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Evaluation of Publicly Accessible Nature-Based Solutions Databases as Sources for Evidence of Effectiveness

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INTRODUCTION

Nature-based solutions (NBS) are "actions to protect, sustainably manage, or restore natural or modified ecosystems to address societal challenges, simultaneously providing benefits for people and the environment" (White House Council on Environmental Quality, White House Office of Science and Technology Policy, White House Domestic Climate Policy Office 2022). They present opportunities to simultaneously tackle both the climate and biodiversity crises by supporting carbon sequestration in ecosystems, enhancing community resilience to climate hazards, and providing high-quality habitats for diverse species. However, uncertainty around the performance and reliability of NBS continues to be raised by engineers, local decision-makers, grant-makers, and the insurance industry as an obstacle for widespread implementation of NBS at scale. This uncertainty indicates the need for comprehensive and accessible data on NBS projects and outcomes that could be used to develop engineering standards, assess projects' cost-benefit ratios, and incorporate NBS into insurance premium pricing.

A first step in addressing this challenge is understanding where different types of NBS projects have been implemented, what their intended outcomes were, how those projects have performed, and what factors have influenced their performance. This report evaluates the NBS data currently accessible through public databases to get a sense of what types of information they contain, what types of NBS are included, their geographic scope, and how accessible the data are. In total, 27 databases with publicly available information were assessed—6 on NBS research studies and 21 on individual projects (Table 1).

The project objectives were to achieve the following:

- Understand the information currently available on NBS performance through research literature and project-level reporting in existing databases
- Evaluate the type and utility of information contained in each identified database
- Assess the coverage of NBS information available in the identified databases in terms of geography and NBS types
- Identify gaps in NBS database coverage and utility

Table 1. Evaluated NBS Databases

	Literature Databases		Project Databases
٠	Agricultural Best Management Practices (BMP) Database	٠	Coastal Resilience Dashboard (National Fish and Wildlife Foundation)
	(International Stormwater BMP Database)	•	Coastal Systems Portfolio Initiative (US Army Corps of Engineers [ACE])
٠	BlueValue (Harte Research Institute)	•	Conservation and Adaptation Resources
•	Green Infrastructure Effectiveness Database (National Oceanic and Atmospheric Administration [NOAA])		Toolbox Case Study Dashboard (US Department of the Interior [DOI], University of Arizona)
•	Nature-Based Solutions Evidence Platform (University of Oxford)	•	Engineering with Nature ProMap (Engineering with Nature)
•	River Engineering Resources (Network for Engineering with Nature)	•	Great Lakes Regional Habitat Restoration Database (NOAA-Great Lakes Commission [GLC] Regional Habitat Restoration Partnership)

Literature Databases	Project Databases
Stream Restoration Database (International Stormwater BMP	 Gulf Spill Restoration Projects (NOAA, Deepwater Horizon Trustee Council)
Database)	 Habitat Restoration & Protection Database (Long Island Sound Study)
	 Living Shorelines Project Map (NOAA)
	 Low Impact Development (LID) Atlas Map (South Carolina Sea Grant)
	 Low Impact Development Atlas (Nonpoint Education for Municipal Officials [NEMO] Program, University of Connecticut)
	 National Beach Nourishment Database (American Shore & Beach Preservation Association)
	 Naturally Resilient Communities Solutions and Case Studies (Naturally Resilient Communities)
	 Nature-Based Solutions (Nature-Based Solutions)
	 Nonpoint Source Watershed Projects Data Explorer (US Environmental Protection Agency [EPA])
	 Regulatory In-Lieu Fee and Bank Information Tracking System (US ACE)
	Restoration Atlas (NOAA)
	 Restoration Database (Society for Ecological Restoration)
	 Thin-Layer Placement Case Studies Map Portal (US ACE)
	 Urban BMP Operations and Maintenance (O&M) Cost Database (International Stormwater BMP Database)
	 Urban Stormwater BMP Mapping Tool (International Stormwater BMP Database)
	 US DOI Bipartisan Infrastructure Law Projects Map (DOI)

Note: Several additional databases with NBS-relevant information were not further evaluated because they focused on large-scale planning or programs rather than individual projects or because NBS-relevant information could not be separated from non-NBS information. These databases are listed in Table C1.

RESULTS

We found two primary types of databases—those that collate research publications and those that collate project data. Database features and detail provided on individual NBS publications and projects vary, influencing their utility for understanding NBS implementation and effectiveness (Figure 1). The literature databases are useful for identifying key outcomes of NBS project types and finding studies with effectiveness data, but effectiveness information is generally not available within the database itself—users must access the underlying primary literature. Similarly, most of the literature databases do not provide details on project design or baseline (pre-project) data, but some of the underlying publications may have more detail. The level of detail of descriptive information (e.g., location, NBS type) and how that information can be used to find publications (e.g., in filters or searches) varies by database. The utility of some databases is limited as it is not easy to find relevant publications when filters or descriptive information are too broad. Four of the six literature databases allow users to download results for use in a broader workflow.



Figure 1. Overview of NBS database characteristics

Note: Numbers represent the number of databases with each characteristic. The database features section (top half) categorizes each database by whether it includes each listed feature. Some databases include a limited version of the feature (e.g., only some of the information in the database is downloadable). The level of detail and coverage section (bottom half) categorizes each database on a low/moderate/high scale for several aspects of level of detail and breadth of coverage. High level of detail on NBS project type means that specific project types are listed (e.g., living shoreline, rain garden), while low level of detail means that descriptions are very broad (e.g., habitat restoration). High breadth of NBS types included means that the database focuses on just one type of NBS. Databases with high level of detail on project/study location provide point locations or city-level information, while databases with low location detail provide no location information or country-level information. Databases with high breadth of geographic scope are limited to one state.

The project-level reporting databases primarily provide information on NBS project types and locations. While some include information on primary project benefits or objectives to help users understand why projects are being implemented, only four have any effectiveness data for evaluating project performance, and these tend to be limited or incomplete (e.g., data is only available for water quality parameters, not all projects in the database include effectiveness information, and so on). While few databases include baseline (pre-project) data or details on project design, the databases that do have this information tend to be the same ones with at least some effectiveness data, making them most useful for evaluating how project design impacts performance.

All but three project databases included mapped points or footprints for individual projects, but several do not allow users to search or filter by geographic attributes (e.g., state), making it difficult to identify projects within a focal area or assess the distribution of projects among states. Only six of the project databases allow users to download project information, which is necessary to combine information from multiple sources, overlay project locations with other spatial data, or document search results.

Geographic coverage is unequally distributed within the United States in both literature and project databases (Figure 2). The Northeast and Southeast regions have the most publications in the evaluated literature databases and the most projects in the evaluated project databases. The Alaska, North Central, and Pacific Islands regions are poorly represented across all evaluated databases, while the Northwest and Southwest are also poorly represented in the literature databases. A handful of states are prominently featured in both database types: 24% of all publications in the literature databases are from Florida, North Carolina, or Louisiana; 25% of all projects in the project databases are from California, Florida, or North Carolina.



Figure 2. Total number of entries within all evaluated databases, summarized by Climate Adaptation Science Center region

Note: See Figures A4-5 and B3-4 for regional and state-level maps differentiated by database type (literature or project).

Assessing coverage of different NBS topics across multiple databases is challenging. Each database uses its own set of categories to classify entries by NBS type (or in some cases habitat type), making it difficult to combine information from multiple databases or find similar projects in different databases. We classified entries in each database based on the primary relevant habitat type (Figure 3).



Figure 3. Database entries by type (project or publication) and habitat

Note: Box size represents the number of entries. There are about five times as many projects included in the project databases (a) as there are publications included in the literature databases (b).

NBS projects in coastal habitats are most represented in the project databases, followed by built environments (NBS in urban areas; often but not limited to stormwater projects). For project databases, there is relatively little information (50 projects or fewer) on NBS in agricultural lands, grasslands, and mountains.

Agricultural settings are by far the most represented in the literature databases, followed by coastal habitats. For literature databases, there is very little information (five publications total) on NBS in deserts and shrublands, and relatively little information (fewer than 50 publications) on NBS in grasslands, mountains, and nontidal wetlands. While forests have relatively low representation in either literature or project databases, data on effectiveness of forest management techniques that could be considered NBS may be available in databases not found through our search, which focused on databases that use descriptors such as *nature-based solutions, restoration*, and *green infrastructure*.

RECOMMENDATIONS

There is a large amount of useful information on NBS projects and (to a lesser degree) effectiveness available in the evaluated databases, but the lack of consistent organization and terminology makes it difficult to combine or compare data from various sources. We have several recommendations that could be implemented by individual databases to improve user experience in the short term while also taking steps toward allowing data from multiple sources to be combined in a synthetic database as a centralized way to access key information and aggregate results:

- Make the full database downloadable as a comma-separated value (CSV) file
- Include categorical geographic information (e.g., county, state, country) as an attribute of each database entry, in addition to project coordinates where available

- Develop and use a unified typology for nature-based solutions and habitat types for consistency across databases
- If possible, include key project outcomes as a separate attribute, rather than including them in a longer project description
- In project databases, include pre-project measurements if available, and as much design and build information as possible (as attached PDFs if necessary) to provide baseline information for retrospectively evaluating effectiveness of projects

Addressing the lack of project effectiveness data will require significant additional effort, as effectiveness is not currently measured or reported by many NBS projects consistently or at all. In-depth discussions by stakeholders and experts are likely needed to identify consensus metrics and monitoring techniques, and it will take time to implement monitoring and collect the effectiveness data that is most needed. In the meantime, the recommendations we propose are relatively minor adjustments that would significantly enhance the usability of existing NBS databases and facilitate collation of data in a synthetic database to which effectiveness data could be added.

For more detail on the methods and results of this database review, see the Appendices.

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APPENDIX A—LITERATURE DATABASES

Table A1. Key Attributes of NBS Literature Databases

Database (Organization)	Entries	Last Update	Search?	Filters?	Outcomes Listed and Quantified?	Location Detail	NBS Type Detail	Downloadable (Format)
Agricultural BMP Database (International Stormwater BMP Database)	1317 publications	2019	No	Yes	Water quality measurements provided, but more analysis would be needed to assess outcomes	None	Specific (e.g., cover crops, filter strips, grassed waterways)	Yes (Access database)
BlueValue (Harte Research Institute)	1279 valuations from 173 publications	Not provided	No	Yes	Ecosystem services are listed and quantified in economic units	Country and state	Broad (type of habitat, e.g., mangroves, coastal wetlands)	Yes (CSV or PDF)
Green Infrastructure Effectiveness Database (NOAA)	378 publications	3/12/2024	Yes	Yes	Outcomes listed but not quantified	State	Specific (e.g., artificial reef, beach restoration)	No
Nature-Based Solutions Evidence Platform (University of Oxford)	223 publications	Not provided	Yes	Yes	Climate change impacts listed with direction of effect (not quantified); ecological outcomes and social outcomes not listed, but a combined direction of effect is provided for each	Country	Broad (e.g., management, protection, restoration; also has habitat information)	Yes, literature information only (CSV)
River Engineering Resources	127 publications	Not provided	Yes	Yes	No	None	Specific (e.g., dam removal retrofit, floodplain	No

Database (Organization)	Entries	Last Update	Search?	Filters?	Outcomes Listed and Quantified?	Location Detail	NBS Type Detail	Downloadable (Format)
(Network for Engineering with Nature)							reconnection, beaver dam analog)	
Stream Restoration Database (International Stormwater BMP Database)	24 publications	2015	No	Yes	Monitoring data provided, but more analysis would be needed to assess outcomes	City, county, state, country	Specific (project design table has information on activities performed)	Yes (Access database)

Note: Information is current as of April 2024. Some databases include multiple rows, or cases, from individual studies. For example, the BlueValue database includes a row for each reported valuation in a study; some studies report separate valuations for different benefits or habitat types.

Content and Functionality

The six literature databases all provide lists of published literature that can be filtered (e.g., by ecosystem type, project type, geography), and half also have search functionality (Figure A1, Table A1). Most of these databases focus on research about the effectiveness or benefits of NBS projects. This makes them a useful starting point for literature synthesis about NBS project effectiveness and can also help users find studies that address the effectiveness of certain project types in particular locations, which can guide initial project planning.

Figure A1. The NOAA Green Infrastructure Effectiveness Database includes several filter options (fields with drop-down arrows in the right column, along with the "Source Type" field in the left column) as well as search functions for title, authors, and keywords

Green Infrastructure Effectiveness Database This database is a compilation of literature resources documenting the effectiveness and economics of green infrastructure for coastal resilience.									
	Title:	Use quotations when searching for an exact title.	Green Infrastructure Type:	~					
	Author(s):	e.g. author(s), comma separated	Hazards:	~					
	Year published:	201 2023	Methodological Approaches:	~)				
	Source:	e.g. journal name	Study Scale:	~					
	Source Type:	~ ``	Region:	~					
	Keywords:	e.g. keyword(s), comma separated	State:	~					
				Clear form	n				
			Search						
			YAUT						

These literature databases are useful for identifying studies of NBS projects that may provide effectiveness data or that could be used in a targeted synthesis or valuation study. Most of them do not include key results from the publications within the database itself, instead requiring users to access the individual publications to obtain that information. One database that does provide some effectiveness information is the NBS Evidence Platform, which includes the direction of the effect for each targeted climate change outcome, as well as for ecological and social outcomes (Figure A2). However, the specific ecological and social outcomes considered by each study are not listed. The Agricultural BMP Database and the Stream Restoration Database include a large amount of monitoring data (e.g., water quality, hydrological, biological, and physical measurements) presented as individual data points. The monitoring data include baseline (upstream of project) measurements as well as downstream measurements, facilitating evaluation of effectiveness. Further analysis using these data is required to understand the effect that the NBS projects being studied had on these parameters.

Figure A2. Screenshot from the NBS Evidence Platform with information on the effect of the intervention on the specified climate change impacts ("CCI" column), described as a directional effect in the "Effect of NbS" column

Case 050-1	Country United States of America	Intervention Restoration	Ecosystem type Temperate grasslands Wetlands	CCI Freshwater flooding	Effect of NbS Positive	Ecological & social outcomes Positive, Positive
Case 067-1	Country United States of America	Intervention Restoration	Ecosystem type Deserts and xeric shrublands	CCI Soil erosion	Effect of NbS Unclear results	Ecological & social outcomes Not reported, Mixed
Case 081-1	Country United States of America	Intervention Restoration	Ecosystem type Saltmarsh	CCI Biomass cover loss	Effect of NbS Positive	Ecological & social outcomes Not reported, Positive
Case 100-1	Country United States of America	Intervention Restoration	Ecosystem type Deltas and estuaries	CCI Coastal inundation	Effect of NbS Positive	Ecological & social outcomes Not reported, Positive
Case 102-1	Country United States of America	Intervention Restoration	Ecosystem type Mangroves	CCI Coastal inundation	Effect of NbS Positive	Ecological & social outcomes Not reported, Positive
Case 107-1	Country United States of America	Intervention Restoration	Ecosystem type Streams, rivers, riparian	CCI Loss of food production	Effect of NbS Positive	Ecological & social outcomes Not reported, Positive
Case 107-2	Country United States of America	Intervention Restoration	Ecosystem type Streams, rivers, riparian	CCI Soil erosion Loss of food production	Effect of NbS Positive Positive	Ecological & social outcomes Not reported, Positive

Note: The "Ecological & social outcomes" column includes the overall direction of effect on all ecological or social outcomes measured in the study, but these outcomes are grouped together and not specified.

Literature databases vary in the level of detail in the location, habitat, and NBS type information provided for each publication and used in filters. Location information ranges from city-level (Stream Restoration Database) to state-level (NOAA Green Infrastructure Effectiveness Database, BlueValue) to country-level (NBS Evidence Platform). However, some sources (River Engineering Resources) do not include any location information. Habitat type is defined and available as a filter in the NBS Evidence Platform and BlueValue, but not in the Green Infrastructure Effectiveness Database. The remaining literature databases are devoted to specific habitat types (River Engineering Resources, Agricultural BMP Database, Stream Restoration Database) and therefore do not include habitat filters. NBS types are very specific in the Green Infrastructure Effectiveness Database, River Engineering Resources, Agricultural BMP Database, and Stream Restoration Database, but broader in the NBS Evidence Platform and BlueValue (see examples in Table A1). Users will have an easier time finding relevant information when databases provide more detailed categories for location, habitat, and NBS type.

Only half of the literature databases (Green Infrastructure Effectiveness Database, Agricultural BMP Database, and Stream Restoration Database) provide information about when they were last updated. For the others, it is unclear whether they are regularly updated or even if they have been updated at all since their initial release. The most recent entries in the NBS Evidence Platform were published in 2020, BlueValue contains publications as recent as 2023, and River Engineering Resources includes entries up to 2022.

Finally, four of the identified literature databases allow users to download results, which facilitates the use of the results in a broader workflow such as screening literature for synthesis or incorporating publications into a larger list. BlueValue provides a downloadable CSV file containing information on the literature sources and ecosystem service valuation results, while the NBS Evidence Platform provides a CSV file that includes identifying information for the literature sources, but not the information on project type, location, climate change impacts, or direction of effects that is shown in the database. The Agricultural BMP Database and Stream Restoration Database are both downloadable as very detailed Access databases. These comprehensive resources provide the foundation for evaluating performance.

Geographic and Topical Coverage

Only the Green Infrastructure Effectiveness Database, BlueValue, and Stream Restoration Database could be assessed for geographic coverage within the United States, since the NBS Evidence Platform provides country-level information and River Engineering Resources and Agricultural BMP Database provide no location information. For those three literature databases, the Northeast and Southeast regions have the most publications; 61% of publications in the databases are from one of those regions (Figures A3 and A4). In contrast, the Alaska, North Central, Northwest, and Southwest regions are poorly represented, with just 10% of publications in the databases from these regions.





Note: A publication may be counted under multiple regions if its study area spans more than one region.



Figure A4. Map view of regional representation in literature databases

Note: Literature databases included: Green Infrastructure Effectiveness Database, BlueValue, and Stream Restoration Database.

At the state level, Florida, North Carolina, and Louisiana are most represented, collectively making up 24% of all publications in these databases (Figure A5). Nine states (Alaska, Kansas, Missouri, Nebraska, Nevada, New Mexico, Oklahoma, Utah, and Wyoming) are represented by only one publication across the three databases. Five states (Idaho, Kentucky, Montana, Tennessee, and West Virginia) are not represented at all. The greater representation of coastal states is not surprising, because two of these three databases focus on coastal NBS and habitats, as discussed in the next paragraph. See Table A2 for complete information on state-level representation within these databases.



Figure A5. State-level representation in literature databases

Note: Literature databases included: Green Infrastructure Effectiveness Database, BlueValue, and Stream Restoration Database.

State or Territory	No. of Publications–Literature Databases
Alabama	17
Alaska	1
American Samoa	6
Arizona	2
Arkansas	2
California	17
Colorado	5
Connecticut	10
District of Columbia	2
Delaware	10
Florida	54
Georgia	8
Guam	7
Hawaii	12
Idaho	0
Illinois	11
Indiana	2
lowa	4
Kansas	1
Kentucky	0
Louisiana	39
Maine	7
Marshall Islands	4
Maryland	24
Massachusetts	20
Michigan	15
Minnesota	6
Mississippi	7
Missouri	1
Montana	0
Nebraska	1
Nevada	1
New Hampshire	8
New Jersey	28
New Mexico	1
New York	24
North Carolina	39
North Dakota	2
Northern Mariana Islands	5

Table A2. State- or Territory-Level Representation in Literature Databases

Ohio	7	
Oklahoma	1	
Oregon	7	
Palau	2	
Pennsylvania	10	
Puerto Rico	9	
Rhode Island	9	
South Carolina	12	
South Dakota	2	
Tennessee	0	
Texas	25	
US Virgin Islands	7	
Utah	1	
Vermont	4	
Virginia	24	
Washington	15	
West Virginia	0	
Wisconsin	13	
Wyoming	1	

Assessing coverage of different NBS topics across multiple literature databases is challenging because each database uses its own set of categories to classify entries by NBS type or (in some cases) habitat type (see the Project Type Detail column in Table A1 for examples). Therefore, for this evaluation we classified publications in each database based on the primary relevant habitat type (Figure A6). Four of the six literature databases (River Engineering Resources, BlueValue, Agricultural BMP Database, and Stream Restoration Database) each focus on just one broad habitat type. The Green Infrastructure Effectiveness Database began with a focus on NBS to address coastal hazards; it has since broadened to include other types of hazards as well, but its included publications still reflect the original coastal emphasis. However, this database could not be included in Figure A6 because the database structure did not allow for the habitat type of individual publications to be easily determined. The Nature-Based Solutions Evidence Platform contains publications from a broader range of habitat types. Across all habitat types, agricultural settings are best represented in the literature databases (exclusively within the Agricultural BMP Database), followed by coastal habitats. All other habitat types had fewer than 200 publications across all databases.



Figure A6. Number of publications in each literature database, categorized by the relevant habitat type

Note: The *y*-axis uses a logarithmic scale. Numbers on top of each column are the total number of publications in the database. Habitat types were assigned using database filters; one publication can be categorized under multiple habitat types (this was common in the Nature-based Solutions Evidence Platform). Publications from both inside and outside the United States are included. Publications were categorized as "unspecified" when the information within the database did not make it clear what habitat they were relevant to.

APPENDIX B-PROJECT DATABASES

Table B1. Key Attributes of NBS Project Databases

Database (Organization)	Entries	Filters?	Search?	Project Location Data?	NBS Type Detail	Primary Project Benefits Listed?	Effectiveness Data Provided?	Downloadable? (Format)
Coastal Resilience Dashboard (National Fish and Wildlife Foundation)	207	Yes	No	Mapped points	General (e.g., green infrastructure, floodplain restoration)	Partial (dashboard only shows benefits aggregated across projects; CSV lists certain ecological benefits tied to restoration extent and several socioeconomic benefits)	Yes (extent restored, property protection, avoided travel time losses, jobs created provided in CSV; dashboard only shows data aggregated for multiple projects)	Yes (CSV)
Coastal Systems Portfolio Initiative (US ACE)	1,098	Yes	No	Mapped points	Detailed (all projects are beach nourishment or dredging)	No	No	Yes (CSV, GeoJSON, or JSON)
Conservation and Adaptation Resources Toolbox Case Study Dashboard (DOI, University of Arizona)	207	Yes	No	Mapped points	General (e.g., restoration, land conservation, water conservation and reuse; also has ecosystem information)	No (could get more information from individual case study writeups)	No (could get more information from individual case study writeups)	No
Engineering with Nature ProMap (Engineering with Nature)	Unknow n	Yes	Yes	Mapped points	General (e.g., beaches and dunes, wetlands, reef)	Yes (up to three primary benefits per project)	No	No

Database (Organization)	Entries	Filters?	Search?	Project Location Data?	NBS Type Detail	Primary Project Benefits Listed?	Effectiveness Data Provided?	Downloadable? (Format)
Great Lakes Regional Habitat Restoration Database (NOAA-GLC Regional Habitat Restoration Partnership)	11	No	No	No; may be available in linked project document s	General (most are described as "habitat restoration projects")	Partial (e.g., area of habitat restored, fish and invertebrate communities, habitat evaluation index)	Partial (some projects include effectiveness data such as change in slope or riparian width, nutrients or debris removed)	No
Gulf Spill Restoration Projects (NOAA, Deepwater Horizon Trustee Council)	347	Yes	No	Mapped points	None (related information included in project description)	Yes	Yes (monitoring and adaptive management section includes monitoring results and whether or not targets were achieved)	Yes (CSV)
Habitat Restoration & Protection Database (Long Island Sound Study)	329	Yes	Yes	Mapped points	Detailed (e.g., tidal flow restoration, fill removal)	No	Νο	No
Living Shorelines Project Map (NOAA)	208	Yes	No	Mapped points	Detailed (all are living shorelines projects)	Partial (most project descriptions refer to restoring or stabilizing shoreline)	No	No
LID Atlas Map (SC Sea Grant)	54	No	No	Mapped points	General (all are low- impact development or urban stormwater	No	No	No

Database (Organization)	Entries	Filters?	Search?	Project Location Data?	NBS Type Detail	Primary Project Benefits Listed?	Effectiveness Data Provided?	Downloadable? (Format)
Low Impact	1,429	Yes	Yes	Mapped	projects, but no additional information is provided) Detailed (e.g., swale, rain garden	*	*	*
Atlas* (NEMO Program, University of Connecticut)				points	stormwater wetlands)			
National Beach Nourishment Database (American Shore & Beach Preservation Association)	3,627	Yes	No	Mapped points	Detailed (all projects are beach nourishment)	No	No	No (may be possible for ASBPA members)
Naturally Resilient Communities Solutions and Case Studies (Naturally Resilient Communities)	33	Yes	No	Location descriptio n only	Detailed	Yes	No	No
Nature-Based Solutions (Nature-Based Solutions)	38	Νο	No	Mapped points	No	Partial (goals are very general [e.g., restore habitat, adapt to sea level rise])	No	No
Nonpoint Source	3,380	Yes	Yes	State only	General (project title and description	Partial (project description	No	Yes (CSV)

Database (Organization)	Entries	Filters?	Search?	Project Location Data?	NBS Type Detail	Primary Project Benefits Listed?	Effectiveness Data Provided?	Downloadable? (Format)
Watershed Projects Data Explorer (US EPA)					usually have some project type information, but no separate column)	sometimes includes objectives)		
Regulatory In- lieu Fee and Bank Information Tracking System (US Army Corps of Engineers)	4,526	Yes	Yes	Mapped project footprint, but cannot see multiple projects at the same time	No (could get more information from individual project documents)	No (could get more information from individual project documents)	No (could get more information from individual project documents)	Yes, but only table on main page (mitigation bank name, type, status, and state [CSV])
Restoration Atlas (NOAA)	3,407	Yes	No	Mapped points	Detailed (e.g., culvert modification, invasive species removal, weir construction)	Partial (list of species benefited, area of habitat restored)	No	Yes (CSV)
Restoration Database (Society for Ecological Restoration)	293	Yes	Yes	Project coordinat es and country	Detailed (two levels of detail on restoration activities implemented)	Yes	Yes (most projects have at least ecological effectiveness data)	No
Thin-Layer Placement Case Studies Map Portal (US Army Corps of Engineers)	46	No	No	Mapped points	Detailed (all are thin-layer placement projects; project type field does not add much information)	Partial (description sometimes describes primary benefits)	No	No

Database (Organization)	Entries	Filters?	Search?	Project Location Data?	NBS Type Detail	Primary Project Benefits Listed?	Effectiveness Data Provided?	Downloadable? (Format)
Urban BMP O&M Cost Database (International Stormwater BMP Database)	983	Yes	No	Project coordinat es	Detailed (rain garden, green roof, permeable pavement, retention pond, wetland basin)	No	No	Yes (Access database)
Urban Stormwater BMP Mapping Tool (International Stormwater BMP Database)	Unknow n	Yes	No	Mapped points	Detailed (e.g., wetland basin, grass swale, porous pavement)	No	Yes (water quality parameters only)	No (can send a request for access; API is under development)
US Department of the Interior Bipartisan Infrastructure Law Projects Map (DOI)	1,908	Yes	No	Mapped points	General (some program areas or program names provide this info [e.g., ecosystem restoration, Abandoned Mine Reclamation Fund])	Partial (some program areas mention primary objectives like addressing drought, wildland fire, etc.)	No	No

Note: All information is current as of April 2024

*This database is not fully functional as of publication, so not all information in this table could be completed.

Content and Functionality

The 21 project databases primarily provide information on NBS project types and locations. All but three include mapped points or footprints for individual projects. Just over half provide detailed information on NBS type while many of the others use general categories such as restoration (Table B1). Some also provide information on primary project benefits to help users understand why projects are being implemented, but only four databases include any effectiveness data that could allow users to evaluate project performance. A majority of the databases (17) include filters to help users find projects relevant to their interests, and five of them also have a search functionality.

While specific geographic information is provided by most of the NBS project databases, there are a few limitations in how this information is provided. Several of the databases (Urban Stormwater BMP Mapping Tool, Engineering with Nature ProMap, Living Shorelines Project Map, and Thin-Layer Placement Case Studies Map Portal) map project locations but do not include geographic attributes such as states among their filters or project attributes (Figure B1). This makes it difficult to identify multiple projects within an area of interest or assess distribution of projects among states without downloading the entire dataset and manually overlaying the points with a states dataset in a geographic information system. In many cases, this is not possible, as data is not available in a downloadable format (discussed in the last paragraph of this section). In addition, none of the databases with mapped project points allow users to select projects within a custom area of interest (e.g., by drawing a shape on the map).

Figure B1. Screenshot of the Engineering With Nature ProMap, which shows project locations as points but does not include a location field in the details for each project or have a filter to find projects in particular states or regions



Like the literature databases, the NBS project databases vary widely in how they categorize types of NBS. Some use very specific project types, while others use much broader categories (e.g., restoration, land conservation) that do not specify what activities were involved in the project (see Table B1 for examples). The categories and terminology used are

inconsistent across databases, making it difficult to combine information from multiple databases or to find similar projects in different databases. Some databases, such as the Gulf Spill Restoration Projects database, include detailed project descriptions with information about the project activities and habitat in which the project was implemented, but do not have NBS type or habitat type pulled out into separate fields.

Using the project databases to understand the primary benefits or goals of a project is hit or miss, depending on the database. Only five of them list specific project benefits within the database; seven more offer a partial list or very general benefits. Even when specific benefits are listed within the database, they are sometimes only visible after selecting a specific project, so it is not possible to view or compare benefits of multiple projects at the same time. Of the eight NBS project databases that do not provide benefit lists, two of them link to detailed project documents.

Only four databases provide any kind of effectiveness information. The Gulf Spill Restoration Projects database includes information on monitoring results compared to performance targets and whether or not targets were achieved, but not all projects have complete information. These are primarily biophysical or ecological outcomes (e.g., reef height, oyster density and size). The Urban Stormwater BMP Mapping Tool includes water quality parameters measured upstream and downstream of the project, but no other outcomes. Some of the projects in the Great Lakes Regional Habitat Restoration Database include specific results, such as information on change in slope or riparian width, or the amount of debris or nutrients removed. Many of the projects in the Restoration Projects database include information on ecological effectiveness (e.g., change in abundance of target species) in the project outcomes section. The Coastal Resilience Dashboard is the only database to provide socioeconomic outcomes data, with information on coastal protection and jobs provided by the projects.

Few databases provide any detailed information on project design or construction, which is necessary to inform design standards for effective projects. Only the Urban BMP O&M Cost Database and the Restoration Database include design details. Baseline (pre-project) or reference site data is also lacking; several databases refer to baseline data collection, but only the Urban Stormwater BMP Mapping Tool includes pre-project (upstream) water quality data. Some other databases report on changes (e.g., in water quality) due to the project, implying baseline data collection, but the actual baseline data is not provided. Retrospective evaluation of project effectiveness is not possible without baseline data.

Most of the project databases do not provide any information about when they were last updated or their update frequency, leaving users uncertain about how current their information is. Of the seven project databases with update logs, six were updated within the past year. Seven of the databases include a way for users to submit updates or new projects.

Only 6 of the 21 project databases allow users to download project information, which is necessary to combine information from multiple sources, overlay other spatial data with project locations, or document results (e.g., the number of projects of a certain type present in a state).

Geographic and Topical Coverage

Of the 21 NBS project databases identified, 18 had sufficient data to assess their geographic coverage within the United States. Within these 18 databases, the Southeast and Northeast regions are most represented, with 54% of projects in the databases from those regions (Figures B2–B3). In contrast, the Pacific Islands, Alaska, and North Central regions are poorly represented, with just 7% of projects from those regions.



Figure B2. Number of projects in the 18 project databases with statelevel geographic information, summarized by Climate Adaptation Science Center region

Note: A project may be counted under multiple regions if the project footprint spans more than one region.



Figure B3. Regional representation in NBS project databases

Note: Includes all project databases in Table B1 except for Urban Stormwater BMP Mapping Tool, Engineering with Nature ProMap, and Great Lakes Regional Habitat Restoration Database.

At the state level, California, Florida, and North Carolina are most represented, each with more than 1,600 projects and together making up more than 25% of all projects in the databases (Figure B4). New York, Minnesota, Virginia, Washington, New Jersey, Massachusetts, and Louisiana each have at least 600 projects in the databases. The seven entities in the list with the fewest projects (each with 31 or fewer) are all US territories plus the District of Columbia. Arkansas, Wyoming, and South Dakota all have fewer than 100 projects among the databases. See Table B2 for complete information on state-level representation within these databases.



Figure B4. State-level representation in NBS project databases

Note: Includes all project databases in Table B1 except for Urban Stormwater BMP Mapping Tool, Engineering with Nature ProMap, and Great Lakes Regional Habitat Restoration Database.

State or Territory	No. of Projects—Project Databases
Alabama	302
Alaska	385
American Samoa	18
Arizona	239
Arkansas	73
California	1,939
Colorado	177
Connecticut	505
District of Columbia	21
Delaware	383
Florida	1,699
Georgia	343
Guam	15
Hawaii	226
Idaho	284
Illinois	184
Indiana	125
lowa	142
Kansas	176
Kentucky	175
Louisiana	601
Maine	451
Marshall Islands	0
Maryland	322
Massachusetts	685
Michigan	556
Minnesota	945
Mississippi	188
Missouri	255
Montana	183
Nebraska	107
Nevada	123
New Hampshire	251
New Jersey	671
New Mexico	178
New York	1,164
North Carolina	1,668
North Dakota	109
Northern Mariana Islands	13
Ohio	375

Table B2. State- or Territory-Level Representation in Project Databases

State or Territory	No. of Projects—Project Databases
Oklahoma	128
Oregon	494
Palau	0
Pennsylvania	237
Puerto Rico	103
Rhode Island	209
South Carolina	517
South Dakota	63
Tennessee	237
Техаз	588
US Virgin Islands	31
Utah	114
Vermont	111
Virginia	694
Washington	713
West Virginia	131
Wisconsin	272
Wyoming	91

For this evaluation we classified entries in each database based on the primary relevant habitat type (Figure B5). Of the 21 NBS project databases, 15 had sufficient information to classify projects based on habitat types. Of the projects in those databases, coastal habitats were the best represented, because several contained only coastal projects. However, these are heavily skewed toward beach nourishment projects. These were followed by projects in built environments (urban areas) and floodplains/rivers. All other habitat types each had fewer than 350 projects across all the databases.





Note: Habitat types were assigned using database filters; projects can be categorized under multiple habitat types if information in the database indicates they are relevant to more than one habitat type. Projects from both inside and outside the United States are included.

APPENDIX C-EXCLUDED DATABASES

Several databases with NBS-relevant information were not included in this assessment because they focused on large-scale planning projects or programs rather than individual projects, because they point to multiple datasets for individual projects but do not collate them, or because NBS-relevant information could not be separated from non-NBS information (Table C1).

Table C1. Databases with Some NBS Information Excluded From theAssessment

Database (Organization)	Description	Reason for Exclusion from Evaluation
Grants Library (National Fish and Wildlife Federation)	Grants awarded by NFWF for conservation projects	Can't separate design and planning grants from on-the- ground projects, lack of specific project information (very general description of what the grant will be used for)
Climate Adaptation Knowledge Exchange Resources (CAKEX)	Variety of resources related to climate adaptation action, including case studies and tools	Most resources relate to large- scale planning or climate vulnerability assessments rather than on-the-ground projects, includes many non- NBS resources
NBS Knowledge Database (Network Nature)	Resources related to policy and business needs and opportunities for NBS, NBS research papers (primarily white papers by international NGOs), and project reports	Most resources do not relate to individual NBS projects; project resources primarily relate to large-scale programs or evaluations
US Climate Resilience Toolkit (US Global Change Research Program)	Framework for stakeholders to build climate resilience, tool to explore projected future climate conditions, case studies for climate resilience actions	Most case studies are for planning or assessment, and project-based case studies can't be easily identified
Hazard Mitigation Assistance Projects (FEMA)	Dataset of funded projects under FEMA Hazard Mitigation Assistance grant programs	Most projects are not NBS, and NBS-relevant projects can't be easily identified
Coastal Resilience Open Data Platform (NFWF)	Repository of datasets from projects funded through NFWF's Coastal Resilience program	Datasets are for individual projects and metrics, rather than bringing together data from multiple projects

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https://nicholasinstitute.duke.edu/publications/evaluation-publicly-accessible-nature-based-solutions-databases-sources-evidence.

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Disclaimer

The databases evaluated in this report are those identified by the authors at the time of writing. It is possible that there are additional relevant databases not included in this assessment, and included databases may change over time. Therefore, we may update this report in the future to incorporate new databases or reflect changes to the databases currently included. Your suggestions for additional databases are welcome for consideration in future updates.

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