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Update on U.S. Geological Survey Fundamental Science Practices

Circular 1503

U.S. Department of the Interior
U.S. Geological Survey

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By the Fundamental Science Practices Advisory Council

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U.S. Geological Survey, Reston, Virginia: 2023

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Abbreviations

BAO	Bureau approving official
FGDC	Federal Geographic Data Committee
FSP	Fundamental Science Practices
FSPAC	Fundamental Science Practices Advisory Council
IPDS	Information Product Data System
OSQI	Office of Science Quality and Integrity
SDC	Science Data Catalog
SM	Survey Manual
SPN	Science Publishing Network
USGS	U.S. Geological Survey

Update on U.S. Geological Survey Fundamental Science Practices

By the Fundamental Science Practices Advisory Council

Background and General Description

The U.S. Geological Survey (USGS) serves the Nation as an independent science agency that provides scientific information and facilitates understanding of natural resources and hazards. With no regulatory or management mandate, the USGS provides impartial science, free of political or outside influence, to address the needs of our changing world. A diversity of scientific expertise enables the USGS to carry out multiscale, multidisciplinary investigations that continue to add to the knowledge base about the Earth. Through these efforts, the USGS provides citizens and decision makers at all levels of government with information needed to address critical societal issues.

The USGS Fundamental Science Practices (FSP) are a set of standards fundamental to how the USGS conducts its science activities and how resulting information products and data are reviewed, approved, and released (fig. 1). These policies, practices, philosophical premises, and operational principles serve as the foundation for all USGS research and monitoring activities and apply to all levels of the organization. The strength and future of the USGS depend on following these practices. The USGS initiated the FSP in 2006 and fully implemented them in 2009 to consolidate and standardize science practices across multiple scientific mission areas and science disciplines within the USGS. FSP is complemented with other important policies and requirements, such as the Quality Management System for USGS Laboratories (https://www.usgs.gov/survey-manual/im-osqi-2022-01) and Scientific Integrity (https://www.usgs.gov/survey-manual/50025-scientific-integrity).

FSP policy is provided in the USGS Survey Manual (SM; all chapters and instructional memoranda are available at https://www.usgs.gov/survey-manual and are listed by topic in table 1) and is also supported through a series of actively maintained frequently asked questions (https://www.usgs.gov/office-of-science-quality-and-integrity/fundamental-science-practices-fsp-faqs). The FSP include (1) planning scientific research (SM 502.2); (2) peer review (SM 502.3); (3) review, approval, and release (SM 502.4) of information products; (4) safeguarding unpublished data (SM 502.5); (5) data management (SM 502.6); (6) metadata requirements (SM 502.7); (7) review and approval of scientific data (SM 502.8) and software (Office of Science Quality and Integrity Instructional Memorandum [IM OSQI] 2019–01); (8) data preservation (SM 502.9); and (9) authorship (SM 502.10).

Figure 1. Diagram showing what Fundamental Science Practices cover.

Table 1. Fundamental Science Practices topics and related documentation.

[Survey Manual chapters and instructional memoranda are available at https://www.usgs.gov/survey-manual. SM, Survey Manual; IM, instructional memorandum]

Fundamental Science Practice topic	Related SM chapter or IM
Fundamental Science Practices foundation	SM 502.1
Planning and conducting scientific research	SM 502.2
Authorship	SM 502.10
Peer reviews	SM 502.3
Review and approval—publications	SM 502.4
Product production—publications	SM 1100.3, SM 1100.4
Product release	SM 502.4
Safeguarding unpublished U.S. Geological Survey data, information, and associated scientific materials	SM 502.5
Review and approval—data	SM 502.8
Data management	SM 502.6
Metadata	SM 502.7
Digital data preservation	SM 502.9
Software	IM OSQI 2019–01

USGS Scientific Research Planning

The FSP require USGS data-collection and scientific research activities to be documented in project work plans that may be part of the project proposal, reviewed by appropriate experts, and approved by management generally at the science center director or equivalent level. Data-collection and research activities must be carried out in an objective and replicable manner and vetted through a rigorous and open process of peer review to ensure that the best possible results are achieved; that is, the data are error-free and the conclusions are sound. Methods used must be fully documented in publications associated with research to allow results to be replicated and quality-assurance procedures to be applied. These methods must be published or referenced in any related publications. Publications anticipated to result from data collection and research and the means by which data will be released free to the public are explicitly documented in a data-management plan as part of the project work plan. Additional details of the FSP requirements for scientific research planning are described in the USGS SM chapter 502.2.

USGS Authorship of Scientific Information Products

The FSP describe how USGS authors are credited for authorship and how responsibilities are assigned to those who create content for scientific information products. USGS authors are required to cite their Bureau affiliation in scientific information products. The policy applies to all scientific information products (including data releases and software releases) published by the Bureau and by outside entities. More information on authorship of USGS information products is available in SM 502.10.

Peer Review

Peer review, as a cornerstone of scientific practice, validates and ensures the objectivity of published USGS science. FSP requirements for peer review of USGS information products apply to all USGS scientific information, whether published by the USGS or an outside entity. A minimum of two scientific peer reviews by qualified peers with no conflict of interest is mandatory for all USGS scholarly publications. Additional details of the FSP requirement for peer review are described in SM 502.3. USGS FSP peer-review practices support the 2004 Office of Management and Budget Peer Review Bulletin requirements for Federal Government information products containing influential scientific information and highly influential scientific assessments (https://www.whitehouse.gov/wp-content/uploads/legacy_drupal_files/omb/memoranda/2005/m05-03.pdf).

Review, Approval, and Release of Information Products

In addition to peer review, all science information products (SM 502.1.1.b) must be reviewed and approved for official release and dissemination (fig. 2). This is an internal process that is used regardless of whether the product is published by the USGS or externally. The requirement for this level of review applies regardless of the status of the USGS author (for example, full time, part time, volunteer, or having a shared affiliation between the USGS and another entity) or the order of authorship. Requiring this additional level of review helps ensure that USGS information remains policy neutral and nonpartisan.

The USGS refers to the process of approval for public release as Bureau approval, and it is provided by either the Bureau approving official (BAO) in the Office of Science Quality and Integrity (OSQI) or the science center director, depending on the product. In other Federal agencies, the equivalent of the USGS Bureau approval is often referred to as the agency's clearance to publish. Additional details of the FSP requirements for Bureau approval are described in SM 502.4. Bureau approval certifies that the USGS stands behind its published scientific products.

Safeguarding Unpublished Data, Information, and Associated Scientific Materials

Unpublished data include pre-decisional, proprietary, and provisional or preliminary scientific information (including data and software) and associated materials. The term "unpublished" refers to the draft, interim, or background information and materials developed or collected and used to finalize USGS scientific information products for approval and release. The USGS conducts its activities and provides the results of its scientific investigations in a manner that will best serve the entire public rather than the interests of any particular group, corporation, individual, or other entity. Therefore, the FSP require the safeguarding of unpublished scientific information and associated materials produced by USGS employees, volunteers, and contractors working on behalf of the USGS and prohibit public release or disclosure of information and materials exclusively to any group or individual prior to final release to the public. The only exception to this policy is the use of restricted-file Federal interagency reports, which allow the USGS to distribute potentially sensitive or confidential information to another Federal agency or foreign government entity for internal use. The information in these reports generally becomes available to the public once the receiving Federal agency has had a chance to consider the information and incorporate the findings into their decision-making process. Specific details regarding the FSP requirement for safeguarding unpublished data and materials and its exceptions are described in SM 502.5.

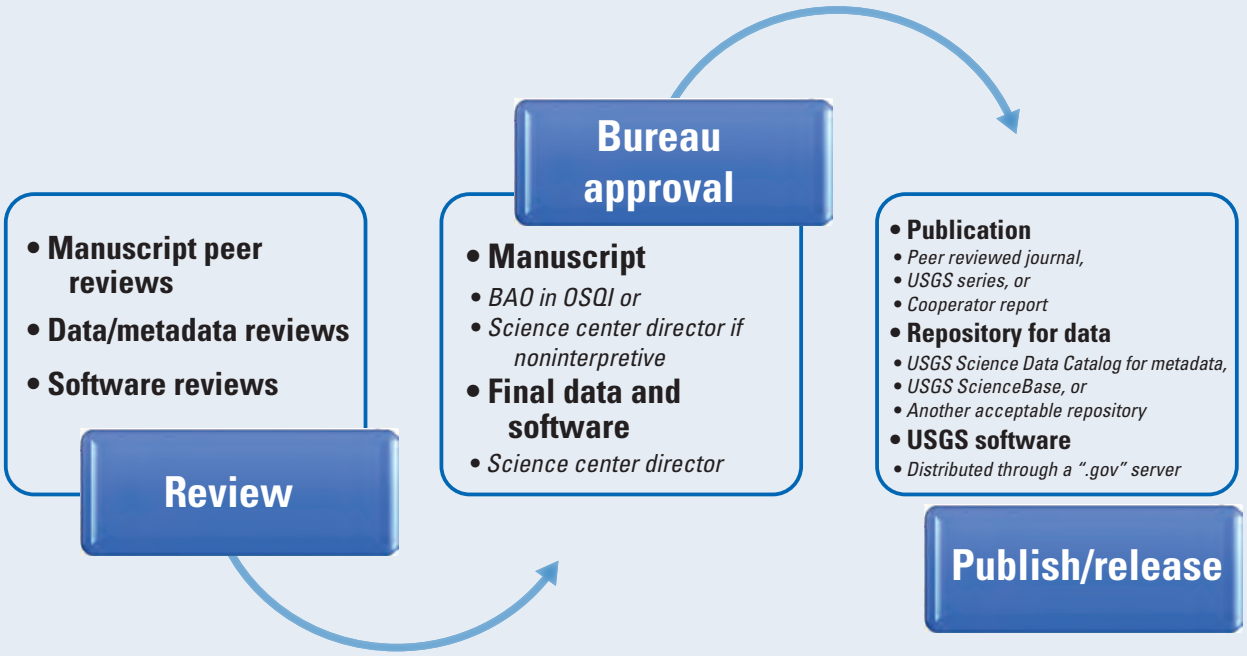

Figure 2. Diagram showing process for releasing the results of U.S. Geological Survey (USGS) research. Information about digital repositories for USGS information products, including a list of acceptable repositories, is available at https://www.usgs.gov/survey-manual/5021-fundamental-science-practices-foundation-policy. BAO, Bureau approving official; OSQI, Office of Science Quality and Integrity.

Scientific Data Management

The FSP require that USGS scientific data be managed throughout their data lifecycle and that a data-management plan be included with the project work plan or proposal that follows the USGS Science Data Lifecycle Model. Specific details regarding scientific data management and implementation are described in SM 502.6 and the USGS Data Management website (https://www.usgs.gov/data-management).

Metadata for USGS Scientific Information Products Including Scientific Data

Metadata accompany all USGS scientific data and other information products. The content and format of metadata depend upon the type of data or information product described. When data and other information products are digitally released, metadata include an appropriate persistent identifier for the product, such as a digital object identifier. Metadata records for scientific data comply with standards such as the Federal Geographic Data Committee (FGDC) Content Standard for Digital Geospatial Metadata, the International Organization for Standardization suite of standards, or other USGS-endorsed FGDC standards (refer to https://www.fgdc.gov/metadata). Publication metadata include authorship, title, originating office or center, product type and number, and reference to any associated data, if applicable. Additional details are described in SM 502.7.

Review and Approval of Scientific Data for Release

The FSP require timely and free public access to scientific data that are developed or funded by USGS information and research programs. The USGS releases provisional (that is, preliminary) and approved scientific data. Scientific data approved for release comply with the metadata requirements as described in SM 502.7, and the metadata are deposited in and shared through the USGS Science Data Catalog (SDC; https://data.usgs.gov/datacatalog/). Approved scientific data and provisional or preliminary data are accompanied by the appropriate disclaimer statement. Reviews of scientific data and associated metadata are required before data are approved. USGS data approved for release are managed through a data repository that can ensure their preservation, discoverability, accessibility, and usability. Scientific data are approved for release by science center directors or their designees. More information on review and approval of scientific data release is available in SM 502.8.

Preservation Requirements for Digital Scientific Data

The FSP require the preservation of scientific data and associated metadata funded by Bureau information and research programs. These data must be preserved in accordance with USGS records disposition requirements and the Federal Records Act (36 CFR §1220.14). USGS digital data and associated metadata must be stored in digital repositories approved by the USGS. Additional details about preservation requirements for digital scientific data are available in SM 502.9. Following these practices helps ensure that the data collected by USGS scientists will be properly archived and made available in perpetuity (fig. 3).

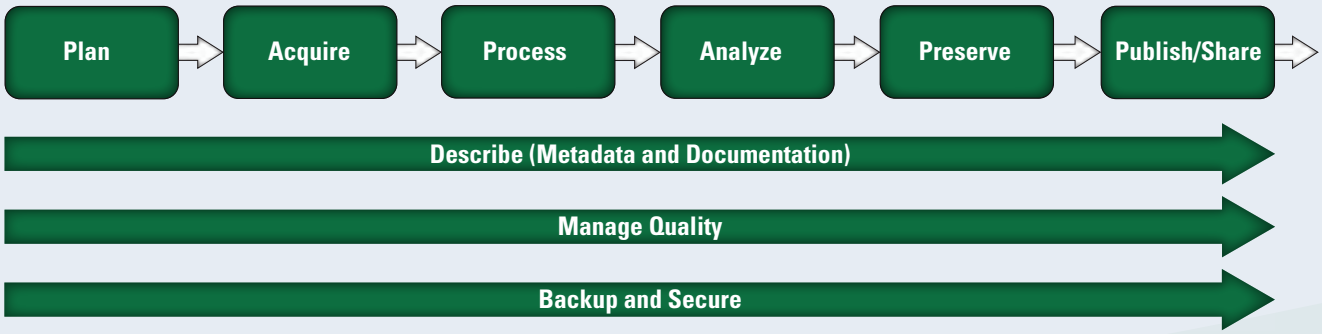

Figure 3. Diagram showing U.S. Geological Survey Science Data Lifecycle Model.

Review and Approval of Scientific Software for Release

The complexity of research conducted by USGS scientists makes it increasingly necessary to develop unique software to run models or conduct statistical analyses. To support these efforts, the USGS releases provisional and approved software. Scientific software intended for approval and release as a USGS scientific information product (SM 502.1) must comply with the appropriate FSP requirements. Scientific software is subject to two types of review, a software code review and a domain review. Providing this level of review helps ensure that software code is robust and does not infringe on the efforts of other software developers. Other requirements for software approval and release are described in IM OSQI 2019–01, and the USGS software management website provides details on implementation.

Bureau Approving Officials

BAOs, who have extensive scientific backgrounds, are in the Office of Science Quality and Integrity and provide review and approval of new interpretive information products and FSP-related guidance to staff in the science centers they serve. The BAOs are well versed in FSP requirements and are another experienced resource for authors in their assigned centers. The USGS Fundamental Science Practices Advisory Council (FSPAC) and BAOs work together to help ensure that the FSP are a living policy that adapts as scientific and publishing needs evolve and to conduct FSP training (FSP training modules are available at https://www.usgs.gov/office-of-science-quality-and-integrity/fundamental-science-practices-training-modules).

Fundamental Science Practices Advisory Council

In January 2009, the Director of the USGS established the Fundamental Science Practices Advisory Committee, now referred to as the Advisory Council or FSPAC.

The FSPAC has four functions: (1) to provide advice and recommendations to USGS leadership and others regarding the FSP, (2) to develop new FSP policy and guidance, (3) to propose modifications to existing policy and guidance for consideration by the USGS Executive Leadership Team (SM 308.75) in carrying out the USGS mission (https://www.usgs.gov/about/about-us/who-we-are), and (4) to respond to inquiries from scientists regarding policy implementation and suggestions for improvement. FSPAC membership is deliberately broad to benefit from various perspectives across the Bureau. Additional information on FSPAC functions and membership selection is available in SM 308.74.

Science Publishing Network

The Science Publishing Network (SPN) is the publishing entity of the USGS. The publications produced by the SPN include USGS reports, geologic maps, and outreach products. The SPN supports all employees of the USGS, as well as many partners and consumers of USGS information products and services. The publishing services include technical and scientific editing, graphics support, publication layout and design, and web and print release of all USGS reports. Additionally, the SPN provides customized support for other USGS products. USGS publishing information is available at https://www.usgs.gov/usgs-publishing-information.

USGS Information Product Data System

The USGS maintains a database system to document and track the development of scientific products. The standard workflow steps for USGS products that are reviewed and approved in accordance with FSP requirements are incorporated into an internal tracking system. The Information Product Data System (IPDS) is the Bureau's official product-tracking system for managing and documenting the development steps and peer reviews of USGS information products that require Bureau approval. Information and documents stored in the IPDS document compliance with the FSP and satisfy the National Archives and Records Administration requirements for managing these documents.

USGS Publications Warehouse

As a Federal agency, the USGS has a responsibility to make the results of its scientific investigations accessible, free, and promptly available to the public through the web. These publications include USGS publication series, journal articles, books, book chapters, other government and nongovernment publications, cooperator publications, and conference proceedings. The Publications Warehouse is the authoritative catalog and publicly accessible website for accessing USGS peer-reviewed scientific publications, as indicated in SM 502.4 and the USGS Public Access Plan (https://www.usgs.gov/office-of-science-quality-and-integrity/public-access-results-federally-funded-research-us). More details about the Publications Warehouse are available at https://pubs.er.usgs.gov/documentation/about.

USGS Science Data Catalog

The USGS Science Data Catalog (SDC) provides seamless access to USGS research and monitoring data from across the Nation. The SDC provides a search and discovery tool that allows for scientific metadata retrieval, visualization, data downloads, and the ability to link back to original data, regardless of the repository in which they reside. The SDC meets White House Open Data reporting requirements for the USGS and offers a single source from which the USGS serves its metadata to data.doi.gov, Data.gov, and the Office of Management and Budget. The SDC is the authoritative source for USGS scientific data.

Summary

The policies and procedures in the Fundamental Science Practices support and guide USGS scientists to ensure the consistency, quality, and integrity of all USGS science across diverse missions and science topics. They also embody principles and procedures that the USGS uses when monitoring, analyzing, and predicting current and evolving dynamics of complex human and natural Earth-system interactions and delivering actionable intelligence at scales and timeframes relevant to decision makers. Establishing and adhering to the FSP help the USGS serve the Nation and provide a legacy of science information.

> It is also vitally important, in all aspects of our science and service mission, to uphold our commitment to scientific integrity and objective results codified in our fundamental science practices.
>
> —David Applegate, 18th USGS Director

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