EPA/600/B-24/336 | April 2025
www.epa.gov/research

United States Environmental Protection Agency

Final Ecosystem Goods and Services (FEGS) Document Reader

User Guide

Office of Research and Development
Center for Environmental Measurement and Modeling

EPA/600/B-24/336
April 2025

Final Ecosystem Goods and Services (FEGS) Document Reader

User Guide

By

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The citation for this manual is:

Yee, S.H., R.S. Ennis, L.M. Sharpe, M.C. Harwell, T. Newcomer-Johnson. 2025. Final Ecosystem Goods and Services (FEGS) Document Reader. U.S. Environmental Protection Agency, Gulf Breeze, FL. EPA/600/B-24/336.

Notice and Disclaimer

This manual is a contribution to the EPA ORD Sustainable and Healthy Communities (SHC) Research Program under project SHC 409.1.2 "Translation and Communication of Existing Ecosystem Services and Benefits Tools to Assess Restoration Success." The information generated in this manual was performed under the Quality Assurance Project Plan (QAPPs) J-GEMMD-0032706-QP-1-1. This manual has been reviewed by the ORD/CEMM Quality Assurance Manager and it has been determined to be consistent with EPA Category B quality assurance requirements. This document has been reviewed in accordance with U.S. Environmental Protection Agency policy and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use. Contractor's role did not include establishing Agency policy.

The R shiny application development was partially fulfilled through Contract 68HERD24A0001 / 68HERD24F0094 with General Dynamics Information Technology (GDIT) under the sponsorship of the United States Environmental Protection Agency.

The FEGS Document Reader is based on the National Ecosystem Services Classification System Plus (NESCS Plus) for identification and classification of ecosystem services, and the Final Ecosystem Goods and Services (FEGS) Scoping Tool for prioritizing ecosystem services. Individual users of these tools are responsible for evaluating the uncertainties associated with the original documents or other information being entered into these tools and characterizing results for applicability, precision, accuracy, uncertainty, and other qualifications associated with usability of results.

Acknowledgements

This work builds off NESCS Plus[1] and the FEGS Scoping Tool[2], and is the culmination of document analysis efforts initially conducted for National Estuary Programs[3], Massachusetts Bays communities[4], and tidal wetland management[5]. We are grateful to all the collaborators on those efforts who helped to build the foundational material for the FEGS Document Reader. We are grateful to the contractor support of GDIT, including Robert Aumer, Sage Bonomo, Wilson Melendez, and Denise Hale, who provided valuable insights and support on application development. We are grateful to Steven Pfeiffer for assisting with the EPA ORD application development process. We also greatly appreciate the efforts and feedback of technical reviewers and test users.

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About The FEGS Document Reader

This user guide is meant to accompany the Final Ecosystem Goods and Services (FEGS) Document Reader, which is available as an R Shiny Application at:

https://shiny.epa.gov/FEGS_Document_Reader

Users may find it useful to follow along in the application while reading the user guide. Steps to using the tool start on page 20 "Using the FEGS Document Reader".

The FEGS Document Reader is a deep learning technology designed to accelerate the process of identifying and prioritizing ecosystem services when existing information, in the form of written documents, is available. The FEGS Document Reader classifies the relative frequency of ecosystem services terms in documents uploaded by the user, and provides an assessment of:

i) the relative importance of different ecosystems mentioned in documents;
ii) the types of users, or beneficiaries, who use or care about those ecosystems; and
iii) the most relevant ecosystem services attributes important to those users.

The FEGS Document Reader is designed to work with the National Ecosystem Services Classification System Plus (NESCS Plus) and the Final Ecosystem Goods and Services (FEGS Scoping Tool). These two tools rely heavily on manual user input, including working directly with decision-makers and other organizational representatives to identify, classify, and prioritize ecosystem services based on their relative importance across different groups of stakeholders. Stakeholders are individuals or groups that have an interest in, or may be affected by, an environmental decision-making process. Stakeholders can include government representatives, businesses, scientists, landowners, users of natural resources, activist groups, farmers, conservationists, community organizations, environmental groups, tribes and indigenous peoples, among others.

Though not intended to substitute for thoughtful stakeholder engagement, the FEGS Document Reader can provide a preliminary assessment of priority ecosystem services, which can serve as a starting point for more efficient or targeted stakeholder engagement to refine that prioritization. For user applications where there may be barriers to stakeholder engagement (e.g., low participation rates, large distances between decisionmakers and stakeholders, short timeline) or a preliminary assessment is adequate (e.g., leveraging past engagement to characterize research priorities), the output of the FEGS Document Reader may meet user needs without further engagement. Additionally, for users who may be interested in more investigative analysis, such as spatial or temporal differences in ecosystem services preferences, the FEGS Document Reader can facilitate a consistent comparison across documents using a highly structured set of keywords.

This user guide provides an overview of the FEGS Document Reader, the foundational tools of NESCS Plus and FEGS Scoping Tool, the keyword analysis approach, step-by-step guidance for using the R Shiny Application, and example applications.

Purpose

There is growing recognition that linking community planning and resource management decisions to the social and economic value of ecosystems can lead to actions that not only contribute to ecological protection, but create social and economic returns on investment that gain greater stakeholder support (MEA 2005, Olander et al. 2015, White House 2022). Environmental management decision impacts on human welfare can be characterized by the supply, quality, and accessibility of benefits from the environment and the demand for them by users (Pouso et al. 2020). Inclusion of 'ecosystem services' into environmental management has the potential for attracting broad support, motivating action, communicating progress, and sustaining long-term interest when projects link benefits of restoration to stakeholder and community interests (DeAngelis et al. 2020).

Broadly speaking, 'ecosystem services' are the benefits humans receive through their interactions with nature (MEA 2005), and the term generally includes both goods and services. "Final" ecosystem goods and services (FEGS) can be further characterized as the ecosystem products and processes that are directly used, enjoyed, or appreciated by people (DeWitt et al. 2020). Examples include productive soil for farmers, clean water for swimmers, wild fish for recreational anglers, storm surge protection for coastal property owners, and inspirational landscapes for artists. Final ecosystem goods and services can be thought of as the 'hand-off' between what ecosystems provide and the actions by humans to use or enjoy them.

An essential step to effectively setting environmental management goals, designing projects, and characterizing outcomes is identifying key stakeholders and understanding what ecosystem services benefits are important to them (Schuster and Doerr 2015). Stakeholders are typically members of the local community who will be affected by the decision, but may include other individuals or organizations outside the community that also have an interest in the decision.

The Final Ecosystem Goods and Services (FEGS) Document Reader is intended to classify important user groups and the ecosystem services benefits they care about through a document-based assessment that uses text mining. The FEGS Document Reader can be used alone or in combination with stakeholder engagement to refine priority ecosystem services.

Identification and prioritization of ecosystem services forms the foundation to support identification of stakeholders, to set the stage for defining locally relevant restoration goals and targets, for designing and implementing projects that reflect what the community cares about, and for monitoring the project outcomes in terms of accruing benefits to local communities.

PHOTOGRAPHS OF PEOPLE INTERACTING WITH NATURE. CREDIT: US EPA

Design and Development

Extracting Information from Documents

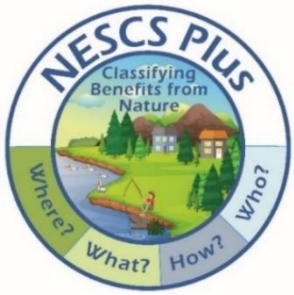
Communities, land and environmental management programs, and public or private organizations invest heavily in developing planning and reporting documents to communicate goals, activities, and progress to a variety of audiences. Document development often involves stakeholder engagement efforts to understand local values and concerns (Reed 2008), or assessments of natural resource benefits to local communities (Elmendorf 2000), providing a potential wealth of information to understand local ecosystem service priorities and the people who benefit.

A key challenge is finding a consistent and efficient way to extract information from documents, given the inconsistencies in structure, language, and purpose. Text-based content analysis is a well-established technique to identify keywords across documents representing a common theme (Hsieh and Shannon 2005), including for identification of ecosystem services to characterize community goals and identify relevant indicators (Fulford et al. 2017, Angradi et al. 2019, Williams and Hoffman 2020, Rossi et al. 2022). Comparative analysis relies on the development of a 'corpora' or linguistics database that allows written language to be tagged to common themes (Cushing 2017). Content analysis has been used to evaluate environmental management priorities (Altaweel et al. 2019), community well-being goals (Fulford et al. 2017), sustainable development goals (Li et al. 2023), trends in fisheries research (Fytilakos 2021), and wildlife observations in social media (Edwards et al. 2022).

The FEGS Document Reader is the culmination of text mining efforts to identify people who benefit from National Estuary Programs (Yee et al. 2019), compare community-scale ecosystem services values along the Massachusetts coastline (Yee et al. 2023), and compare regional management goals for tidal wetland management and restoration (Jackson et al. 2024). These three studies developed and iteratively refined the keywords and analytical approach used to classify document language in the application, and provide example applications of how an ecosystem services document analysis can be interpreted and used.

The FEGS Document Reader leverages a final ecosystem goods and services classification framework, the National Ecosystem Services Classification System Plus (NESCS Plus; Newcomer-Johnson et al. 2020, US EPA 2022b) as a systematic way to categorize document language describing users or beneficiaries of natural resources, the ecosystem services attributes they use or care about, and the coastal habitats providing those services. The FEGS Scoping Tool was used to provide a structured process for identifying priority user groups and ecosystem services profiles for each community, based on the relative frequency of mentions in community planning documents (Sharpe 2021, US EPA 2022a). The NESCS Plus forms the backbone for consistency and compatibility among a collection of tools that can be used to scope important stakeholders, identify and prioritize ecosystem services objectives, develop measures of ecosystem services for assessment and monitoring, and explore data, maps, and models for comparing decision options (Sharpe et al. 2023).

The National Ecosystem Services Classification System (NESCS) Plus



The FEGS Document Reader uses the National Ecosystem Services Classification System Plus (NESCS Plus, https://www.epa.gov/eco-research/national-ecosystem-services-classification-system-nescs-plus) to categorize types of beneficiaries and types of ecosystem services attributes (Newcomer-Johnson et al. 2020). Classification systems help provide structure for comprehensively identifying ecosystem services and the types of users who benefit from them, so that less obvious attributes or beneficiaries are not overlooked.

The NESCS Plus defines a classification system for FEGS based on three components: 1) the **environment** providing the service; 2) a **beneficiary** who uses or cares about the service; and 3) the **ecosystem attributes** defining the service. Each component is composed of classes and subclasses.

The FEGS Document Reader uses a script written in R (www.r-project.org) to search sentences in each uploaded document for terms associated with each FEGS component. The application also searches the prior and following adjacent sentences (sets of three sentences), to allow for the possibility of relevant information being parsed across multiple sentences (e.g., the environment mentioned in one sentence, the beneficiary in the next sentence, and what they care about in the third sentence). In the document reader, and throughout this user guide, a 'sentence' actually represents an independent clause of text, which in general may be separated by a period (.), semi-colon (;), colon (:), or a bulleted or numbered list.

Classes and Subclasses are defined by their own set of keywords (See **KEYWORD TABLES**). Keywords may be paired with companion words ('and') or exclusion words ('but not') to minimize false hits (e.g., "air" and "quality" but not "airplane"; "pig" and "farm" but not "pigeon"). Alternative spellings (e.g., hyphenated, plural, past tense, "ing") of words are also included where appropriate.

In general, the FEGS Document Reader categories align with the Subclasses in NESCS Plus (Tables 1, 2, 3). There are a few key differences:

- Categories of development intensity under the Environment Subclass 'urban/suburban greenspace' in NESCS Plus were considered too nuanced to parse in document language. The document reader collapses these into a single category of 'urban/suburban greenspace' (Table 1).
- Some subclasses not originally in NESCS Plus were added to help facilitate the keyword search to capture general references to a subclass that could not be further classified (e.g., general references to 'aquatic ecosystems' or 'forests'). Assignment of sentences to more generic categories (e.g., 'forests in general') were only kept if a more detailed Subclass (e.g., 'deciduous forests') could not be assigned. In the application output, therefore, a NESCS Plus Subclass I such as "21. Forests" could include specific Subclass II references to 211. Deciduous, 212. Evergreen, or 213. Mixed forests, as well as generic references to forests (Table 1).
- The reader uses some additional sub-categories not originally in NESCS Plus to facilitate further detail in keyword searches. For example, the application breaks down the NESCS Plus category of 'fauna' into the type of taxa (e.g., fish, birds), distinguishes open space for aesthetic value from open land for development, and adds intermediate regulating services (e.g., buffering, filtration), to provide an additional layer of detail and make sure important concepts commonly mentioned in documents were not overlooked (Table 3). At this time, these sub-subclasses are only used as part of the internal keyword analysis to facilitate document searches, and not exported as part of application output.

Environment Classes and Subclasses

*Table 1. FEGS Document Reader Categories, and the numerically coded **Environment** Class, Subclass I, and Subclass II from NESCS Plus to which they were assigned. Key differences between the FEGS Document Reader and NESCS Plus are highlighted in grey. Un-numbered Subclass I or II were added to capture general references in document language that could not be further classified. Word matches used to assign subclasses are listed in* ***Environment Keyword Search Terms****.*

NESCS+ Class	NESCS+ Subclass I (Pie Charts)	NESCS+ Subclass II (Bar Charts)	FEGS Document Reader Category for Searching
1. Aquatic	**Aquatic in General**	Aquatic in General	Aquatic in General*
			Groundwater†
	11. Open Water	Open Water in General	Open Water in General*
		111. Rivers and Streams	Rivers and Streams
		112. Lakes and Ponds	Lakes and Ponds
		113. Near Coastal Marine/ Estuarine	Coastal Ecosystems in General*
			Beach and Dunes†
			Eel and Sea Grass†
			Rocky Shore†
			Tidal Flat†
		114. Open Oceans and Seas	Open Oceans & Seas in General*
			Kelp Forest†
			Reefs†
	12. Wetlands	Wetlands in General	Wetlands in General*
		121. Woody Wetlands	Woody Wetlands in General*
			Mangroves†
		122. Emergent Wetlands	Emergent Wetlands in General*
			Salt Marsh†
2. Terrestrial	**Terrestrial in General**	Terrestrial in General	Terrestrial in General*
	21. Forests	Forests in General	Forest in General*
		211. Deciduous Forest	Deciduous Forest
		212. Evergreen Forest	Evergreen Forest
		213. Mixed Forest	Mixed Forest
	22. Agroecosystems	Agroecosystems in General	Agroecosystems in General*
		221. Pasture and Hay	Pasture and Hay
		222. Cultivated Crops	Cultivated Crops
	23. Grasslands	231. Grasslands	Grasslands
	24. Scrub/Shrublands	241. Scrub/Shrublands	Scrublands and Shrublands
	25. Tundra	Tundra in General	Tundra in General*
		251. Lichens	Lichens
		252. Moss	Moss
		253. Dwarf Scrub	Dwarf Scrub
		254. Sedge/Herbaceous Tundra	Sedge and Herbaceous Tundra
	26. Ice and Snow	261. Ice and Snow	Ice and Snow
	27. Urban Suburban Greenspace	Urban Suburban Greenspace	Urban Suburban Greenspace
		271. Developed Open Space‡	
		272. Developed Low Intensity‡	
		273. Developed Medium Intensity‡	
		274. Developed High Intensity‡	
	28. Barren Rock/Sand	281. Barren Rock/Sand	Barren Rock and Sand

** Generic categories in each Class were only assigned to sentences if a more specific category could not be assigned.*

† Sub-sub classes not originally in NESCSPlus were used internally in the FEGS Document Reader to facilitate searching and not exported as output

‡ Separate keywords were not identified for Subclasses of Urban Suburban greenspace.

Beneficiary Classes and Subclasses

*Table 2. FEGS Document Reader Categories for **Beneficiaries** and the numerically coded Class and Subclass I from NESCS Plus to which they were assigned. In NESCS Plus, Beneficiaries are not further divided into Subclass II. Word matches used to assign subclasses are listed in **Beneficiary Keyword Search Terms**.*

NESCS+ Class (Pie Charts)	NESCS+ Subclass I / FEGS Document Reader Category for Searching (Bar Charts)
01. Agricultural	011. Livestock Grazers
	012. Agricultural Processors
	013. Aquaculturists
	014. Farmers
	015. Foresters
	016. Agricultural in General*
02. Commercial & Industrial	021. Commercial Food Extractors & Fisheries
	022. Commercial Timber/Fiber/Ornamental Extractors
	023. Commercial/Industrial Processors
	024. Private Energy Generators
	025. Pharmaceutical & Supplement Suppliers
	026. Commercial Fur/Hide Hunters and Trappers
	027. Private Water Facilities Operators
	028. Commercial/Industrial Property Owners
	029. Commercial & Industrial in General*
03. Government / Municipal / Residential	031. Public Water Facilities Operators
	032. Residential Property Owners
	033. Public Property Owners
	034. Military and Coast Guard
	035. Public Energy Generators
	036. Government/Residential in General*
04. Transportation & Shipping	041. Transporters of Goods
	042. Transporters of People
	043. Transportation in General*
05. Subsistence Users	051. Water Subsisters
	052. Food and Medicinal Subsisters
	053. Timber & Fiber & Fur Subsisters
	054. Building Material Subsisters
	055. Subsistence in General*
06. Recreational	061. Experiencers/Viewers
	062. Food Pickers/Gatherers
	063. Recreational Hunters
	064. Recreational Fishermen
	065. Waders & Swimmers & Divers
	066. Recreational Boaters
	067. Recreational in General*
07. Inspirational	071. Spiritual and Ceremonial Participants
	072. Artists
	073. Inspirational in General*
08. Learning	081. Educators/Students
	082. Researchers
	083. Learning in General*
09. Non-Use	091. People Who Care (Existence)
	092. People Who Care (Option/Bequest)
	093. People Who Care in General*
10. Humanity	101. All Humans

** Generic categories in each Class were only assigned to sentences if a more specific category could not be assigned.*

Ecosystem Attribute Classes and Subclasses

*Table 3. FEGS Document Reader Categories, and the numerically coded Ecological End-Product Class and informal **Ecosystem Attribute** Subclass from NESCS Plus to which they were assigned. In NESCS Plus, Attributes are not formally divided into an enumerated Subclass I or II. Key differences between the FEGS Document Reader and NESCS Plus are highlighted in grey. Word matches used to assign subclasses are listed in* ***Ecosystem Attribute Keyword Search Terms****.*

NESCS+ Class (Pie Charts)	NESCS+ Attribute Subclass (Bar Charts)	FEGS Document Reader Category for Searching
1. Atmosphere	Atmosphere in General	Atmosphere in General*
	Air Quality	Air Quality
	Precipitation	Precipitation
	Sunlight	Sunlight
	Temperature	Temperature
	Wind Strength & Speed	Wind Strength & Speed
2. Soil & Substrate	Soil & Substrate in General	Soil & Substrate in General*
	Soil Quality	Soil Quality
	Soil Quantity	Soil Quantity
	Substrate Quality	Substrate Quality
	Substrate Quantity	Substrate Quantity
3. Water	Water in General	Water in General*
	Water Quality	Water Quality
	Water Quantity	Water Quantity
	Water Movement & Navigability	Water Movement/Navigability
4. Fauna	Fauna in General	Fauna in General*
		Birds†
		Fish & Shellfish†
		Insects & Invertebrates†
		Mammals†
		Reptiles & Amphibians†
	Fauna Community	Fauna Community (by Taxa)
	Edible Fauna	Edible Fauna (by Taxa)
	Medicinal Fauna	Medicinal Fauna (by Taxa)
	Keystone Fauna	Keystone Fauna (by Taxa)
	Charismatic Fauna	Charismatic Fauna (by Taxa)
	Rare Fauna	Rare Fauna (by Taxa)
	Pollinating Fauna	Pollinating Fauna (by Taxa)
	Pest Predator & Pest Fauna	Pest/Invasive‡ Fauna (by Taxa)
	Commercially Important Fauna	Commercially Important Fauna (by Taxa)
		Bait Fauna† *(by Taxa)*
		Fauna for Fur/Hide/Trophy † *(by Taxa)*
	Spiritually/Culturally Important Fauna	Spiritually/Culturally Important Fauna (by Taxa)
5. Flora	Flora in General	Flora in General*
	Flora Community	Flora Community
		Pest/Invasive Flora†
	Edible Flora	Edible Flora
	Medicinal Flora	Medicinal Flora
	Keystone Flora	Keystone Flora
	Charismatic Flora	Charismatic Flora
	Rare Flora	Rare Flora
	Commercially Important Flora	Commercially Important Flora

NESCS+ Class (Pie Charts)	NESCS+ Attribute Subclass (Bar Charts)	FEGS Document Reader Category for Searching
	Spiritually/Culturally Important Flora	Culturally Important Flora
6. Fungi	Fungi in General	Fungi in General*
	Fungal Community	Fungal Community
		Keystone Fungi†
		Pest/Invasive Fungi†
	Edible Fungi	Edible Fungi
	Medicinal Fungi	Medicinal Fungi
	Rare Fungi	Rare Fungi
	Commercially Important Fungi	Commercially Important Fungi
	Spiritually/Culturally Important Fungi	Culturally Important Fungi
		Charismatic Fungi†
7. Other Natural Components	Other Natural Components in General	Natural Materials in General (Sand/Rock)*
	Fuel Quality	Fuel Quality
	Fuel Quantity	Fuel Quantity
	Fiber Material Quality	Fiber Material Quality
	Fiber Material Quantity	Fiber Material Quantity
	Mineral/Chemical Quality	Mineral/Chemical Quality
	Mineral/Chemical Quantity	Mineral/Chemical Quantity
	Natural Materials for Artistic Use or Consumption	Natural Materials for Artistic Use or Consumption
8. Composite	Composite in General	Composite in General*
8. Composite: Site Appeal	Site Appeal in General	Site Appeal in General*
	Site Appeal: Sounds	Environmental Aesthetics (Sounds)
	Site Appeal: Scents	Environmental Aesthetics (Scents)
	Site Appeal: Viewscapes	Environmental Aesthetics (Viewscapes)
	Site Appeal: Phenomena	Atmospheric Phenomena
8. Composite: Ecological Condition	Ecological Condition	Ecological Condition in General
		Regulating Services in General†
		Air Quality & Atmospheric Regulation†
		Climate & Carbon Regulation†
		Soil & Sediment Regulation†
		Water Quality Regulation†
8. Composite: Open Space	Open Space	Open Space in General*
		Open Space (Natural Area) †
		Open Space (Land for Development)†
8. Composite: Extreme Events	Extreme Events in General	Mitigating Extreme Events in General*
	Extreme Events: Flooding	Mitigating Flooding
	Extreme Events: Wildfire	Mitigating Wildfire Risk
	Extreme Events: Extreme Weather	Mitigating Extreme Weather
	Extreme Events: Earthquakes	Mitigating Earthquakes & Landslides

** Generic categories in each Class were only assigned to sentences if a more specific category could not be assigned.*
† Sub-sub classes not originally in NESCSPlus were used internally in the FEGS Document Reader to facilitate searching and not exported as output
‡ Expanded from "Pest Predator/depredator Fauna" in NESCS Plus to include pest species more generally, including invasive species and fauna that prey upon pest species (biocontrol).

To be considered a FEGS, a sentence (or set of three adjacent sentences) must contain each of the three components: an **Environment**; a **Beneficiary**; and the **Ecosystem Attribute** they use or care about. Sentences may be classified into more than one Class/Subclass for each component if they mention more than one classifiable keyword. If all three components are present in a single sentence, the sentence is binned to the classes or subclasses that match the contained keywords. If one or two of the three components is missing from a single sentence, the application then searches the prior and following sentences for mentions of keywords that can be tagged to the missing component.

Table 4. Examples of document language classified into NESCS Plus classes/subclasses.

Document language	Environment	Beneficiary	Ecosystem Attribute
Fishermen and crabbers are the lifeblood of the economy.	Open Water in General	Commercial Food Extractors and Fisheries	Edible Fauna
Visitors to the area enjoy bird watching tours.	Terrestrial Ecosystems in General	Experiencers & Viewers	Charismatic Fauna
500 square feet of non-tidal wetlands will be used to construct a surface parking lot and paved trail.	Wetlands in General	Experiencers & Viewers	Site Appeal in General
500 square feet of non-tidal wetlands will be used to construct a surface parking lot and paved trail.	Wetlands in General	Transporters of People	Open Space for Development
The river was dredged to better accommodate all kinds of boats.	Rivers and Streams	Transportation & Shipping in General	Water Movement & Navigability
The island marsh provides a unique setting for enjoying stunningly beautiful sunsets.	Near Coastal Marine and Estuarine	Experiencers & Viewers	Environmental Aesthetics (Viewscapes)
Subdivision options to preserve open space are not generally employed. Agricultural zoning is one tool for protecting farmland.	Agroecosystems	Agriculture in General	Open Space

By searching keywords, the FEGS Document Reader generates a list of relevant FEGS for each document and tracks the number of times that FEGS combination (Environment + Beneficiary + Ecosystem Attribute) appears in each document. Any one sentence may be assigned multiple FEGS. The list of FEGS is used to generate priority beneficiary and ecosystem services attribute scores for each document, following the steps of the FEGS Scoping Tool.

The Final Ecosystem Goods and Services (FEGS) Scoping Tool

The FEGS Scoping Tool provides a step-by-step approach for identifying and prioritizing ecosystem services (Sharpe 2021, US EPA 2022a) and has been used in a number of case studies, including to identify benefits of wetland restoration (Hernandez et al. 2022) and upstream benefits of management practices to improve estuarine water quality (Rossi et al. 2022). The tool is available for download at https://www.epa.gov/eco-research/final-ecosystem-goods-and-services-fegs-scoping-tool.

The FEGS Scoping Tool uses the National Ecosystem Services Classification System Plus (NESCS Plus; Newcomer-Johnson et al. 2020, US EPA 2022b) to categorize types of beneficiaries and types of ecosystem services attributes. First, key stakeholders are identified along with criteria to prioritize them. Second, a beneficiary profile for each stakeholder group is developed based on how they use or why they care about the environment. Third, relevant ecosystem attributes are identified for each beneficiary type. A final value for each ecosystem attribute subclass is calculated based on their total importance across beneficiaries, weighted by the relative importance of each beneficiary subclass to stakeholders.

As an alternative to using the FEGS Scoping Tool in workshops with decision-makers or organizational representatives, the FEGS Document Reader uses documents to represent 'stakeholders', analogous to the first step of the FEGS Scoping Tool. For example, FEGS Scoping Tool users might identify a state environmental agency as one of many key stakeholders, and use their own personal knowledge or discussions with agency representatives to identify the beneficiary roles and ecosystem attributes most relevant to that agency. An analogous document might be a management plan associated with that agency, from which written material can be used to infer the beneficiaries and ecosystem attributes most relevant to that agency. The process is then repeated for other key stakeholders, to generate an overall prioritization averaging across all stakeholders (or documents).

Box 1. Examples of documents that may contain ecosystem services information.

- Adaptation Plans or Strategies
- Brochures or Guides
- Climate, Resilience, or Vulnerability Plans
- Community or Town Reports
- Conservation or Restoration Projects/Plans
- Economic Plans
- Environmental Impact Reports or Statements
- Feasibility Reports or Studies
- Harbor Plans
- Open Space or Recreation Plans
- Mitigation Plans
- Habitat Assessments
- Landscape or Resource Inventories
- Recovery or Improvement Plans
- Scientific Journal Articles
- Stormwater or Wildlife Management Plans
- Sustainability or Stewardship Plans
- Watershed Plans or Reports
- Water Quality Assessments or Reports
- Website Content
- Workshop Discussion Notes or Summaries

The Document Reader builds a beneficiary profile for each 'stakeholder' document based on the frequency of mentions of beneficiary types in document sentences. Relevant ecosystem attributes are identified for each type of beneficiary based the frequency at which they are mentioned in the same sentence (or set of three adjacent sentences) as the beneficiary. Ecosystem attributes are then prioritized based on having high relative importance to one or more

beneficiaries, weighted by the relative importance of those beneficiaries across 'stakeholder' documents, following the general steps of the FEGS Scoping Tool.

Step 1: Documents as "Stakeholders"

In the FEGS Document Reader, each document essentially represents a 'stakeholder', as mathematically analogous in the FEGS Scoping Tool. They might represent different authors, different agencies, different spatial locations, different time periods, but generally form the pool of key information sources that the user of the FEGS Document Reader is trying to evaluate. Documents should be a text-readable portable document file (pdf).

A user of the FEGS Document Reader could interpret 'stakeholders' very literally, by first generating a list of stakeholder groups, and then identifying documents to represent each stakeholder (one document per stakeholder) in that list. Alternatively, a user may wish to generate a prioritization across all available documents, recognizing that many individual documents may represent multiple stakeholder perspectives, and many stakeholder groups may be represented across multiple documents. As with the FEGS Scoping Tool, the Document Reader allows flexibility in how to interpret 'stakeholders' or 'collections of stakeholders' in a way that is most practical for the application at hand.

Document Weights

Note the FEGS Scoping Tool includes a prior step not in the Document Reader, in which criteria are used to prioritize stakeholders by factors such as their economic interest, level of influence, or proximity. The FEGS Document Reader assumes all documents are of equal importance, equivalent to giving each stakeholder equal priority in the FEGS Scoping Tool. If it is desired to modify the relative influence of those criteria, the FEGS Document Reader output can be exported to a FEGS Scoping Tool file (*.fegs*) where weighting criteria may be edited. Alternatively, stakeholder priority can be modified in an ad hoc fashion within the document reader by combining or duplicating pdfs. For example, less important documents might be combined into a single pdf so they are treated as one, and therefore have equal weight to a single more important document. Similarly, multiple documents from one stakeholder might be combined into a single document pdf so that they are weighted equally with another stakeholder for which there might only be a single document available.

Documents must be uploaded as a pdf but could include other kinds of documents (.html, .doc) converted to pdf prior to uploading. Sometimes pdfs are not readable (such as scanned image pdfs), and will be dropped from further analysis (i.e., dropped from the overall document average). Documents that did not mention any environment subclass in combination with at least one type of beneficiary and one type of ecosystem attribute will also be dropped from further analysis.

Environment Subclasses Mentioned in Documents

The FEGS Scoping Tool inherently assumes the ecosystem(s) of interest have already been identified, and stakeholders have been identified as those who have an interest in decisions related to the ecosystem(s). By contrast, the FEGS Document Reader allows the user to choose the focal ecosystem(s) of interest based on ecosystems mentioned in uploaded documents. For example, a user could consider all mentioned environment subclasses or limit results to a particular environment subclass (e.g., urban greenspace), depending on the specific application.

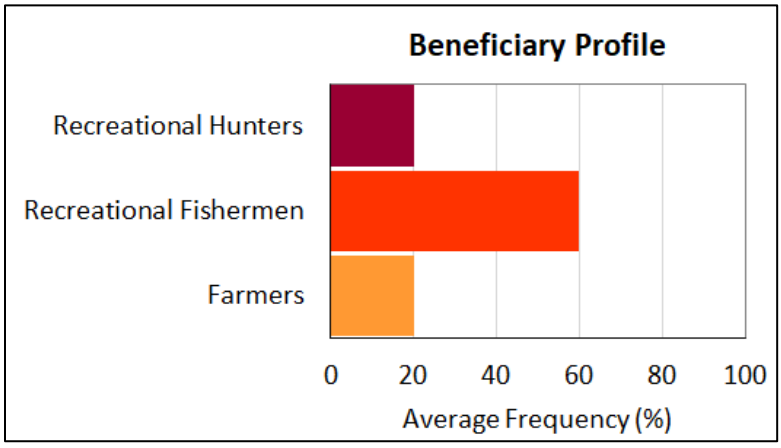
The relative frequency of environments across all uploaded documents is calculated as the number of sentences categorized as mentioning a particular environment in each document divided by the total number of sentences mentioning any of the 27 environment subclasses, averaged across all documents. The relative frequency across all environment subclasses sums to 1 for any given document, as well as across all documents.

Step 2: Beneficiary Profile

The FEGS Document Reader generates a beneficiary profile showing the relative importances of different beneficiaries based on how frequently they were mentioned in uploaded documents. The relative importance of each beneficiary *i* (B_i) is calculated as the fraction of sentences mentioning beneficiary *i* relative to the total number sentences mentioning any of the 46 beneficiary subclasses, averaged across all documents (Table 5). The relative importance across all beneficiary subclasses sums to 1 for any given document, as well as across all documents. Beneficiary profiles can be visualized across all mentioned environment subclasses, or for a particular environment subclass (e.g., urban greenspace).

Table 5. Example of calculating average beneficiary frequencies from documents.

Document	Beneficiary	Number of Sentences Mentioning That Beneficiary	Total Number of Sentences Mentioning Any Beneficiary	Frequency (Percent)
Document 1	Farmers	2	10	0.2 (20)
	Recreational Fishermen	8		0.8 (80)
	Recreational Hunters	0		0.0 (0)
Document 2	Farmers	5	25	0.2 (20)
	Recreational Fishermen	10		0.4 (40)
	Recreational Hunters	10		0.4 (40)
Average Importance Score for Each Beneficiary				
Average	**Farmers**	-	-	**0.2 (20)**
	Recreational Fishermen	-	-	**0.6 (60)**
	Recreational Hunters	-	-	**0.2 (20)**



SIMPLIFIED EXAMPLE OF A BENEFICIARY PROFILE GENERATED FROM TABLE 5.

Step 3: Ecosystem Attribute Profile

Next, the FEGS Document Reader identifies the ecosystem attributes relevant to each identified beneficiary subclass for each document. The relative importance of each ecosystem attribute *j* to each beneficiary *i* (EA_{ij}) is calculated as the fraction of sentences mentioning that attribute relative to the total number of sentences mentioning any of the 81 ecosystem attribute subclasses in the same sentence as beneficiary *i*. For each document, the relative importance across all ecosystem attributes sums to 1 for a given beneficiary (Table 6).

Table 6. Example of calculating average attribute frequencies from documents for each beneficiary. Numbers indicate the number of sentences mentioning each attribute in combination with each beneficiary. Sentence counts per beneficiary may exceed those listed in Table 5 if more than one attribute is mentioned in a single sentence. Frequencies (in parentheses) indicate the relative importance of each attribute to each beneficiary in each document, and sum to 1 (100%) for each beneficiary (each row), as well as averaged across documents.

Document	Beneficiary	Attribute 1: Water Quality	Attribute 2: Scenic Views	Attribute 3: Edible Fauna
Document 1	Farmers	2 (0.5)	2 (0.5)	-
	Recreational Fishermen	1 (0.1)	3 (0.3)	6 (0.6)
	Recreational Hunters	-	-	-
Document 2	Farmers	3 (0.6)	2 (0.2)	-
	Recreational Fishermen	3 (0.2)	4 (0.267)	8 (0.533)
	Recreational Hunters	1 (0.1)	4 (0.4)	5 (0.5)
Average Attribute Importance Score for Each Beneficiary				
Average	**Farmers**	**0.55**	**0.45**	**-**
	Recreational Fishermen	**0.15**	**0.283**	**0.567**
	Recreational Hunters	**0.1**	**0.4**	**0.5**

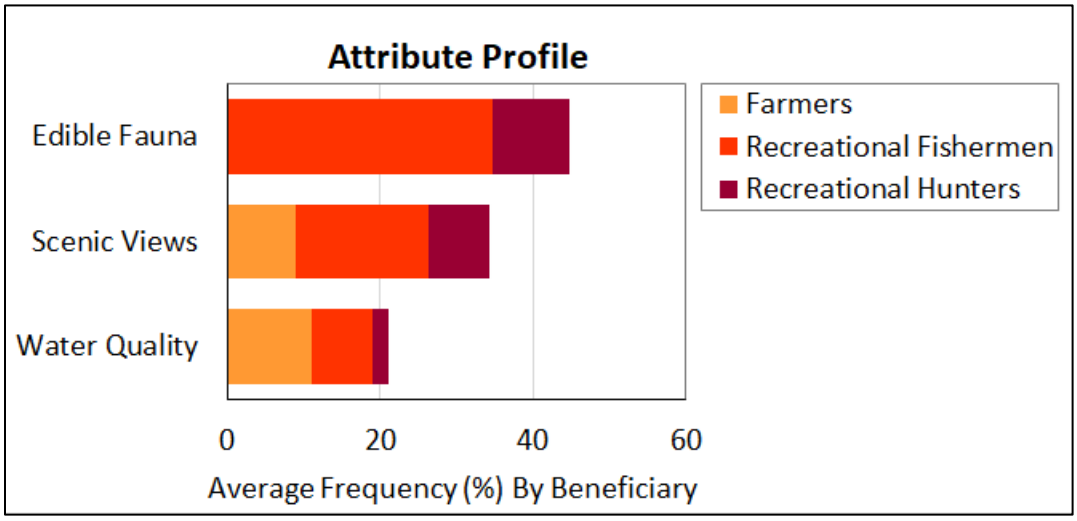
The total importance score of each ecosystem attribute *j* is then calculated as the sum of relative importance scores EA_{ij} for each beneficiary *i* weighted by the relative importance of each beneficiary type B_i (Step 2), such that ecosystem attributes of importance to multiple beneficiaries or of importance to a high scoring beneficiary would receive higher overall priority scores:

$$EAj = \sum_i B_i \times EA_{ji}$$

The relative importance across all ecosystem attributes (EA_j), or equivalently across the full matrix of weighted ecosystem services components for each beneficiary ($B_i \times EA_{ji}$), sums to 1 for any given document and choice of environment, as well as averaged across all documents (Table 7).

Table 7. Example of calculating overall weighted attribute scores, summing the relative importance scores for each beneficiary (Table 6) by the relative importance of each beneficiary in Table 5. Scores sum to 1 (100%) across all beneficiaries for each document, as well as averaged across all documents.

Document	Beneficiary	Beneficiary Frequency	Attribute 1: Water Quality	Attribute 2: Scenic Views	Attribute 3: Edible Fauna
Document 1	Farmers	0.2	0.10 (10%)	0.10 (10%)	0.00 (0%)
	Recreational Fishermen	0.8	0.08 (8%)	0.24 (24%)	0.48 (48%)
	Recreational Hunters	0.0	0.00 (0%)	0.00 (0%)	0.00 (0%)
	Attribute Relative Score	-	**0.18 (18%)**	**0.34 (34%)**	**0.48 (48%)**
Document 2	Farmers	0.2	0.12 (12%)	0.08 (8%)	0.00 (0%)
	Recreational Fishermen	0.4	0.08 (8%)	0.11 (11%)	0.21 (21%)
	Recreational Hunters	0.4	0.04 (4%)	0.16 (16%)	0.20 (20%)
	Attribute Relative Score	-	**0.24 (24%)**	**0.35 (35%)**	**0.41 (41%)**
Average Weighted Attribute Score					
Average	**Farmers**	-	0.11 (11%)	0.09 (9%)	0.00 (0%)
	Recreational Fishermen	-	0.08 (8%)	0.17 (17%)	0.35 (35%)
	Recreational Hunters	-	0.02 (2%)	0.08 (8%)	0.10 (10%)
	Attribute Relative Score	-	**0.21 (21%)**	**0.34 (34%)**	**0.45 (45%)**



SIMPLIFIED EXAMPLE OF AN ATTRIBUTE PROFILE GENERATED FROM TABLE 7. STACKED COLORS INDICATE THE RELATIVE CONTRIBUTION OF EACH BENEFICIARY TO THE OVERALL PRIORITIZATION SCORE.

FEGS Document Reader Accuracy

Sometimes pdfs contain symbolic characters, complex column spacing, tables, text boxes, bulleted lists, graphics, or other non-standard text that impact the extraction of sentences. As a result, FEGS categories assigned to a sentence may actually represent disjoint pieces of information (e.g., such as a section header and the following sentence, or cells of neighboring text in a table). The FEGS Document Reader has been tested to detect clauses of information by removing abbreviations, urls, contractions, numeric decimals, columns, etc. However, some errors are inevitable, especially in more complex pdfs. In general, these 'false sentences' are uncommon compared to standard paragraphs of text, and still typically represent valid information contained within the document, and therefore have minimal influence on the overall prioritization results.

Despite efforts to optimize accuracy of the automated search process and the list of search terms, some of the FEGS classified from documents inevitably will be 'false positives' that arise from combinations of words by happenstance occurring in the same sentence. High scoring FEGS components, e.g., those that occur more than once in a single document or occur in multiple different documents, are generally more robust to being 'true' FEGS, rather than artifacts of the automated search protocol. False positives are also minimized by the requirement that all three components (Environment, Beneficiary, Ecosystem Attribute) must appear together in a sentence, or adjacent set of sentences.

The list of keyword terms is the culmination of reviewing hundreds of documents, but it is inevitable that some language (e.g., species names, local or regional slang, specialized markets or activities, acronyms) were missed. Moreover, the document reader searches at most sets of three sentences, such that relevant context within a longer paragraph might be missed. These factors may result in 'false negatives', where ecosystem services references in documents are not identified. However, generally in a document if something is important it will be mentioned more than once, and in different ways.

Although false hits cannot be eliminated entirely in an automated analysis, they are uncommon and have minimal influence on an overall prioritization when identifying 'top' FEGS, beneficiaries, or attributes. If the user application seeks a comprehensive list of FEGS (rather than just the top-most common ones), the list of matched sentences and how they were classified can be exported and checked to verify how document language is being classified, particularly for lower ranking or 'unexpected' classifications.

Using the FEGS Document Reader

Overview

The FEGS Document Reader is available as an R Shiny Application at:

https://shiny.epa.gov/FEGS_Document_Reader

Users upload documents and select "Find Matches" to search for keywords and identify sentences that contain each of the three components: an **Environment**, a **Beneficiary**, and the **Ecosystem Attribute** they use or care about. The application generates profiles showing the relative frequency of different Environment subclasses, Beneficiary subclasses, and Ecosystem attribute subclasses in documents. The application will also generate a word cloud of common terms found in documents, which can help aid in interpretation.

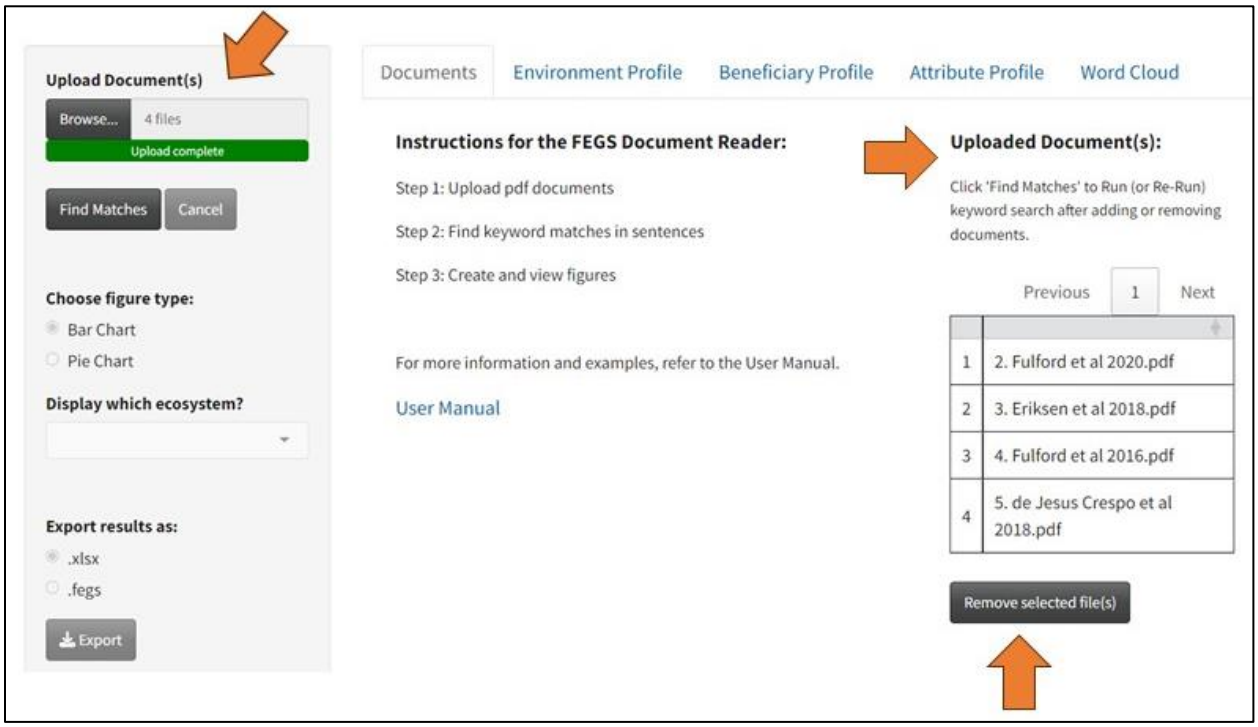
Do not close or minimize the browser window while the application is running, otherwise the server may time out and any results will not be saved. Similarly, if left inactive for too long, or if the user's computer goes to sleep or stand-by, results may not be saved. If this happens, the documents may need to be re-uploaded to run the keyword search again. It is recommended to export results as soon as possible after finding matches to ensure results are saved.

FEGS Document Reader Steps

Upload Documents

On the left side menu, select the "**Browse…**" button to upload documents. Documents must be pdf format, but other kinds of documents (ascii text, html websites, MS Word documents, etc.) can typically be converted to pdf using "Save to PDF" or "Print to PDF" in the corresponding software. There is a maximum file size per document of 100 MB. PDF compression or splitting tools (available for free online) can work well to reduce file sizes while maintaining integrity. Online tools are also available for combining multiple pdfs into a single pdf document, for example to represent a single 'stakeholder'.

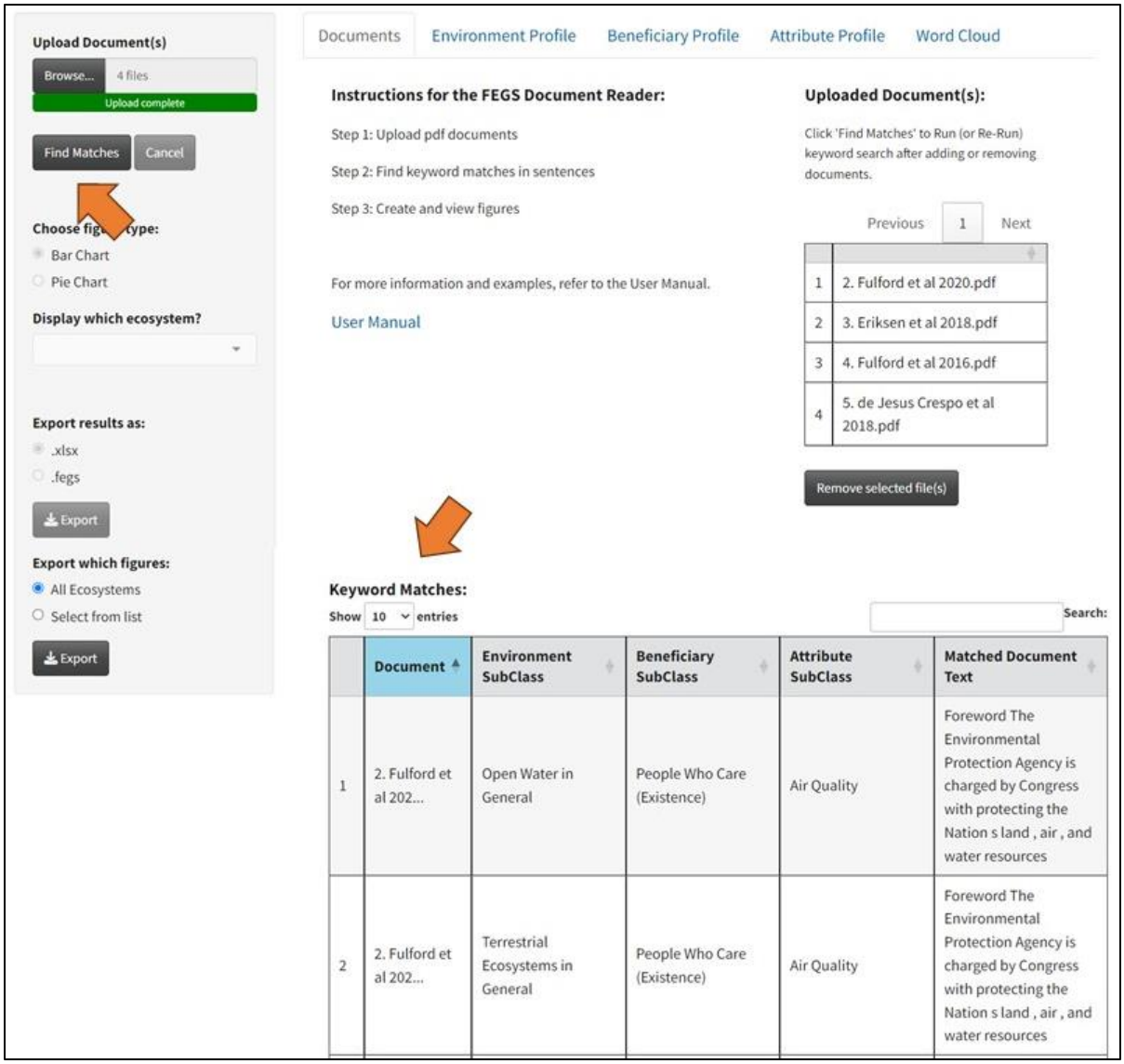
The number of documents that can be read at one time depends on the overall document file sizes, but can be anywhere from one single document to dozens or even hundreds. One or more documents can be removed from analysis after uploading using the "**Remove selected file(s)"** button. The user can click once on the documents they would like to remove and then select "Remove selected file(s)". If a user erroneously clicks on a document title, they can click once more to deselect it. The "Remove selected file(s)". The "Remove selected file(s)" button can also be used after finding matches and generating figures, to re-run the analysis on a modified set of documents.



Find Keyword Matches and Generate Figures

On the left side menu, select the "**Find Matches**" button to run the keyword search and generate results and figures. A pop-up window will alert the user that the document search is running and can take 10-30 seconds per document, or more than 60 seconds for a very large document. A progress bar at the top of the shiny app window will denote progress in running the search and generating figures. A window will pop up when the search is complete. Once the search is complete, additional documents can be uploaded and the analysis re-run. Re-running the analysis will include both the original and any new documents, unless documents are intentionally removed using "**Remove selected file(s)**".

When the search is complete, a table of **Keyword Matches** will appear at the bottom of the **Documents Tab** window. Each row is a sentence that was identified as containing keywords that could be classified as an Environment subclass, Beneficiary subclass, and Attribute subclass. In the Keyword Matches table, only the first part of each sentence is shown, but the full sentence (or sets of 2-3 adjacent sentences) and the keyword subclasses they matched can be seen by exporting the results as an Excel file (.xlsx).

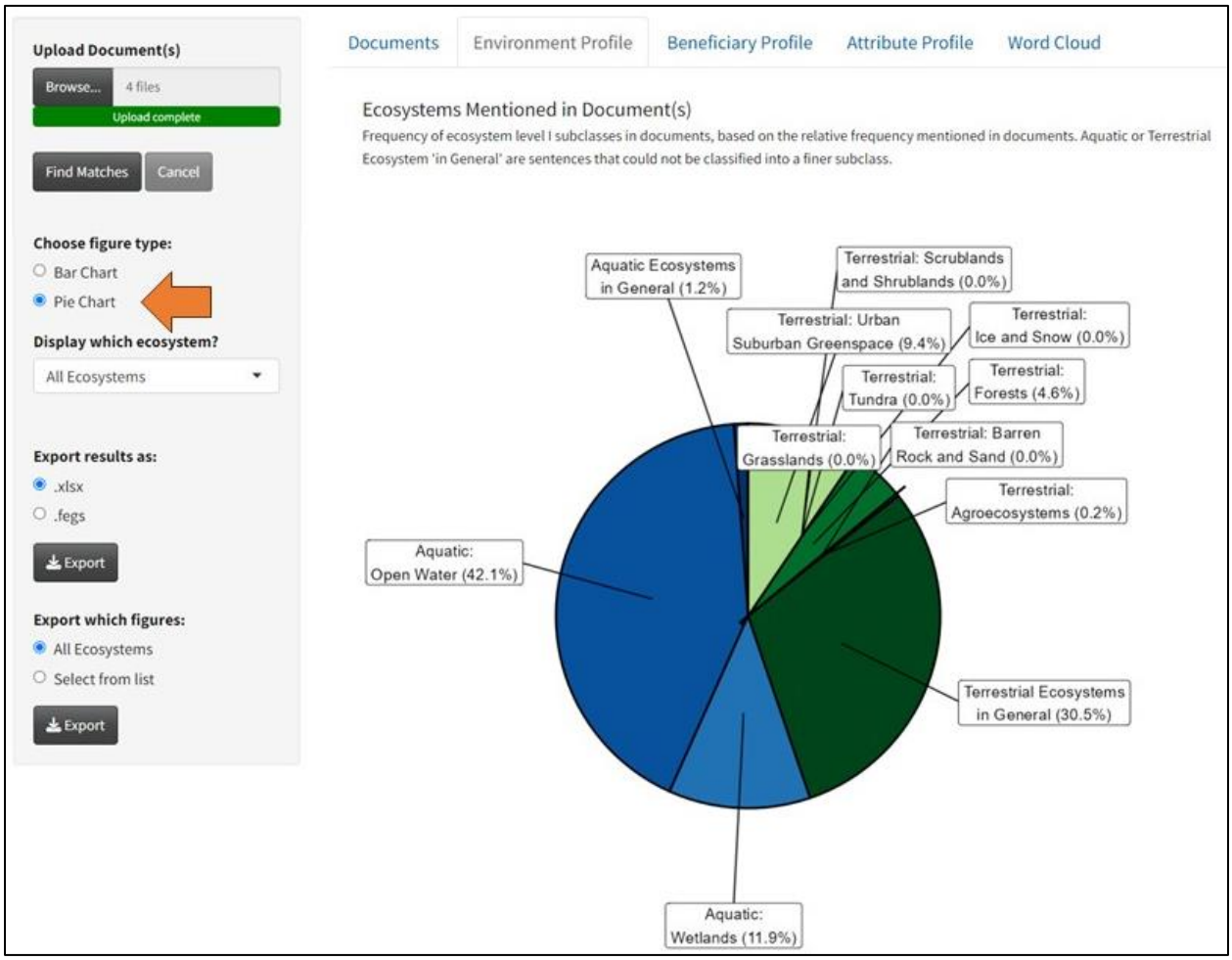


Environment Profile

The **Environment Profile Tab** shows the relative frequency at which different Environment subclasses were mentioned in uploaded documents. The default bar chart displays the average percent of sentences in each document that mention each Environment subclass, totalling 100% across all subclasses.

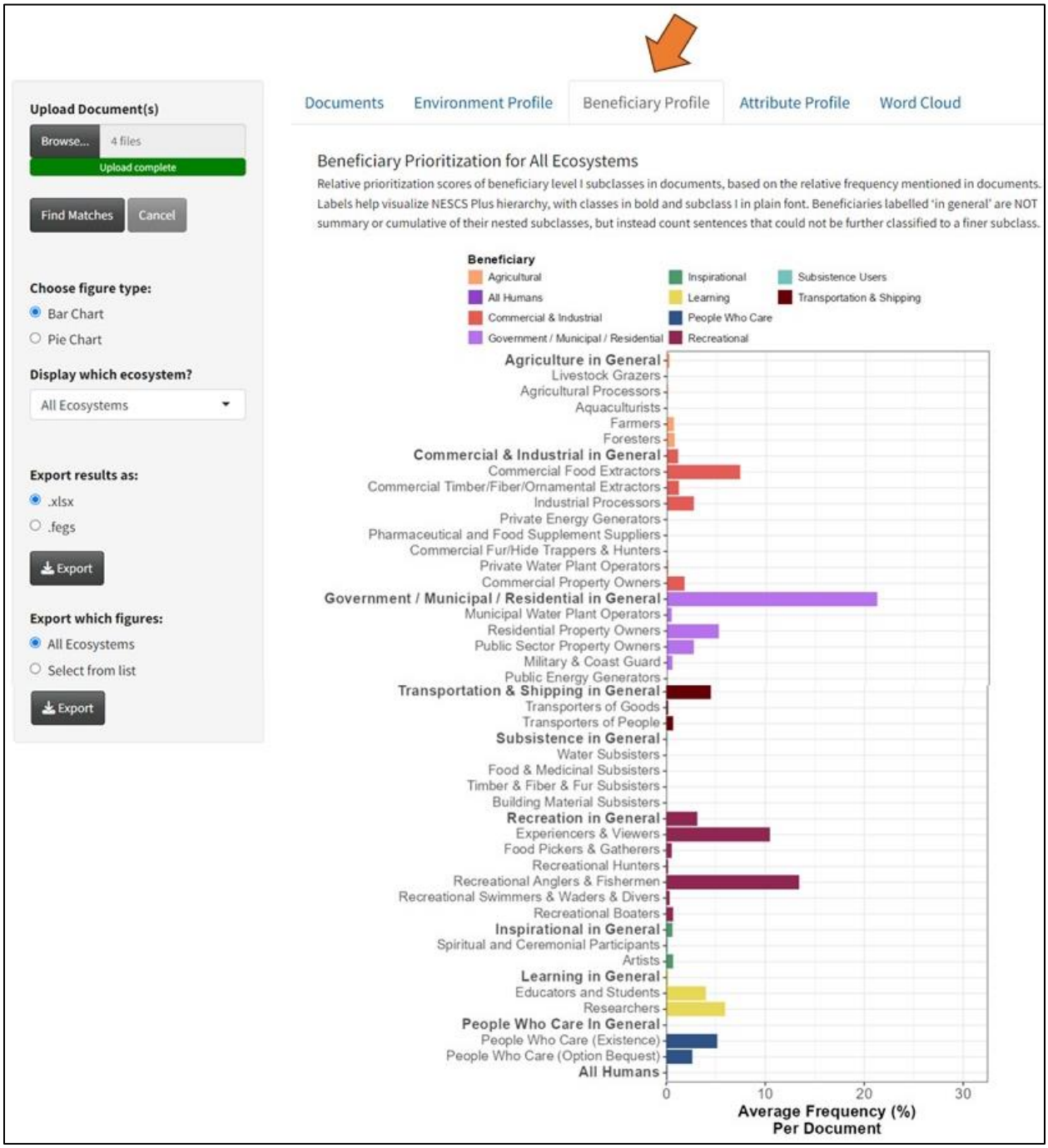
Labels on the bar chart help to visualize the NESCS Plus hierarchy, with classes in bold, subclass I in italics, and subclass II in plain font. Frequencies of broader classes (e.g., Forests in General) are NOT shown as a calculated cumulative sum of their nested subclasses (e.g., deciduous forest, evergreen forest, mixed forest). Each ecosystem category (rows in the bar chart; Level II subclasses in Table 1) is unique, and all ecosystem categories in the bar chart sum to 100% (no double counting). Ecosystems labelled 'in general' reflect sentences that could not be further classified to a finer subclass. For example, mentions of anything related to "Forests" would be calculated manually as Forests in General + the three forest subclasses (Deciduous, Evergreen, Mixed).

On the left side menu, the "**Choose figure type:**" button can be used to toggle between displaying the relative frequencies as a bar chart or a pie chart. The pie chart option displays the relative frequencies of Environment Subclass Level I, here as a cumulative sum of their nested subclasses, whereas the bar chart displays a finer degree of information at Subclass Level II (Table 1).



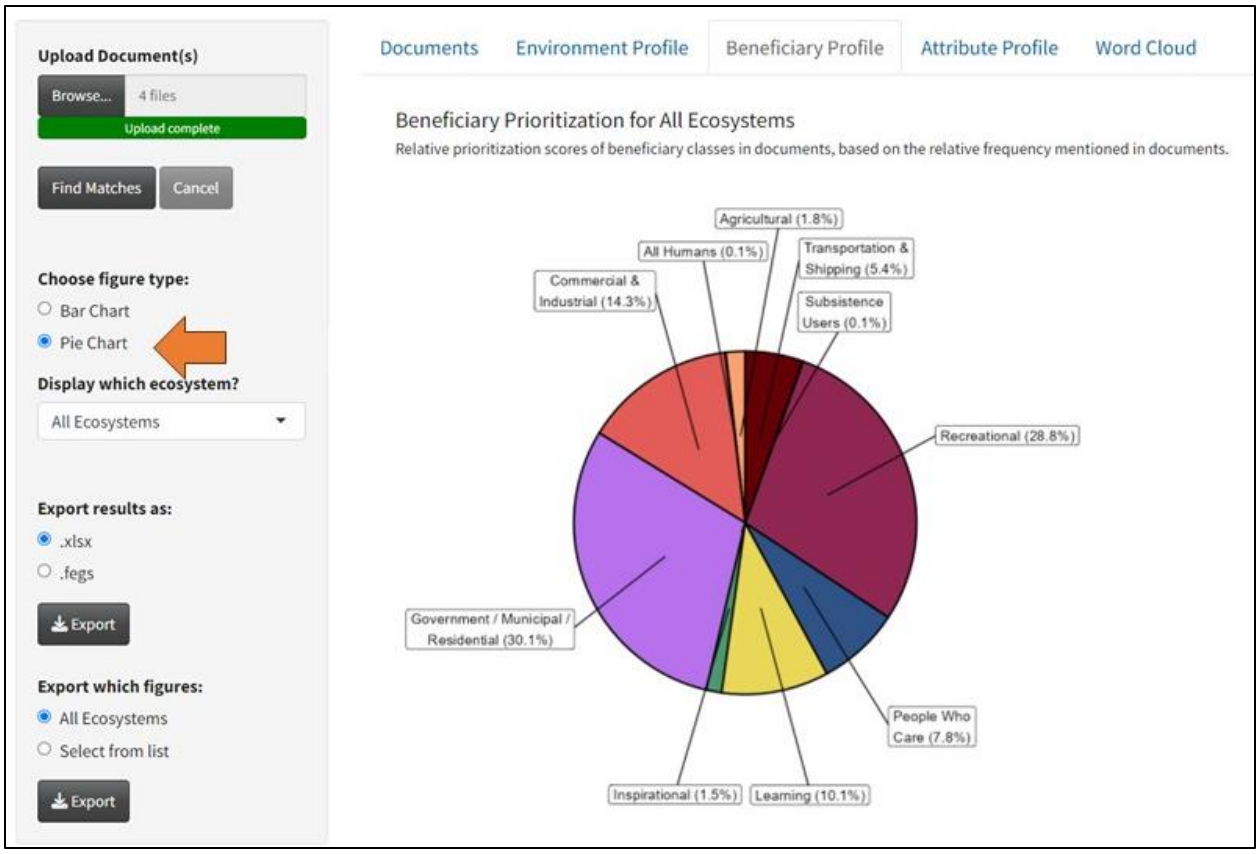
Beneficiary Profile

The **Beneficiary Profile Tab** shows the relative frequency at which different Beneficiary subclasses were mentioned in uploaded documents. The default bar chart displays the average percent of sentences that mention each Beneficiary subclass, totalling 100% across all subclasses. A color legend above the bar chart shows the colors assigned to Beneficiary classes.



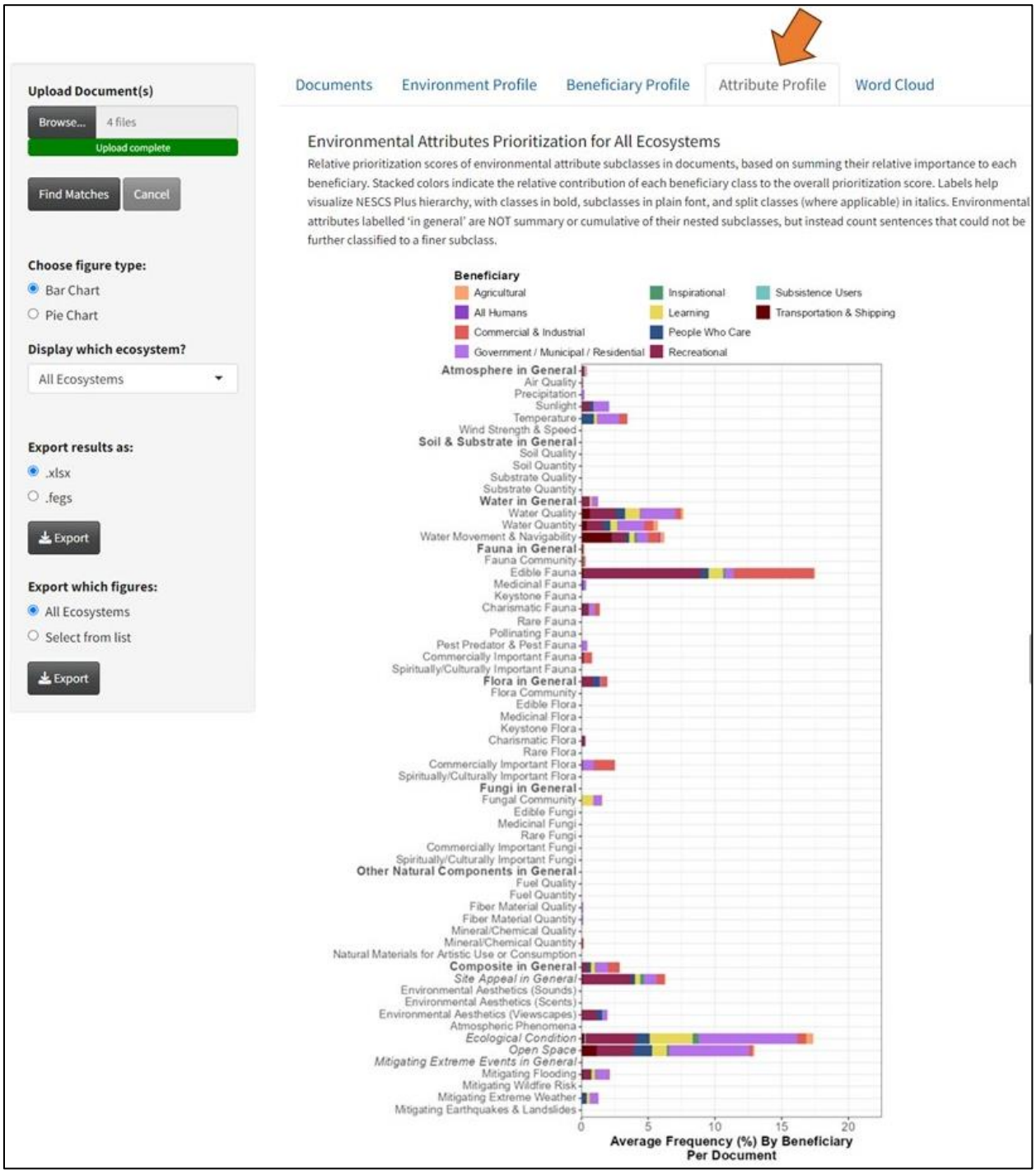
Labels on the bar chart help to visualize the NESCS Plus hierarchy, with classes in bold, subclass I in plain font. Frequencies of broader classes (e.g., Recreation in General) are NOT shown as a calculated cumulative sum of their nested subclasses (e.g., Experiencers & Viewers, Recreational Hunters, etc.). Each beneficiary category (rows in the bar chart; Level 1 subclasses in Table 2) is unique, and all beneficiary categories in the bar chart sum to 100% (no double counting). Beneficiaries labelled 'in general' reflect sentences that could not be further classified to a finer subclass. For example, mentions of anything related to "Recreation" would be calculated manually as Recreation in General + the six subclasses.

As with the Environment Profile, the Beneficiary Profile can also be displayed as either a bar chart or a pie chart. On the left side menu, the "**Choose figure type:**" button can be used to toggle between displaying the relative frequencies as a bar chart or a pie chart. The pie chart option displays the relative frequencies of Classes, here as a cumulative sum of their nested subclasses, whereas the bar chart displays a finer degree of information at Subclass level (Table 2).



Ecosystem Attribute Profile

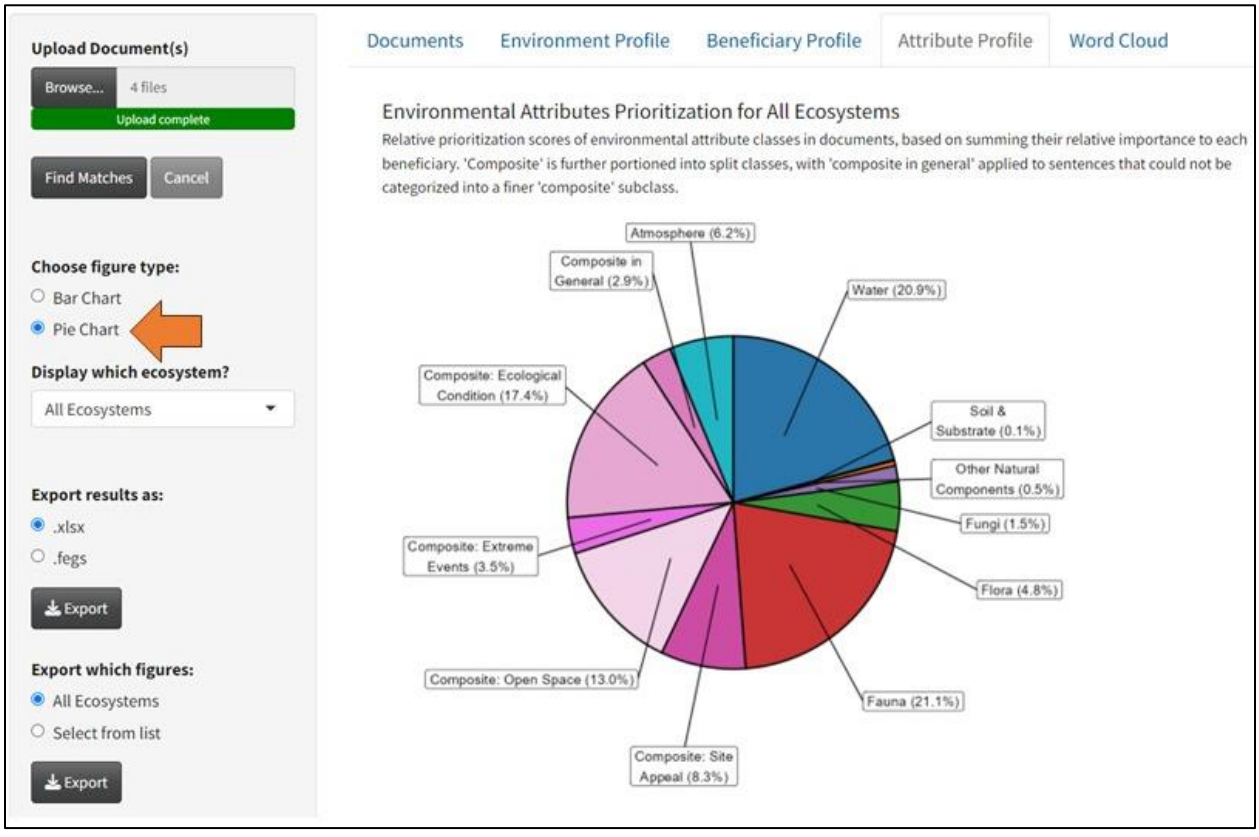
The **Attribute Profile Tab** shows the relative prioritization score of different Ecosystem Attribute subclasses. The total importance score of each ecosystem attribute is the sum of relative importance scores for each beneficiary, weighted by the relative frequency of each beneficiary (as shown in the **Beneficiary Profile Tab**), such that ecosystem attributes of importance to multiple beneficiaries or of importance to a high scoring beneficiary would receive higher overall priority scores.



The default bar chart displays the relative frequency of sentences that mention each Attribute subclass, totalling 100% across all subclasses. A color legend above the bar chart shows relative frequency of Beneficiary classes that 'care' about that attribute, identified as being mentioned in the same sentence as that attribute.

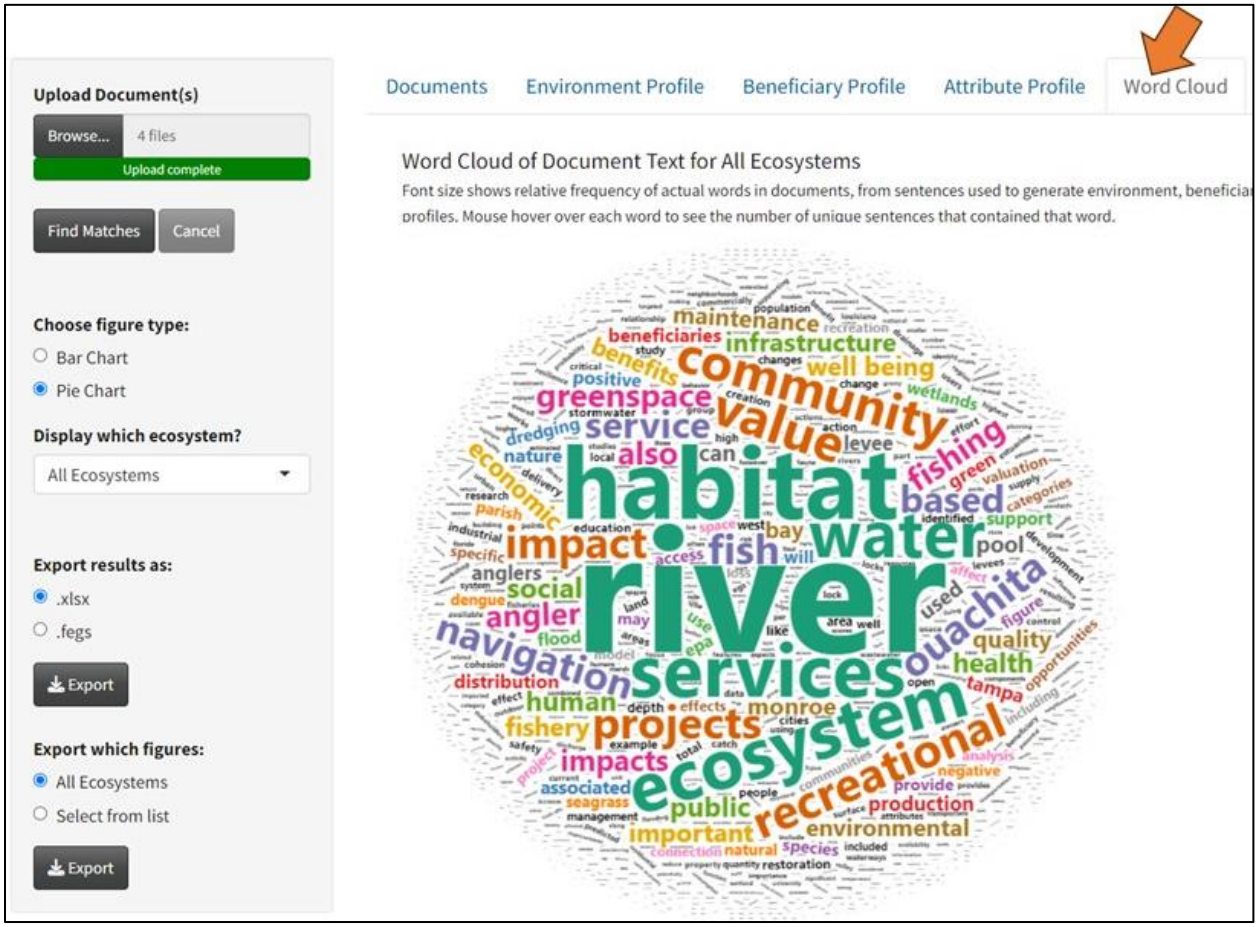
Labels on the bar chart help to visualize the NESCS Plus hierarchy, with classes in bold, subclasses in plain font, and 'Composite' split classes in italics. Frequencies of broader classes (e.g., Fauna in General) are NOT shown as a calculated cumulative sum of their nested subclasses (e.g., Edible Fauna, Charismatic Fauna, etc.). Each attribute category (rows in the bar chart; attribute subclasses in Table 3) is unique, and all attribute categories in the bar chart sum to 100% (no double counting). Attributes labelled 'in general' reflect sentences that could not be further classified to a finer subclass. For example, mentions of anything related to "Fauna" could be calculated manually as Fauna in General + the other ten subclasses.

As with the Environment Profile and the Beneficiary Profile, the Ecosystem Attribute Profile can also be displayed as either a bar chart or a pie chart. On the left side menu, the "**Choose figure type:**" button can be used to toggle between displaying the relative frequencies as a bar chart or a pie chart. The pie chart option displays the relative frequencies of Classes, here as a cumulative sum of their nested subclasses, whereas the bar chart displays a finer degree of information at Subclass level (Table 3).



Word Cloud

To aid in interpretation of Environment, Beneficiary, and Attribute profiles, the **Word Cloud Tab** generates a visualization of the relative frequency of words in documents. Only sentences in documents identified as having a keyword match are included in the word cloud. The relative font size of each word indicates the relative frequency of that word in matched sentences. The user can hover their mouse over each word to see the number of unique sentences that contained that word. This can help aid in interpretation of the kinds of document words contributing to high scoring subclasses.



The specific sentences mentioning a word, and how they were categorized, can be examined in the **Keyword Match Table** on the **Documents Tab** by using the "**Search**" function.

Display Options

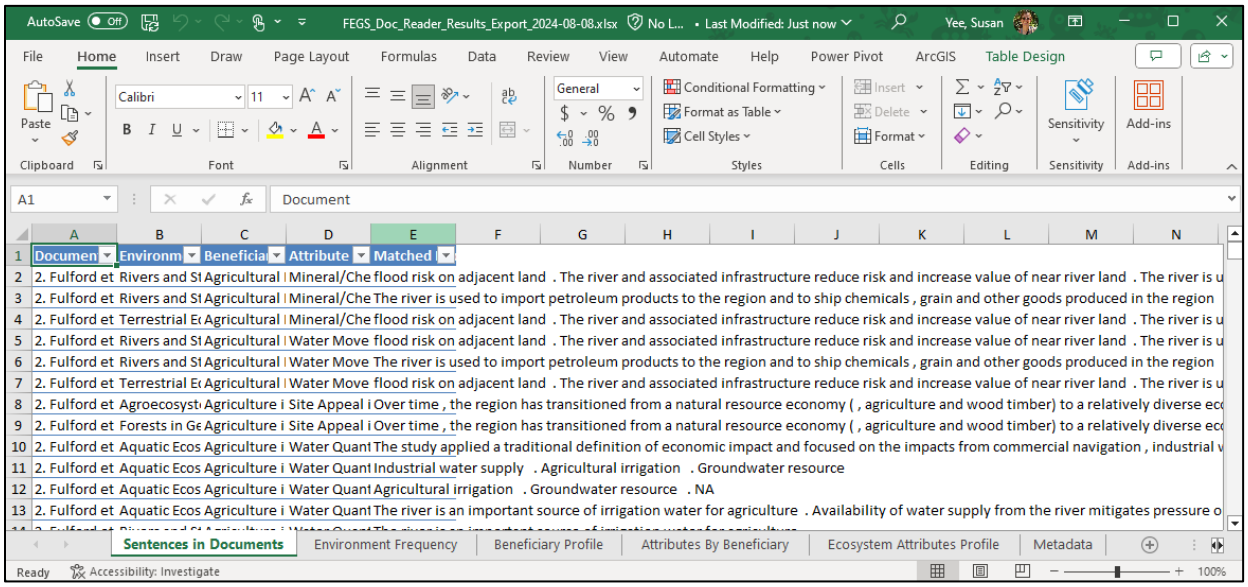
Displaying Different Ecosystems

The default option is to generate Beneficiary and Attribute Profiles across all categories of Environment subclasses. On the left side menu, the "**Display which ecosystem?**" drop-down menu can be used to restrict the output to one particular Environment subclass. This option calculates the relative frequencies at which sentences mentioned each Beneficiary subclass or each Ecosystem Attribute subclass, but only for sentences that contain the selected Environment subclass. Note that the sum total of Beneficiary Scores or Attribute Scores will still add up to 100%. Both the bar charts and pie charts will be updated based on the selected Ecosystem, as well as the word cloud. Selectable levels in the Environment hierarchy are Not nested; ecosystems labelled 'in general' reflect sentences that could not be further classified to a finer subclass. For example, scores reflecting mentions of <u>any</u> Wetland would need to be calculated as Wetlands in General + Woody Wetlands + Emergent Wetlands from exported values.

Exporting Results

Exporting Results as an Excel File

On the left side menu, the toggle button "**Export**" as "**.xlsx**" can be used to export the application results as a Microsoft Excel file.



The Excel file contains 6 tabbed sheets:

- Sheet 1. Sentences in Documents – This sheet provides the full list of sentences (or sets of sentences) for all uploaded documents that were identified by the document search as having matching keywords. Matches based off sets of sentences (rather than single sentences) will display as multiple sentences (or clauses) separated by periods. This same table is displayed on the **Documents Tab**. To be included, a sentence must have keywords related to all three FEGS components: an Environment subclass; a Beneficiary subclass; and an Attribute subclass. The matched sentences are also used to generate the **Word Cloud**.
- Sheet 2. Environment Frequency – This sheet provides the data used to generate the bar chart on the **Environment Profile Tab**. Across all uploaded documents, the mean percentage of sentences mentioning keywords related to each Environment subclass are provided. Note that all rows should sum to 100%.
- Sheet 3. Beneficiary Profile – This sheet provides the data used to generate the bar chart on the **Beneficiary Profile Tab**. Across all uploaded documents, the mean Beneficiary score is the relative percent of sentences mentioning keywords related to each Beneficiary subclass. Note that, for a given Ecosystem Subclass, all rows should sum to 100%.
- Sheet 4. Attributes by Beneficiary – This sheet provides intermediate data showing the relative importance of different Ecosystem attributes to each Beneficiary subclass, averaged across uploaded documents. Note that, for a given Ecosystem subclass, all rows should sum to 100%.
- Sheet 5. Ecosystem Attributes Profile – This sheet provides the data used to generate the bar chart on the **Attributes Profile Tab**. For a given Ecosystem subclasses, the scores for each Ecosystem

Attribute in this sheet are generated by summing across all Beneficiary subclasses on Sheet 4, visualized as the stacked colors for Beneficiary classes in the Attribute Score bar chart.

- Sheet 6. Metadata – This sheet provides a brief overview of the contents of this Excel file.

Exporting Results as a FEGS Scoping Tool File

On the left side menu, the toggle button "**Export**" as "**.fegs**" can be used to export the document reader results as a FEGS Scoping Tool file. The default profiles for All Ecosystems combined, as well as for each identified Environment subclass are all exported in a .zip file. The FEGS Scoping Tool software will be needed to pen these files and can be downloaded from https://www.epa.gov/eco-research/final-ecosystem-goods-and-services-fegs-scoping-tool. The FEGS Scoping Tool has options to:

1. Assign weights to important decision criteria, such as 'level of influence' or 'economic interest.' In the FEGS Document Reader, these criteria weights are assumed to be equally important and assigned equal weighting. In the exported .fegs file, the user has the opportunity to modify these criteria and see how it influences the Beneficiary and Attribute prioritizations.
2. Identify stakeholder groups, and how the decision criteria from step 1 relate to each. In the FEGS Document Reader, each uploaded document is identified as a stakeholder group, and all criteria are assumed to fit all documents equally. In the exported .fegs file, the user has the opportunity to modify the degree to which these criteria fit each stakeholder group (e.g., providing different scores for stakeholder groups with an economic interest vs. those without), or even manually delete or add stakeholder groups.
3. Identify the types of beneficiaries making up each stakeholder group to generate a Beneficiary Prioritization. The FEGS Document Reader results from the **Beneficiary Profile Tab** are exported directly here. In the exported .fegs file, the user has the opportunity to modify the relative proportions of beneficiary subclasses assigned to each stakeholder group. In this case, the Document Reader results may be used as a starting point, but modified based on user knowledge or local expert input.
4. Identify the types of attributes making up each beneficiary group to generate an Ecosystem Attribute Prioritization. The FEGS Document Reader results from the **Attribute Profile Tab** are exported directly here. In the exported .fegs file, the user has the opportunity to modify the relative proportions of attribute types assigned to each beneficiary. In this case, the Document Reader results may be used as a starting point, but modified based on user knowledge or local expert input.

Files in the .zip file are named by the ecosystem type and date of output, resulting in long file names that can cause errors when unzipping if placed within nested folders. If this occurs, it is recommended to copy the .zip folder to folder with no or little nesting (such as the C: drive) prior to unzipping, and then move the unzipped contents to the desired sub-folder.

Exporting Figures

On the left side menu, the "**Export**" button can be used to export the document reader result figures for All Ecosystems or by selecting Environment subclasses from a list. Both bar charts and pie charts from the Environment Profile, the Beneficiary Profile, and the Attribute Profile are exported as a .zip file.

Alternatively, a user can 'right click' on each displayed bar chart or pie chart and select "Save image as.." or "Copy image" to export an individual figure.

Demonstrations

Foundational Studies

The FEGS Document Reader is the culmination of text mining efforts to identify people who benefit from National Estuary Programs and how (Yee et al. 2019), to compare community-scale ecosystem services values along the Massachusetts coastline (Yee et al. 2023), and to compare regional management goals for tidal wetland management and restoration (Jackson et al. 2024). These three studies, in combination with the additional test cases described in the following sections, were used to develop and iteratively refine the list of keywords and analytical approach used to classify document language in the reader, and provide example applications of how ecosystem services document analysis can be interpreted and used.

Table 8. Published studies used to develop the FEGS Document Reader.

Name of Study	Primary Objective	Key Results
Who Benefits from National Estuaries? Applying the FEGS Classification System to Identify Ecosystem Services and their Beneficiaries (Yee et al. 2019)	Review the broad suite of ecosystem services and their beneficiaries relevant to the management of two federal programs for estuary management, the National Estuary Program (NEP) and the National Estuarine Research Reserve System (NERRS).	Although estuary management and monitoring tend to focus on water quality and habitat, management documents identified more than 1,600 unique ecosystem services combinations (an attribute that a user cares about provided by an ecosystem).
Ecosystem services profiles for communities benefitting from estuarine habitats along the Massachusetts coast, USA (Yee et al. 2023)	Evaluate variability in beneficial uses of estuarine habitats across 68 coastal embayment communities in Massachusetts Bays.	Beneficiaries, such as residents, experiencers, educators, and commercial fishermen, had a surprising degree of overlapping interests, with top attributes of broad relevance including for sight appeal, fish and shellfish, water movement and navigability, water quality and quantity, aesthetic viewscapes, open space for development, flood mitigation, and birds. Community-level priorities that emerged were primarily related to regional differences, the local job industry, and local demographics.
Identifying priority ecosystem services in tidal wetland restoration (Jackson et al. 2024)	Examine regional (northern Gulf of Mexico, Mid-Atlantic, and Pacific Northwest) and organizational (federal agencies, state agencies, conservation organizations, and land stewards) differences in potential benefits of tidal wetland restoration activities and the potential user groups who may benefit.	Ecological condition/site appeal paired with People Who Care was the most commonly mentioned ecosystem service. Land steward organizations were more likely to mention ecosystem services than other organizations. The results complement a more traditional stakeholder engagement approach using the FEGS Scoping Tool (e.g., Hernandez et al. 2022) to identify restoration planning goals.

Identifying Common Themes from Case Study Research

Background

EPA's Office of Research and Development (ORD) has conducted dozens of case studies highlighting methods and tools to integrate ecosystem services thinking into environmental decision making, including ecological restoration and community revitalization (Harwell et al. 2021). EPA ORD place-based ecosystem services research was recently compiled into a database (Barrett and Sharpe 2023).

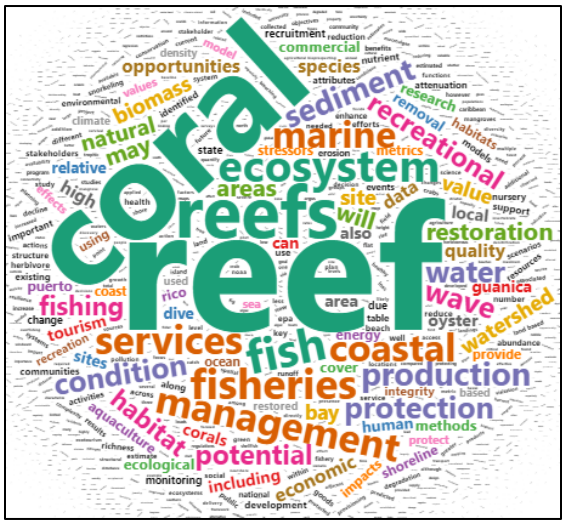
The FEGS Document Reader was used to identify the breadth of ecosystems, beneficiary types, and types of ecosystem services attributes covered by EPA ORD ecosystem services place-based research.

Documents

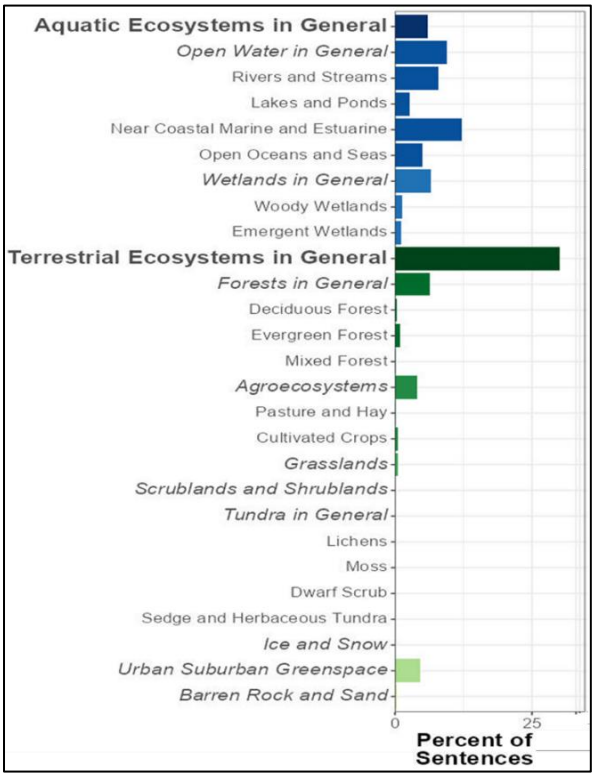
The sixty-four journal articles listed in the case study database were obtained from journal websites as pdf files and uploaded to the FEGS document reader.

Select Document Reader Output

The **Environment Profile** showed place-based research focused on aquatic ecosystems, including wetlands, estuaries, rivers, lakes, and open oceans, but many of the studies discussed these aquatic ecosystems within the context of other terrestrial ecosystems within the watershed. Place-based studies also focused on forests, agroecosystems, and urban/suburban greenspace.



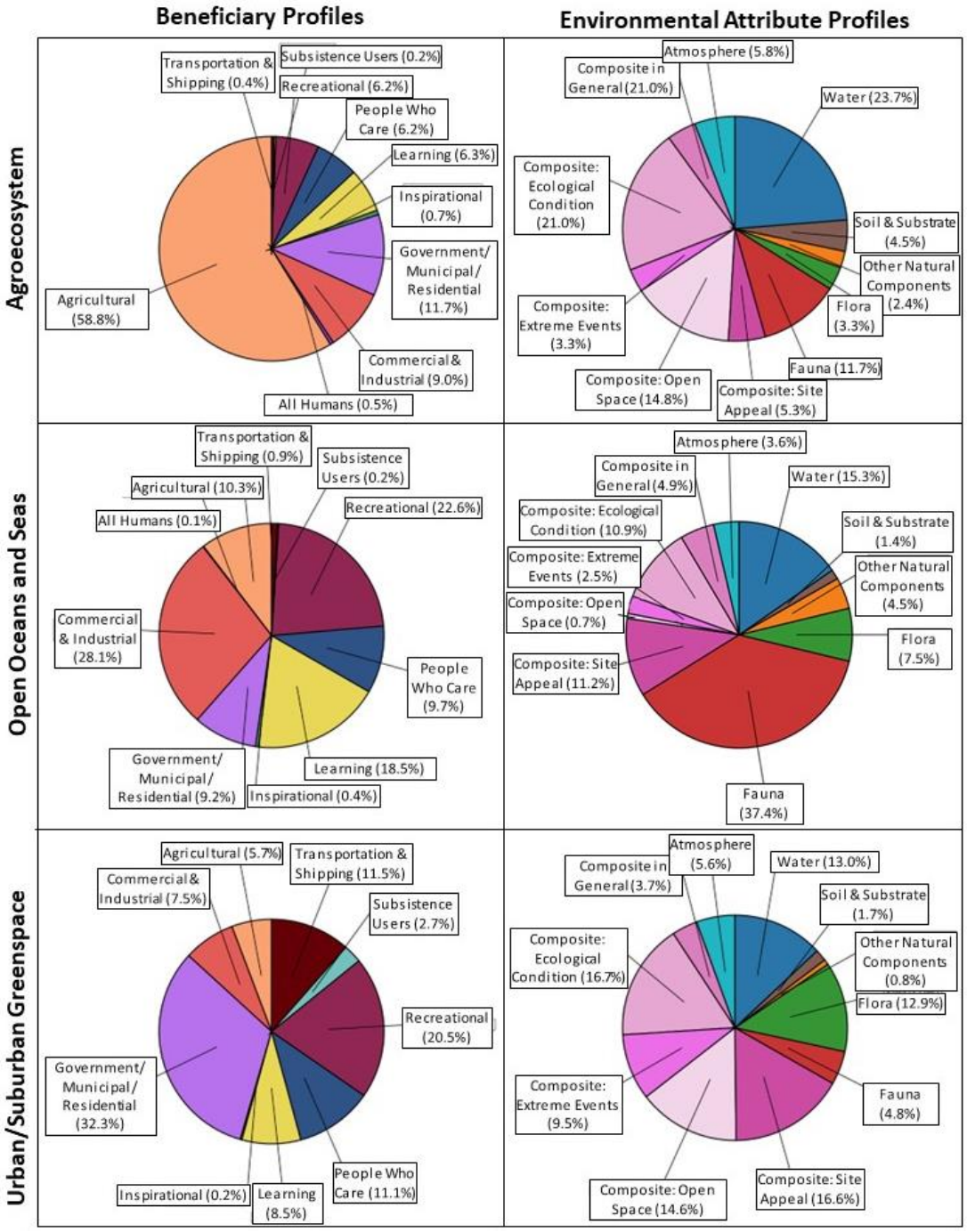
WORD CLOUD FOR OPEN OCEANS/SEAS



ENVIRONMENT PROFILE FOR 64 CASE STUDIES

A **Word Cloud** was used for ecosystems selected by the dropdown menu to interpret what kinds of habitats were being categorized in each Environment Subclass. For example, mangroves were most commonly mentioned in sentences classified as Woody Wetlands; coral reefs were most commonly mentioned under Open Oceans and Seas.

Place based studies considered a variety of beneficiaries (**Beneficiary Profile**) and attributes those beneficiaries care about (**Attribute Profile**), with the specifics depending on the focal environment of the case study. Agroecosystem studies most commonly mentioned agricultural beneficiaries like farmers and attributes such as water quantity and ecological condition. Open oceans and seas most commonly mentioned commercial fisheries and recreational uses, with edible fauna (fish/shellfish) the predominant attribute of interest. For Urban/Suburban Greenspace, residents, experiencers/viewers, and transportation were commonly mentioned, with site appeal, open space, and flora of primary interest.



BENEFICIARY AND ATTRIBUTE PROFILES FOR SELECT ENVIRONMENT SUBCLASSES

Soliciting Stakeholder Input on Benefits of Nature-Based Solutions

Background

EPA's ORD has partnered with a coastal Maryland community to explore the potential of natural infrastructure, or nature-based solutions (NBS), to help decrease storm surge in the face of ongoing sea-level rise, in addition to providing social and economic co-benefits, such as fishing and recreational opportunities, to the community. In April 2024, EPA ORD conducted two stakeholder meetings to better understand how communities use and may benefit from coastal habitat restoration (US EPA 2024).

The FEGS Document Reader was used to analyze existing management documents in order to provide a starting point for discussions with institutional partners at the first stakeholder meeting. In a separate analysis, the FEGS Document Reader was also applied to synthesize written notes from the second stakeholder meeting where members of the public engaged in breakout group discussions and written activities.

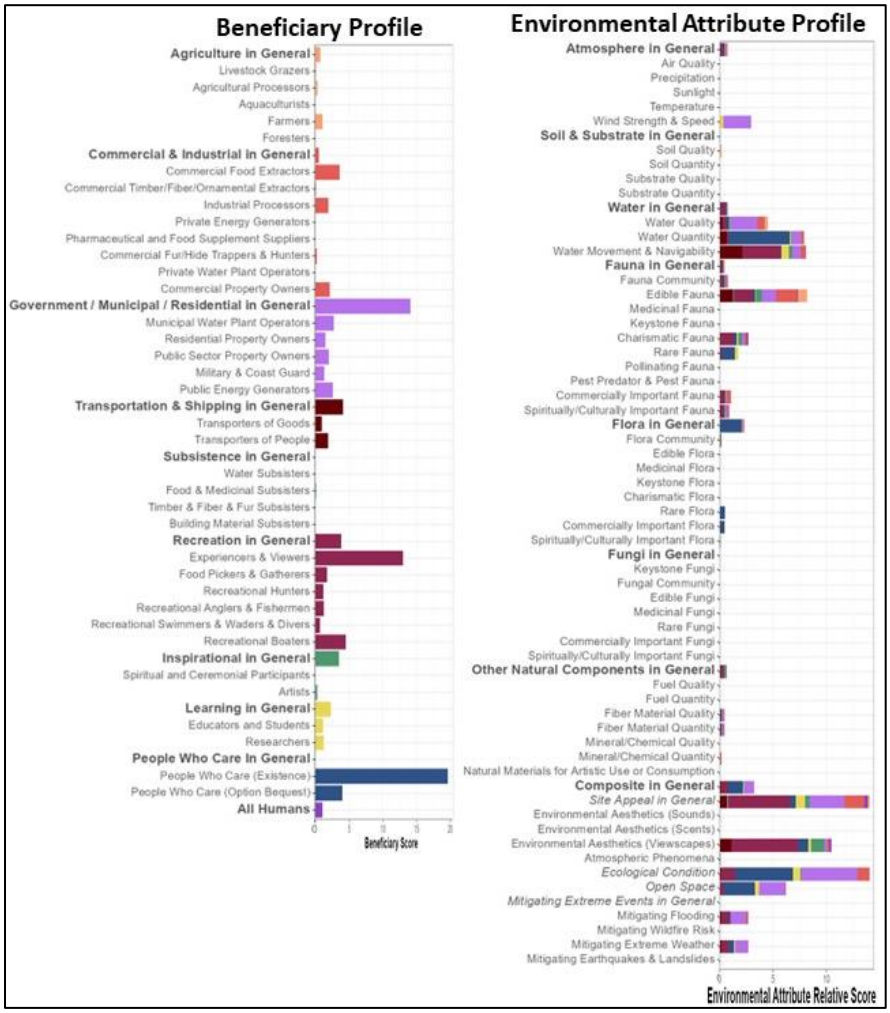
A Strawman for an Institutional Partner Meeting

Documents

Prior to meeting with institutional partners, an internet search of city or county management, planning, and visioning reports mentioning the city and coastal habitats was conducted. Thirty-two pdf documents were identified and uploaded to the document reader.

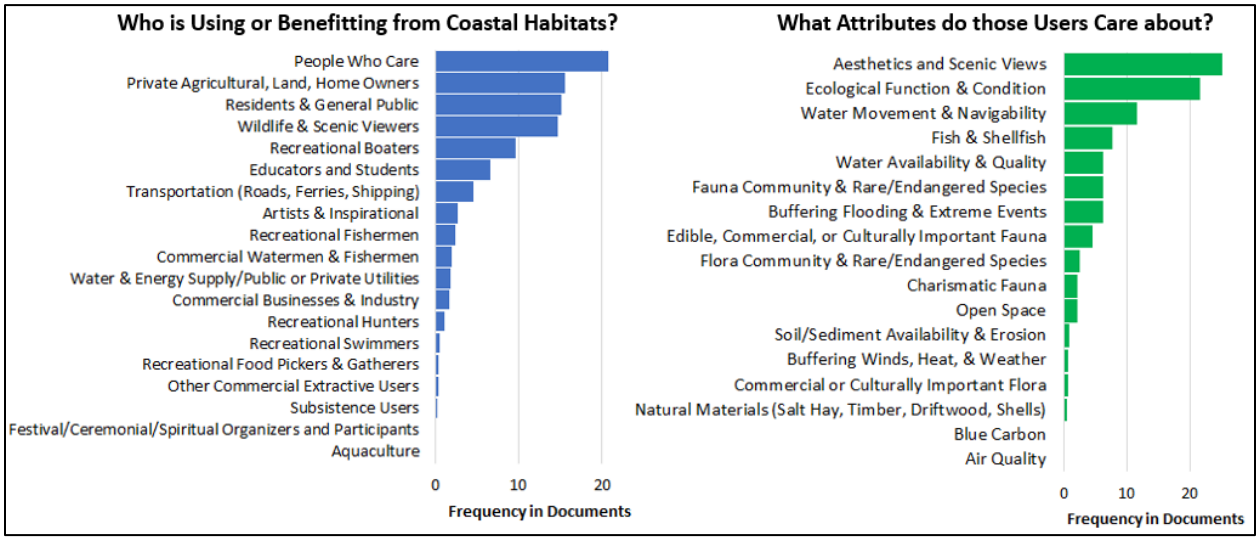
Document Reader Output

The Document Reader was used to generate a strawman **Beneficiary Profile** and **Attribute Profile**. The dropdown menu was used to subset results to those mentioning "Near Coastal" Environment Subclass.



BENEFICIARY AND ATTRIBUTE PROFILES FOR 32 COMMUNITY PLANNING REPORTS

The output was **Exported to .xlsx** (Excel) file, where Beneficiary subclasses and Attribute subclasses were sorted by rank order from most mentioned to least mentioned. A simplified version of the Beneficiary and Attribute Profiles in rank order were created as bar charts. Subclass language was modified slightly, and some subclasses combined to simplify presentation or better resonate with community partners. The figures were presented to meeting participants, as part of introductory material describing the potential social and economic benefits of NBS, such as marsh restoration or living shorelines, to the community. Meeting participants were then asked to brainstorm what they thought were some of the important ways the community uses or benefits from coastal habitats, and what may be important measures to quantitatively assess.



LIST OF TOP BENEFICIARIES AND ATTRIBUTES PRESENTED TO MEETING PARTICIPANTS, CREATED FROM EXCEL EXPORT

Synthesizing Notes from a Public Meeting

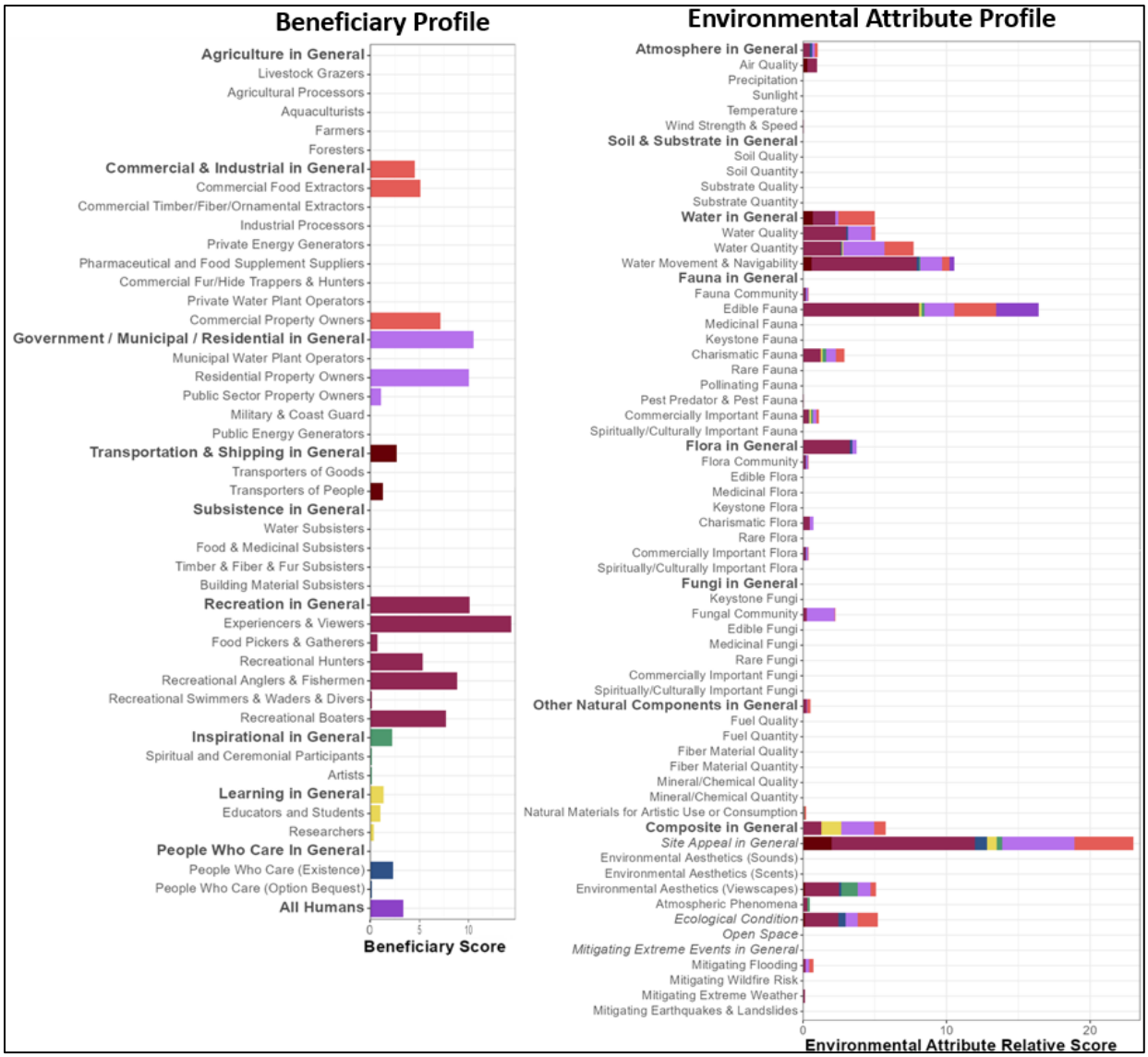
Documents

A public meeting was held with two dozen community area residents to discuss how people in the community feel about natural coastal spaces. The meeting facilitators used sticker dot exercises, written brainstorming activities, and breakout group discussions with report outs to the larger group in order to ask: i) who uses coastal habitats; ii) what attributes of coastal habitats matter to people; and iii) how past and future changes in coastal habitats affect the community.

Meeting notes from: i) four individual breakout groups; ii) one written brainstorming exercise; iii) group report outs; and iv) the facilitator's post-meeting summary report were converted to seven pdfs and uploaded to the document reader. Notes were modified slightly to improve readability by the document reader by first adding explicit references to coastal habitats when it was implied (i.e., a question about 'coastal habitats' was posed to the group, but written notes listed the individual answers not necessarily the question), and second by adding periods or bullets to break up run-on sentences in written notes. The Document Reader searches from one to three adjacent sentences, and must find all three components within that sentence set (Environment, Beneficiary, Attribute), so minor modifications to written notes were necessary to make sure the Reader was interpreting notes appropriately.

Document Reader Output

The Document Reader was used to generate a strawman **Beneficiary Profile** and **Attribute Profile**. The default of "All Ecosystems" was used, rather than subsetting to "Nearshore Coastal" because meeting discussions were intentionally focused on coastal natural spaces, so mentions of any ecosystems or habitats would be considered relevant within the context of the meeting.



BENEFICIARY AND ATTRIBUTE PROFILES FROM PUBLIC MEETING NOTES

The attribute prioritization was cross-walked against language in matching sentences to develop a list of 'most important' benefits that may be impacted by coastal habitat restoration and are of greatest relevance to the community: Natural Beauty; Ecological Condition; Species for Fishing/Seafood Industry; Species for Hunting; Water Movement & Navigability; Flora Community; Flood Protection; Water Access; Charismatic Fauna; Water Quality; Fauna Community; Mold Reduction; Natural Open Spaces; Natural Materials for Artistic or Ornamental Use; Weather (Wind); and Nuisance & Invasive Species. Information learned from the meeting will be used to help EPA ORD focus research to quantify and compare the potential benefits of different NBS options to the community.

Scoping Benefits of River Watershed Restoration for Key Stakeholders

Background

Massachusetts Bays National Estuarine Partnership recently updated their Comprehensive Conservation and Management Plan to include restoration targets for coastal habitats, and as part of this effort, the program explored how to better demonstrate that recovery of degraded ecosystems also provides ecosystem services that humans want and need (MassBays 2023). EPA ORD is working with MassBays and partners in the Saugus River watershed to explore the potential for local-scale restoration projects to not only contribute toward regional habitat acreage targets, but provide benefits to local communities.

The FEGS Document Reader was used in parallel with FEGS Scoping Tool to provide an additional, independent source of information on potential ecosystem services benefits of watershed restoration and management to communities in the watershed.

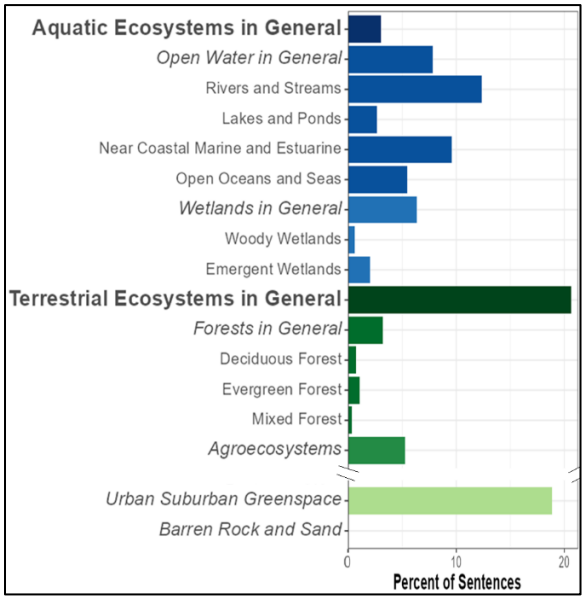
Documents

EPA ORD facilitated use of the FEGS Scoping Tool through discussions with a non-profit organization in the Saugus River Watershed. FEGS Scoping Tool steps included: i) weighting criteria, such as economic impact and underrepresented groups to prioritize stakeholders; ii) identifying and assigning criteria to key stakeholder organizations that including non-profits, businesses, and governmental organizations; iii) identifying ways each stakeholder organization interacts with the environment as beneficiaries; and iv) identifying attributes of greatest important to those beneficiaries in order to develop a prioritized list of attributes to target for further assessment or monitoring.

In parallel, representative documents, such as website content, organizational mission statements, news articles, plans or reports, were obtained for each of the same 52 stakeholder organizations identified by the community partner. Multiple documents (where available) were combined into a single pdf for each stakeholder organization, so that all stakeholders were equally weighted in the Document Reader, even though some might have more available content than others.

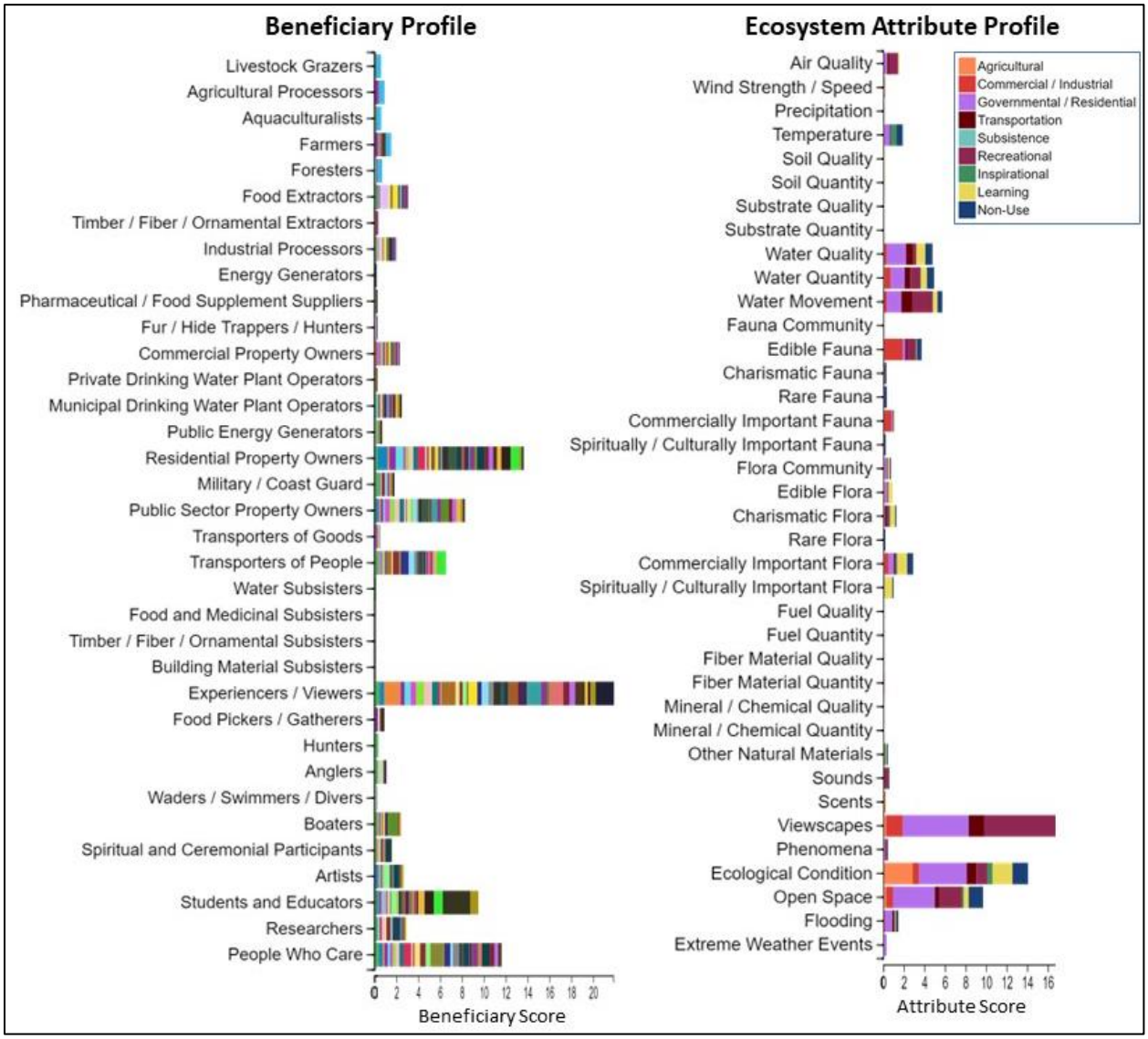
Document Reader Output

The Document Reader was used to generate an **Environment Profile**. The default of "All Ecosystems" was used to create a **Beneficiary Profile** and **Attribute Profile**, rather than using the drop-down option to subset to "Rivers and Streams," because the river runs from headwaters through ponds and marsh habitat to estuarine embayments on the coast, and the watershed includes forested and urban habitats that influence water quality.



ENVIRONMENT PROFILE FOR STAKEHOLDER ORGANIZATIONS

Output was **Exported to .fegs** file so that it could be most directly compared with facilitated FEGS Scoping Tool results. The community partner was shown the Document Reader output alongside facilitated results. Documents generally put a greater emphasis on experiential users, residents, and people who care, with viewscapes, ecological condition, and water quality commonly mentioned attributes. Documents also rarely discussed sediment quality in the river, a factor identified by the community partner as a fairly important attribute that stakeholder documents may be overlooking.



BENEFICIARY AND ATTRIBUTES PROFILES FOR STAKEHOLDER DOCUMENTS EXPORTED TO FEGS SCOPING TOOL FILE. IN THE BENEFICIARY PROFILE, EACH STACKED COLOR REPRESENTS A DIFFERENT STAKEHOLDER DOCUMENT.

EPA ORD is using FEGS Scoping Tool results to generate a list of priority ecosystem services for the watershed that may be impacted by restoration. Ultimately, these will be used to identify metrics and data to characterize the range of ecosystem services benefits throughout the watershed, in terms of what has been 'lost' due to degradation and what potential benefits to local communities could be 'gained' through restoration projects.

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Keyword Tables

Environment Keyword Search Terms

*Table 9. Examples of keywords for each **Environment** category in the FEGS Document Reader.*

	FEGS Document Reader Category: Environment	Example keywords
	Aquatic in General	(aquatic, water, benthic, fish, watershed) AND (natural, ecology, ecosystem, habitat, wild, environment, area, valuable, resource, goods)
	Groundwater	groundwater, aquifer, geyser, underground reservoir, OR underground water
	Open Water in General	open water, deep water, anadromous, diadromous; natural water ecosystems or fish/shellfish habitat that is not groundwater or wetland;
	Rivers and Streams	river, creek, canal, stream, channel, riparian
	Lakes and Ponds	lake, pond, reservoir, vernal pool; water or flooded quarry
	Coastal Ecosystems in General	(coast, shore, bay, embayment) AND (natural, ecology, ecosystem, habitat, wild, environment, area, valuable, resource, goods); estuary, lagoon, delta
	Beach and Dunes	beach, sandy shore, seashore, dune, sand dune
	Eel and Sea Grass	eelgrass, seagrass, zostera, thalassia, tape grass, paddle grass, posidonia, star grass, widgeon grass, shoal grass, turtle grass, halophila, halodule, syringodium, oyster grass, submerged aquatic vegetation, SAV
	Rocky Shore	(rocky or bedrock) AND (shore, beach, coast, outcrop, tide, tidal)
	Tidal flat	Tidal flat, mud flat, clam flat, tideland; coastal flats
	Open Oceans & Seas in General	ocean, continental shelf, sea, marine; coastal open or deep water
	Kelp Forest	kelp forest
	Reefs	coral, coralline, reef, artificial reef; sunken ship or shipwreck as habitat/ecosystem
	Wetlands in General	wetland, bog, floodplain, marsh, swamp, slough, rush fen, sedge fen, shrub fen, marsh hay, salt hay, playa, peatland, sedge meadow, wet meadow, wet depression, depression basin
	Woody Wetlands in General	general wetland keywords AND (wood, tree, forest)
	Mangroves	mangrove
	Emergent Wetlands in General	general wetland keywords AND (emergent, herbaceous, or grass)
	Salt Marsh	salt marsh, cordgrass, spartina, juncus, black rush, salt hay, glasswort, salicornia, sea lavender, limonium, plantain, plantago, sedge, phragmites, pepperweed, saltwater marsh
	Terrestrial in General	(terrestrial, upland, land) AND (natural, ecology, ecosystem, habitat, wild, environment, area, valuable, resource, goods); natural ecosystems or habitats that are not specifically identified as aquatic (lakes, rivers, wetlands, etc.);
	Forest in General	forest (but not kelp); wood, trees, tree stand
	Deciduous Forest	deciduous forest or trees; oak, elm, hickory, ash, maple, birch, buckeye, cottonwood, dogwood, magnolia, pecan
	Evergreen Forest	conifer, evergreen, alpine, or pine forest or trees; cypress, hemlock, fir, spruce, palm, balsam
	Mixed Forest	mixed forest or trees; any type of deciduous tree mentioned in same sentence as an evergreen tree
	Agroecosystems in General	agroecosystem, orchard, vineyard, farm, silviculture, plantation; (homestead or agriculture) AND (land, acre, green, vegetation, area, habitat, ecosystem, nature)

	FEGS Document Reader Category: Environment	Example keywords
	Pasture and Hay	general agroecosystem keywords AND pasture or hay (but not salt hay or marsh hay)
	Cultivated Crops	general agroecosystem keywords AND (crop, cropland, cultivated)
	Grasslands	prairie, grassland
	Scrublands and Shrublands	sageland, scrubland, shrubland, chaparral
	Tundra in General	tundra; (alpine or arctic) AND (natural, ecology, ecosystem, habitat, wild, environment, area, valuable, resource, goods)
	Lichen	lichen AND (tundra, alpine, arctic, Alaska)
	Moss	moss AND (tundra, alpine, arctic, Alaska)
	Dwarf Scrub	dwarf scrub AND (tundra, alpine, arctic, Alaska)
	Sedge and Herbaceous Tundra	(sedge, herbaceous, forb, tussock) AND (tundra, alpine, arctic, Alaska)
	Ice and Snow	glacier; (ice or snow) AND (perennial, habitat, ecosystem environment)
	Urban Suburban Greenspace	park, playground, greenway, green roof, garden, green infrastructure, lawn, golf course, yard, athletic field (soccer, football, baseball), brownfield, greenfield, abandoned land or lot; (urban, suburban, development, city, streets, roads, neighborhood, highway, shopping, industrial, commercial area, town) AND (tree, trail, green, vegetation, grass)
	Barren Rock and Sand	Desert; (mine or quarry) AND (pits, strip, land); (barren, bedrock, or volcanic) AND (natural, ecology, ecosystem, habitat, wild, environment, area, valuable, resource, goods)

Beneficiary Keyword Search Terms

*Table 10. Examples of keywords for each **Beneficiary** category in the FEGS Document Reader.*

	FEGS Document Reader Category: Beneficiary	Example keywords
	Livestock Grazers	pasture, rancher, herding; (ranch, graze, range, movement) AND (livestock, cattle, hog, poultry, cow, pig, sheep, goat)
	Agricultural Processors	(process, product, mill, commodity, good) AND (agriculture, farm, grain, sugar, meat, vegetable, fruit, coffee, rice, cotton, flax, cider, lumber)
	Aquaculturists	aquaculture; (shellfish, fish, oyster, scallop, mussel, shrimp, aquatic plant, crab, aquatic) AND (hatchery, culture, grower, cultivate, garden)
	Farmers	crops, cropland, farmer; (rice, vegetable, cranberry) AND (bog, farm, harvest, grow, paddy)
	Foresters	forester, forestry, tree farm, silviculture, forest management, forest industry, forest practices
	Agricultural in General	agriculture;
	Commercial Food Extractors & Fisheries	[(hunt, trap AND meat, consume, eat, edible) OR (fishing, shrimping, fishery, clamming, watermen, baitfish, crab, oyster, mullet, lobster, mussel, bass, herring, walleye, flounder, shark, stingray, scallop, geoduck, crawfish, crayfish, seafood)] WITH (extract, commercial, business, product, commodity, good, profit, buy, job, sell, dealer, livelihood, market, corporation, profession, income, artisan, trade, worker)
	Commercial Timber/Fiber/Ornamental Extractors	logging, timber, shell mining; (pine, wood, pulp, oak, elm, cedar, cypress, ash, fir, balsam, maple, hickory, reed, grass, salt hay, turpentine, shells, aquaria, ornamental, pet store, aquatic plant) WITH (extract, commercial, business, product, commodity, good, profit, buy, job, sell, dealer, livelihood, market, corporation, profession, income, artisan, trade, worker)
	Commercial/Industrial Processors	industrial or commercial products or processing; product development; manufacturing, textile, steel, factory, cannery, papermill, mining, quarry; (chemical, iron, metal, oil, gas, petroleum, lime, seafood, fish) WITH (industry, factory, manufacture, foundry, operation, refinery, facility, processing)
	Private Energy Generators	(solar, wind, water, geothermal, hydro, dam, renewable, production, generate, supply, station) AND (power, energy, turbine, electric) AND (private, commercial);
	Pharmaceutical & Supplement Suppliers	(pharmaceutical, medicine, vitamin, drug, medical, surgical) AND (species, discovery, research, harvest, develop, testing, natural); biotechnology, bio-technology, natural product, biomaterial, biochemical, biopharmaceutical
	Commercial Fur/Hide Hunters and Trappers	skin, hide, fur, pelt, tanning, deer, fowl, duck, goose, turkey, rabbit, racoon, squirrel, fox, possum, nutria, beaver, hogs, alligator, turtle, tortoise, crocodile, snake) AND (extract, commercial, business, product, commodity, good, profit, buy, job, sell, dealer, livelihood, market, corporation, profession, income, artisan, trade, worker)
	Private Water Facilities Operators	(drinking water, water supply, water treatment, desalination, dam water, well) AND (private, commercial)
	Commercial/Industrial Property Owners	local business, local economy, local industry; marina, resort, hotel, shop, restaurant; (land, development, property, owner, building) AND (commercial, industry, business)
	Commercial & Industrial in General	commercial, industry, industrial, business, commerce

	FEGS Document Reader Category: Beneficiary	Example keywords
	Public Water Facilities Operators	(drinking water, water supply, water treatment, desalination, dam water, well) AND (public, government, municipal, village, county, town, city, state, community, project, need, provide, operation)
	Residential Property Owners	residential development, homeowner, homestead, housing, private land, private property, resident, septic tank, trailer park; (residential, private, or domestic) AND (property, land, owners, neighborhood)
	Public Property Owners	(land, development, property, owner, building, infrastructure) AND (government, municipal, village, town, city, public, community, state); city hall, town hall, library;
	Military and Coast Guard	military, coast guard, navy, army, marines, air force, military, defense base, defense installation, armed service
	Public Energy Generators	(solar, wind, water, geothermal, hydro, dam, renewable, production, generate, supply, station) AND (power, energy, turbine, electric) AND (public, government, municipal, village, county, town, city, state, community, project, need, provide, operation)
	Government/Residential in General	government, municipal, village, town, city, public access, public use, public good, public purpose; community AND (sustainable, local, waterfront, plan); neighborhood; families, resident, children, citizen, family living; development pattern; coastal development; urban sprawl; our AND (community, region, country, county, state, area, watershed); (habitant, resident, occupant, living in, reside, govern, public, people, person, human) AND (watershed, area, region, community, country, state, county, urban, rural, quality of life, health, wellbeing, welfare, safety)
	Transporters of Goods	(cargo, goods, freight, commodity, container) AND (transport, train, ship, vessel, airline, airport, airplane, airfield, airstrip, rail, pilot, captain, highway, interstate, road, port, barge, gundalow)
	Transporters of People	parking area, parking lot, cruise, ferry, airplane, airport, airstrip, airfield, runway, vehicle, bus, taxi, private jet; (transport, train, ship, vessel, airline, airport, airplane, airfield, airstrip, rail, pilot, captain, highway, interstate, road, port) AND (commuting, travel, people, passenger)
	Transportation in General	transport AND (commercial, military, business, infrastructure, facility, public); train, ship, vessel, airline, airport, airplane, railway, railroad, pilot, captain, highway, interstate, road, port
	Water Subsisters	cistern, rain barrel; collect or store rain to reuse, drink, or irrigate; private, artesian, or domestic wells; (tribal, indigenous people, Indian, native people, Native American, sustenance, self sufficient, traditional knowledge) AND (water)
	Food and Medicinal Subsisters	(tribal, indigenous people, Indian, native people, Native American, sustenance, self sufficient, traditional knowledge) AND (food, medicine, hunting, trapping, gatherer, harvest, forage, berries, mushroom, fruit, vegetable, herb, shellfish, rice, fish, shrimp, salmon, oyster, crab, lobster, mullet, mussel, bass, herring, walleye, flounder, shark, stingray, clam, duck, waterfowl, honey, deer, fowl, goose, turkey, cottontail, rabbit, raccoon, squirrel, fox, possum, nutria, beaver, hogs, alligator, turtle, tortoise, crocodile, snake, maple sugar, maple syrup)
	Timber & Fiber & Fur Subsisters	firewood, campfire; (tribal, indigenous people, Indian, native people, Native American, sustenance, self sufficient, traditional knowledge) AND (skin, hide, fur, pelt, tanning, feather, timber, fiber, wood, pulp, turpentine, various tree species as identified for “Forests”)
	Building Material Subsisters	(tribal, indigenous people, Indian, native people, Native American, sustenance, self sufficient, traditional knowledge) AND (mud, stone, rock, granite, limestone, shells, sand, build, construct)

FEGS Document Reader Category: Beneficiary	Example keywords
Subsistence in General	subsistence, traditional use, traditional way, dependent on the land; (tribal, indigenous people, Indian, native people, Native American, sustenance, self sufficient, traditional knowledge) AND (resource, use, survival)
Experiencers/Viewers	horseback riding, hiking, walking, playing, rock climbing, biking, camping, birding, sightseeing, outing, shelling, picnic, off-road vehicle, all terrain vehicle, birdwatching, wildlife viewing, encounter, nature tour, pier, waterfront, boardwalk, trail, scenic view, scenery, horizon, skyline, vantage point, vista, observation point, beauty, panoramic, viewscape, idyllic, sound, listen, sensory, auditory, olfactory, noise, scent, smell, aroma, visual, hear insects, fragrant, songbird, sunrise, sunset, eclipse, sundown, rainbow, twilight; (collect, gather, pick) AND (natural material, flower, shells, seeds, plants, insects, fungi, mushrooms, minerals, rocks); (view, watch, witness, experience, observe, overlook, vista, opportunity, roaming, participate, destination, encounter, festival, ceremony, celebration) AND (nature, environment, landscape, amenity, appreciate, artist, attractive, beauty, bounty, beneficial, care, charismatic, charming, cherish, children, comfort, concern, conserve, critical, desirable, economy, encourage, enhance, enjoy, enthusiastic, family, favorable, feel, hallmark, inspirational, interesting, leisure, pleasant, phenomenon, popular, preserve, promote, purpose, protect, rare, recreation, relax, resource, restore, save, special, spectacular, sport, threatened, together, tourist, visitor, sustainable, tradition, treasure, unique, valuable, well-suited, alluring, appealing, mystique, jewel, extraordinary, scenic, excellent, amazing, stunning, majestic, panoramic, aesthetic)
Food Pickers/Gatherers	(collect, pick, gather, recreation, edible, sport, opportunity, experience, enjoy, relax, family, children, visitor, forage) AND (food, berries, mushroom, fruit, herbs, nuts, roots, asparagus, maple sugar, maple syrup, shellfish, clam, oyster, lobster, mussel, crab, shrimp, crawfish, crayfish, crustacea, edible, consumption, eat, food, delicious)
Recreational Hunters	(hunter, trapper, wild game, hide, fur, skin, pelt) AND (recreation, sport, opportunity, experience, enjoy, relax, family, children, visitor, tourist, permit, activity); (deer, fowl, duck, goose, turkey, rabbit, racoon, squirrel, fox, possum, nutria, beaver, hogs, alligator, turtle, tortoise, crocodile, snake) AND (recreation, sport, permit); mentions of hunting not otherwise identified as commercial
Recreational Fishermen	(fisher, fishing, bait) AND (recreation, sport, opportunity, experience, enjoy, relax, family, children, visitor, tourist, permit, activity, saltwater, freshwater); flyfishing; mentions of fishing not otherwise identified as commercial
Waders & Swimmers & Divers	snorkel, SCUBA, swimmer, wader, diver, bather, surfer
Recreational Boaters	boat, canoe, kayak, rowing, jet ski, watercraft, paddle; (harbor, dock, marina, channel) AND (traffic, wake, activity, moor, private, public, access, available, crowd)
Recreational in General	recreation, sport, vacation, amenities, visitor, tourism, golf course, athletic field, baseball, football, soccer
Spiritual and Ceremonial Participants	festival, observance, religious, ceremony, baptism, wedding, spirit, worship, prayer, parade, community event, popular event, special event, free event, totem, sacred
Artists	poet, painter, artist, sculptor, carver, pottery, photographer, mural, cinematographer, jeweler, story, creative; writer AND (nature, inspirational, environment, outdoor, creative, visitor, tourist; contest AND (Christmas card, essay, poetry, art, photograph)
Inspirational in General	inspiring, cultural significance, cherished, treasure, wonder, beauty, renowned, sense of place, sense of community, pride, way of life, placemaking, community identity, cultural identity; (cultural or historic) AND (significant, valuable, important, vital, resource, need);

	FEGS Document Reader Category: Beneficiary	Example keywords
	Educators/Students	educator, academic, teacher, professor, class, student, elementary, school, field trip, outdoor lab, outdoor classroom, internship, college university, youth development, youth program
	Researchers	research, scientist, postdoc, graduate student, monitoring, specimen collection, sample collection, data collection, gather data, biologist, ecologist, scientific use, scientific resource, scientific study, experimental study, field study, lab study, experiment
	Learning in General	learn, museum, visitor center, diorama, natural history, history tour, discovery lab, lab offering, outreach, education; (interpretive, interactive, educational, environment, outdoor, science, nature) AND (trail, guide, center, program, panel, exhibit)
	People Who Care (Existence)	existence value, right to exist, endangered, threatened, refuge, sanctuary, conservation, preservation, species of concern, environmentally or ecologically sensitive, rare species, protected species, critical species; (volunteer, membership, friends of, save the) AND (nature, ecosystem, environment, wild, open space, outdoor, various animal species as specified for “Fauna” (e.g., bird, whale, frog), various plant species as specified for “Flora” (e.g., cottonwood, pines), various ecosystems as specified in “Environment” (e.g., estuary, wetland, forest, river))
	People Who Care (Option/Bequest)	bequest, option value, steward, land trust, inheritance, sustainable, future or next generation, inter-generational, grandchildren; (future, heritage, legacy, inherit) AND (enjoy, preserve, conserve, invest, valuable, resource, vital); (heritage, legacy, inherit) AND (nature, ecosystem, environment, wild, open space, outdoor, various animal species as specified for “Fauna” (e.g., bird, whale, frog), various plant species as specified for “Flora” (e.g., cottonwood, pines), various ecosystems as specified in “Environment” (e.g., estuary, wetland, forest, river))
	People Who Care in General	non-use value, non-use resource, non-use opportunity
	All Humans	humanity, everyone, humankind, all ages, all people, all humans, the world, the planet

Ecosystem Attribute Keyword Search Terms

*Table 11. Examples of keywords for each **Ecosystem Attribute** category in FEGS Document Reader.*

	FEGS Document Reader Category: Attribute	Example keywords
	Atmosphere in General	(atmosphere, weather, climate, cloud, summer, fall, winter, spring, autumn, skies, sky, season) AND (accommodate, activity, aesthetic, allure, appeal, amaze, amenable, amenity, appreciate, aromatic, artisan, artist, attract, beauty, benefit, bequest, bounty, business, buy, calm, care, charismatic, charming, cherish, children, comfort, concern, conserve, corporation, critical, dealer, delicious, desired, destination, diversity, economy, educate, encourage, enhance, enjoy, encounter, enthusiast, essential, excellent, experience, exploit, extract, extraordinary, family, favorable, feeling, festival, ceremony, future, gather, hallmark, harvest, healthy, heritage, hunter, important, income, indigenous people, Indian population, industry, initiative, inspiration, interest, jewel, job, knowledge, learn, legacy, leisure, lifeblood, livelihood, lost, lovely, majestic, market, marketable, markets, mystique, native, observe, option value, opportunity, participant, peaceful, people, pleasant, phenomenon, popular, preserve, products, profession, profit, promote, purpose, protect, quality of life, rare, recreate, relax, research, restore, save, sight, serene, soothe, special, specimen, spectacular, sport, steward, stunning, subsist, supply, sustain, sustenance, threatened, together, tourism, trade, tradition, treasure, tribal, unique, use, valuable, view, visit, vital, volunteer, watch, well suited, wonder, mild, moderate)
	Air Quality	air AND (quality, clean, pollution, fog, smog, breathe, fresh, oxygen, carbon dioxide, helium, nitrogen, hydrogen, respiratory, asthma, health, safe, protect, restore, resource, discharge, emission, load, carried, point source, reduce); fog AND (catcher, moisture, irrigate, garden, drink, hygiene); air AND any of the descriptive terms in "Atmosphere in General"
	Precipitation	(precipitation, rain, snow, hail) AND (irrigate, farm, crop); (precipitation, rain, snow, hail) AND any of the descriptive terms in "Atmosphere in General"
	Sunlight	(sun, solar, sunny, sunlight, sunshine) AND (crop, farm, photosynthesis, energy, power); (sun, solar, sunny, sunlight, sunshine) AND any of the descriptive terms in "Atmosphere in General"
	Temperature	(temperature, humidity) AND (heat, hot, cold, freezing, climate, summer, fall, winter, spring, autumn, season); urban heat, heat island, heat hazard, shading; (temperature, humidity) AND any of the descriptive terms in "Atmosphere in General"
	Wind Strength & Speed	(wind, gale) AND (strength, speed, gust, power, boat, energy, electric, sport, turbine, sailing); (wind, gale) AND any of the descriptive terms in "Atmosphere in General"

	FEGS Document Reader Category: Attribute	Example keywords
	Soil & Substrate in General	(sediment, soil, dirt, muck, mud, clay, loam, stones, rocks, peat, substrate) AND (accommodate, activity, aesthetic, allure, appeal, amaze, amenable, amenity, appreciate, aromatic, artisan, artist, attract, beauty, benefit, bequest, bounty, business, buy, calm, care, charismatic, charming, cherish, children, comfort, concern, conserve, corporation, critical, dealer, delicious, desired, destination, diversity, economy, educate, encourage, enhance, enjoy, encounter, enthusiast, essential, excellent, experience, exploit, extract, extraordinary, family, favorable, feeling, festival, ceremony, future, gather, hallmark, harvest, healthy, heritage, hunter, important, income, indigenous people, Indian population, industry, initiative, inspiration, interest, jewel, job, knowledge, learn, legacy, leisure, lifeblood, livelihood, lost, lovely, majestic, market, marketable, markets, mystique, native, observe, option value, opportunity, participant, peaceful, people, pleasant, phenomenon, popular, preserve, products, profession, profit, promote, purpose, protect, quality of life, rare, recreate, relax, research, restore, save, sight, serene, soothe, special, specimen, spectacular, sport, steward, stunning, subsist, supply, sustain, sustenance, threatened, together, tourism, trade, tradition, treasure, tribal, unique, use, valuable, view, visit, vital, volunteer, watch, well suited, wonder, agriculture, farm, garden, hatchery, aquaculture)
	Soil Quality	(sediment, soil, dirt, muck, mud, clay, loam, stones, rocks, peat) AND (arable, capacity, concentration, condition, content, decomposition, drainage, fertile, good, habitable, health, microbe, microorganism, moisture, nourish, nutrient, organic, prime, productive, quality, rich, suitability, well-drained)
	Soil Quantity	(sediment, soil, dirt, muck, mud, clay, loam, stones, rocks, peat) AND (quantity, bounty, commercial, commodity, goods, resource, option value, asset, rare, resource, restore, sale, save, sell, collect, create, construct, produce, product, accrete, erosion, stability, plentiful, abundant, construct, replenish, economic, support, deposit, formation, base, volume, harvest, source, storage, supply); dredge placement, dredge disposal;
	Substrate Quality	(substrate, create surface, provide surface, form surface) AND (arable, capacity, concentration, condition, content, decomposition, drainage, fertile, good, habitable, health, microbe, microorganism, moisture, nourish, nutrient, organic, prime, productive, quality, rich, suitability, well-drained)
	Substrate Quantity	(substrate, create surface, provide surface, form surface) AND (quantity, bounty, commercial, commodity, goods, resource, option value, asset, rare, resource, restore, sale, save, sell, collect, create, construct, produce, product, accrete, erosion, stability, plentiful, abundant, construct, replenish, economic, support, deposit, formation, base, volume, harvest, source, storage, supply)

	FEGS Document Reader Category: Attribute	Example keywords
	Water in General	water AND (accommodate, activity, aesthetic, allure, appeal, amaze, amenable, amenity, appreciate, aromatic, artisan, artist, attract, beauty, benefit, bequest, bounty, business, buy, calm, care, charismatic, charming, cherish, children, comfort, concern, conserve, corporation, critical, dealer, delicious, desired, destination, diversity, economy, educate, encourage, enhance, enjoy, encounter, enthusiast, essential, excellent, experience, exploit, extract, extraordinary, family, favorable, feeling, festival, ceremony, future, gather, hallmark, harvest, healthy, heritage, hunter, important, income, indigenous people, Indian population, industry, initiative, inspiration, interest, jewel, job, knowledge, learn, legacy, leisure, lifeblood, livelihood, lost, lovely, majestic, market, marketable, markets, mystique, native, observe, option value, opportunity, participant, peaceful, people, pleasant, phenomenon, popular, preserve, products, profession, profit, promote, purpose, protect, quality of life, rare, recreate, relax, research, restore, save, sight, serene, soothe, special, specimen, spectacular, sport, steward, stunning, subsist, supply, sustain, sustenance, threatened, together, tourism, trade, tradition, treasure, tribal, unique, use, valuable, view, visit, vital, volunteer, watch, well suited, wonder)
	Water Quality	water AND (concentration, condition, content, fertile, good, habitable, health, microbe, microorganism, nourish, nutrient, organic, prime, productive, quality, rich, suitability); clean water, water discharge compliance; (discharge, emission, point source, dilution, TMDL, load, ballast, divert, waste disposal, material disposal, debris disposal, pollution, contaminant, sediment load, effluent) AND (water, aquatic, river, stream, creek, lake, pond, estuary, ocean, sea, bay, reservoir, channel, beach, seagrass, tidal flat, mangrove, marsh, wetland, boat, ship)
	Water Quantity	water AND (quantity, bounty, commercial, commodity, goods, resource, option value, asset, rare, resource, restore, sale, save, sell, collect, create, construct, produce, product, accrete, erosion, stability, plentiful, abundant, construct, replenish, economic, support, deposit, formation, base, volume, drainage, capacity, storage, supply); rain garden, rain barrel, rain storage, cistern, water demand, water supply, well water, reclaimed water, receiving water, water withdraw, irrigation, water pump, water cattle, water livestock; (subsist, drink, intake, aquifer, hydroelectric, hydropower, electric dam, energy dam, cooling) AND (water, aquatic, river, stream, creek, lake, pond, estuary, ocean, sea, bay, reservoir, channel)
	Water Movement/Navigability	water AND (movement, flow, current); (navigate, navigable, transport, boat, ship, vessel, ferry, paddle) AND (water, aquatic, river, stream, creek, lake, pond, estuary, ocean, sea, bay, reservoir, channel); (boat, ship, vessel, ferry, paddle) AND (recreation, enjoy, moor, charter, tourism, visit, cruise, port, harbor, access, traffic, launch); watercraft, jet-ski, kayak, canoe, boating, shipping channel, stream channel, channel migration, tidal flow, dam, dike, levee;

	FEGS Document Reader Category: Attribute	Example keywords
	Fauna in General	(animal, fauna, wildlife) AND (accommodate, activity, aesthetic, allure, appeal, amaze, amenable, amenity, appreciate, aromatic, artisan, artist, attract, beauty, benefit, bequest, bounty, business, buy, calm, care, charismatic, charming, cherish, children, comfort, concern, conserve, corporation, critical, dealer, delicious, desired, destination, diversity, economy, educate, encourage, enhance, enjoy, encounter, enthusiast, essential, excellent, experience, exploit, extract, extraordinary, family, favorable, feeling, festival, ceremony, future, gather, hallmark, harvest, healthy, heritage, hunter, important, income, indigenous people, Indian population, industry, initiative, inspiration, interest, jewel, job, knowledge, learn, legacy, leisure, lifeblood, livelihood, lost, lovely, majestic, market, marketable, markets, mystique, native, observe, option value, opportunity, participant, peaceful, people, pleasant, phenomenon, popular, preserve, products, profession, profit, promote, purpose, protect, quality of life, rare, recreate, relax, research, restore, save, sight, serene, soothe, special, specimen, spectacular, sport, steward, stunning, subsist, supply, sustain, sustenance, threatened, together, tourism, trade, tradition, treasure, tribal, unique, use, valuable, view, visit, vital, volunteer, watch, well suited, wonder)
	Birds	bird, fowl, raptor, falcon, osprey, hawk, eagle, owl, duck, geese, heron, ibis, spoonbill, mallard, egret, songbird, sparrow, wren, warbler, grouse, blackbird, thrush, plover, rookery, feather, avian
	Fish & Shellfish	fish, seahorse, aquarium, seafood, salmon, shellfish, oyster, pike, crab, lobster, bivalve, mullet, mussel, bass, herring, walleye, grouper, snapper, alewife, flounder, shark, stingray, abalone, scallop, clam, geoduck, mollusk, crustacean, quahog, smelt, American shad, sturgeon, trout, fishery, fisherman, angler, shellfish, eels, elvers, gaper, coho, chinook, minnow, silverside, bass, tarpon, snook, horseshoe crab; (wildstock, wildcatch) AND (water, aquatic, river, stream, creek, lake, pond, estuary, beach, seagrass, eelgrass, tidal flat, ocean, sea, reef, kelp, wetland, marsh, mangrove, bay, reservoir)
	Insects & Invertebrates	insect, dragonfly, beetle, bee, moth, butterfly, mosquito, invertebrate, worm, snail, polychaete, oligochaete, coral, sponge, anemone, gastropod, jellyfish
	Mammals	mammal, seal, dolphin, whale, otter, deer, beaver, elk, moose, cougar, panther, fox, muskrat, raccoon, nutria, bobcat, lynx, marten, coyote, rabbit, bat
	Reptiles & Amphibians	reptile, alligator, turtle, tortoise, crocodile, snake, python, cottonmouth, amphibian, frog, toad, newt, salamander
	Fauna Community (by Taxa)	any Fauna term (“Fauna in General”, “Birds”, “Fish & Shellfish”, “Insects & Invertebrates”, “Mammals”, “Reptiles & Amphibians”) AND (community, diversity, food chain, food web, diverse)
	Edible Fauna (by Taxa)	any Fauna term (“Fauna in General”, “Birds”, “Fish & Shellfish”, “Insects & Invertebrates”, “Mammals”, “Reptiles & Amphibians”) AND (edible, eat, ate, delicious, subsist, sustenance, people or human forage, people or human food, people or human consumption, meat, protein); (hunt, trap) AND (meat, edible, consume, subsist, delicious, food); any “Fish & Shellfish” term AND (harvest, collect, gather, catch, dig, nets, trap, angler, fishermen, clamming, crabbing); seafood; shellfish garden or farm; oyster garden or farm; fishermen; fishery; wildstock; wildcatch; (blood, organ, liver, kidney, bladder, gland, offal, gurry, entrails) AND (edible, eat, ate, delicious, subsist, sustenance)

	FEGS Document Reader Category: Attribute	Example keywords
	Medicinal Fauna (by Taxa)	any Fauna term ("Fauna in General", "Birds", "Fish & Shellfish", "Insects & Invertebrates", "Mammals", "Reptiles & Amphibians") AND (medicine, ailment, healing, human disease, people disease, vaccine, pharmaceutic, drug, surgical, vitamin, biotechnology, natural product, biochemical, biomaterial); (blood, hair, fur, bone, organ, liver, kidney, bladder, gland, offal, gurry, entrails) AND (medicine, ailment, healing, human disease, people disease, vaccine, pharmaceutic, drug, surgical, vitamin, biotechnology, natural product, biochemical, biomaterial);
	Keystone Fauna (by Taxa)	any Fauna term ("Fauna in General", "Birds", "Fish & Shellfish", "Insects & Invertebrates", "Mammals", "Reptiles & Amphibians") AND (keystone, important species, vital species, ecological engineer, ecosystem engineer, foundation species); bioturbation
	Charismatic Fauna (by Taxa)	any Fauna term ("Fauna in General", "Birds", "Fish & Shellfish", "Insects & Invertebrates", "Mammals", "Reptiles & Amphibians") AND (aesthetic, alluring, appeal, amazing, amenable, amenity, appreciate, asset, attract, beautiful, charismatic, colorful, fragrant, aromatic, desirable, enhance, enjoy, encounter, extraordinary, excellent, favorable, feeling, hallmark, inspirational, interesting, majestic, mystique, observe, pleasant, phenomenon, popular, sight, spectacular, stunning, view, watch, wonder, wild, pick, collect, gather)
	Rare Fauna (by Taxa)	any Fauna term ("Fauna in General", "Birds", "Fish & Shellfish", "Insects & Invertebrates", "Mammals", "Reptiles & Amphibians") AND (rare, endangered, red list, endemic, species of concern, special concern, management concern, threatened, federally listed); critical wildlife
	Pollinating Fauna (by Taxa)	pollinator, pollinate; (bee, moth, butterfly, hummingbird, bat) AND (flower, flora, crop, garden, farm, agriculture, native plant)
	Pest/Invasive Fauna (by Taxa)	any Fauna term ("Fauna in General", "Birds", "Fish & Shellfish", "Insects & Invertebrates", "Mammals", "Reptiles & Amphibians") AND (pest, invasive, non-native, not native, weed species, nuisance, noxious weed, exotic, biological control, biocontrol, natural population control, natural check, biological methods, natural pest control, natural pathogen control, depredator, pest predator, agricultural environmental management, integrated pest management);
	Bait Fauna (by Taxa)	bait, baitfish
	Commercially Important Fauna (by Taxa)	any Fauna term ("Fauna in General", "Birds", "Fish & Shellfish", "Insects & Invertebrates", "Mammals", "Reptiles & Amphibians") AND (business, buy, commercial, commodity, company, corporation, economic, exploit, extract, goods, harvest, income, industry, job, market, product, profession, promotion, resource, sell, sale, trade); (blood, hair, fur, bone, organ, liver, kidney, bladder, gland, offal, gurry, entrails) AND (business, buy, commercial, commodity, company, corporation, economic, exploit, extract, goods, harvest, income, industry, job, market, product, profession, promotion, resource, sell, sale, trade)
	Fauna for Fur/Hide/Trophy (by Taxa)	any Fauna term ("Fauna in General", "Birds", "Fish & Shellfish", "Insects & Invertebrates", "Mammals", "Reptiles & Amphibians") AND (pelt, tannery, skin, hide, fur, trophy, stuffed, mounted, prize); (skin, hide, fur, feather) AND (exploit, hunt, trap, harvest, company, corporation, trade, subsist); catch and release

	FEGS Document Reader Category: Attribute	Example keywords
	Spiritually/Culturally Important Fauna (by Taxa)	any Fauna term ("Fauna in General", "Birds", "Fish & Shellfish", "Insects & Invertebrates", "Mammals", "Reptiles & Amphibians") AND (spiritual, cultural, festival, ceremony, ritual, charming, cherish, tradition, legacy, tribal, heritage, steward, indigenous people, native people, native American, Indian population); (blood, hair, fur, bone, organ, liver, kidney, bladder, gland, offal, gurry, entrails) AND (spiritual, cultural, festival, ceremony, ritual, charming, cherish, tradition, legacy, tribal, heritage, steward, indigenous people, native people, native American, Indian population)
	Flora in General	(flora, plant, foliage, flower, kelp, seaweed, algae, vegetation, mangrove, reed, cypress, sphagnum, cattail, moss, palm, berry, seed, fruit, nut, tree, sedge, lichen, pine, evergreen, conifer, hemlock, fir, spruce, deciduous, oak, elm, hickory, ash, fir, balsam, maple, birch, buckeye, cottonwood, dogwood, magnolia, pecan, hardwood, cedar, daffodil, tulip, tupelo, iris, lily, orchid, pitcher plant, carnivorous plant, willow, sundew, loosestrife, bogbean, fern, shrub, bush, vine, leaf, root, seed, stem, bark, pollen, frond, stipe, blade, hay, marsh) AND (accommodate, activity, aesthetic, allure, appeal, amaze, amenable, amenity, appreciate, aromatic, artisan, artist, attract, beauty, benefit, bequest, bounty, business, buy, calm, care, charismatic, charming, cherish, children, comfort, concern, conserve, corporation, critical, dealer, delicious, desired, destination, diversity, economy, educate, encourage, enhance, enjoy, encounter, enthusiast, essential, excellent, experience, exploit, extract, extraordinary, family, favorable, feeling, festival, ceremony, future, gather, hallmark, harvest, healthy, heritage, hunter, important, income, indigenous people, Indian population, industry, initiative, inspiration, interest, jewel, job, knowledge, learn, legacy, leisure, lifeblood, livelihood, lost, lovely, majestic, market, marketable, markets, mystique, native, observe, option value, opportunity, participant, peaceful, people, pleasant, phenomenon, popular, preserve, products, profession, profit, promote, purpose, protect, quality of life, rare, recreate, relax, research, restore, save, sight, serene, soothe, special, specimen, spectacular, sport, steward, stunning, subsist, supply, sustain, sustenance, threatened, together, tourism, trade, tradition, treasure, tribal, unique, use, valuable, view, visit, vital, volunteer, watch, well suited, wonder)
	Flora Community	any "Flora in General" term AND (community, diversity, food chain, food web, diverse)
	Pest/Invasive Flora	any "Flora in General" term AND (pest, invasive, non-native, not native, weed species, nuisance, noxious weed, exotic, biological control, biocontrol, natural population control, natural check, biological methods, natural pest control, natural pathogen control, depredator, pest predator, agricultural environmental management, integrated pest management)
	Edible Flora	any "Flora in General" term AND (edible, eat, ate, delicious, subsist, sustenance, people or human forage, people or human food, people or human consumption); maple sugar, sap, syrup, honey, nuts, pecans, herbs
	Medicinal Flora	any "Flora in General" term AND (medicine, ailment, healing, human disease, people disease, vaccine, pharmaceutic, drug, surgical, vitamin, biotechnology, natural product, biochemical, biomaterial); medicinal herbs
	Keystone Flora	any "Flora in General" term AND (keystone, important species, vital species, ecological engineer, ecosystem engineer, foundation species)

	FEGS Document Reader Category: Attribute	Example keywords
	Charismatic Flora	any "Flora in General" term AND (aesthetic, alluring, appeal, amazing, amenable, amenity, appreciate, asset, attract, beautiful, charismatic, colorful, fragrant, aromatic, desirable, enhance, enjoy, encounter, extraordinary, excellent, favorable, feeling, hallmark, inspirational, interesting, majestic, mystique, observe, pleasant, phenomenon, popular, sight, spectacular, stunning, view, watch, wonder, wild, pick, collect, gather); fall foliage
	Rare Flora	any "Flora in General" term AND (rare, endangered, red list, endemic, species of concern, special concern, management concern, threatened, federally listed)
	Commercially Important Flora	any "Flora in General" term AND (business, buy, commercial, commodity, company, corporation, economic, exploit, extract, goods, harvest, income, industry, job, market, product, profession, promotion, resource, sell, sale, trade); essential oil, resin
	Culturally Important Flora	any "Flora in General" term AND (spiritual, cultural, festival, ceremony, ritual, charming, cherish, tradition, legacy, tribal, heritage, steward, indigenous people, native people, native American, Indian population)
	Fungi in General	(fungal, fungi, fungus, mushroom) AND (accommodate, activity, aesthetic, allure, appeal, amaze, amenable, amenity, appreciate, aromatic, artisan, artist, attract, beauty, benefit, bequest, bounty, business, buy, calm, care, charismatic, charming, cherish, children, comfort, concern, conserve, corporation, critical, dealer, delicious, desired, destination, diversity, economy, educate, encourage, enhance, enjoy, encounter, enthusiast, essential, excellent, experience, exploit, extract, extraordinary, family, favorable, feeling, festival, ceremony, future, gather, hallmark, harvest, healthy, heritage, hunter, important, income, indigenous people, Indian population, industry, initiative, inspiration, interest, jewel, job, knowledge, learn, legacy, leisure, lifeblood, livelihood, lost, lovely, majestic, market, marketable, markets, mystique, native, observe, option value, opportunity, participant, peaceful, people, pleasant, phenomenon, popular, preserve, products, profession, profit, promote, purpose, protect, quality of life, rare, recreate, relax, research, restore, save, sight, serene, soothe, special, specimen, spectacular, sport, steward, stunning, subsist, supply, sustain, sustenance, threatened, together, tourism, trade, tradition, treasure, tribal, unique, use, valuable, view, visit, vital, volunteer, watch, well suited, wonder)
	Keystone Fungi	(fungi, mushroom) AND (keystone, important species, vital species, ecological engineer, ecosystem engineer, foundation species)
	Fungal Community	(fungi, mushroom) AND (community, diversity, food chain, food web, diverse, symbiont); mycorrhiza
	Pest/Invasive Fungi	(fungi, mushroom) AND (pest, invasive, non-native, not native, weed species, nuisance, noxious weed, exotic, biological control, biocontrol, natural population control, natural check, biological methods, natural pest control, natural pathogen control, depredator, pest predator, agricultural environmental management, integrated pest management); mold
	Edible Fungi	(fungi, mushroom) AND (edible, eat, ate, delicious, subsist, sustenance, people or human forage, people or human food, people or human consumption)
	Medicinal Fungi	(fungi, mushroom) AND (medicine, ailment, healing, human disease, people disease, vaccine, pharmaceutic, drug, surgical, vitamin, biotechnology, natural product, biochemical, biomaterial);
	Rare Fungi	(fungi, mushroom) AND (rare, endangered, red list, endemic, species of concern, special concern, management concern, threatened, federally listed)

	FEGS Document Reader Category: Attribute	Example keywords
	Commercially Important Fungi	(fungi, mushroom) AND (business, buy, commercial, commodity, company, corporation, economic, exploit, extract, goods, harvest, income, industry, job, market, product, profession, promotion, resource, sell, sale, trade)
	Charismatic Fungi	(fungi, mushroom) AND (aesthetic, alluring, appeal, amazing, amenable, amenity, appreciate, asset, attract, beautiful, charismatic, colorful, fragrant, aromatic, desirable, enhance, enjoy, encounter, extraordinary, excellent, favorable, feeling, hallmark, inspirational, interesting, majestic, mystique, observe, pleasant, phenomenon, popular, sight, spectacular, stunning, view, watch, wonder, wild, pick, collect, gather)
	Culturally Important Fungi	(fungi, mushroom) AND (spiritual, cultural, festival, ceremony, ritual, charming, cherish, tradition, legacy, tribal, heritage, steward, indigenous people, native people, native American, Indian population)
	Natural Materials (Sand/Rock)	(natural material, natural object, environmental material, aquatic material, ecosystem material, sand, shell, acorn, stick, clay, rock, fossil, stone, driftwood, gravel) AND (accommodate, activity, aesthetic, allure, appeal, amaze, amenable, amenity, appreciate, aromatic, artisan, artist, attract, beauty, benefit, bequest, bounty, business, buy, calm, care, charismatic, charming, cherish, children, comfort, concern, conserve, corporation, critical, dealer, delicious, desired, destination, diversity, economy, educate, encourage, enhance, enjoy, encounter, enthusiast, essential, excellent, experience, exploit, extract, extraordinary, family, favorable, feeling, festival, ceremony, future, gather, hallmark, harvest, healthy, heritage, hunter, important, income, indigenous people, Indian population, industry, initiative, inspiration, interest, jewel, job, knowledge, learn, legacy, leisure, lifeblood, livelihood, lost, lovely, majestic, market, marketable, markets, mystique, native, observe, option value, opportunity, participant, peaceful, people, pleasant, phenomenon, popular, preserve, products, profession, profit, promote, purpose, protect, quality of life, rare, recreate, relax, research, restore, save, sight, serene, soothe, special, specimen, spectacular, sport, steward, stunning, subsist, supply, sustain, sustenance, threatened, together, tourism, trade, tradition, treasure, tribal, unique, use, valuable, view, visit, vital, volunteer, watch, well suited, wonder, fill, geotube, bag); shell mining
	Fuel Quality	(firewood, campfire, fuelwood, fuel source, forest fuel, wood fuel) AND (arable, capacity, concentration, condition, content, decomposition, drainage, fertile, good, habitable, health, microbe, microorganism, moisture, nourish, nutrient, organic, prime, productive, quality, rich, suitability, well-drained)
	Fuel Quantity	(firewood, campfire, fuelwood, fuel source, forest fuel, wood fuel) AND (quantity, bounty, commercial, commodity, goods, resource, option value, asset, rare, resource, restore, sale, save, sell, collect, create, construct, produce, product, accrete, erosion, stability, plentiful, abundant, construct, replenish, economic, support, deposit, formation, base, volume, harvest, source, storage, supply); (firewood, campfire, fuelwood, fuel source, forest fuel, wood fuel) AND any term associated with “Flora in General”; any of (firewood, campfire, fuelwood, fuel source, forest fuel, wood fuel) not specifically identified as “Fuel Quality”
	Fiber Material Quality	(fiber, timber, logging, lumber) AND (arable, capacity, concentration, condition, content, decomposition, drainage, fertile, good, habitable, health, microbe, microorganism, moisture, nourish, nutrient, organic, prime, productive, quality, rich, suitability, well-drained)

	FEGS Document Reader Category: Attribute	Example keywords
	Fiber Material Quantity	fiber AND (quantity, bounty, commercial, commodity, goods, resource, option value, asset, rare, resource, restore, sale, save, sell, collect, create, construct, produce, product, accrete, erosion, stability, plentiful, abundant, construct, replenish, economic, support, deposit, formation, base, volume, harvest, source, storage, supply); timber, logging, lumber; (subsist, mill, paper, fiber, filament, fabric, textile, goods, bedding, mulch, insulation, cloth, rope, thread) AND (wood, forest, salt hay, reeds, grass, marsh hay)
	Mineral/Chemical Quality	(mineral, chemical) AND (arable, capacity, concentration, condition, content, decomposition, drainage, fertile, good, habitable, health, microbe, microorganism, moisture, nourish, nutrient, organic, prime, productive, quality, rich, suitability, well-drained)
	Mineral/Chemical Quantity	(mineral, chemical) AND (quantity, bounty, commercial, commodity, goods, resource, option value, asset, rare, resource, restore, sale, save, sell, collect, create, construct, produce, product, accrete, erosion, stability, plentiful, abundant, construct, replenish, economic, support, deposit, formation, base, volume, harvest, source, storage, supply, mining, quarry)
	Ornamental Natural Materials (Shells/Bone/Honey)	(nature, organic, environment, ecosystem, salt hay, reed, grass, wood, driftwood, forest, timber, lumber, shells, acorn, stick, clay, rock, fossil, stone, bone, feather, fur, hide, driftwood, sand, gravel, skeleton)
	Composite in General	(nature, the environment, landscape, seascape, outdoor, wilderness, watershed, park, greenspace) AND (accommodate, activity, aesthetic, allure, appeal, amaze, amenable, amenity, appreciate, aromatic, artisan, artist, attract, beauty, benefit, bequest, bounty, business, buy, calm, care, charismatic, charming, cherish, children, comfort, concern, conserve, corporation, critical, dealer, delicious, desired, destination, diversity, economy, educate, encourage, enhance, enjoy, encounter, enthusiast, essential, excellent, experience, exploit, extract, extraordinary, family, favorable, feeling, festival, ceremony, future, gather, hallmark, harvest, healthy, heritage, hunter, important, income, indigenous people, Indian population, industry, initiative, inspiration, interest, jewel, job, knowledge, learn, legacy, leisure, lifeblood, livelihood, lost, lovely, majestic, market, marketable, markets, mystique, native, observe, option value, opportunity, participant, peaceful, people, pleasant, phenomenon, popular, preserve, products, profession, profit, promote, purpose, protect, quality of life, rare, recreate, relax, research, restore, save, sight, serene, soothe, special, specimen, spectacular, sport, steward, stunning, subsist, supply, sustain, sustenance, threatened, together, tourism, trade, tradition, treasure, tribal, unique, use, valuable, view, visit, vital, volunteer, watch, well suited, wonder); composite, component, features

	FEGS Document Reader Category: Attribute	Example keywords
	Site Appeal in General	(nature, environment, ecosystem, estuary, coast, landscape, shore, grass, green, farmland, wetland, hills, beach, outside, outdoor, habitat, wild, land, bay, watershed, wetland, park, region, mountain, water, river, stream, creek, lake, pond, seagrass, eelgrass, tidal flat, ocean, sea, kelp, reef, marsh, mangrove, bay, reservoir, forest, orchard, pasture, hay, cropland, tundra, scrub, shrub, lichen, moss, sedge, greenspace, desert, volcano) AND (accommodating, aesthetic, appeal, allure, amazing, appreciate, aromatic, artisan, art, attractive, beauty, bountiful, calming, charisma, charming, cherished, comforting, colorful, desirable, destination, diverse, encouraging, enhance, enjoy, encounter, enthusiastic, excellent, experience, extraordinary, favorable, feeling, fragrant, hallmark, inspirational, interesting, jewel, lifeblood, lovely, majestic, mystique, peaceful, phenomenal, pleasant, popular, relaxing, serene, soothing, sight, special, spectacular, stunning, treasure, unique, valuable, view, visit, volunteer, watch, well suited, wonder, way of life, sense of place, tour guide); hike, walk, play, rock climb, bike, camping, outing, sightseeing, picnic, snowmobile, skiing, sledding, ski area, ski resort, snow sport, trail, off road vehicle, all terrain vehicle, nature tour, outdoor program, environmental program, photography, writing, waterfront, marina, field trip, interpretive program, boardwalk, ecotourism, field activity
	Environmental Aesthetics (Sounds)	(sound, noise, sing, song) AND (listen, hear, sensation, audible); (bird, croak, chirp, rustle, splash, thunder, waves, ocean, cricket, insect, wildlife, nature, environment, avian, wood, forest, grass, cicada, katydid, howl, frog, toad) AND (sounds, noise, sing, song, listen, hear, sensation, audible); (ameliorate, mitigate, buffer, concern, appealing, alluring, amazing, appreciate, beautiful, bountiful, calming, charming, cherished, desirable, diverse, enjoyable, excellent, experience, extraordinary, favorable, inspirational, interesting, lovely, majestic, peaceful, pleasant, popular, pristine, relaxing, serene, soothing, special, spectacular, stunning, treasure, unique, wonderful) AND (sounds, noise, sing, song, listen, hear, sensation, audible); serene, serenity, singing sand, wildlife calls, bird calls, owl calls;
	Environmental Aesthetics (Scents)	scent, olfactory, aroma, fragrant; (odor, smell) AND (ameliorate, mitigate, buffer, concern, appealing, alluring, amazing, appreciate, beautiful, bountiful, calming, charming, cherished, desirable, diverse, enjoyable, excellent, experience, extraordinary, favorable, inspirational, interesting, lovely, majestic, peaceful, pleasant, popular, pristine, relaxing, serene, soothing, special, spectacular, stunning, treasure, unique, wonderful)

	FEGS Document Reader Category: Attribute	Example keywords
	Environmental Aesthetics (Viewscapes)	(view, viewscape) AND (ameliorate, mitigate, buffer, concern, accommodate, activity, aesthetic, allure, appeal, amaze, amenable, amenity, appreciate, aromatic, artisan, artist, attract, beauty, benefit, bequest, bounty, business, buy, calm, care, charismatic, charming, cherish, children, comfort, concern, conserve, corporation, critical, dealer, delicious, desired, destination, diversity, economy, educate, encourage, enhance, enjoy, encounter, enthusiast, essential, excellent, experience, exploit, extract, extraordinary, family, favorable, feeling, festival, ceremony, future, gather, hallmark, harvest, healthy, heritage, hunter, important, income, indigenous people, Indian population, industry, initiative, inspiration, interest, jewel, job, knowledge, learn, legacy, leisure, lifeblood, livelihood, lost, lovely, majestic, market, marketable, markets, mystique, native, observe, option value, opportunity, participant, peaceful, people, pleasant, phenomenon, popular, preserve, products, profession, profit, promote, purpose, protect, quality of life, rare, recreate, relax, research, restore, save, sight, serene, soothe, special, specimen, spectacular, sport, steward, stunning, subsist, supply, sustain, sustenance, threatened, together, tourism, trade, tradition, treasure, tribal, unique, use, valuable, visit, vital, volunteer, watch, well suited, wonder); (view, viewscape, appealing, alluring, amazing, beautiful, charming, desirable, extraordinary, inspirational, lovely, lush , majestic, pristine, scenic, scenery, spectacular, stunning, visually pleasing) AND (nature, environment, ecosystem, estuary, coast, landscape, shore, grass, green, farmland, wetland, hills, beach, outside, outdoor, habitat, wild, land, bay, watershed, wetland, park, region, mountain, water, river, stream, creek, lake, pond, seagrass, eelgrass, tidal flat, ocean, sea, kelp, reef, marsh, mangrove, bay, reservoir, forest, orchard, pasture, hay, cropland, tundra, scrub, shrub, lichen, moss, sedge, greenspace, desert, volcano); sight AND (ameliorate, mitigate, buffer, concern, appealing, alluring, amazing, beautiful, charming, desirable, extraordinary, inspirational, lovely, lush , majestic, pristine, scenic, scenery, spectacular, stunning, visually pleasing); scenic, scenery, horizon, skyline, vantage point, vista, observation point, observation deck, observation platform, observation area, beauty, panorama, viewscape, idyllic, rolling hills, rolling farmland, rolling landscape, waterfall
	Atmospheric Phenomena	sunrise, sunset, eclipse, sundown, rainbow, twilight, atmospheric phenomenon, northern lights, aurora borealis, geyser, hot spring
	Ecological Condition in General	(health, condition, function, quality, supporting service, degradation) AND (vegetation, flora, fauna, land, habitat, nature, environment, ecosystem, estuary, coast, landscape, shore, grass, green, farmland, wetland, hills, beach, outside, outdoor, habitat, wild, land, bay, watershed, wetland, park, region, mountain, water, river, stream, creek, lake, pond, seagrass, eelgrass, tidal flat, ocean, sea, kelp, reef, marsh, mangrove, bay, reservoir, forest, orchard, pasture, hay, cropland, tundra, scrub, shrub, lichen, moss, sedge, greenspace, desert, volcano)
	Regulating Services in General	(fixation, sequestration, filter, purify, buffer, sequester, natural treatment, filtration, regulating service) AND any “Environment” term (e.g., nature, environment, habitat, forest, grassland, etc.)
	Air Quality & Atmospheric Regulation	(air, atmosphere, smog) AND (capture, clean, clear, control, filter, improve, infiltrate, purify, reduce, regulate, remove, sink, natural treatment, natural process, promote, recycle, replenish, retain, sequester, shelter, stabilize)
	Climate & Carbon Regulation	(carbon, climate) AND (capture, clean, clear, control, filter, improve, infiltrate, purify, reduce, regulate, remove, sink, natural treatment, natural process, promote, recycle, replenish, retain, sequester, shelter, stabilize); blue carbon, carbon capture, carbon market

	FEGS Document Reader Category: Attribute	Example keywords
	Soil & Sediment Regulation	(erosion, soil, sediment) AND (capture, clean, clear, control, filter, improve, infiltrate, purify, reduce, regulate, remove, sink, natural treatment, natural process, promote, recycle, replenish, retain, sequester, shelter, stabilize)
	Water Quality Regulation	(water, lake, river, stream, wetland) AND (nitrogen, phosphorous, nutrient, contaminant, pollutant, sediment, toxins) AND (capture, clean, clear, control, filter, improve, infiltrate, purify, reduce, regulate, remove, sink, natural treatment, natural process, promote, recycle, replenish, retain, sequester, shelter, stabilize); bioswale, bioretention, denitrification, drainfield
	Open Space	open space, green space, nature preserve, open area, wildland, vast expanse
	Open Space (Natural Area)	(open space, green space, nature preserve, open area, wildland, vast expanse) AND (appealing, alluring, amazing, appreciate, beautiful, bountiful, calming, charming, cherished, desirable, diverse, enjoyable, excellent, experience, extraordinary, favorable, inspirational, interesting, lovely, majestic, peaceful, pleasant, popular, pristine, relaxing, serene, soothing, special, spectacular, stunning, treasure, unique, wonderful); rural atmosphere; rural character
	Open Space (Land for Development)	(smart growth, development, sustainable growth, convert, fill, drain, ditch, acquire, reclaim, cleared, new construction, replace) AND (land, habitat, nature, environment, ecosystem, estuary, coast, landscape, shore, grass, green, farmland, wetland, hills, beach, outside, outdoor, habitat, wild, land, bay, watershed, wetland, park, region, mountain, water, river, stream, creek, lake, pond, seagrass, eelgrass, tidal flat, ocean, sea, kelp, reef, marsh, mangrove, bay, reservoir, forest, orchard, pasture, hay, cropland, tundra, scrub, shrub, lichen, moss, sedge, greenspace, desert, volcano); sprawl, public land, easement, land trust, disposal site, dumpsite, waste dump, land development, unpaved parking, land preserve
	Mitigating Extreme Events in General	(extreme event, natural disaster, natural hazard) AND (buffer, dampen, absorb, control, protect, attenuate, mitigate, risk, resilience, reduce, shelter)
	Mitigating Flooding	(flood, storm surge, waves, wave height, wave energy, king tide, water surge, water inundation) AND (buffer, dampen, absorb, control, protect, attenuate, mitigate, risk, resilience, reduce, shelter)
	Mitigating Wildfire Risk	(fire, wildfire, smoke) AND (buffer, dampen, absorb, control, protect, attenuate, mitigate, risk, resilience, reduce, shelter)
	Mitigating Extreme Weather	(storm, hurricane, tornado, cyclone, derecho, wind, heat, freeze, gale, drought) AND (buffer, dampen, absorb, control, protect, attenuate, mitigate, risk, resilience, reduce, shelter)
	Mitigating Earthquakes & Landslides	(earthquake, seismic, tsunami, landslide, mudslide) AND (buffer, dampen, absorb, control, protect, attenuate, mitigate, risk, resilience, reduce, shelter)

Glossary

Environment Classes and Subclasses

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.")

Agroecosystems in General – References to agroecosystems that could not otherwise be classified as pasture, hay, or cultivated crops.

Aquatic – Lakes, rivers, streams, wetlands, estuaries, and the open ocean. These ecosystems may be covered with ice either permanently or seasonally.

Aquatic in General – Water ecosystems in documents that could not be specifically attributed to subclasses (e.g., lakes, ponds, open ocean). Mentions of groundwater, not specifically attributed to a class of surface water, are also included in this category.

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.

Beach and Dunes – Stretches of sand and accumulated wind-swept sand along the coastline.

Coastal Ecosystems in General – General references to Near Coastal Marine/Estuarine ecosystems that could not otherwise be classified more specifically as beaches, eelgrass, rocky shore, or tidal wetlands.

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.

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.

Developed High Intensity – Highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses, and commercial/industrial. Impervious surfaces account for 80% to 100% of the total cover. Classified more generally as Terrestrial Urban/Suburban Environment in the document reader.

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. Classified more generally as Terrestrial Urban/Suburban Environment in the document reader.

Developed Medium Intensity – Areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50% to 79% of the total cover. Classified more generally as Terrestrial Urban/Suburban Environment in the document reader.

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. Classified more generally as Terrestrial Urban/Suburban Environment in the document reader.

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.

Eelgrass and Seagrass – True plants that live in estuaries and the sea and can form expansive underwater meadows.

Emergent 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.

Emergent Wetlands in General – References to emergent wetlands that could not otherwise be classified as Salt Marsh.

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.

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.

Forest in General – References to forest or trees that could not otherwise be classified as Deciduous, Evergreen, or Mixed.

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.

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.

Groundwater – Fresh water (from rain or melting ice and snow) that soaks into the soil and is stored in the tiny spaces (pores) between rocks and particles of soil. Classified as “Aquatic in General” in the document reader, if additional information not provided (e.g., groundwater feeding a wetland).

Ice and snow – Areas characterized by a perennial cover of ice and/or snow, generally greater than 25% of total cover.

Kelp Forest – Dense underwater canopies of large brown algae.

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).

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.

Mangroves – A habitat of shrubs and trees that grow in coastal saline or brackish water.

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.

Moss – Areas dominated by mosses, generally greater than 80% of total vegetation. In the United States, this Terrestrial Environment only occurs in Alaska.

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).

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).

Open Oceans and Seas in General – References to open oceans and seas that could not specifically be classified as kelp forest or reefs.

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).

Open Water in General – General references to open water that could not otherwise be classified to subclasses (e.g., rivers, lakes, estuarine).

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 vegetation accounts for greater than 20% of total vegetation. This is a subclass of Agroecosystems.

Perennial Ice/Snow – Areas characterized by a perennial cover of ice and/or snow, generally greater than 25% of total cover.

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).

Reefs – A ridge of material, such as oysters, coral, rocks, or artificial materials, just below the surface of the sea.

Rocky Shore – A narrow strip of land between the land and the sea made of solid rocks, cliffs, rock pools, and boulders.

Salt Marsh – Areas of coastal grasses that are regularly flooded by seawater.

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.

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.

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.

Terrestrial – Areas of the Earth's surface that are not Aquatic.

Terrestrial in General – Ecosystems or mentions of nature in documents that could not be specifically attributed to Aquatic ecosystems or terrestrial subclasses.

Tidal Flat – Large, flat, often muddy areas of land located in the intertidal zone.

Tundra – Treeless regions in which the subsoil is permanently frozen.

Tundra in General – References to tundra that could not otherwise be classified as Lichen, Moss, Dwarf Scrub, or Sedge/Herbaceous Tundra.

Urban/Suburban Greenspace – 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. Includes four subclasses development intensity.

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).

Wetlands in General – References to wetlands that could not be otherwise classified as Woody or Emergent Wetlands.

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.

Woody Wetlands in General – References to woody wetlands that could not otherwise be classified as Mangroves.

Beneficiary Classes and Subclasses

Agricultural – This class includes Beneficiaries who use Ecological End-Products (also known as Final Ecosystem Goods, or FEGs) for agricultural or forest production activities.

Agricultural in General – Agricultural Beneficiaries not captured in the other agricultural subclasses.

Agricultural Processors – This Beneficiary primarily consumes Water for washing edible products.

All Humans (Humanity) – 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).

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.

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.

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).

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.

Commercial/Industrial in General – Commercial/Industrial beneficiaries not captured in the other commercial/industrial subclasses.

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.

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.

Experiencers and Viewers – This Beneficiary views and appreciates Ecological End-Products (also known as FEGs) views and experiences the Environment.

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).

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.

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.

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.

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.

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.

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.

Government/Residential in General – Government, Municipal, and Residential Beneficiaries not captured in the other government, municipal, and residential subclasses.

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).

Industrial Processors – This Beneficiary primarily consumes Water for cooling, producing pulp, etc. Except for agricultural processing which is a separate subclass.

Inspirational – This class includes Beneficiaries who use or appreciate Ecological End-Products (also known as FEGs) as a source of inspiration.

Inspirational in General – 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.

Learning – This class includes Beneficiaries who use Ecological End-Products (also known as FEGs) for educational or scientific research activities.

Learning in General – Learning Beneficiaries not captured in the other learning subclasses.

Livestock Grazers – This Beneficiary uses Ecological End-Products (also known as FEGs) to graze livestock.

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.

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.

Non-Use in General – Non-use beneficiaries not captured in the other non-use subclasses.

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.

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.

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.

Private Energy Generators – This Beneficiary encompasses privately run entities that rely 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.

Private Water Facilities Operators – This Beneficiary encompasses privately run entities that provide water to a community and may do so by collecting Water from rivers, reservoirs, lakes, wells, bays, or estuaries. Water is treated and distributed. “Private Drinking Water Plant Operators” in NESCS Plus, expanded here to include managed water utilities beyond drinking water.

Public Energy Generators – This Beneficiary encompasses publicly (government, municipal) managed or owned entities that rely 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.

Public Water Facilities Operators – This beneficiary encompasses publicly (government, municipal) managed or owned entities that provide water to a community and may do so by collecting water from rivers, reservoirs, lakes, wells, bays, or estuaries. Water is treated and distributed. “Municipal Drinking Water Plant Operators” in NESCS Plus, expanded here to include managed water utilities beyond drinking water.

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.

Recreational – This class includes Beneficiaries who use Ecological End-Products (also known as FEGs) to support recreational activities.

Recreational Boaters – This Beneficiary may use motorized (i.e., motor boats) or non-motorized boats (i.e., canoes, kayaks, rafts) to recreate.

Recreational Fishermen – This Beneficiary fishes recreationally (i.e., not for survival) and includes catch-and-release or catch-and-consume activities. "Anglers" in NESCS Plus.

Recreational Hunters – This Beneficiary is primarily interested in hunting mammals and fowl (not flora or fungi) recreationally (i.e., not for survival or subsistence).

Recreational in General – This Beneficiary engages in nature-based recreational activities not covered by the other recreational subclasses.

Researchers – This Beneficiary uses Ecological End-Products (also known as FEGs) for academic and applied purposes.

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.

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.

Subsistence – This class includes Beneficiaries who use Ecological End-Products (also known as FEGs) to support subsistence activities.

Subsistence in General – This Beneficiary uses Ecological End-Products (also known as FEGs) for subsistence activities not covered by the other subsistence subclasses.

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.

Timber, Fiber, and Ornamental Extractors – This Beneficiary relies on Ecological End-Products (also known as FEGs) for products used or sold commercially.

Transportation & Shipping – This class includes military and commercial Beneficiaries who use Ecological End-Products (also known as FEGs) as a media to transport goods or people. "Commercial/Military Transportation" in NESCS Plus.

Transportation in General – Transportation & Shipping Beneficiaries not captured in the other transportation subclasses.

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.

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.

Waders, Swimmers, and Divers – This Beneficiary recreates in or under the water by either wading, swimming, or diving (i.e., snorkeling, SCUBA diving).

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).

Ecosystem Attribute Classes and Subclasses

Air Quality – The degree to which air is clean, clear, and pollution-free.

Air Quality and Atmospheric Regulation – The ability of ecosystems to filter pollutants from the air or otherwise modify characteristics of the air and atmosphere. Document text is focused on function or process (e.g., buffering, filtering) rather than specifying direct benefits to humans (e.g., breathing clean air).

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 extreme weather events (which are included under "Composite").

Atmosphere in General – References to Atmosphere that could not be otherwise classified to subclasses (e.g., Air quality, temperature).

Atmospheric Phenomena – Natural phenomena arising from a combination of ecosystem attributes (e.g., sunsets, northern lights, etc.).

Bait Fauna – Fauna used as bait to catch other fauna. Categorized as Commercially Important Fauna.

Birds – Avian fauna. Warm-blooded feathered vertebrates.

Charismatic Fauna – Fauna with symbolic value or widespread popular appeal.

Charismatic Flora – Flora with symbolic value or widespread popular appeal.

Charismatic Fungi – Fungi with symbolic value or widespread popular appeal.

Climate and Carbon Regulation – The ability of ecosystems to sequester carbon and regulate climate. Document text is focused on function or process (e.g., sequestration) rather than specifying direct benefits to humans (e.g., warming climate).

Commercially Important Fauna – Fauna that has importance for commerce.

Commercially Important Flora – Flora that has importance for commerce.

Commercially Important Fungi – Fungi that has importance for commerce.

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.

Composite in General – References to multiple environmental elements that could not otherwise be classified as site appeal, ecological condition, open space, or mitigation of extreme events.

Culturally Important Fungi – Fungi that has importance for spiritual or cultural practices or beliefs.

Ecological Condition – The overall quality of the ecological system based on physical, chemical, and biological characteristics. Includes regulating services that contribute indirectly to ecosystem services by maintaining a healthy functioning ecosystem.

Ecological Condition in General – References to ecological condition that could not specifically be categorized as regulating services (e.g., regulating air or water quality).

Edible Fauna – Fauna fit to be eaten by humans.

Edible Flora – Flora fit to be eaten by humans.

Edible Fungi – Fungi fit to be eaten by humans.

Environmental Aesthetics (Scents) – The scents or combination of scents arising from the area. Same as "Site Appeal: Scents" in NESCS Plus.

Environmental Aesthetics (Sounds) – The sounds or combination of sounds arising from the area. Same as "Site Appeal: Sounds" in NESCS Plus.

Environmental Aesthetics (Viewscapes) – The views and vistas available in the area. Same as "Site Appeal: Viewscapes" in NESCS Plus.

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*).

Fauna in General – References to animals that could not be categorized to a specific taxon group.

Fauna Community – The interacting animal life present in the area

Fauna for Fur/Hide/Trophy – Fauna harvested or hunted for something other than their meat. Categorized as Commercially Important Fauna.

Fiber Material Quality - The amount of fiber material 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.

Fish and Shellfish – Aquatic animals that live in fresh or saltwater. Fish include sharks, salmon, tuna, and trout. Shellfish are aquatic invertebrates specifically used for food. Common shellfish include shrimp, crabs, and oysters.

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.

Flora in General – References to flora that could not otherwise be categorized into subclasses (e.g., edible, medicinal).

Flora Community – The interacting plant life present in the area.

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.

Fungal Community – The interacting fungal life present in the area.

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*).

Fungi in General – References to fungi that could not otherwise be categorized to subcategories (e.g., pest, edible).

Insects and Invertebrates – Cold-blooded animals with no backbone that may inhabit terrestrial or aquatic environments. Terrestrial examples include spiders and butterflies. Aquatic examples include coral and anemones. Aquatic invertebrates commonly harvested for food (e.g., oysters, shrimp) are categorized as "Fish and Shellfish".

Keystone Fauna – Fauna on which other species depend, its absence would significantly alter the ecosystem.

Keystone Flora – Flora on which other species depend, its absence would significantly alter the ecosystem.

Mammals – Warm-blooded vertebrates with hair.

Medicinal Fauna – Fauna that has healing properties as is or after processing.

Medicinal Flora – Flora that has healing properties as is or after processing.

Medicinal Fungi – Fungi that has healing properties as is or after processing.

Mineral/chemical Quality – The suitability of material for use based on physical, chemical, and/or biological characteristics.

Mineral/chemical Quantity – The amount of material present, could be measured in terms of volume, mass, and/or extent.

Mitigating Earthquakes and Landslides – The ability of ecosystems to reduce the likelihood and severity of experiencing mudslides, landslides, earthquakes, or either seismic-related events, such as through ground stabilization.

Mitigating Extreme Events in General – References to the ability of ecosystems to protect from extreme events or natural hazards that are not specifically identifies (e.g., floods, wildfire).

Mitigating Extreme Weather – The ability of ecosystems to reduce the likelihood the area will experience extreme weather events and the likely severity of the events, such as creating wind breaks for tornados or hurricanes.

Mitigating Flooding – The ability of ecosystems to reduce the likelihood the area will experience flooding and the likely severity of the flooding through processes such as water infiltration or protecting from storm surge.

Mitigating Wildfire Risk – The ability of ecosystems to reduce the likelihood the area will experience wildfire and the likely severity of the fire by producing natural firebreaks or altering amounts of combustible natural materials.

Natural Materials for Artistic Use or Consumption – The presence and/or extent of materials suitable for artistic use or consumption (e.g., shells, acorns, honey).

Natural Materials in General – "Other Natural Components" not specifically categorized as fuel, fiber, minerals, or ornamental natural materials.

Open Space – Land that is undeveloped, but may be landscaped or otherwise in use, and is available for use.

Open Space (Natural Area) – References to undeveloped land, intended to be preserved.

Open Space (Land for Development) – References to undeveloped land, intended as available for development.

Open Space in General – References to open space that could not be specifically categorized as aesthetic open space or open land available for development.

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.

Pest/Invasive Fauna – Modified from "Pest Predator/depredator Fauna" in NESCS Plus to include pest species more generally, including invasive species and fauna that prey upon pest species (biocontrol).

Pollinating Fauna – Fauna that moves pollen from plant to plant.

Precipitation – Weather in which something, including rain, snow, sleet, and/or hail, is falling from the sky.

Rare Fauna – Fauna that are uncommon or infrequently encountered.

Rare Flora – Flora that are uncommon or infrequently encountered.

Rare Fungi – Fungi that are uncommon or infrequently encountered.

Regulating Services in General – Benefits that ecosystems provide by moderating natural phenomena. References to regulating services that could not be more specifically categorized as regulating air, climate, soil, or water.

Reptiles and Amphibians – Cold-blooded vertebrates including snakes, lizards, turtles, and frogs.

Site Appeal – A subclass of "Composite" that includes multiple ecosystem components contributing to appealing aesthetics that people enjoy.

Site Appeal in General – References to site appeal that could not specifically be categories as sounds, scents, viewscapes, or phenomena.

Soil and Sediment Regulation – Ability of ecosystems to control erosion or regulate sediment runoff. Document text is focused on function or process (e.g., erosion) rather than specifying direct benefits to humans (e.g., soil quantity).

Soil and Substrate – 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").

Soil and Substrate in General – References to soil and substrate that could not be specifically attributed to quality or quantity.

Soil Quality – The suitability of soil for use based on physical, chemical, and/or biological characteristics.

Soil Quantity – The amount of soil present, could be measured in terms of volume, depth, and/or extent.

Spiritually/culturally Important Fauna – Fauna that has importance for spiritual or cultural practices or beliefs.

Spiritually/culturally Important Flora – Flora that has importance for spiritual or cultural practices or beliefs.

Spiritually/culturally Important Fungi – Fungi that has importance for spiritual or cultural practices or beliefs.

Substrate Quality – The suitability of substrate 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.

Sunlight – Light from the sun.

Temperature – A measure of the warmth or coldness of the weather or climate.

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").

Water in General – References to water that could not specifically be classified as quality, quantity, or movement.

Water Movement and Navigability – The amount of water flowing per unit of time, includes aspects such as surface water movement through watersheds, wave action, etc.

Water Quality – The suitability of water for use based on physical, chemical, and/or biological characteristics.

Water Quality Regulation – Ability of ecosystems to filter pollutants from water. Document text is focused on function or process (e.g., buffering, filtering) rather than specifying direct benefits to humans (e.g., drinkable or swimmable water).

Water Quantity – The amount of water present, could be measured in terms of volume, depth, total yield, and/or peak flow.

Wind Strength/speed – The speed and force of the wind.

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