing and hunting (if legal) but excludes subsistence beneficiaries.
022. Timber, Fiber, and Ornamental Extractors	This Beneficiary relies on Ecological End-Products (also known as FEGs) for products used or sold commercially.
023. Industrial Processors	This Beneficiary primarily consumes Water for cooling, producing pulp, etc. Except for agricultural processing which is a separate subclass.
024. Private Energy Generators	This Beneficiary relies on Ecological End-Products (also known as FEGs) for energy or placement of power generation structures, including dams, wind, water, or wave turbines, solar panels, geothermal systems, etc.
025. Pharmaceutical and Food Supplement Suppliers	This Beneficiary collects organisms or wild products from organisms that are used as or for the basis of pharmaceuticals or food supplements for commercial sale.
026. Fur / Hide Trappers and Hunters	This Beneficiary captures wild Fauna (i.e., not farm-raised or domesticated animals) for fur or hides for commercial use or sale.
027. Private Drinking Water Plant Operators	This Beneficiary provides drinking water to a community and may do so by collecting Water from rivers, reservoirs, lakes, wells, bays, or estuaries. Water is treated and distributed
028. Commercial/Industrial Property Owner	This Beneficiary uses or benefits from Ecological End-Products (also known as FEGs) as an owner of commercial/industrial property and in a way not specified in other commercial/industrial subclasses.
029. Other Commercial/Industrial	Commercial/Industrial beneficiaries not captured in the other commercial/industrial subclasses.

<b>Beneficiary Subclass I</b>	<b>Definition</b>
031. Municipal Drinking Water Plant Operators	This beneficiary provides drinking water to a community and may do so by collecting water from rivers, reservoirs, lakes, wells, bays, or estuaries. Water is treated and distributed.
032. Residential Property Owners	This Beneficiary uses or benefits from Ecological End-Products (also known as FEGs) as an owner of residential property and in a way not specified in other beneficiary subclasses.
033. Public Sector Property Owners	This Beneficiary uses or benefits from Ecological End-Products (also known as FEGs) as an owner of property and in a way not specified in other government, municipal, and residential subclasses.
034. Military / Coast Guard	This Beneficiary relies on Ecological End-Products (also known as FEGs) for the placement of infrastructure (e.g., ports, bases, etc.) or conditions for training activities.
035. Public Energy Generators	This Beneficiary relies on Ecological End-Products (also known as FEGs) for energy or placement of power generation structures, including dams, wind, water, or wave turbines, solar panels, geothermal systems, etc.
036. Other Government, Municipal, and Residential	Government, Municipal, and Residential Beneficiaries not captured in the other government, municipal, and residential subclasses.
041. Transporters of Goods	This Beneficiary uses Ecological End-Products (also known as FEGs) as a media to transport goods - specifically, via boats (e.g., barges), and overland/off-road vehicles (e.g., quads). It does not include railroads (which are covered under other property owners) or cars and trucks on public or private roads as the roads are covered under other property owners.
042. Transporters of People	This Beneficiary uses Ecological End-Products (also known as FEGs) as a media to transport people - specifically, via boats (e.g., barges), and overland/off-road vehicles (e.g., quads). It does not include railroads (which are covered under property owners) or cars and trucks on public or private roads as the roads are covered under property owners.
043. Other Commercial/Military Transportation	Commercial/Military Transportational Beneficiaries not captured in the other transportation subclasses.
051. Water Subsisters	This Beneficiary relies on a wild source for drinking water and may use wells or cisterns for storage (i.e., they do not receive municipal drinking water).
052. Food and Medical Subsisters	This Beneficiary use the abundance of [edible] Flora, Fungi, and Fauna whether collecting, hunting, or fishing as a major supplement to their existence.

<b>Beneficiary Subclass I</b>	<b>Definition</b>
053. Timber, Fiber, and Fur / Hide Subsisters	This Beneficiary relies on the wild abundance of timber, fiber, and Fauna for fur and hides for survival. Timber, fiber, and fur and hides used for building material are accounted for in this class.
054. Building Material Subsisters	This Beneficiary uses Ecological End-Products (also known as FEGs) to provide renewable, non-cellular material (primarily snow and ice) used for infrastructure and housing for personal use (i.e., not for commercial sale).
055. Other Subsistence	This Beneficiary uses Ecological End-Products (also known as FEGs) for subsistence activities not covered by the other subsistence subclasses.
061. Experiencers and Viewers	This Beneficiary views and appreciates Ecological End-Products (also known as FEGs) views and experiences the Environment.
062. Food Pickers and Gatherers	This Beneficiary recreationally picks or gathers from the wild abundance of [edible] flora, fungi, and some fauna (as long as it is not fished or hunted). This Beneficiary has potential contact with water.
063. Hunters	This Beneficiary is primarily interested in hunting mammals and fowl (not flora or fungi) recreationally (i.e., not for survival or subsistence).
064. Anglers	This Beneficiary fishes recreationally (i.e., not for survival) and includes catch-and-release or catch-and-consume activities.
065. Waders, Swimmers, and Divers	This Beneficiary recreates in or under the water by either wading, swimming, or diving (i.e., snorkeling, SCUBA diving).
066. Boaters	This Beneficiary may use motorized (i.e., motor boats) or non-motorized boats (i.e., canoes, kayaks, rafts) to recreate.
067. Other Recreational	This Beneficiary engages in nature-based recreational activities not covered by the other recreational subclasses.
071. Spiritual and Ceremonial Participants and Participants of Celebration	This Beneficiary uses Ecological End-Products (also known as FEGs) for spiritual, ceremonial, or celebratory purposes, such as harvest festivals, seafood festivals, Native American observances, religious rites (i.e., baptisms, weddings), personal growth, etc.
072. Artists	This Beneficiary uses Ecological End-Products (also known as FEGs) for materials and inspiration to produce art. This class may include writers, cinematographers, and recording artist among others.
073. Other Inspirational	This Beneficiary uses Ecological End-Products (also known as FEGs) as a source of inspiration but in a way not covered by the other inspirational subclasses

<b>Beneficiary Subclass I</b>	<b>Definition</b>
081. Educators and Students	This Beneficiary uses Ecological End-Products (also known as FEGs) includes both formal and self-taught educators and students. All parts of the environment are of interest.
082. Researchers	This Beneficiary uses Ecological End-Products (also known as FEGs) for academic and applied purposes.
083. Other Learning	Learning Beneficiaries not captured in the other learning subclasses
091. People Who Care (Existence)	Ecological End-Product is of value these Beneficiaries simply because it exists. It is neither used nor directly experienced. People simply value the knowledge that it exists.
092. People Who Care (Option /Bequest)	Ecological End-Product is of value to these Beneficiaries now, not because they use or experience it, but rather because of the value they place on ensuring that the resource can be used, enjoyed, or appreciated by future generations.
093. Other Non-Use	Non-use beneficiaries not captured in the other non-use subclasses.
101. All Humans	This class includes everyone, regardless of whether they actively recognize or appreciate Ecological End-Products (also known as FEGs), because the FEGs are available to everyone and used by everyone to live (e.g., air for breathing).



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