[DM-07-079] U.S. National Spatial Data Infrastructure

Abstract

Spatial data infrastructures may be thought of as socio-technical frameworks for coordinating the development, management, sharing and use of geospatial data across multiple organizational jurisdictions and varying geographic extents. The United States was an early adopter of the SDI concept and the U.S. National Spatial Data Infrastructure (NSDI) is an example of a country-wide SDI implementation facilitated by coordination at the federal-government level. At the time of its establishment in the early 1990s, a unique characteristic of the NSDI was a mandate for federal agencies to establish partnerships with state- and local-level government. This entry summarizes the origins of the NSDI's establishment, its original core components and how they've evolved over the last 25 years, the role of the Federal Geographic Data Committee (FGDC), and the anticipated impact of passage of the Geospatial Data Act of 2018. For broader technical information about SDIs, readers are referred to GIST BoK Entry DM-60: Spatial Data Infrastructures (Hu and Li 2017). For additional details on the history of the NSDI, readers are referred to Rhind (1999). For the latest information on recent and emerging NSDI initiatives, please visit the FGDC web site (www.fgdc.gov).

Keywords: clearinghouse, FGDC, framework, geographic information policy, governance, metadata, NSDI, spatial data infrastructure, standards

Author & citation

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Explanation

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1. Definitions

spatial data infrastructure: The technology, policies, standards, and human resources necessary to acquire, process, store, distribute, and improve utilization of geospatial data, services, and other digital resources.

Federal Geographic Data Committee (FGDC): The federal government interagency coordinating committee responsible for providing direction and oversight for geospatial

decisions and initiatives across the United States federal government, including advancement of the U.S. National Spatial Data Infrastructure.

geoportal: a gateway website through which people can search, discover, access, and visualize the geospatial resources within an SDI. (Previously, often referred to as a 'geospatial clearinghouse'.)

geospatial data standard: A commonly agreed specification on the content, structure, and/or exchange methods for data possessing geographically-referenced location information.

metadata: 'Data about data'; documentation about who, when, how, what, why, and many other facets of the data and the data production process. Metadata can be used for describing not only data, but also tools, services, and other geospatial resources.

framework data: Those geospatial data themes identified as the 'core' or 'base' data layers upon which all other data layers are structured and integrated for a specific analysis or geographic domain. The framework concept represents the base data elements of a spatial data infrastructure. The original framework themes for the U.S. NSDI included: geodetic control, orthoimagery, elevation and bathymetry, transportation, hydrography, cadastral and governmental units. These data include an encoding of the geographic extent of the features and a minimal number of attributes needed to identify and describe the features.

2. Origins of the NSDI

The term "spatial data infrastructure" (SDI) broadly refers to the technology, policies, standards, and human resources necessary to acquire, process, store, distribute, and improve utilization of geospatial data, services, and other digital resources. A functional SDI "is an important asset in societal decision and policy making... effective governance... citizen participation processes... and private sector opportunities" (Budhathoki and Nedovic-Budic 2007).

More than simply software and datasets, SDIs are comprised of three major categories of defining elements: (a) policy and organization, including institutional, financial, political and cultural issues; (b) interoperability and sharing, including both technical and nontechnical factors; and (c) discovery, access and use, facilitated by such things as metadata standards and geoportal web sites (Masser 2005; Budhathoki and Nedovic-Budic 2007). SDI implementations exist from the global to local scales, but historically it has been the national level that occupies the critical central position between higher and lower levels of the overall SDI hierarchy (Rajabifard et al. 2000)

The U.S. National Spatial Data Infrastructure concept grew out of a body of research in the late 1980s and early 1990s on geographic information policy in the United Kingdom and the United States. In 1990, the U.S. Office of Management and Budget released the Revised Circular A-16 which established the Federal Geographic Data Committee (FGDC) to coordinate the "development, use, sharing, and dissemination of surveying, mapping, and related spatial data." In 1993, the U.S. National Research Council's Mapping Science Committee (MSC) published Toward a Coordinated Spatial Data Infrastructure for the Nation

(Mapping Science Committee 1993). In the report the MSC coined the term “National Spatial Data Infrastructure” to represent the totality of the policies, technology, institutions, data and individuals producing and using geospatial data in the United States. Through the newly formed FGDC, the U.S. NSDI concept was recognized as “a means to foster better intergovernmental relations, to empower State and local governments in the development of geospatial datasets, and to improve the performance of the federal Government” (Rhind 1999, p. 782). In April 1994, Executive Order #12906: ‘Coordinating Geographic Data Acquisition and Access: The National Spatial Data Infrastructure’ was signed by President Clinton, further formalizing the U.S. NSDI and the coordination role of the FGDC.

3. NSDI Components

Executive Order #12906 and the FGDC’s first strategic plans (Federal Geographic Data Committee 1994, 1997) identified three primary areas to promote development of the NSDI:

1. Standards – for both theme-specific geospatial data and for metadata documentation;
2. National Geospatial Data Clearinghouse – to improve access to and sharing of geospatial data;
3. National Digital Geospatial Data Framework – defining and promoting a set of authoritative ‘base’ data layers to be developed at a nation-wide scope, and benefiting data production, reducing operating costs, and improved service and decision making.

The Order further mandated that federal agencies address these needs in part through partnerships with state and local government, the private and academic sectors, and non-profit organizations.

3.1 Standards

Efforts related to this aspect of the NSDI have primarily been organized around specific data themes (e.g., hydrography, transportation, soils, land parcels) with designated federal agency agencies leading standard-specific working groups. Topics addressed in such standards have ranged from data collection and content, to information classification and presentation, as well as data management to facilitate data sharing.

3.2 National Geospatial Data Clearinghouse

The Clearinghouse concept was “intended to facilitate access to [geo-]spatial data, with the goal of minimising [sic] duplication and assisting partnerships for data production where common needs exists,” (Rhind 1999, p. 783). A network of clearinghouse sites grew significantly in the late 1990s, first among federal agencies and at universities and later in centralized state government locations. At first these sites were primarily warehouses of pre-defined geospatial data layers accessible via FTP download, but soon were supported by more interactive –and visual - GUIs that facilitated, for example, customized ‘clip-and-zip’ functionality.

3.3 National Digital Geospatial Data Framework

In an SDI, framework data refers to those geospatial data themes identified as the ‘core’ or ‘base’ data layers, upon which all other data layers are structured and integrated for a specific analysis or geographic domain. In addition to theme-specific content specifications, framework policies also address mechanisms for defining, maintaining, sharing, and accessing these data. Framework data are generally considered to have widespread usefulness, forming a critical foundation for many applications (Hamerlinck 2008). Seven nationwide framework themes were initially identified for the NSDI: geodetic control, orthoimagery, elevation and bathymetry, transportation, hydrography, cadastral and governmental units.

3.4 Additional Components

As the NSDI continued to take shape throughout the 1990s, the three original components expanded in a number of ways (Figure 1). For example, Framework Data gained a complement with the recognition of a wide range of other categories of non-Framework, georeferenced “GEOdata” themes, some derived from Framework base layers and others developed and maintained independently. Metadata standards emerged as the most prominent category of geospatial standards, designed to facilitate uniform documentation for geospatial data, particularly for Clearinghouse sites where it could facilitate data discovery and assessing appropriateness for use. The functionality of clearinghouse sites also evolved, from one of data repository warehouses to metadata registries (or ‘catalog’) and finally the sharing of dynamic map services from a distributed collection of authoritative data sources (see Section 5).

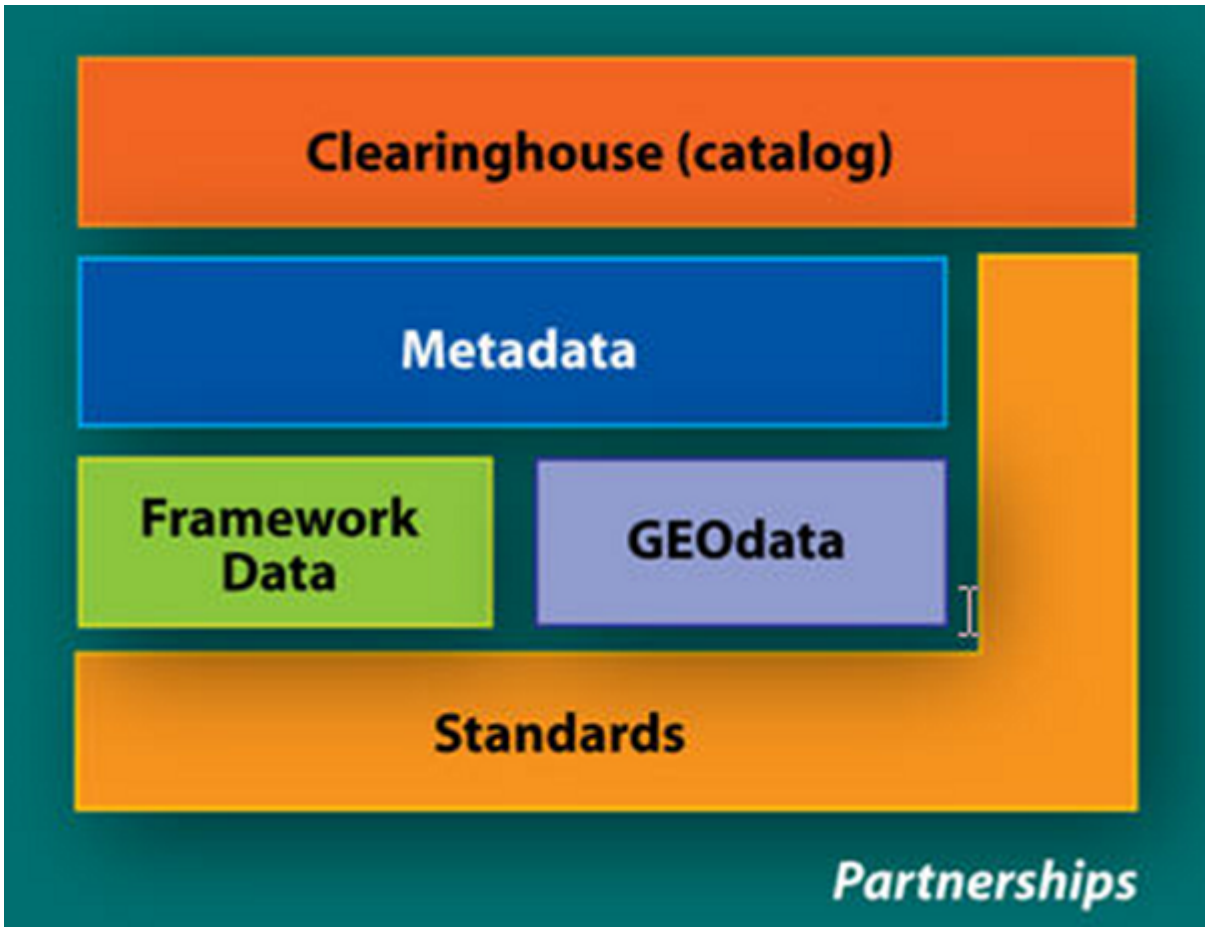


Figure 1. NSDI components and their relationships, as portrayed in mid-1990s FGDC

training materials. Image source: author.

Non-federal partnerships also became better established. In particular, relationships with state governments became more formalized through the growth of the establishment of the National States Geographic Information Council (NSGIC; www.nsgic.org). NSGIC was established in 1991, shortly after the Revised Circular A-16 created the FGDC. Since that time it has grown to serve as a coordinating body and advocacy arm for state government geospatial entities in more than 40 of the States, collaborating with the FGDC on a number of capacity building activities over the past 25 years, including the Cooperative Agreements Program and the Fifty States Initiative (see Section 5).

4. NSDI Governance

4.1 Federal Geographic Data Committee

Since 1990, the FGDC has had primary responsibility for overseeing OMB Circular A-16 related activities and the implementation of the NSDI. In accordance with Circular A-16, the FGDC is chaired by the Secretary of the Interior with the Deputy Director for Management, OMB as Vice-Chair. Governance is led by the FGDC Steering Committee, a policy-level interagency group whose central focus is to provide executive leadership for the coordination of federal geospatial activities between, among, and within agencies by establishing policy and providing guidance and direction to the member agencies.

The FGDC Coordination Group provides advice on the day-to-day business of the FGDC to facilitate interagency coordination and implementation of the NSDI at the operational level. The Coordination Group oversees and provides the functional leadership for the FGDC subcommittees and working groups. The Coordination Group is co-chaired by the Executive Director of the FGDC Office of the Secretariat and an elected member of the Federal Coordination Group members. Non-Federal collaborating partners participate in most of the Coordination Group meetings and work on subcommittees and working groups. Subcommittees are defined according to data themes (including framework layers). Working groups crosscut the subcommittees and focus on infrastructure issues common to many of the NSDI data themes, for example standards, metadata, and common services.

4.2 National Geospatial Advisory Council (NGAC)

In 2008, non-federal involvement in management of the NSDI was significantly expanded with establishment of the National Geospatial Advisory Council (NGAC). Sponsored by the U.S. Department of the Interior, NGAC is an advisory body that provides advice and recommendations on Federal geospatial policy and management issues and a forum to convey views representative of partners in the geospatial community. NGAC membership includes representatives from 28 Government and nongovernmental organizations. The committee holds public forums to discuss geospatial activities and solicits input from State, tribal, regional, and local governments, academic institutions, and the private sector.

4.3 Significant NSDI Governing Policy Updates

Between 2002 and 2014, a number of significant policy and delegated legislative actions occurred relative to updating the scope, structure, and mandates of the NSDI. The following

is a partial listing of these actions:

- In 2002, OMB “Circular A-16 Revised” was issued, which strengthened coordination responsibilities of Federal agencies and incorporated NSDI into the Circular;
- In 2003, Executive Order 13286 was issued. This Order amended and reaffirmed Executive Order 12906, incorporating the newly-created Department of Homeland Security.
- In 2010, the “A-16 Supplemental Guidance” was released, further defining and clarifying elements of OMB Circular A-16 to facilitate the adoption and implementation of a coordinated and effective Federal geospatial asset management capability, and improve support of mission-critical business requirements of the Federal Government and its stakeholders. It also provided the foundation for a portfolio management approach to National Geospatial Data Asset Themes (NGDA Themes) and their associated National Geospatial Data Asset Datasets (NGDA Datasets).
- In 2011, as an outcome of the implementation of the OMB Circular A-16, Supplemental Guidance, and the resulting National Geospatial Data Asset Management Plan (next bullet), the official list of NSDI Data Themes, Definitions, and Lead Agencies is updated in OMB Circular A-16, Appendix E (an action designed to occur regularly as needed in the future).
- In 2014, the National Geospatial Data Asset Management Plan was approved by the FGDC Steering Committee. Described in OMB Circular A–16 Supplemental Guidance, the plan laid out a structure and processes for managing Federal National Geospatial Data Assets (NGDAs) as a single Federal Geospatial Portfolio in accordance with OMB policy and Administration direction.

5. Twenty-five Years of NSDI Programs and Initiatives

Over the last 25 years, a number of capacity-building and technical implementation initiatives were undertaken by the FGDC for purposes of growing the NSDI both within and beyond federal agencies. One long-term program designed to engage outside constituencies was the now-closed NSDI Cooperative Agreements Program, “an annual program to assist the geospatial data community through funding and other resources in implementing the components of the NSDI." Running from 1999 through 2013, CAP awards were available to state, local and tribal governments, academia, commercial, and non-profit organizations and provided small seed grants to initiate sustainable on-going NSDI implementations and emphasized partnerships, collaboration and the leveraging of geospatial resources in achieving its goals.

The Fifty States Initiative (2005 – 2013) was a sub-program under the NSDI Cooperative Agreements Program which supported the development and implementation of statewide strategic and business plans to facilitate NSDI advancement within and across individual states. The FGDC worked with the National States Geographic Information Council for the initiative. Nearly all of the States and U.S. Territories participated in this program over its nine-year existence (Figure 2).

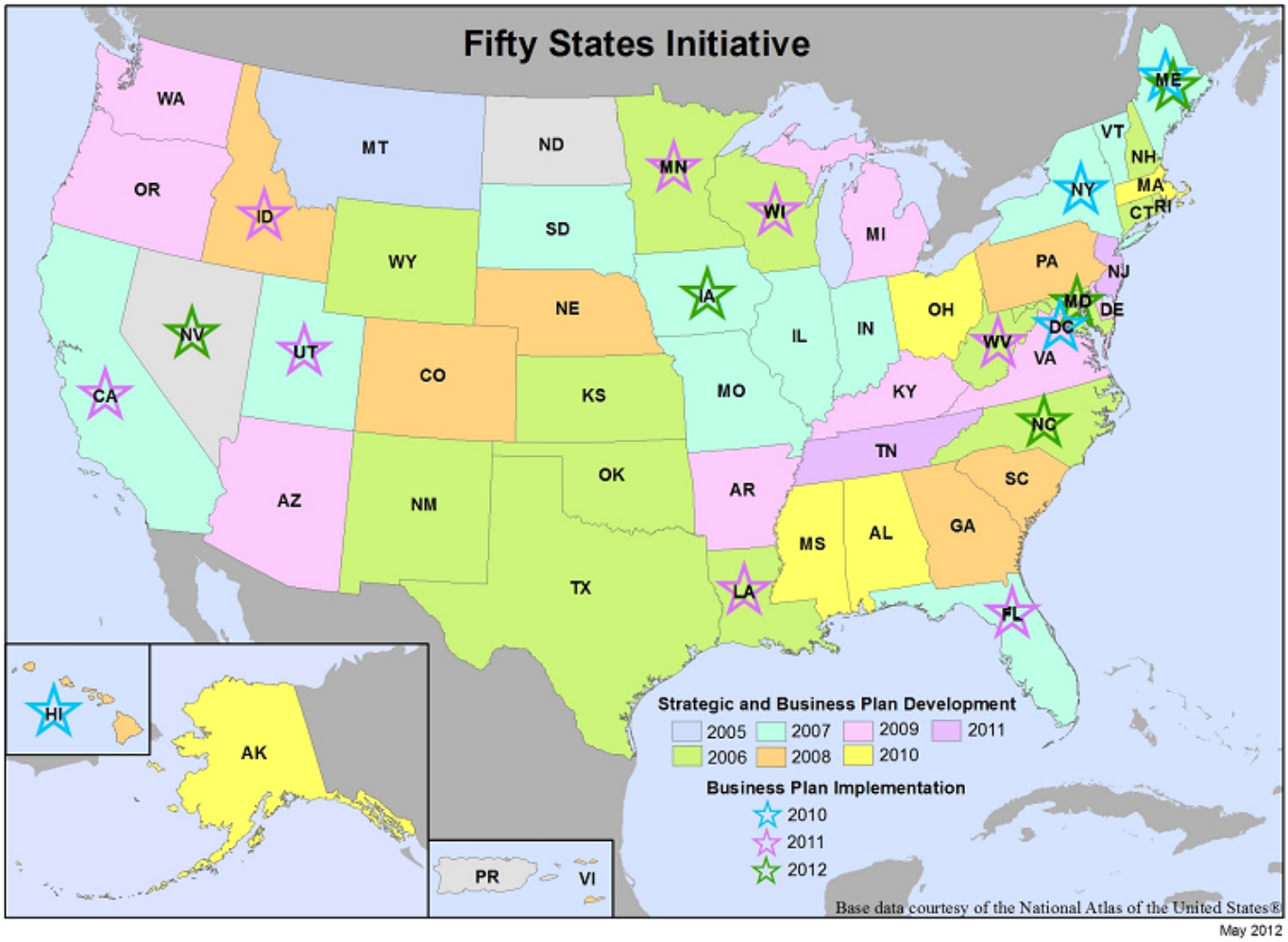


Figure 2. Fifty States Initiative Awards, 2005-2012. Image source: FGDC.

The original NSDI Clearinghouse concept has also been re-invented numerous times over the lifespan of the NSDI. In 2001, the Geospatial One-Stop (GOS) portal was launched to enable discovery and search of geospatial assets from all levels of government with a goal of better integrating federal clearinghouse sites with state clearinghouse sites through harmonization of thematic data standards. In 2008, the Geospatial Line of Business (LoB) initiative was released by OMB with a focus on "improving the effectiveness of government through the more widespread use of geospatial information ...[to] improve the quality and timeliness of agency decision-making across a wide variety of programmatic contexts." (OMB 2008, p. 1). As the LoB initiative describes, "The Strategy was created to provide Federal CIOs [Chief Information Officers] and key stakeholders guidance on the implementation of shared IT services as a key part of their efforts to eliminate waste and duplication and reinvest in innovative mission systems."

One of the key outcomes of the Geospatial LoB was establishment of the Geospatial Platform, a multi-agency supported shared service that took the place of the Geospatial One Stop portal in 2011:

The GeoPlatform focuses on web applications that facilitate participatory information sharing, interoperability, user-centered design, and collaboration on the World Wide Web. The GeoPlatform is a key component connecting many goals of the NSDI Strategic Plan in

advancing the NSDI. The portfolio of data, applications, and services provided on the GeoPlatform is stewarded through the use of open licenses and careful review and hosted on cloud infrastructure that maximizes geospatial interoperability.

Today, the GeoPlatform continues to provide standard search, browse and download capabilities for geospatial datasets (Figure 3), as well as more sophisticated issue-specific information products like the joint Bureau of Ocean Energy Management-National Oceanic and Atmospheric Administration OceanReports web tool (Figure 4).

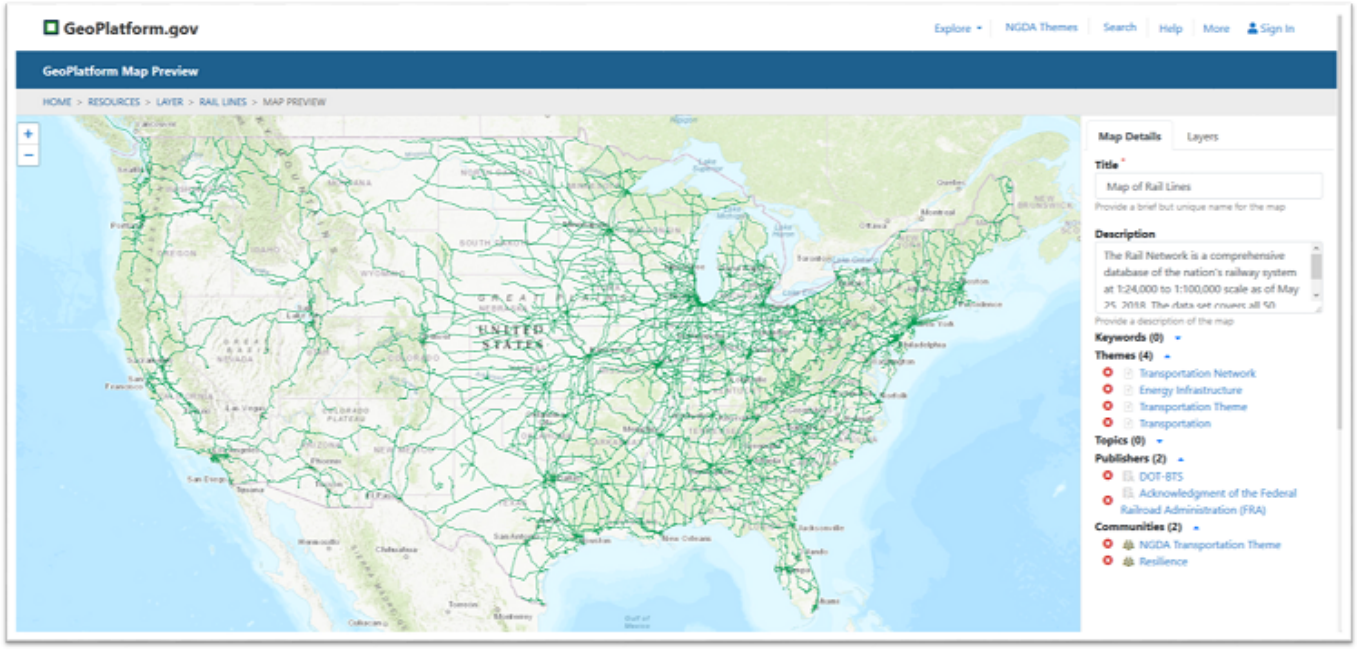


Figure 3. Example of GeoPlatform data browse and download interface, in this instance a national rail lines database. Image: author.

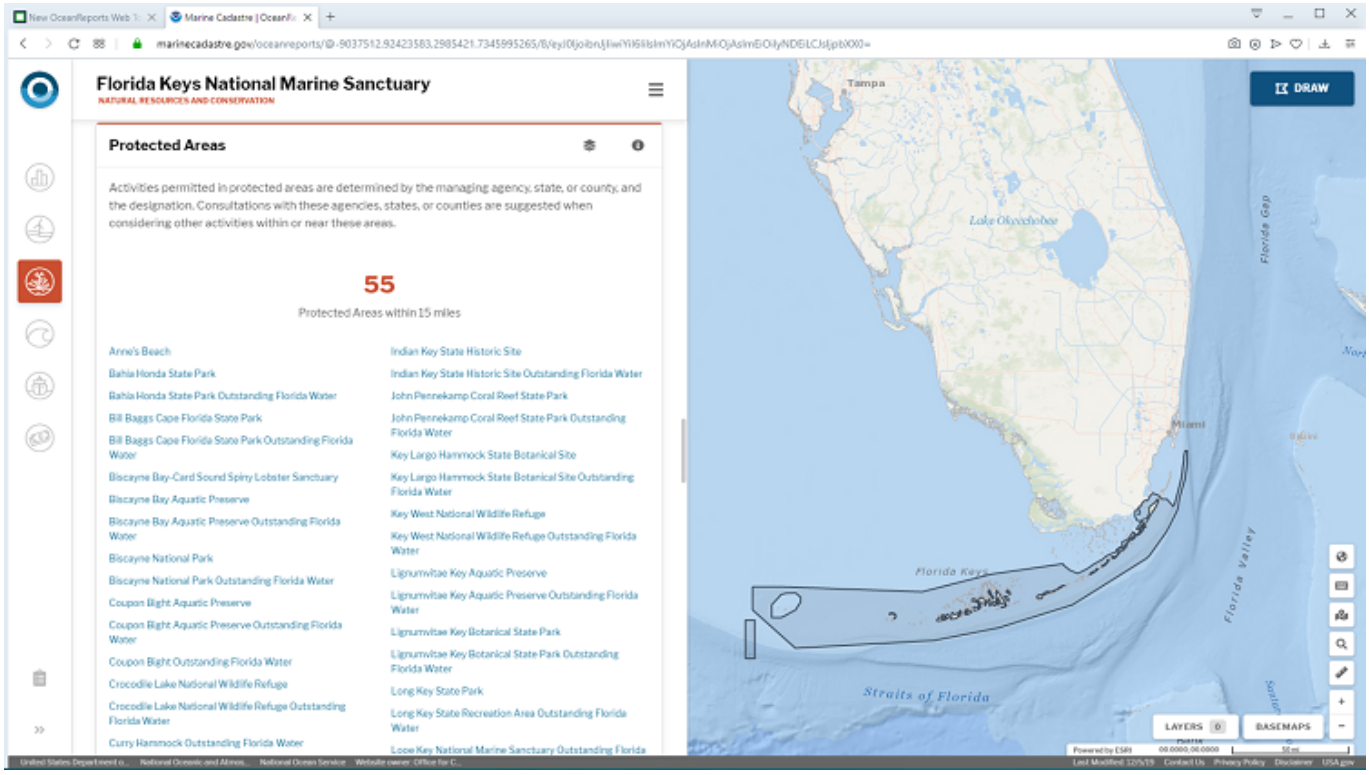


Figure 4. Example of OceanReports interface accessible from the GeoPlatform application, delivering descriptive infographics and supporting data that support offshore planning, permitting, environmental review, and public engagement. Image: author.

For more information about the programs described above and other FGDC / NSDI Initiatives, visit the interactive history timeline on the FGDC web site or browse under the Initiatives drop-down menu at the FGDC website.

6. Looking Forward

Over the last decade, the vision for the NSDI has continued to evolve and today may be defined as leveraging “investments in people, technology, data, and procedures to create and provide the geospatial knowledge required to understand, protect, and promote our national and global interests” (FGDC 2013, p. 2). This vision supports three major contemporary goals:

- Develop capabilities for national shared services;
- Ensure accountability and effective development and management of federal geospatial resources;
- Convene leadership of the national geospatial community (FGDC 2013).

A major step forward in achieving these goals came with passage of the Geospatial Data Act (GDA) of 2018 (P.L. 115-254, Subtitle F). In addition to reaffirming the function of the NSDI in facilitating coordinated geospatial data development, sharing and use, the GDA significantly strengthened governance of federal geospatial data activities by codifying the role and authorities of FGDC, establishing NGAC as a statutory advisory committee, and

specifying agency budgeting and reporting requirements in order to foster more efficiency and reduce duplication of effort in managing federal – and national geospatial resources.

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