Ecosystem Services in U.S. Environmental Law and Governance for the Ecosystem-Based Management Practitioner

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Abstract This chapter provides an overview of ecosystem services issues in United States (U.S.) law and governance for the Ecosystem-Based Management (EBM) practitioner. A brief overview summary of a suite of U.S. federal environmental laws where ecosystems services are relevant is presented along with a high-level overview of ecosystem services in federal and state agency regulations as it helps inform ecosystem-based management. As with the published science-based literature on ecosystem services, there is also a sizeable law-based literature available on ecosystem services. A HeinOnline law journal library focused search identified 1903 legal articles that contained reference to ecosystem services. Focusing on a snapshot of key literature, this chapter presents an overview of those articles that contained "ecosystem services" or "ecosystem based management" just in the article's title. From this survey across the breadth of law journals, a suite of ecosystem services topics related to EBM in environmental law are identified and summarized. Overall, the goal of this chapter is to present a high-level overview and direct the reader to resources to find more in-depth legal analyses of select ecosystem services topics.

Lessons Learned

- EBM practitioners need to have the large suite of federal environmental laws that impact EBM as a frame of reference.
- There is active legal scholar literature on the intersection between ecosystem services and environmental laws.
- The majority of the active legal scholar literature is focused on the core environmental laws, however, the summary table informs the reader of the potential applications of other legal and governance frameworks to ecosystem services and EBM.

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- The community of EBM practitioners should take advantage of the legal scholar literature; the chapter demonstrates to the reader the value of adding the intersection between ecosystem services and environmental laws into the information space for EBM practitioners.
- In the recent past, a few U.S. states have started to add ecosystem services language into their statutory and regulatory materials.

Needs to Advance EBM

- EBM practitioners need to add information from the environmental law literature to their background information as part of efforts to frame ecosystem services information in their EBM activities.
- Practitioners can look to the environmental law literature to identify examples where relevant information might be transferable to their specific scenarios, such as the examples of watershed-based services (e.g., Funk et al. 2020).
- The suite of traditional EBM practitioners needs to expand to include law and governance practitioners in order to merge and create a large overlap and cross-information exchange between the disciplines.

1 Introduction to Ecosystem Services and EBM in Law and Governance

There are multiple ways to present the intersection between ecosystem services and environmental law and policy as it informs Ecosystem-Based Management (EBM). One perspective involves considering how the authority of individual law or regulations may influence the access, condition, protection, and/or utilization of nature. Examples of high-level overviews of key environmental laws include Ruhl and Salzman (2007), Thompson (2008), Davis (2010), Ruhl et al. (2013), and Farber and Findley (2014). Another perspective might be from an ecosystem-type lens. For example, Ruhl et al. (2013) explores three examples of United States (U.S.) environmental laws and regulations from wetland, coastal, and forest resources protection perspectives. The full suite of U.S. statutes for natural resources are highly domain-specific in character (Scarlett and Boyd 2015); Ruhl (2005b) successfully argues that, "(U.S.) ecosystem management law is a cobbled-together body of law, if it can even be called that much."

There is a large breadth of U.S. federal environmental laws that can be broadly organized around overarching purposes of protection/conservation, restoration/remediation, and regulations focused on socio-ecological interactions (Fig. 1; note that acronyms are captured in Table 1's compilation of these laws). As an individual law is inherently complex (e.g., containing multiple goals and objectives), its placement on a Venn diagram showing the relationships between protection and conservation, restoration and remediation, and socio-ecological perspectives shown in Fig. 1 is overly simplistic.

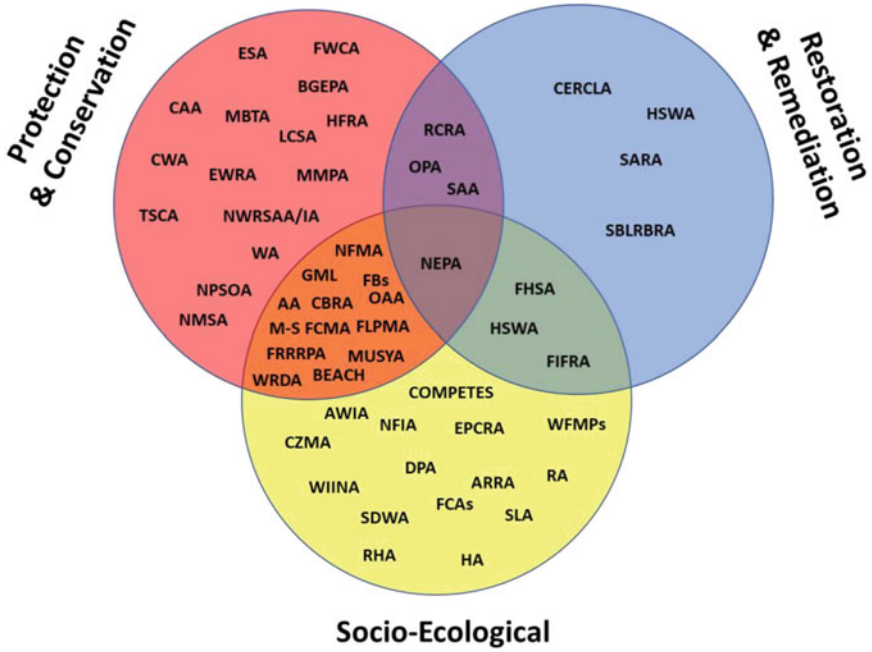

Fig. 1 Venn diagram identifying U.S. Federal environmental laws organized by three main perspectives. See Table 1 for acronyms used

Ruhl et al. (2013) highlights how the breadth of the U.S. environmental regulatory infrastructure from the 1970s–1990s became considered "top heavy." Hirokawa and Porter (2013) argue that, "the effort to integrate ecosystem services valuation into law has yielded complicated and unsatisfactory results." Further, legal scholars have called for the evolution of the application of environmental laws and regulatory tools to not only increase protection of ecosystems, but also the services they provide to people (e.g., Markell 2007; Ruhl et al. 2013). Examples of this perspective of characterizing how to protect ecosystem services through the use of regulations include Markell (2007), Davis (2010), and Pardy (2014).

The objectives of this chapter are two-fold: (1) to present an overview of the suite of U.S. Federal environmental laws and regulations with connections to ecosystem services; and (2) to present a survey of the legal scholar literature for a synopsis of ecosystem services issues in U.S. environmental law. These reviews are not intended to be fully exhaustive, but rather capture the broad suite of ecosystem services topics in U.S. environmental law and translated for EBM practitioners. For a recent overview of case law on ecosystem services, including U.S. examples, the reader is directed to Sharon et al. (2018).

Table 1 U.S. Federal environmental laws

Law & citation	Summary
Foundational laws over 100 years old	
Swamp Land Act 43 U.S.C. § 23 *et seq*.	The 1850 **SLA** provided legislation for giving Federal lands to the States in order to convert swamp lands into land for provision of agricultural and flood protection services.
Homestead Act 12 Stat. 392	The 1862 **HA** provided 160 acres of public land to homesteaders who paid a filing fee and lived on the land for five years before receiving the deed in order to promote westward expansion and the productive use (as a service) of the frontier. This was mostly repealed in 1976.
General Mining Law 30 U.S.C. § 22 *et seq*. (as amended)	The 1872 **GML** established that all valuable mineral deposits, and the lands where found, belonging to the United States were to be free and open to exploration and purchase for extractive services.
Organic Administration Act 16 U.S.C. § 551 *et seq*.	The 1897 **OAA** provided the authorizing legislation for the National Forest Service. The National Forest Service focuses on supporting forestry-based services.
Rivers and Harbors Act 33 U.S.C. § 407	The **RHA** of 1899 prohibited the construction over or in navigable waterways of the U.S. without Congressional approval and provided initial protection from water quality pollution.
Reclamation Act 43 U.S.C. § 391 *et seq*.	The **RA** was put into place in 1902 to set up water development (irrigation) projects in the U.S. west to support increasing westward settlement, including the productive use lands as a service, at the beginning of the twentieth century.
National Park Service Organic Act 16 U.S.C. § 1b *et seq*.	The 1916 **NPSOA** authorized the establishment of the U.S. National Park Service. The broad ecogeographic spectrum of National Parks encompasses a range of services associated with coastal, aquatic, and terrestrial services, along with public use and recreational-focused services.
Federal Migratory Bird Treaty Act 16 U.S.C. §§ 703–712	The 1918 **MBTA** is the federal enactment of the Migratory Bird Treaty (United States and Great Britain, acting on behalf of Canada; Mexico, Japan, and Russia subsequently signed onto this treaty) providing protections making it illegal to take, possess, sell or purchase any migratory bird (or parts) without a federal permit. The MBTA supports ecosystem services protection for recreational experiences and use for spiritual and ceremonial purposes.

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Table 1 (continued)

Law & citation	Summary
"Granddaddy" of U.S. Environmental Law	
National Environmental Policy Act 42 U.S.C. § 4321 *et seq*.	The 1969 **NEPA** law establishes the U.S.' goal to live harmoniously with nature by identifying where there is a federal nexus for the consideration of actions on the environment. It created the Environmental Impact Statement process that requires all federal agencies to review all potential actions for their impact on the environment. As a foundational piece of environmental legislation, there is a broad range of potentially relevant ecosystem services. (see Sect. 2.3)
Air Resources	
Clean Air Act 42 U.S.C. § 7401 *et seq*.	The **CAA** (including the 1970 Amendments) created a regulatory system to control most of the commonly produced and significant air pollutants. It set up air quality control regions and established National Ambient Air Quality Standards. Relevant ecosystem services may include air pollution removal and breathable air for human health and well-being. (see Sect. 2.3)
Water Resources	
Flood Control Acts 33 U.S.C. § 15 *et seq*.	A suite of legislation starting 1917, the **FCA**s provided authorizations for federal water control and flood protection services-based projects. The U.S. Army Corps of Engineers was established by the 1941 FCA with the authority to implement flood control policies such as the Flood Control and Coastal Emergency Act (Pub. L. No. 84–99).
Federal Water Pollution Control Act (**Clean Water Act**) 33 U.S.C. § 1251 *et seq*.	The 1972 **CWA** established that dumping in U.S. waters was not a right, that any person or corporation that wanted to dump anything into U.S. waters must have a permit, and that all wastewater must be treated, no matter the condition of the receiving waters. The CWA may involve many types of relevant ecosystem services, including pollution removal and supporting habitat condition for commercial and recreationally valuable species. (see Sect. 2.3)
Coastal Zone Management Act 16 U.S.C. § 1451 *et seq*.	The 1972 **CZMA** promotes development in the coastal zone area using a national perspective. but attempts to limit pollution arising from such development.
Safe Drinking Water Act 42 U.S.C. § 201 *et seq*.	The 1974 **SDWA** protects public drinking water supplies across the nation. It requires the U.S. Environmental Protection Agency to establish national primary and secondary drinking water standards to limit contaminants in drinking water, supporting the service of drinkable water.

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Table 1 (continued)

Law & citation	Summary
Coastal Barrier Resources Act 16 U.S.C. § 3501 *et seq*.	The 1982 **CBRA** was passed to protect and conserve coastal barriers, habitats that provide important flood protection and storm mitigation services. It prevents individuals who build in these zones from receiving any federal assistance, including federal flood insurance policies.
Emergency Wetlands Resources Act 16 U.S.C. §§ 3901–3932	The 1986 **EWRA** instructs the U.S. Fish & Wildlife Service to map the status and conditions of wetlands (and resulting services) across the U.S. and create a National Wetlands Priority Conservation Plan.
Water Resources Development Acts e.g., WRDA 2000 Pub. L. No. 106–541	**WRDA**s are a suite of laws focusing on a range of water resource management, protection, and utilization activities (and services) involving a federal nexus. For example, WRDA 2000 authorized most projects for the Comprehensive Everglades Restoration Plan in addition to other water resources protection plans across the country.
Beaches Environmental Assessment and Coastal Health (BEACH) Act Pub. L. No. 106–284	The Beaches Environmental Assessment and Coastal Health (**BEACH**) Act (2000) amends part of the Clean Water Act and focuses on monitoring and notifying the public about possible human health problems related to the ecosystem service of use for coastal recreation.
Water Infrastructure Improvements for the Nation Act Pub. L. No. 114–322	**WIINA** was passed in 2016 to focus on aspects of the U.S. drinking water infrastructure involving public health, supporting the service of drinkable water.
National Flood Insurance Act 42 U.S.C. § 4001 *et seq*.	The 1968 **NFIA** encourages states to create floodplain management programs that place restrictions on the location and type of construction, supporting the ecosystem service of flood protection. It also has a buy-out program component to take people out of floodplains to reduce rebuilding costs.
Deepwater Port Act 33 U.S.C. § 1501 *et seq*.	The 1974 **DPA** focuses on construction, operation, and decommissioning of deepwater ports (located beyond the U.S. territorial sea boundaries) and minimization of adverse impacts on the marine environment and the services they provide.
America COMPETES Reauthorization Act of 2010 Pub. L. No. 111–358	The 2010 **COMPETES** law instructs the Administrator of the National Oceanic and Atmospheric Administration to "identify emerging and innovative research and development priorities to enhance United States competitiveness, support development of new economic opportunities based on NOAA research, observations, monitoring modeling, and predictions that sustain ecosystem services." 33 U.S.C. § 893(b)(1)

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Table 1 (continued)

Law & citation	Summary
America's Water Infrastructure Act of 2018 Pub. L. No. 115–270	The 2019 **AWIA** law includes asking the National Academy of Science to examine how the U.S. Army Corps of Engineers approaches formulation, evaluation, and budget determination for water resources development projects, including "an analysis of whether such principles and methodologies fully account for all of the costs of project alternatives, including potential societal costs, such as lost ecosystem services, and full lifecycle costs for such alternatives." (Sec. 1103)
Land, Fish & Wildlife Resources	
Farm Bills 7 U.S.C. covers Agriculture	A suite of legislation starting in 1933, the **FB**s provided authorizations for, among other things, efforts on development and sale of agricultural products and other agroservices, research, and conservation. The Agricultural Act of 2014 (**AA**) called for an update to the strategic plan for forest inventory and analysis, with the implementation of an, "annualized inventory of trees in urban settings, including the status and trends of trees and forests, and assessments of their ecosystem services, values, health, and risk to pests and diseases." (Pub. L. No. 113–179; Sec. 8301)
Fish and Wildlife Coordination Act 16 U.S.C. § 661 *et seq*.	The 1934 **FWCA** law created the U.S. Fish and Wildlife Service, established the National Wildlife Refuge System, and requires the Secretary of the Interior to protect and conserve wildlife resources and authorize the public-use service of hunting of overabundant species.
Federal Wildland Fire Management Policies	The **WFMP**s are a suite of cross-Federal Agency wildland fire policies dating back to 1935 and have been revised following large-scale fire seasons (e.g., post-1998 fire season and the Yellowstone National Park fires). These policies have focused on supporting resource objectives in federal wildlands, including balancing the use of prescribed natural fires and ecosystem services (e.g., recreational access to nature) and potential negative ecosystem services effects such as smoke and stream sedimentation.
Bald and Golden Eagle Protection Act 16 U.S.C. § 668 *et seq*.	The 1962 **BGEPA** focuses on a suite of protections for two eagle species, including addressing issues of interference and abuse related to different aspects of shelter, breeding, nest abandonment, and feeding. BGEPA supports ecosystem services protection for recreational experiences and use for spiritual and ceremonial purposes.

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Table 1 (continued)

Law & citation	Summary
Multiple Use—Sustained Yield Act 16 U.S.C. § 528 *et seq*. (amended 1996)	The 1960 **MUSYA** established the system of National Forests for multiple outdoor recreation, range, timber, watershed, and fish and wildlife purposes (and services).
Wilderness Act 11 U.S.C. § 1131 *et seq*.	The **WA** of 1964 was established to preserve and protect, for current and future generations, certain wilderness lands in their "natural condition" with a number of relevant ecosystem services related to recreation and existence services.
National Wildlife Refuge System Administration Act 16 U.S.C. § 668dd	The 1966 **NWRSAA** is the U.S. Fish and Wildlife Service's "Organic Act" analog of the Park Service for management of the National Wildlife Refuge System for the purpose of protecting lands for the conservation of fish and wildlife, including threatened and endangered species, and puts boundaries on the ecosystem services of public access/use of refuge lands and waters.
Marine Mammal Protection Act 16 U.S.C. §§ 1361–1407	The 1972 **MMPA** represents the first legislation for ecosystem-based management for marine resources and was established to manage marine mammal species and population stocks as components of the ecosystems of which they are a part.
National Marine Sanctuaries Act 16 U.S.C. § 1431 *et seq*. (amended 2000)	The 1972 **NMSA** allowed for the designation and protection of special areas of the marine environment supporting a broad suite of coastal, recreational, and fisheries-related services.
Endangered Species Act 16 U.S.C. § 1531 *et seq*.	The 1973 **ESA** established protections for species, and their habitats, that have been listed as endangered or threatened. This law closed down the U.S. market in endangered wildlife, established heavy criminal penalties and fines for "taking" a member of an endangered or threatened species, and prohibits any federal actions that may impact the life or habitat of a listed endangered or threatened species. Habitats and supporting biodiversity preservation are often cited as the most relevant ecosystem services. (see Sect. 2.3)
Forest and Rangeland Renewable Resources Planning Act 16 U.S.C. § 1600 *et seq*.	The 1974 **FRRRPA** law gives authority to the U.S. Forest Service and U.S. Department of Agriculture to assess the Nation's renewable resources and develop and prepare a national renewable resources program for forestry and agriculture-based services.
Magnuson-Stevens Fishery Conservation and Management Act 16 U.S.C. § 1801 *et seq*. (amended 2007)	The 1976 **M-S FCMA** focuses on the valuable and renewable natural resources of U.S. fisheries across a range of geographic boundaries, ranging from anadromous species which spawn in rivers or estuaries, to migratory species of the high seas, and species in U.S. federal waters of the continental shelf. Ecosystem services related to fishery resources include harvesting for food supply and recreational opportunities.

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Table 1 (continued)

Law & citation	Summary
Federal Land Policy and Management Act 43 U.S.C. § 1701 *et seq.*	The 1976 **FLPMA** established the Bureau of Land Management, including inventories for present and future resource use.
National Forest Management Act 16 U.S.C. § 1600 *et seq.*	The 1976 **NFMA** Amends the Forest and Rangeland Renewable Resources Planning Act of 1974.
National Wildlife Refuge System Improvement Act Pub. L. No. 105–57	The 1997 **NWRSIA** updated the guidance for overall management of the National Wildlife Refuge System, including focus on maintaining the environmental health of the Refuge System while providing for determination of "compatible uses" of refuges for ecosystem services such as hunting and fishing, wildlife observation and photography, and environmental education and interpretation.
Healthy Forests Restoration Act Pub. L. No. 108–148	The 2003 **HRFA** was designed to minimize impacts of destructive wildfires on federal lands, including by allowing timber harvests on protected National Forests, and creating the ability for expedited NEPA review for projects under HFRA.
Chemicals	
Federal Hazardous Substances Act 15 U.S.C. § 1261 *et seq.*	The 1960 **FHSA** required labeling of hazardous household products to help consumers safely store and use products and allow for the ban of certain products that are dangerous or hazardous to human health. Ecosystem services are potential endpoints for a risk assessment process to examine the potential adverse effects of chemicals on the environment.
Federal Insecticide, Fungicide and Rodenticide Act 7 U.S.C. § 135 *et seq.*	The 1964 **FIFRA** law covers all chemicals manufactured to deal with pests in relation to agriculture and requires all of these chemicals to be registered with the U.S. Environmental Protection Agency prior to their use. Ecosystem services are potential endpoints for a risk assessment process to examine the potential adverse effects of chemicals on the environment.
Toxic Substances Control Act 15 U.S.C. § 2601 *et seq.*	The 1976 **TSCA** law requires the U.S. Environmental Protection Agency to keep a registry of chemicals used and introduced into everyday life. Ecosystem services are potential endpoints for a risk assessment process to examine the potential adverse effects of chemicals on the environment.
Emergency Planning and Community Right to Know Act 42 U.S.C. § 11001 *et seq.*	The 1986 **EPCRA** was created to help communities plan for chemical emergencies. It also requires industry to report on the storage, use and releases of hazardous substances to federal, state, and local governments. EPCRA requires state and local governments, and Indian tribes to use this information to prepare their community for potential risks. Ecosystem services are potential endpoints for a risk assessment process to examine the potential adverse effects of chemicals on the environment.

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Law & citation	Summary
Frank R. Lautenberg Chemical Safety for the 21st Century Act Pub. L. No 114–182, 130 Stat. 448	The 2016 **LCSA** is an update of the TSCA requiring the U.S. Environmental Protection Agency to have ongoing evaluations of chemicals registered under the TSCA using a risk-based standard. It also requires the EPA to impose fees on chemical manufacturers to pay for these evaluations. Ecosystem services are potential endpoints for a risk assessment process to examine the potential adverse effects of chemicals on the environment.
Environmental Remediation	
Resource Conservation and Recovery Act 42 U.S.C. § 6901 *et seq*.	The 1976 **RCRA** law regulates the waste cycle by defining wastes and dictating how they are to be treated. It aims to prevent the release of hazardous wastes into the environment. RCRA can support the protection or restoration of a suite of ecosystem services that are location specific.
Comprehensive Environmental Response, Compensation and Liability Act 42 U.S.C. § 9601 *et seq*.	The 1980 **CERCLA**, also referred to as Superfund, is an administrative system for removing hazardous materials from sites where they had been improperly dumped into the environment in years past. Sites are identified and placed on a National Priorities List, then assessed through the hazard ranking system. CERCLA can support the protection or restoration of a suite of ecosystem services that are location specific. (see Sect. 2.3)
Hazardous and Solid Waste Amendments Pub. L. No. 98–616, 98 Stat. 3221	The 1984 **HSWA** law requires the U.S. Environmental Protection Agency to develop criteria for identifying hazardous waste: ignitability; corrosivity; reactivity; and toxicity. It added stringent regulation of land disposal of hazard wastes to RCRA. HSWA can support the protection or restoration of a suite of ecosystem services that are location specific.
Superfund Amendments and Reauthorization Act Pub. L. No. 96–510, 94 Stat. 2767	**SARA** (1986) is the reauthorization of CERCLA and required that the hazard ranking system be updated and all identified sites were reviewed for possible water contamination due to run off. SARA supports the protection or restoration of a suite of ecosystem services that are location specific.
Oil Pollution Act 33 U.S.C. § 2701 *et seq*.	The 1990 **OPA** established a trust fund to clean up spills when the responsible party is incapable or unwilling to do so and outlines requirements for facilities (e.g., aboveground storage facilities) and vessels (e.g., oil tankers) to detail how they will respond to large discharges. OPA clean-up activities can support the protection or restoration of a suite of ecosystem services that are location specific.

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Table 1 (continued)

Law & citation	Summary
Small Business Liability Relief and Brownfields Revitalization Act Pub. L. No. 107–118, 115 Stat. 2356	The 2002 **SBLRBRA**, referred to as Brownfields, amended CERCLA to increase funding for cleanup at urban and suburban CERCLA sites. It focuses on cleanup of sites with petroleum or other hazardous waste contamination. Brownfields revitalization can support the protection or restoration of a suite of ecosystem services that are location specific.
American Recovery and Reinvestment Act Pub. L. No. 111–5, 123 Stat. 115	The 2009 **ARRA** updated CERCLA to add a large amount of stimulus monies to the Superfund in order to accelerate ongoing clean-up activities. As a result, ARRA can support the protection or restoration of a suite of ecosystem services that are location specific.
Supplemental Appropriations Act Pub. L. No. 111–212	The 2010 **SAA** included the call for an "ecosystem services impact study" by the National Academy of Sciences to, "conduct a study of the long-term ecosystem service impacts of the Deepwater Horizon oil discharge. Such study shall assess long-term costs to the public of lost water filtration, hunting, and fishing (commercial and recreational), and other ecosystem services associated with the Gulf of Mexico." (Sec. 2004)

The laws are grouped by thematic areas and year, and where the reader can find more information on an individual law via the full title, year, and legal citation information. U.S.C. = U.S. Code; § = Section; §§ = Sections; *et seq*. (*et sequentes*) = "and what follows"; Pub. L. No. = Public Law Number; Stat. = Statutes at Large

A high-level summary provides initial information about each law, its commonly used acronym (used for Fig. 1), and relevant examples to the field of ecosystem services

2 Ecosystem Services in U.S. Federal Environmental Laws

This Section presents a brief overview of a suite of U.S. federal environmental laws where ecosystem services and ecosystem-based management topics may be relevant. Here, this chapter expands beyond the list of what are considered "key" environmental laws to highlight the larger breadth of U.S. laws, and where the reader can turn to find more information, that may have relevance to ecosystem services and ecosystem-based management. Additionally, this chapter includes information on early U.S. federal legislation (over 100 years old), ancillary legislation not considered part of the "traditional suite" of environmental laws, and select Executive Orders that speak to environmental law related to ecosystem services.

2.1 Foundational Legislation

The foundational elements of U.S. environmental law predate the flurry of activities in the 1970s–1990s (Ruhl et al. 2013) and ultimately can be anchored in Roman law's "recognition that the general public had inalienable rights to access and use certain resources, namely the sea and seashore, rivers, and the air" (Connolly 2009). This is referred to as the "Public Trust Doctrine" (cf., Sax 1970; Ruhl 2005a; Ruhl and Salzman 2006); the first case addressing this in the U.S. occurred in 1842 (Smith and Sweeney 2006). Examples of 100+ year old U.S. Federal legislation that set the stage for identifying the importance of (protecting and valuing) ecosystems include: the Swamp Land Act (1850), the Homestead Act (1862); the General Mining Act (1872), the Organic Administrations Act (1897), the Rivers and Harbors Act (1899), the Reclamation Act (1902), the National Park Service Organic Act (1916), and the Migratory Bird Treaty Act (1918) (Donahue 2007; Tarlock 2007; Hirokawa 2011c; Cosens and Fremier 2014; Robbins 2018b).

2.2 U.S. Federal Environmental Laws—Overview

An overview of approximately 50 U.S. Federal environmental laws is presented in Table 1, including a description of each law's goals and purpose and an initial identification of which parts of a given law that may have relevance to ecosystem services and ecosystem-based management. Examples of U.S. Federal regulations that directly speak to ecosystem services are presented in Table 2. For a broader overview of the suite of U.S. environmental laws, the reader is referred to Farber and Findley (2014) and Salzman and Thompson (2003). At, or near, the "top" of the key list of U.S. Federal environmental laws are the National Environmental Policy Act, the Clean Water Act, the Clean Air Act, the Endangered Species Act, and the Comprehensive Environmental Response, Compensation, and Liability Act. The rest of this section briefly introduces these key laws and their intersection with ecosystem services.

2.3 "Key" U.S. Federal Environmental Laws

One of the primary U.S. Federal environmental laws with relevance to ecosystem services is the National Environmental Policy Act (NEPA), with the requirement that federal agencies evaluate a suite of alternatives (including a "no action" scenario) for developing pros/cons lists before a decision is made (Anderson 2011). Fischman (2001) argues for the direct utility of ecosystem services assessments as they may be "exactly the kind of assessment NEPA envisions, providing a means to inform the public and decision-makers about what we stand to gain or lose in several alternative

Table 2 Current U.S. federal regulations capturing "ecosystem services"

Agency	Code section	Summary	Citation
U.S. Department of Agriculture, Natural Resources Conservation Service	Healthy Forests Reserve Program Compensation for Easements and 30-year Contracts	This is part of the Healthy Forests Reserve Program to assist landowners to restore, enhance, and protect forestland resources on private land.	7 CFR § 625.8
	Grasslands Reserve Program Definitions	These definitions include conservation values which covers sustaining and enhancing ecosystem functions of grasslands.	7 CFR § 1415.3
	Wetlands Reserve Program Market Based Conservation Issues	Establishes the use of environmental credits for entities that implement conservation practices and activities.	7 CFR § 1467.20
	Agricultural Conservation Easement Program Environmental Markets	This section gives ecosystem service credits to landowners for conservation improvements to wetland reserve easements.	7 CFR § 1468.10
	National Forest System Land Management Planning Assessment; Sustainability; Multiple Use	This part deals with land management plans and the assessments of plan developments to include collaborative and science-based input so the lands involved are ecologically sustainable and have the capacity to provide ecosystem services to people and the community.	36 CFR § 219.XX (0.1; 0.6; 0.8; 0.10; 0.19)
U.S. Environmental Protection Agency	National Ambient Air Quality Standards Revisions to the Guideline on Air Quality Models	This Appendix provides guidelines for air quality modeling related to the derivation of Ozone National Ambient Air Quality Standards, noting that "emissions of NO_X, sulfur oxides, NH_3, mercury, and secondary pollutants such as ozone and particulate matter" can affect ecosystem services provided by forests and natural areas. (40 CFR Part 51, Appendix W)	40 CFR Part 51 Appendix W

CFR, Code of Federal Regulations; §, Section

scenarios." Fischman (2001) gives an example list of five types of NEPA-relevant decision activities:

1. Community-scale development activities with a federal nexus (e.g., highways; flood protection);
2. Development and use of renewable resource on public lands (e.g., logging and grazing);

3. Use (e.g., development, generation, and transmission) of renewable energy production, including coal, petroleum, and natural gas;
4. Use (e.g., development, processing, and transport) of non-energy mineral resources; and
5. Implementation of water projects, including permitting (e.g., wetland modification).

Cross-walking these examples with the Millennium Ecosystem Assessment's approach (Millennium Ecosystem Assessment 2005; Carpenter et al. 2009; da Silva and de Carvalho 2018) to classifying ecosystem services into four main categories:

- Provisioning (e.g., food/fiber; fuel);
- Regulating (e.g., water, disease);
- Cultural (spiritual; recreational; aesthetic); and
- Supporting (e.g., primary production; nutrient cycling)

it becomes clear that there is extensive relevance of applying NEPA to a range of ecosystem services that may be considered as part of NEPA consultations. Some example topics within NEPA's umbrella that are relevant include: property (Sect. 1.1); valuation (including cost/benefits analysis and markets; Sect. 1.2); development of alternative scenarios (including mitigation; Sect. 2); environmental impact assessments (not discussed here); and habitat evaluations (not discussed here). Recent legal scholar publications on NEPA and ecosystem services include Fischman (2001), Hirokawa and Porter (2013), Ruhl (2015). As a side note, the Millennium Ecosystem Assessment framework has been applied to environmental law issues around a number of topics (Thompson 2008; Ruhl 2015), including agrosystems (Ruhl 2008), public lands (Ruhl 2010a), aquatic resources (Ruhl 2010b), as well as the evolution of the ecosystem approach in international environmental law (Enright and Boteler 2020; Le Tissier 2020; O'Hagan 2020).

The Federal Water Pollution Control Act (commonly referred to as the Clean Water Act) includes provisions to protect aquatic ecosystems from human activities in order to protect a range of ecosystem services, including pollution removal (dilution and breakdown), providing habitat for wildlife (including those harvested commercially and recreationally), and assimilation and sequestration of nutrients (e.g., removal of excess nitrogen) (Salzman et al. 2001; Craig 2008; Ruhl 2010b; Smith et al. 2010). The Clean Water Act also includes provisions for mitigation banking, a mechanism of preservation, enhancement, or restoration of a specific natural resource area in order to provide compensation for the loss or degradation of another natural resource (see Sect. 2.1; Davis 2010). Additionally, there are several current topics of legal discussion with the Clean Water Act, including issues of jurisdiction (e.g., Craig 2008), setting Total Maximum Daily Loads (Ruhl 2010b), and filling wetlands (Ruhl et al. 2009) that are outside the scope of this chapter. As a side note, the Beaches Environmental Assessment and Coastal Health (BEACH) Act (2010), as an amendment to the CWA, is an example of additional legislation

focused on the intersection between identification of human health issues and the ecosystem service of coastal beach use for recreation.

The Clean Air Act focuses on air quality protection and establishment of standards and intersects with ecosystem services in a number of areas, including, nutrient pollution removal (e.g., nitrogen, sulfur), and regulation of greenhouse gas emissions (e.g., Lazarus 2008; McGuire 2015).

The Endangered Species Act focuses on single-species management of threatened and endangered species, but with capacity to give attention to related habitats and for programmatic and multi-species consultations. Consideration of the intersection with ecosystem services is established in the literature for issues related to critical habitat (Salzman 1997; 2006), (indirect) protection of biodiversity (Thompson 2008; McGuire 2015), the use of Habitat Conservation Plans (Davis 2010), and the use of credits (Davis 2010).

The Comprehensive Environmental Response, Compensation, and Liability Act ("Superfund") has ecosystem services related connections to damage assessment (Wilson 2004; Desjardins 2014) as well as approaches to enhance cleanups (e.g., Green Remediation; Lipps et al. 2017) and redevelopment (Thompson 2008). See Sect. 4 on ecosystem services and remediation.

2.4 Non-Traditional Suite of Laws Related to Environmental Law and Ecosystem Services

There are other regulations not considered part of the suite of traditional environmental laws that are related to how ecosystem services are considered. For a land-use example, the National Flood Insurance Program, authorized by the National Flood Insurance Act, include the influences on, and distortion of, land prices that influence coastal and flood-plain development decoupled from other ecosystem valuation efforts for these important ecosystem landscapes (McGuire 2015). In contrast, the 1990 Conservation Reserve Program, established by the "Farm Bill," assesses (ranks) land parcels with the highest environmental benefits based on multiple criteria (Boyd et al. 2001; Davis 2010).

2.5 Executive Orders

Another suite of U.S. federal tools that can be used to examine related issues are Executive Orders (EOs), directives from the U.S. President to the Executive Branch of the government, including covering rulemaking for federal agencies such as the U.S. Environmental Protection Agency, U.S. Department of the Interior, and the U.S. Army Corps of Engineers. It is important to acknowledge that EOs represent policies, which are the operational applications of laws. That is, they capture

different approaches to governing and interpretations of the execution of laws by the Executive Branch. This introduction to EOs is not intended to present an exhaustive survey of EOs relevant to ecosystem services, rather introduce this type of mechanism to the reader. For example, the National System of Marine Protected Areas was established in 2000 through EO 13158 ("Marine Protected Areas"). While EOs have extensive authority in that they are implemented at the same level as a regulation, they do not overrule an individual law, they are not legislatively approved, and they can be rescinded with the stroke of a pen by subsequent administrations.

Examples of EOs that explore further development of environmental-related cost-benefit analyses (Thompson 2008) include a suite of EOs on "Regulatory Planning and Review": EO 12866 (1993; 58 FR 51735), EO 13258 (2002; 67 FR 9385), EO 13422 (2007; 72 FR 2763), EO 13563 (2011; 76 FR 3821), and EO 13777 (2017; 82 FR 12285). This example suite of Executive Orders spans across multiple Presidential administrations.

In another example, EO 13547 ("Stewardship of the Ocean, Our Coasts, and the Great Lakes"; 2010; 75 FR 43023) explicitly referred to ecosystem services in providing guidance for coastal and marine spatial planning, specifically identifying those areas, "most suitable for various types or classes of activities in order to reduce conflicts among uses, reduce environmental impacts, facilitate compatible uses, and preserve critical ecosystem services to meet economic, environmental, security, and social objectives." This EO was revoked in 2018 and replaced by EO 13840 ("Ocean Policy to Advance the Economic, Security, and Environmental Interests of the United States"; 2018; 83 FR 29431) that did not reference the "ecosystem services" that nature provides to people but does reference the "benefits" the ocean provides the U.S. economy. As a side note, the reader is directed to Craig (2007) to learn more about coastal ecosystem services and environmental law and policy.

3 Themes in Ecosystem Services, EBM and Environmental Law

This Section presents a high-level literature review analysis of the existing legal scholarly literature on several current ecosystem services topics within U.S. federal environmental law. A literature search of abstracts, titles, and keywords published in the legal scholar literature was conducted using the HeinOnline law journal library search engine to identify potential peer-reviewed sources. The period of record for HeinOnline searches ranged from the date of inception for each legal journal in their database through March 2019. As a frame of reference, the HeinOnline search identified a total of 1903 legal articles that contained reference to ecosystem services. Focusing in on a snapshot of key literature, this chapter presents an overview of those articles that contained "ecosystem services" or "ecosystem based management" in the article's title. Although this search was not exhaustive, it provides a high-level snapshot of the current state of emphasis within

the legal scholarly literature. The analysis presents a suite of ecosystem services themes in this literature, including fundamental elements (property and ownership; valuation, accounting and markets), conservation and protection (conservation and mitigation banking, public lands), and remediation on the "back end," including an introduction on natural resources damages.

3.1 Property and Ownership

Some aspects of ecosystem services may be subject to property rights law, that is, whether the value of an ecosystem service can be reduced to ownership (Hirokawa 2011c; Ruhl 2015). Pardy (2014) outlines one property premise related to developing approaches to protecting ecosystem services, namely that, "although some ES have no market value because they are not the subject of property rights and/or are not easily exchanged, all ES have an economic value that can be calculated by measuring their actual or potential importance to human well-being." Robbins (2018b) provides a general characterization that the case law for ecosystem services-based regulatory takings generally does not expressly treat ecosystem services as a property interest. And Hirokawa (2011c) argues that because ecosystem services may not have discrete boundaries, they could be considered property interests within another's property boundaries. One area of intersection between environmental law, property law, and ecosystem services is in "ecosystem energy services" (Hodas 2013). Ruhl (2005b) argues that the nuisance aspects of "common law" may be applicable for ecosystem services because the structure of this vehicle is flexible to handle changes, such as those encountered in the evolution of both the science of ecosystem services and its consideration in society (Hirokawa 2011c). The reader is directed towards Abrams (2007) for an overview on nuisance law and ecosystem services.

In the case of conservation easements, areas established to maintain essential habitat for species that can also provide ecosystem services, Cooley and Olander (2012) and Robbins (2018b) argue that because human value for ecosystem services can be extrapolated from easements, ecosystem-services related easements are considered property. Additional areas of development in environmental law and policy include the potential applicability of easements, and the services they may provide, for use in markets (see Sect. 1.2), such as for carbon credits, which require establishing a permanence of the market for credits (Ristino 2010). Easements, however, may not be permanent property instruments, and thus the ownership of the benefits (including delivery of ecosystem services) from a given easement, is an area of active development in the law (McLaughlin 2015).

From a technical perspective, there is a difference between an ecosystem good and an ecosystem service, namely that a good represents a market product (e.g., harvestable timber), while a service represents an ecosystem process or function (e.g., wetland filtering out water pollution) (Brown et al. 2007). Furthermore, the delineation of those ecosystem goods and services into *intermediate* (supporting

products and processes not directly used by humans) and *final* (those used directly by humans) services to advance classification systems and environmental accounting (DeWitt et al. 2020; Russell et al. 2020) may also inform future discussions on ecosystem services and property law as it relates to matters of ownership. As a side note, there is continuing debate about biodiversity as an ecosystem service (Goble 2007), including whether it represents a final ecosystem service (DeWitt et al. 2020) directly benefiting people.

3.2 Ecosystem Services Accounting, Markets

The field of ecosystem services accounting and valuation is an ongoing area of scientific development. Pardy (2014) describes the three primary approaches for protection of ecosystem services as: (1) a regulatory approach (e.g., da Silva and de Carvalho 2018); (2) payments to protect ecosystem services (e.g., Hirsch 2007; Ruhl 2008; Benjamin 2013; Salzman et al. 2018), including investments in green infrastructure (Cosens and Fremier 2014; Salzman et al. 2014; da Silva and de Carvalho 2018); and (3) market-based approaches (e.g., Salzman 2005; Hirsch 2007; Glicksman and Kaime 2013; Kaime 2013). From an environmental law perspective, the authority for using valuation and accounting, and the range of potential approaches and methodologies themselves are all areas of ongoing development, case law, and legal debate. The primary legal spaces include natural resource damages, the consideration of compensation and mitigation, and the establishment of markets.

One primary approach for valuation includes "(focus) on a traditional, tort-like derivation of damages through per-unit calculations of past, present, and future damages" (Desjardins 2014). In one example, the Habitat Equivalency Analysis approach, a CERCLA provision using an accounting approach for habitat status/condition that is used to look at lost and restored services from a one-to-one comparison perspective (Ray 2009; Shaw and Wlodarz 2013), has received attention in a number of areas of environmental policy management, including natural resource damage assessments (NOAA 2000), NEPA projects (e.g., Ray 2009), and restoration decision making (Snyder and Desvousges 2013). Equivalence assessment approaches, including Habitat Equivalency Analysis and the related Resource Equivalency Analysis approach, are used for measuring losses and gains in habitat and biodiversity have been developed for a range of purposes (Desjardins 2014; Bezombes et al. 2017). Another suite of ecosystem services valuation focuses on the "willingness-to-pay" approaches, such as Contingency Valuation, the application of methodologies for natural resources that have no established market (Carson et al. 2001).

Ruhl et al. (2009) and Womble and Doyle (2012) explore mitigation banking in wetland and stream ecosystems resulting from the Clean Water Act and the 2009 Compensatory Mitigation Rule and its focus on market-based assessments of these ecosystems from a compensatory mitigation perspective. Further discussion on

issues associated with geographic boundaries in environmental law and policy are outside the scope of this chapter, but the reader is directed to Womble and Doyle (2012) and Ruhl et al. (2009) for more information. Ruhl and Salzman (2007) and Salzman et al. (2018) present an overview of payments for ecosystem services, including both positive and negative incentives ("carrots vs. sticks"; Salzman et al. 2018) from a mitigation context.

A decade ago, there were more than 700 ecosystem services markets in the U.S. (Ristino 2010), with more than 2400 markets by 2016 (Bennett et al. 2016). Ruhl and Salzman (2007) provides examples of markets for forests. For carbon-based markets, one area of policy development is in carbon offsets, an accounting approach whereby the reduction in carbon emissions by one source could be used to offset the need for reduction in carbon emissions by another source. Carbon credits is one area of property law that is still in development (Ristino 2010; Glicksman and Kaime 2013; Ruhl et al. 2013). While this chapter does not explore current cap-and-trade issues, the reader is directed towards Glicksman and Kaime (2013) and Ruhl et al. (2013) to learn more. Likewise, the reader is pointed towards Brown et al. (2007) to learn more about technical and policy issues associated with measuring "carbon dioxide-equivalents" or the "social cost of carbon."

There are a number of environmental law and policy issues related to the development and implementation of markets, including property law, credits, banking, and accountability and oversight (e.g., Ristino 2010; Glicksman and Kaime 2013). One area of on-going property-based efforts is focused on real property instruments, the legal vehicles used to assign ownership of property (Ristino 2010). Another relates to the potential use of conservation easements (see Sect. 2.1), and whether easements can create permanency of both the credits themselves, and ownership of those credits, as it relates to how those credits are considered from a market or governance perspective.

3.3 Conservation, Protection & Mitigation Banking Tools

The Wilderness Act (1964) was primarily focused on the protection of public lands, including non-extractive services (Kammer 2013). The Federal Land Policy and Management Act (1976), focusing on the management of public lands, has a "no degradation" requirement that including taking necessary actions to prevent unnecessary or undue degradation of public lands (Donahue 2007). The 1978 Public Rangeland Improvement Act, implemented by the Bureau of Land Management, characterizes "less-than-potential production of ecosystem services, namely, 'wildlife habitat, recreation, forage, and water and soil conservation benefits,' is evidence of rangelands' 'unsatisfactory condition.'" (Donahue 2007). There is a large breadth of rangeland improvements called for by the Public Rangelands Improvement Act (and subsequent regulations), including soil resources, water resources, fish and wildlife habitat resources, and improvements for livestock and wild horse management Penderly (1997). Ecosystem services elements of forests are broad (Neuman

2007); Federal forest lands are "administered for outdoor recreation, range, timber, watershed, and wildlife and fish purposes." (16 U.S.C. § 528). Three U.S. Federal laws overseeing forestry services include the National Forest Management Act (1976), the Forest and Rangeland Renewable Resources Planning Act (1974), and the Multiple-Use Sustained-Yield Act (1960). From an environmental law perspective, attention in forestry ecosystem services includes advancing concepts of "payment for services" (Ruhl and Salzman 2007), balancing vegetation management plans, provisioning of forestry goods, and potential impacts on watershed function (Hirokawa and Porter 2013).

There are a number of federal "incentive programs," whereby the government pays private landowners to protect ecosystems and their services, including the Conservation, Wetlands, and Grasslands Reserve programs (Table 2), Environmental Quality Incentives Program, the Farm and Ranch Lands Protection Program, the Conservation Security Program, and the Forestland Enhancement Program (Brown et al. 2007; Ruhl 2008). In a related tool, the U.S. Department of Interior oversees the Land and Water Conservation Fund (1965), designed, in part, to "preserve ecosystem benefits for local communities" for both public and private lands (Land and Water Conservation Fund 2017). Areas of current attention in agricultural ecosystem services is in markets for carbon offsets (Davis 2010; see Sect. 3.2 for more on markets), and the U.S. Department of Agriculture's use of, "ecosystem service values as a basis for payments under traditional conservation program payments" (Ruhl 2015).

The U.S. government's Council of Environmental Quality's regulation on mitigation includes a section on, "compensating for the impact by replacing or providing substitute resources or environments" (40 CFR 1508.20(e)). Mitigation banking, an approach to protect, enhance, or create a habitat (particularly wetlands) as compensation for the impacts at other locations, is one tool used for providing compensation for ecosystem impacts. Examples of mitigation banking include those established through the authority of Sect. 404 of the Clean Water Act. U.S. federal agencies involved in mitigation banking include the U.S. Environmental Protection Agency, U.S. Department of Agriculture, the U.S. Fish and Wildlife Service, and the U.S. Army Corps of Engineers. Conservation easements are established to maintain essential habitat for species, where Cooley and Olander (2012) and Robbins (2018b) argue that human value for the ecosystem service can be extrapolated. Here, ecosystem services related easements are considered property. Discussions on environmental law and policy perspectives on ecosystem services and mitigation banking include Salzman and Ruhl (2000), Boyd et al. (2001), Hirsch (2007), and Robbins (2018b). A spin on wetland mitigation banking for use as a market for biodiversity offsets is presented in Spurgeon (2008).

3.4 Remediation on the "Back End"—Natural Resources Damages

There are a number of examples of natural resource damage provisions in U.S. Federal law that mandate valuation in response to a loss, or deprivation of ecosystem function and services, including the Deepwater Port Act (1974), the Oil Pollution Act (1990), the National Marine Sanctuaries Act (1972), and the Comprehensive Environmental Response, Compensation, and Liability Act (1980) (commonly referred to as Superfund) (Boyd et al. 2001; Wilson 2004; Smith et al. 2010). Salzman (1997) provides an early environmental law analysis of the need for information on ecosystem services information markets to feed the design of remediation strategies in Superfund. Another example of another ecosystem services related regulation that focuses on violation/penalties is the Natural Resources Damage Assessment that focuses on assessing compensation for injuries to natural resources (see Boyd et al. 2001 and Davis 2010 for overviews). In characterizing the U.S. Environmental Protection Agency's three-prong approach to enforcement (deterrence; fairness; swift resolution of environmental problems), Markell (2007) provides an overview of three tools: penalties for violations; injunctive relief (i.e., a court-driven order to address a problem); and Supplemental Environmental Projects (SEPs) as a form of relief in case settlements. A number of U.S. Federal environmental laws focus on prevention of ecosystem contamination (Table 1) using ecological risk assessment characterizations as an important tool. For an overview of efforts to advance ecosystem services as assessment endpoints in the ecological risk assessment process, the reader is directed to Munns et al. (2016).

4 Ecosystem Services and Environmental Law at Different Scales

One guiding principle of EBM involves the interaction across different scales (federal, state, and local) to address geographic-based management issues (Nugent and Cantral 2006; Green et al. 2014). This section presents an overview of where ecosystem services are captured at different scales, including state agency laws, and several examples at regional and local scales. Examples of current State environmental laws are introduced in Table 3. At present, just the three U.S. west coast states (Washington State, Oregon, and California) and Rhode Island have laws that explicitly refer to ecosystem services.

Examples of ecosystem services captured within U.S. regional-scale environmental law issues include:

- Ecosystem-Based Management of the western U.S. (e.g., Smith 1999);
- The use of the Endangered Species Act as an overarching framework for northwest Montana (Guercio and Duane 2009);

Table 3 Current U.S. state laws capturing "ecosystem services"

State	Code Section	Summary	Citation
Oregon	Public Health and Safety	Chapter 468 of the Oregon statutes deals with environmental quality. "It is the policy of this state to support the maintenance, enhancement and restoration of ecosystem services throughout Oregon, focusing on the protection of land, water, air, soil and native flora and fauna." Or. Rev. Stat. 468.583 (2018)	468.581; 468.583; 468.585; 468.587 (2018)
	Forestry and Forest Products	These sections of the Oregon statutes advance the continuation of the Forest Resource Trust to promote establishment and management of nonindustrial state forestland through the use of paying landowners for preserving ecosystem services.	526.695; 526.703; 526.705 (2018)
	Water Resources: Irrigation, Drainage, Flood Control, Reclamation	This Oregon statute establishes the Water Resources Department to develop and implement a holistic water usage plan for the entire state of Oregon. It includes ecosystem services as a point to consider when developing such plan.	536.220 (2018)
Washington	Forest and Forest Products	This Washington statute establishes a forest maintenance plan to wisely use timber resources and replenish such, including payments to forest landowners for ecosystem services provided to the public in preserving timber resources.	76.09.010; 76.09.020 (2019)
	Forest and Forest Products	This Washington statute discusses the Forestry Riparian Easement Program and reimbursement to small forest landowners for preservation of timber resources and ecosystem services supported by the program.	76.13.120 (2019)
	Public Lands	This Washington statute discusses the community forest trust program and that preservation of "ecosystem services such as clean water protection or carbon storage." Wash. Rev. Code s 79.155.030(2)(c)	79.155.030 (2019)
California	Fish and Game	This California statute defines "Ecosystem-based management" as "an environmental management approach relying on credible science, as defined in Section 33, that recognizes the full array of interactions within an ecosystem, including humans, rather	Cal. Fish & Game Code § 43 (West 2019)

(continued)

Table 3 (continued)

State	Code Section	Summary	Citation
		than considering single issues, species, or ecosystem services in isolation." Cal. Fish & Game Code § 43 (West 2019)	
	Fish and Game	This California statute gives definitions of words used in the state's advance mitigation and regional conservation investment strategies and includes incorporating the benefits of ecosystem services as part of the "regional conservation assessment" definition.	Cal. Fish & Game Code § 1851 (West 2019)
	Public Resources	This California statute instructs the Ocean Protection Council to support sharing of information between state agencies and making that information publicly available with respect to "social, economic, and cultural values, including the value of coastal and ocean ecosystems for providing ecosystem services." Cal. Pub. Res. Code § 35620(a)(2)(E) (West 2019)	Cal. Fish & Game Code § 35620 (West 2019)
Rhode Island	Health and Safety	This statute is the legislative findings for the Rhode Island Climate Risk Reduction Act of 2010 where the legislature states that "natural ecosystems and habitats, both coastal and upland, provide critical ecosystem services including, fisheries habitat, drinking water, and flood protection." 23 R.I. Gen. Laws § 23-84-2(6)	§ 23-84-2 (2019)

- The Northwest Forest Plan's framework (e.g., Neuman 2007); and
- Legal and regulatory authorities for managing the coastal resources of the Gulf of Mexico (Nugent and Cantral 2006), such as the use of the Manguson-Stevens Fishery Conservation and Management Act (1976) for red snapper and other fishery species (Pace 2009).

Importantly, Federal laws have spurned state and local laws, often looking at the scale of a watershed, the boundary of which may not necessarily align with political or governance boundaries. Looking at a broader suite of examples related to water protection, Greenwalt and McGrath (2009) explore the tenets of a pay-for-ecosystem-services (PES) model at a watershed scale. For a specific example, the Safe Drinking Water Act spurred New York City to implement local regulations on protecting the Catskills and Delaware watersheds providing the primary source of clean drinking water for its citizens (Thompson 2008; Salzman et al. 2001; Salzman

2011; Robbins 2018a, b). Other watershed-scale examples include water-based natural and engineered services in the Columbia River Basin (Cosens and Fremier 2014), and the production (Greenwalt and McGrath 2009), purification (Salzman et al. 2001), and apportionment of water for municipal and other uses (Ruhl 2003). Green et al. (2014) examine EBM issues at different legal scales for coral reefs, an example where upstream land-use decisions may not align with different scales and domains of existing environmental regulations on the downstream resource of interest.

Local-scale forestry examples in the legal literature includes the ecosystem management of Tillamook State Forest, involving a range of stakeholders, different scales of regulatory hierarchy in forest and adjacent lands, and a suite of forest-related ecosystem services (Neuman 2007 and citations therein). Other local-scale examples include urban forest planning (Hirokawa 2011a, b), land-use policies for agrosystems (Ruhl 2008), and salmon fisheries (Hirokawa and Gottlieb 2011). Other urban ecosystem services issues, also considered local scale, are outlined in Salzman et al. (2014).

5 Conclusions

EBM practitioners work in an interdisciplinary universe, spanning a range of science, engineering, and management/policy backgrounds and expertise. This chapter presents an overview of the large spectrum of U.S. Federal environmental laws, with particular relevance to the field of ecosystem services. Anchored by a review of the extant legal scholarly literature, this chapter presents a review of a broad suite of ecosystem services topics in U.S. Federal environmental law specifically translated for EBM practitioners as the primary audience, pointing the reader towards resources to learn more about individual elements presented throughout the chapter. This chapter provides EMB practitioners information from the environmental law literature to inform how they frame the legal context of ecosystem services information in their EBM activities. Finally, this chapter helps the reader identify examples where relevant information might be transferable to their specific scenarios, such as how policy and legal directives are framed in the watershed-based EBM example of the Danube Basin (Funk et al. (2020)).

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