

Characterizing and Mapping of Ecosystem Services (CMESs) Literature Database Version 1.0

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Background

Ecosystem services (ESs) represent an ecosystem's capacity for satisfying essential human needs, directly or indirectly, above that required to maintain ecosystem integrity (structure, function and processes). The spatial characterization and mapping of ESs is an essential first step in establishing existing conditions to characterize, assess, value and communicate the impact of decisions that affect ESs and the benefits that flow to society. The US Environmental Protection Agency, as part of the Ecosystem Services Research Program, has a goal of developing a National Atlas of Ecosystem Services, thus we conducted an intensive literature survey related to characterizing and mapping ecosystem functions, processes, and services. We reviewed over 250 journal articles dating from 1990 to 2009. The number of articles on ecosystem services and related functions and processes has increased exponentially since 1990. Information on ecosystem services were summarized from the literature and assigned to general ESs classes as shown in Table 1. This literature database hereafter will be referred as the characterization and mapping of ecosystem services (CMESs) database. The CMESs Database was developed to aid the Landscape Ecology Branch in sorting through the ever increasing amount of data specific to mapping ecosystem services and is available to the public.

The following notes detail the construction of the database including keywords that were searched as part of this effort, a brief description of the data fields, and a description of how to access and use the database by adding records or viewing and printing pre-packed report forms.

Databases Searched

Biosis Previews; Environmental Science and Engineering; Agricola; NTIS; (National Technical Information Service); CAB Abstracts; General Science Abstracts; Waternet; Ebsco Greenfile; ScienceDirect; Electronic Collections Online; ArticleFirst; Wilson Select; WorldCat; SpringerLink; Taylor and Francis; AGU.

Key Words Searched

Ecosystem service(s), ecosystem service value(s), ecosystem benefits, natural capital, nature services, ecological economics, public goods, ecological service(s), environmental service(s), and maps, mapping, map, GIS, ecological indicators, metrics, scale(s), land use, landcover, land-cover, land cover, landscape planning, landscape, cover, land use, change, characterization, history, economic valuation, valuation, remote sensing & biodiversity, biodiversity & conservation, human health, human well-being, disease, sustainability, spatial, monitoring, ecosystem function, carbon, carbon sequestration, carbon storage, water quality, water quantity, water supply, hydrologic services, managing ecosystem resources.

Key words added:

Ecosystem structure, ecosystem condition, ecosystem changes, ecosystem, diversity, ecosystem health, ecosystem protection, ecosystem water quality, ecosystem management, ecosystem GIS, ecosystem remote sensing, ecosystem valuation, carbon flux, nitrogen storage, ecological remote sensing, landscape planning, ecosystem carbon sequestration, ecosystem and human health, landcover, land cover, land-cover change, spatially explicit.

Journals from which our compilation is derived

Advances in Marine Biology, Agricultural Systems, Agriculture, Ecosystems & Environment, American Journal of Agricultural Economics, American Journal of Agricultural Economics, American Midland Naturalist, American Society of Agricultural and Biological Engineers, Annals of the Missouri Botanical Garden, Aquatic Botany, Aquatic Conservation, Austral Ecology, Biodiversity Conservation, Biogeochemistry, Biological Conservation, BioScience, Bulletin of Marine Science, Climatic Change, Comptes Rendus Biologies, Conservation Biology, Current Science (Bangalore), Ecological Applications, Ecological Economics, Ecological Engineering, Ecological Indicators, Ecological Informatics, Ecological Modeling, Ecology, Ecology Letters, Ecosystem Health, Ecosystems, Environmental Management,

Environmental Modeling & Software, Environmental Monitoring and Assessment, Environmental Pollution, Environmental Science & Policy, Forest Ecology and Management, Freshwater Biology, Frontiers in Ecology and Environment, Geoderma, GeoJournal, GIScience and Remote Sensing, Global Change Biology, Global Ecology and Biogeography, Hydrobiologia, Hydrology and Earth System Sciences, International Journal of Remote Sensing, Irrigation and Drainage Systems, Journal of Environmental Quality, Journal of Agricultural Meteorology, Journal of Biogeography, Journal of Coastal Research, Journal of Environmental Management, Journal of Environmental Quality, Journal of Forestry, Journal of Hazardous Materials, Journal of Hydrology, Journal of Hydrometeorology, Journal of Paleolimnology, Journal of Remote Sensing, Journal of the American Water Resources Association, Journal of the North American Benthological Society, Journal of Vegetation Science, Journal of Wildlife Diseases, Lake and Reservoir Management, Land Economics, Landscape and Urban Planning, Landscape Ecology, Limnology and Oceanography, Mapping Sciences and Remote Sensing, Marine Ecology Progress Series, Nature, Oecologia, Philosophical Transactions of the Royal Society B: Biological

Sciences, Photogrammetric Engineering & Remote Sensing, Plant Ecology, PLoS Biology, Proceedings of the National Academy of Sciences, Proceedings of the Royal Society of Britain, Remote Sensing of Environment, Science, Silvo Fennica, Society and Natural Resources, Technological Forecasting & Social Change, The Journal of Animal Ecology, Urban Ecosystems, Waste Management, Water Resources Research, Western North American Naturalist, Wetlands, Wuhan University Journal of Natural Sciences.

Pre-defined searches

We developed and include in the database several pre-defined reports that were found to be most useful to the current database users; they include summary reports by individual journal article and by:

- Study Area(s)
- Primary ecosystem
- Types of models
- Report year
- General spatial scale (study area extent)
- Number and type of ecosystem services
- Summary by ecosystem services

Accessing and Using the Database

The database base was originally developed in Microsoft® Excel 97-2003 Worksheet and imported to Microsoft Access 2003. The Microsoft Access Tables, Queries, Forms, Report, Macros and Modules were created in Microsoft Access 2003. It was migrated to Microsoft Office Access 2007 SP2 MSO. It uses the Microsoft Office Access Database (.mdb) that has not been converted to the new Access file format (.accdb). Accessing the database can be done from the CD itself or from your PC (after saving it on your personal computer). To make database changes, you will have to copy the database to your PC.

**Note: page layout will be different between versions of Microsoft Office Access.*

Create a folder named CMES and copy the files on the CD into it. Double clicking on the “Start” button with the Explorer icon will get you to the front page of the database (Figure 1).

You are given the choice of starting Access or going to the LEB website for more information about the Landscape Ecology Branch. Start Access. You will be prompted to save or open the file. If you have not yet saved the database in the CMES file you created, do so now. If you have already saved the database and started from your

(<http://k2626unvgu001.las.epa.gov:9876/lv/CMES/Start.htm>)

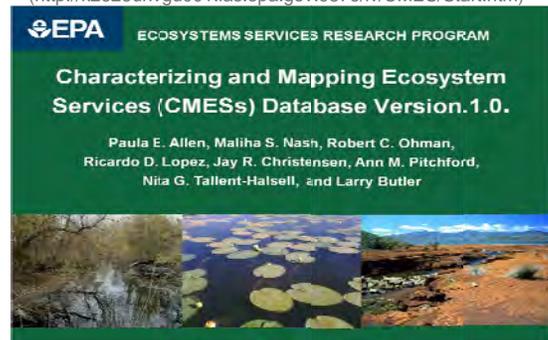


Figure 1. Top Panel

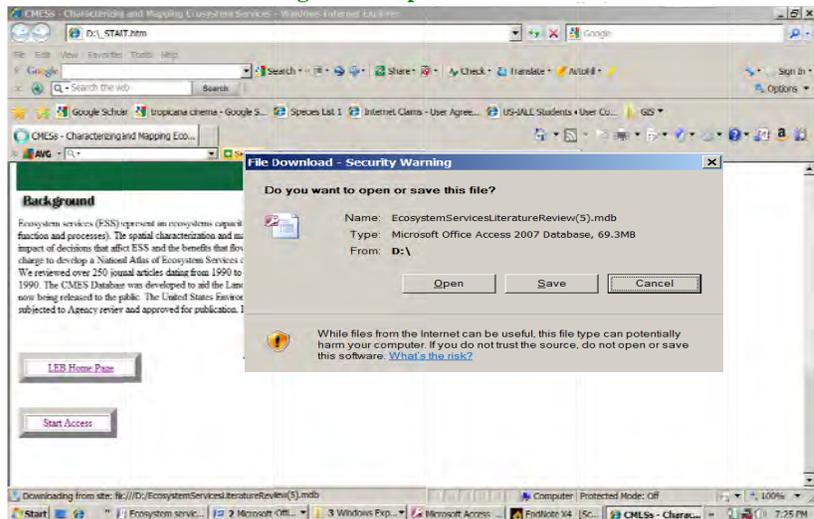


Figure 1. Bottom Panel

CMES file then open the file; you will be brought to the first page of the database (Figure 3). In some cases, new users may be prompted to a security warning (Figure 2).

Clicking the “Open” button will bring you to the first page of the database (Figure 3). From here you have several options. You may advance through each record by selecting the directional arrows in the lowerleft corner of the screen. You can scroll through records based on several types of data. The first button on the right side of the screen with the binocular icon allows you to search the entire database by keyword or to search the database for a particular author. In Microsoft Office Access 2007, this icon may not work unless you first enable the feature.

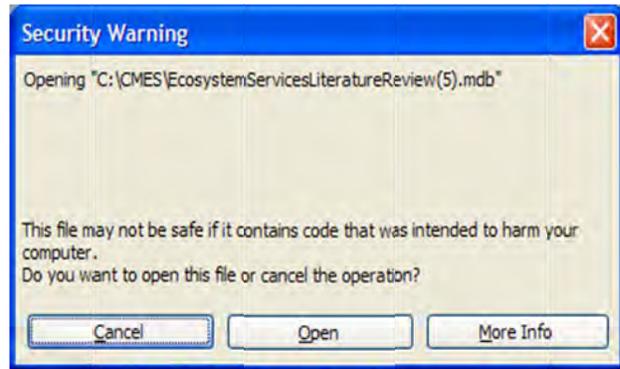


Figure 2. Security warning when opened

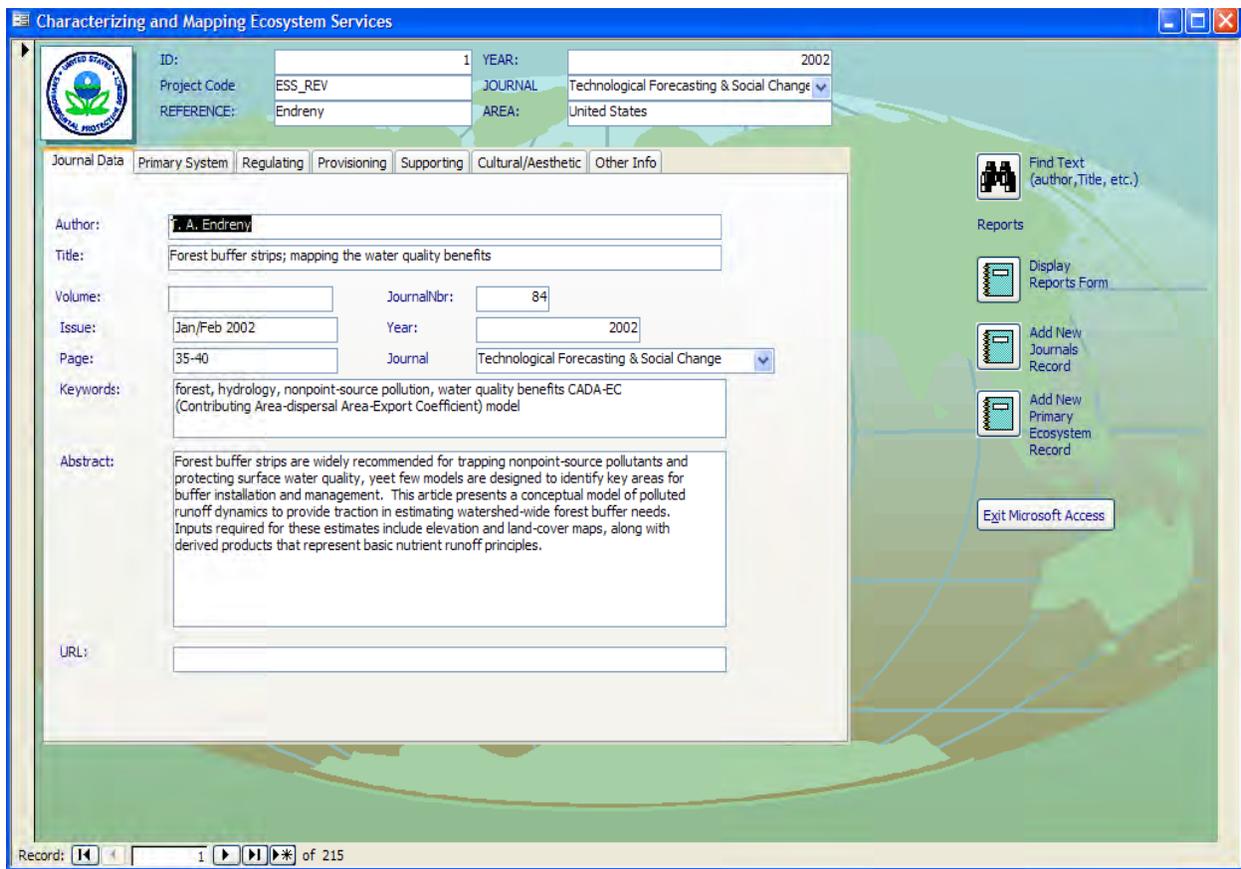


Figure 3. Characterization and Mapping Ecosystem Service window. “ESS_REV” in Project Code denotes ecosystem services reviewed and used by the USEPA Landscape Ecology Branch (LEB).

You may receive a security warning that certain content in the database had been disabled (Figure 4). There is an options button that allows you to enable the content.

You may also use the “binocular” icon or “find” button in the Microsoft Office Access program itself. The other two buttons in Figure 3 “Add New Journal Record” and “Add New Primary Ecosystems Record” allow you to add a new journal or primary ecosystem but the item will not appear on the “JOURNAL” pull down menus.

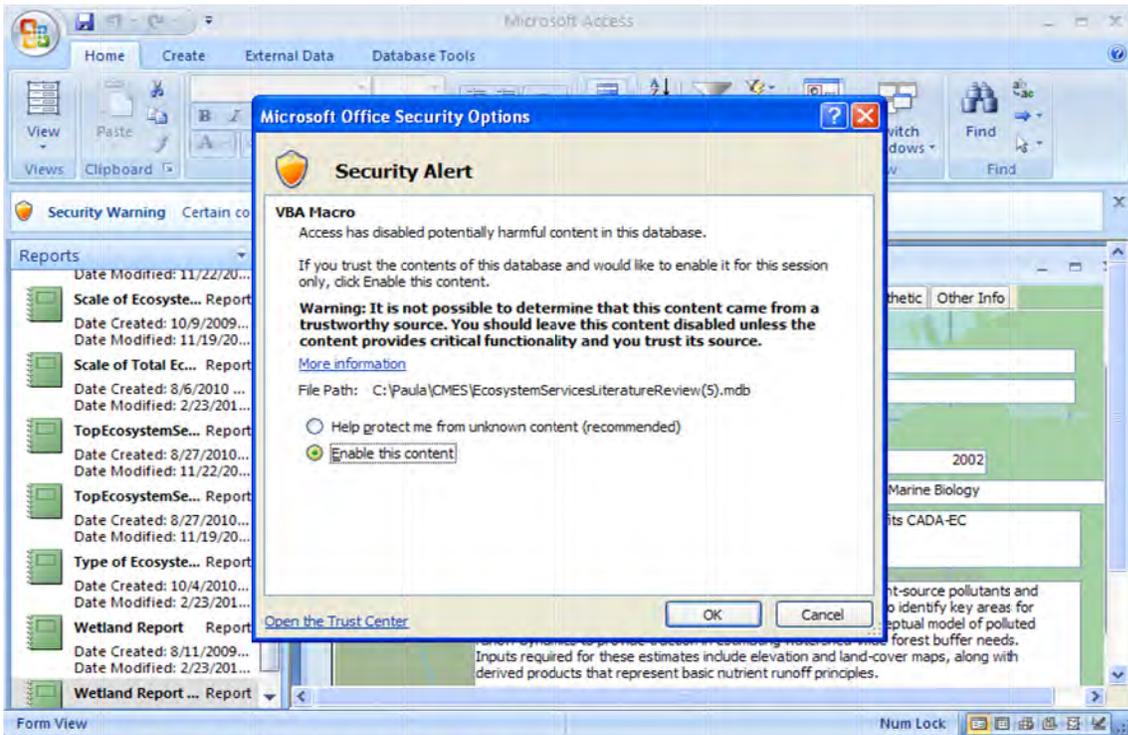


Figure 4. Click on “Enable this content” to proceed.

Making New Database Entries

To make database entries, you will have to copy the database to your PC. To make a new entry in the database, scroll to the last record as in Figure 5, on the first page of the database form (Figure 6) fill out the relevant fields.

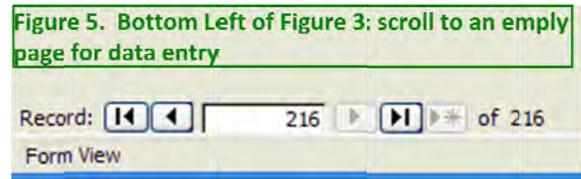


Figure 5. Bottom Left of Figure 3: scroll to an empty page for data entry

If the Journal does not appear on the pull down menu you must first add it. From the CMESs window press , which will take you to Figure 2.

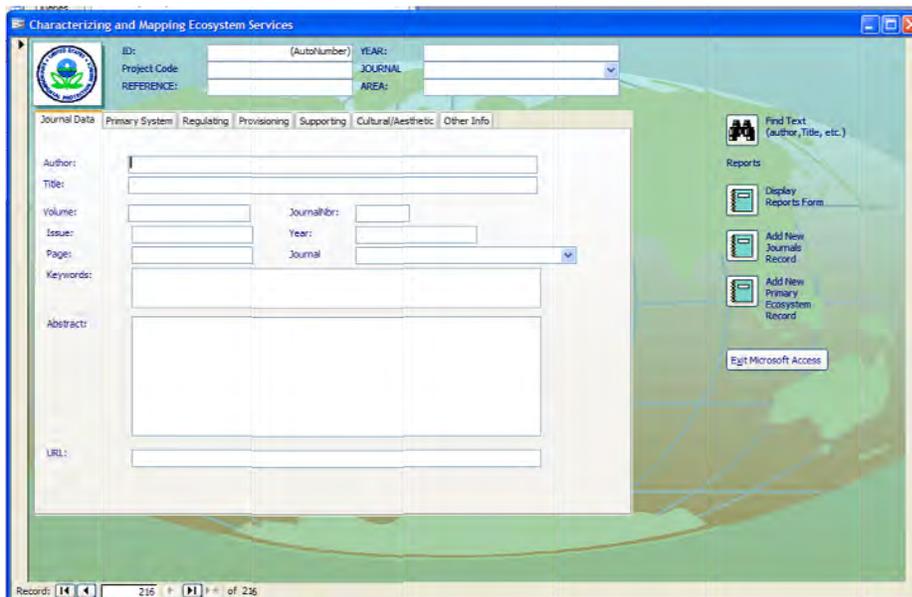


Figure 6. New data entry page.

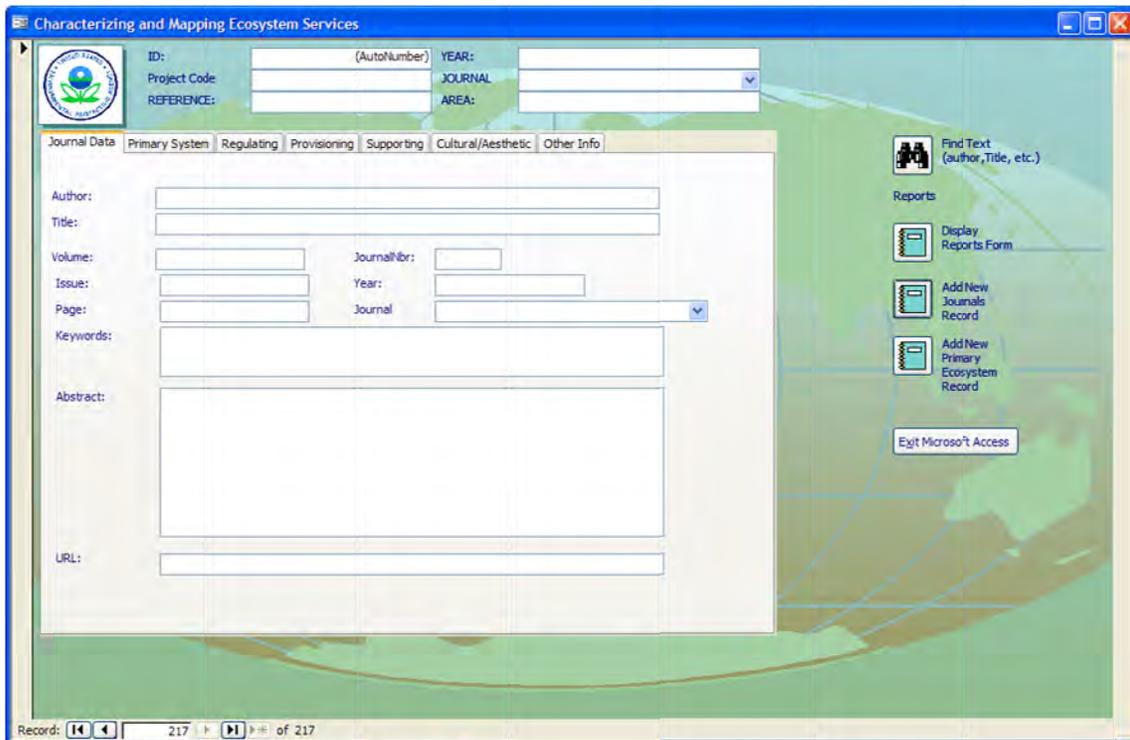


Figure 7. New information entry for record 217.

Then select “Add New Journal Record” button to the right of the screen, you will be taken to a window as shown in Figure 8 which shows the ID number of the last record and last journal (i.e. 92). Press **Home** to go to the first of the blank fields. Now fill in the new ID (e.g. 93), in the JournalID field and type in the Journal name (Fig. 8). The journal will now appear in the pull down menu and can be selected in your new entry. Figures 8 and 9 describe the entry of new journal. Close, refresh, go back and search for the journals in CMESs window to confirm the new entry (Fig. 9).

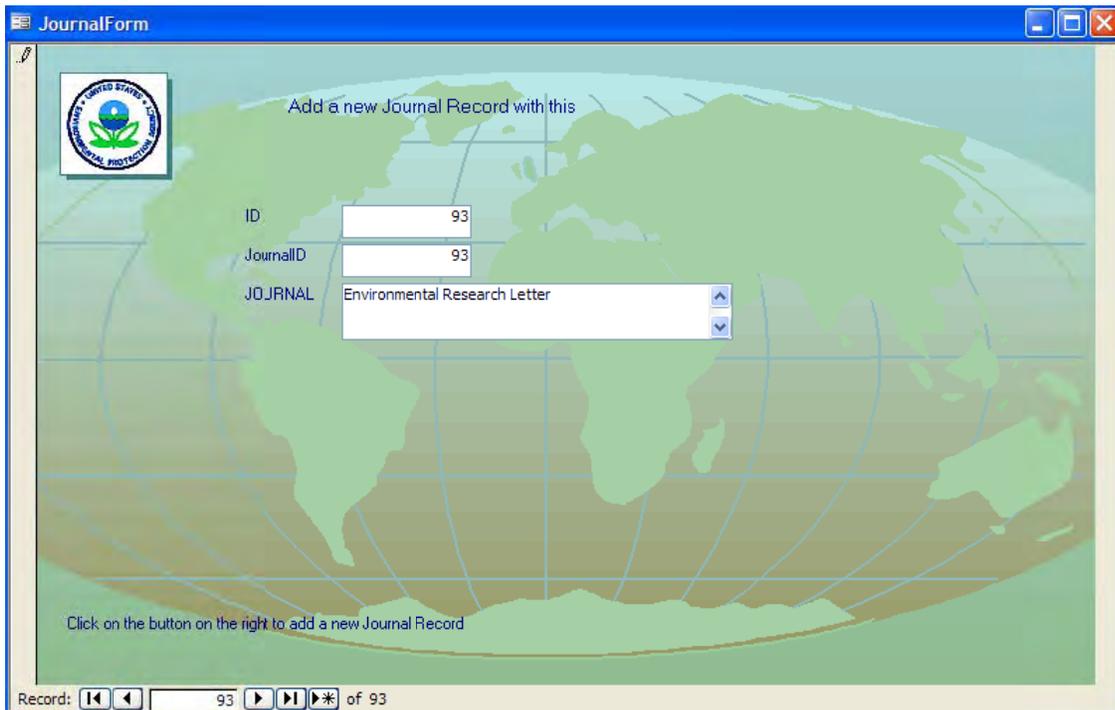


Figure 8. Journal Form for entering new journal that is not in the list.

ID: 221 YEAR: 2008
 Project Code: 216 JOURNAL: Environmental Research Letter
 REFERENCE: AREA:

Journal Data Primary System Regulating Provisioning Supporting Cultural/Aesthetic Other Info

Author: Tourre YM
 Title: Spatio-temporal
 Volume: 3 JournalNbr: 93
 Issue: Year: 2008
 Page: Journal: Environmental Research Letter
 Keywords:

Figure 9. The new Journal has been added, enter the rest of the new information and refresh to retain entries.

This same procedure applies to adding additional ecosystems; select “Add New Ecosystem”, Add the PrimSysID corresponding to the record number in the lower left scroll field, Exit the form, and return to the first page of your new entry. After completing the entry of the Journal Data, select the Primary System folder. The new ecosystem will now appear in the pull down menu of the Primary Ecosystem field. Select yes or no for remaining pages and fields where applicable.

ID: Project Code: ESS_REV REFERENCE: Endreny JournalNbr: 84

Single Journal Article Information	Summary Charts BIBLIO or ESS_REV	Summary Charts All Projects	Ecosystem BIBLIO or ESS_REV	Ecosystem Total
Scale and Eco-System	Number of Articles by Journal	Number of Articles by Journal	Scale (Extent)	
Journal Information	Research Location	Location Research	Models	
Ecosystem Services	Publication Year	Publication Year	Wetland Report	Total Wetland Report
	Top Ecosystem Services	Top Ecosystem Services		
	Research Scale	Research Scale		

Record: 1 of 215

Figure 10. Report print selections.

Printing and Displaying Reports

The Display Reports Form button (Figure 10) takes you to a series of printable forms. The forms can be printed by individual journal article or summarized by article ID. Summaries of data collected from individual journal articles are available on three separate forms (Scale and Ecosystem; Journal Information, or Ecosystem Services). You must input the ID number of the article in the database you want to print on each of the forms that correspond to data you wish to print. To exit the form and return to the selectable forms page simply hit the close window button in the upper right of your menu bar .

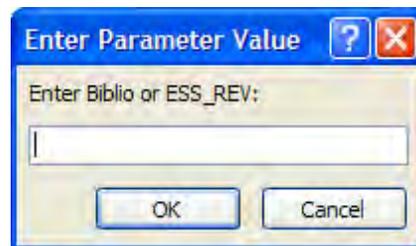
To exit the selectable forms page and return to first page of the database, again simply hit the close window button on your menu bar .

The second set of forms allows you to print histograms and corresponding tables that summarize database information by project code. For example, to develop a summary chart for all projects by number of articles and journal, press.

T



This will prompt you to Enter “Biblio” for bibliography or enter “ESS_REV” for ecosystem reviewed. You must enter the exact project name.



The following information can be summarized: the number of articles by journal, location of research, publication year, ecosystem services and research scales (Figure 11). When any one of these forms is selected you must type in the project code **twice** before the form is completed; once to call up the table and once to create the histogram. Additionally, by right clicking your mouse on the figure and selecting export, you are able to export the summarized data to several different formats including Excel.

The next set of forms (third column of forms) is similar to the second and summarizes data in the entire database; therefore you do not have to enter a project code for these forms.

The wetland report in the next column will list the articles where wetlands were the primary ecosystem after selecting a project code. This report lists the ID numbers and basic reference information for the articles so the wetlands data in the database can be found and printed easily.

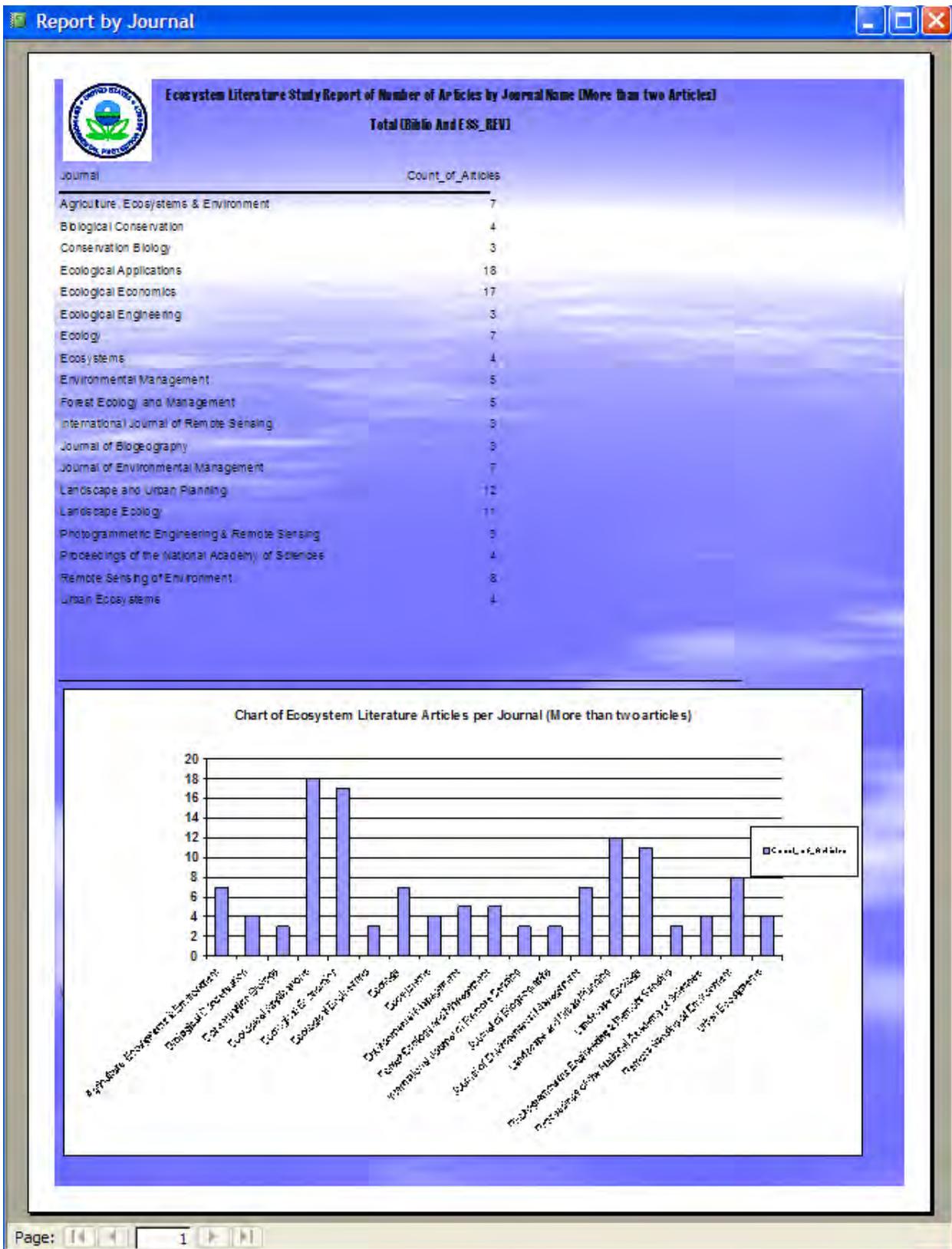


Figure 11. An example of a report output.

Database Fields and Their Definitions

The database was developed in Access 2003 and includes the following data fields:

- Project Code – Provided for LEB internal use, however users have the ability to add their own codes
- Brief comment
- LEB Reference Number – Relates specifically to documents being prepared by the Landscape Ecology Branch
- Short Reference – Primary authors and year of publication
- Year – Year of publication
- Journal – Journal that the article appears in
- Area – The location(s) of project sites studied by the authors
- Spatial Scale – The spatial extent(s) of project sites studied by the authors. If known, the spatial extent is given in km²
- Temporal Scale – The temporal duration of the studies conducted by the authors. If known, the temporal duration is given in years.
- General Scale- The articles were grouped based on the generalized extent of a projects area. The general scales are defined as follows:
 - Local –A single basin or less and include multiple watersheds, urban areas, islands, and households etc.
 - Subregional – More than one basin.
 - Regional – Areas with common biophysical characteristics (e.g., Midwest corn belt, Atlantic Coastal Plain).
 - SubNational – Large areas covering at least 1/3 of the nation.
 - National – Country-wide or for the United States, covering at least the lower 48 states or continental US (CONUS).
 - Continental – North America, South America, Asia, Europe, etc.
 - Global – The entire planet.
- Primary ecosystem addressed – An ecosystem was the primary research target . However, few ecosystems are studied without an understanding of their relationship to other ecosystems.
- Other ecosystems addressed – Ecosystems that were of secondary importance in the study. In some cases where land cover was the target and the researcher did not explicitly establish all of the various cover types, they were regarded as multiple ecosystems only.
- Ecosystem Services – The services that were the focus of the research by the authors. We included biodiversity and habitat as well as several quality of life indicators (Table 1). Although several services can be placed into more than one class, we selected one class for each ecosystem service, based on our expert judgment, in order to summarize the data. For example, waterfowl production could be either a provisioning/supporting or cultural service. Although waterfowl production is managed primarily for recreational purposes (hunting and bird watching), waterfowl may also provide food for subsistence and support biodiversity and ecosystem integrity. Because waterfowl production supports recreation, we felt it played more supporting roles and so placed it in the supporting class. The characterization of a service depends both on semantics and individual research goals.

Our original list of services also included quality of life (QOL) indicators summed as a group. We eliminated this service and placed all of the QOL indicators under the cultural class of services. The QOL indicators are identified in Table 1 with an asterisk. Users can reclassify services in the database.

- Primary Tools – We grouped the primary tools used to study ecosystem services into six major categories; geospatial models, neutral models, process models, statistical models, land cover change models, or climate change models, and further identified where models were used for development of future scenarios.

The United States Environmental Protection Agency, through its Office of Research and Development, funded this research. The work has been subjected to Agency review and approved for publication. Approval does not signify that the contents reflect the views of the Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

Acknowledgment: The authors are grateful for the input of Dr. David Bradford and Ms. Caroline Erickson (US Environmental Protection Agency, Landscape Ecology Branch). Authors also thank Mr. Gerald Brimer for proof reading the manuscript.

Table 1. Ecosystem Services in the database identified from the literature. ‘*’denotes quality of life indicators.

Ecosystem Services	Classes of Ecosystem Services			
	Provisioning	Supporting	Regulating	Cultural
Aesthetics*				X
Air Quality (clean air)	X			
Avalanche Protection			X	
Biodiversity		X		
Bio-prospecting	X			
Carbon cycling			X	
Crop Production	X			
Disturbance Regulation (natural and human)			X	
Economic Activity*				X
Economic Stress (stress reduction, i.e. human health)*				X
Ecosystem Resilience/integrity			X	
Energy Supply*	X			
Existence Value*				X
Fish Production	X			
Flood Control			X	
Food and Fiber	X			
Forage Production	X			
Natural Gas regulation			X	
Habitat (any)		X		
Habitat (fish & wildlife)		X		
Habitat (general)		X		
Habitat (LULC)		X		
Housing Density*				X
Housing Prices/value				X
Human Disease Regulation			X	
Human Health			X	X
Invasive Species Risk Reduction			X	
Jobs*				X
Livestock Production	X			
Nitrogen Cycling			X	
Non-timber forest production	X			
Open Space/greenspace*				X
Phosphorus Cycling			X	
Pollination		X		
Pollution Attenuation			X	
Quality of Life (any)				X
Reduced Traffic*				X
Reed Cutting	X			

Ecosystem Services	Classes of Ecosystem Services			
	Provisioning	Supporting	Regulating	Cultural
Soil formation or retention			X	
Soil Quality		X		
Subsistence Food Production	X			
Timber harvest/ production	X			
Tourism				X
Viewshed*				X
Water Flow Regulation (flow and retention)			X	
Waterfowl Production		X		
Water Quality (clean water)	X			
Wave Attenuation			X	
Wilderness Protection		X		X
Wildlife Health	X			