Thunder Bay AUV Survey 2010

Data Management Plan

Expedition Summary

Thunder Bay National Marine Sanctuary (TBNMS) has a fundamental responsibility to locate new shipwrecks for the purposes of protecting these resources on the public's behalf. In short, the potential to discover historically significant shipwrecks, and to fully determine the quantity and disposition of resources in the proposed expansion area, represents the overarching rationale for the proposed project. Intertwined with this rationale is the sanctuary's need to continually test innovative, efficient, and cost effective methods of remote sensing. Success in this area will benefit the broader maritime archaeology community as well.

Expedition Objectives

The project principals of this expedition plan to utilize state-of-the-art AUV forward-looking sonar technology to map known shipwreck sites and to examine potential previously unknown historic wreck sites in Lake Huron, and in doing so, expand the boundaries of the Thunder Bay National Marine Sanctuary from 450 square miles to approximately 4,000 square miles.

Data Management Plan

The Thunder Bay AUV Survey 2010 cruise is considered a Signature Expedition by the Office of Ocean Exploration & Research (OER). As such, and according to the OER Data Management Guidance (Appendix A), OER is providing a Data Manager for the expedition. The OER Data Manager will use the Cruise Information Management System (CIMS) software to document the metadata, the who, what, when, where, why and how of any raw data sets, samples, multimedia files, and products collected, recorded, and/or produced during and after the Thunder Bay AUV Survey expedition. The OER Data Manager will enter information into CIMS, which was developed specifically for documenting the science activities onboard OER expeditions and producing Federal Geographic Data Committee (FGDC) and Library of Congress Machine Readable Catalog (MARC) compliant metadata records. OER is mandated by the government to archive data from its expeditions at the appropriate NOAA National Data Center within a reasonable amount of time and metadata is required to be included with the corresponding data when it is submitted to be archived.

Several types of metadata records are generated for each expedition. The highest-level record is called a collection-level metadata record and contains the most basic header information about the expedition – title, vessel, chief scientist, mission abstract, dates, geographic region, data inventory summary, and keywords or phrases that enhance discovery of the metadata. More detailed metadata records document the raw data sets recorded, samples collected, multimedia images or video recorded, and products generated as a result of the expedition. The collection-level metadata record enables the archive centers to prepare their systems to receive associated data sets that are their responsibility to archive (see Appendix B). The National Oceanographic Data Center (NODC) archives oceanographic, biological, chemical, and environmental data sets. The National Geophysical Data Center (NGDC) archives geological and geophysical data sets. The NOAA Central Library (NCL) archives physical

multimedia, digital multimedia files (such as video highlights and highlight images), and paper and digital products (such as reports, journal articles, publications, etc).

Anticipated Data Submission for Archive
- Quick Look Report (form to be supplied)
- Processed Sonar Data
- Processed Sonar Imagery
- Highlight Still images with captions/credits.
- Highlight Video clips with captions/credits
- Cruise Summary report
- Publications, Journal Articles, etc.

Data Management Points of Contact
Russ Green, NOAA TBNMS, Co-Chief Scientist, russ.green@noaa.gov
Dr. Charles Loeffler, Applied Research Lab, Chief Scientist, loeffler@arlut.UTexas.edu
Frank Cantelas, NOAA/OER, Expedition Coordinator, frank.cantelas@noaa.gov
Susan Gottfried, NCDDC, Data Management Coordinator, susan.gottfried@noaa.gov

Thunder Bay AUV Survey Cruise Data Archival Matrix

The following table outlines the proposed data submission for the NOAA Data Centers, the requested format for data submission, the targeted archive center and the proposed availability date for public release. The data and its availability date is negotiable. Changes to the proposed date should be communicated to the OER Data Management Coordinator prior to the end of the cruise.

Data Class	Instrument	Data Type	Format	Metadata Granularity	Archive Center	Availability Date for Archive
MET	R/V Storm METOC Sensor Suite	Hull-mounted oceanographic/ meteorological sensors	ASCII	1 meta rec	NODC/ MDSD	
NAV	R/V Storm Navigation	Ship-track, Speed over ground, Course over ground	ASCII	1 meta rec	NODC/ MDSD	
GEO	REMUS 600 Sonar	Processed Sonar Data			NGDC	
PRD	REMUS 600 Sonar	Processed Sonar Imagery			NGDC & NCL	

Data Class	Author	Data Type	Format	Metadata Granularity	Archive Center	Availability Date for Archive
PRD	Chief Scientist(s)	Quick Look Report	.pdf, .doc	1 meta rec	NODC/ NCL	ASAP following End of Cruise
PRD	Chief Scientist(s)	Final Mission Summary Report	.pdf, .doc	1 meta rec	NODC/ NCL	Within six months
PRD	Project Principals	Peer-reviewed journal article	.pdf, .doc	1 meta rec	NODC/ NCL	When available
PRD	Project Principals	Publication	.pdf, .doc	1 meta rec	NODC/ NCL	When available

Situation Reports

Daily operational reports, called Situation Reports, are generated through the CIMS software system. These documents are emailed regularly (usually daily) to the OER Expedition Coordinator and to others specified by the cruise principals.

Situation Report Recipient	Recipient Email Address
Frank Cantelas, Expedition Coordinator	Frank.Cantelas@noaa.gov

Susan Gottfried, Data Management Coordinator	Susan.Gottfried@noaa.gov

Geospatial and other Products for Discovery

NCDDC maintains a Digital Atlas for OER that provides a geographical user interface for data discovery and access to OER-sponsored expeditions. The tool, which can be accessed online at http://explore.noaa.gov/DigitalAtlas, color codes the expeditions by year and provides filters by year and by exploration theme to affect the display. Clicking on an expedition icon will display a bubble of information. The first screen is a brief summary of the expedition and a link to its web page on http://oceanexplorer.noaa.gov, OER's Education and Outreach website. Once the data from the expedition is archived, a 'Data Access' tab will be available with instant access by the user to the location of the expedition's data at each of the archive centers. If an Expedition Education Module (EEM) was created by OER's Education Program for the expedition, a link to the EEM will also be available on this 'Data Access' tab. A 'GIS Tools' tab will be available if the expedition has been included in a more sophisticated Geographic Information System (GIS) application with an Interactive Map Service allowing the user to view information and data from the expedition in relation with other data sources in the same study area. Navigational and underway data from the vessels and submersibles provide the initialization data necessary to be included in the GIS. Once incorporated, other data sets or products can be accessible to the user. Finally, a "Pubs" tab will provide access to the NOAA Central Library's Ocean Exploration Bibliography website and a comprehensive list and online access to the peer-reviewed journal articles and publications that have resulted from the expedition.

The NCL maintains a Video Data Management System (VDMS) of all physical media archived in their climate-controlled storage rooms. Each media unit is catalogued in the library and is accessible for viewing, with the principal investigator's permission, in the Library's Media Room.

The NODC assigns Accession numbers to the data sets they receive for their Ocean Archive System (OAS). Visitors to the NODC website are able to discover the data sets archived at NODC through the OAS user interface, accessible through http://www.nodc.noaa.gov.

The NGDC uses the GEOphysical DAta System (GEODAS), http://www.ngdc.noaa.gov/mgg/ to archive and provide access to multibeam bathymetry and other geophysical and geological data.

Appendix A: Data Management Guidance

NOAA's Office of Ocean Exploration & Research (OER) is in accord with the 2000 President's Panel on Ocean Exploration call for a Federal program that promotes data management and dissemination to ensure that discoveries can have maximum impacts in the research, commercial, regulatory, and educational realms. OER advocates open scientific communication and expects significant findings from supported research and educational activities to be promptly submitted for publication with authorship that accurately reflects the contributions of those involved. It expects PIs to share with other researchers, at no more than incremental cost and within a reasonable time, the data, samples, physical collections and other supporting materials created or gathered in the course of the work. It also encourages grantees to share software and inventions, once appropriate protection for them has been secured, and otherwise act to make the innovations they embody widely useful and usable. OER will put these principles into practice, in ways appropriate to field and circumstances, through the proposal review process; through award negotiations and conditions; and through appropriate support and incentives for data cleanup, documentation, dissemination, storage and the like. Adjustments and, where essential, exceptions may be allowed to safeguard the rights of individuals and subjects, the validity of results and the integrity of collections, or to accommodate legitimate interests of investigators.

Each applicant should articulate his/her willingness to comply with these principles. The proposal Project Description should outline the plans for preservation, documentation, and sharing of data, samples, physical collections, curricula materials and other related research and education products. Plans for handling of data and other products will be considered in the review process.

Grant recipients are responsible for archiving all acquired data sets and associated products in the appropriate NOAA archive (i.e., National Oceanographic Data Center, National Geophysical Data Center, National Coastal Data Development Center, National Climate Data Center, and the NOAA Central Library) as soon as practical and, in no case, later than two years following the completion of the expedition. Within 60 days of completion of the expedition/field work/etc, grant recipients should provide a collection level metadata record (e.g., number & type of data, and description of the data collected) to the OER Data Manager for submission to the National Data Clearinghouse. This record should be created in compliance with the Federal Geographic Data Committee Content Standards for Digital Geospatial Metadata (FGDC-STD-001-1998) in accordance with Executive Order 12906, Co-ordinating Geographic Data Acquisition and Access: The National Spatial Data Infrastructure dated April 1994 http://www.fgdc.gov/policyandplanning/executive_order.

For continuing observations, data inventories should be submitted periodically if there is a significant change in location, type or frequency of such observations. Archiving of any specific archaeological site information that is considered sensitive material under Section 304 of the National Historic Preservation Act of 1966 (as amended) will not be required to be in compliance with these requirements.

For a subset of funded expeditions, OER will facilitate data collection, management and archival by providing the in-field services of an OER Data Manager. The OER Data Manager will be responsible for documenting all expedition activities (e.g., science, education and outreach, transits, shuttles) in the OER Cruise Information Management System (CIMS). The metadata records contained in the CIMS will be provided to the Science Team for inclusion in required reports, and will be distributed to the appropriate NOAA archive.

To aid in the Census of Marine Life (CoML; http://www.coml.org) goal of determining the distribution, abundance and diversity of marine life, all projects are encouraged to maintain their biological species information on-line and linked (either directly or via a Federal data center) to the CoML database, the Ocean Biogeographic Information System (OBIS) (http://www.iobis.org). A statement to this effect should be included in the proposal. Biological samples should be registered with the Census of Marine Life's OBIS database (http://www.iobis.org) or a Federal database that is linked to OBIS.

Other data or data products may also be requested at the discretion of the OER Director for administrative, scientific, or educational use. All such product requests will be considered in full collaboration with the applicant, and any data sensitivity issues will be handled appropriately. PIs and their institutions are responsible for meeting all legal requirements for submission of data and research results that are imposed by foreign governments as a condition of that government's granting research clearances. Each PI and institution must determine their legal obligations in this respect, with the assistance of the Department of State and NOAA, as necessary.

The applicant is encouraged to consider budgeting appropriate resources for any anticipated costs to comply with these data management principles. This generally includes budgeting for the following types of activities: reports, reprints, page charges or other journal costs (except costs for prior or early publication); necessary illustrations; cleanup, documentation, storage and indexing of data and databases; development, documentation and debugging of software; and storage, preservation, documentation, indexing, etc., of physical specimens, collections or fabricated items. The OER Data Manager, when not otherwise specifically designated in each Grant or Contract award, will be the NOAA National Coastal Data Development Center's OER Liaison Officer (228-688-2936 or toll free 1-866-732-2382).

Appendix B: NOAA Office of Ocean Exploration and Research (OER) Expedition Data Submission Instructions

In preparation for your expedition, OER would like to discuss how we may assist you with archiving your expedition data at NOAA, generating associated metadata, and protecting your proprietary and intellectual rights to the data and data products. Archiving the data and publishing the associated metadata will enable OER to be in compliance with government mandates for data management, and we believe it will provide you advantages as well:

- Published metadata will ensure that your research will be discoverable through internet searches and that it always will be accredited to you.
- Published metadata will never expose the actual data unless that is something that you authorize.
- Archived data will be withheld from public access for a minimum of two years and will be preserved for the long term.
- Archived data that have been made publicly accessible will benefit future research.

OER offers science parties three levels of data management support related to their expeditions:
1. An OER designee accompanies the expedition and performs data management duties using the CIMS.[1]
2. OER provides CIMS and trains a science party member as a data manager.[1]
3. If CIMS is not used in association with an expedition, OER works with the science party to ensure that a subset of the data and information is archived in the appropriate NOAA data centers.[2]

[1] When CIMS is used during an expedition, post-cruise procedures provide a metadata generation utility that will programmatically generate FGDC compliant metadata from the information entered into the system. These metadata records are then owned and controlled by the chief scientist through the MERMAid.

[2] When the CIMS is not utilized, a science party metadata contact must be identified for the expedition. This contact will be given access to the MERMAid in order to create and manage metadata for archived datasets. Metadata and archive staff will be assigned to work with that contact to ensure that metadata requirements are understood and that the metadata is compliant with the appropriate standards.

Regardless of the support level, OER is committed to the process of efficiently and effectively managing data and information derived from all funded projects. In our upcoming pre-cruise data management conference call, we would like to accomplish several goals:

1. Identify the data sets that you will acquire and the subset of NOAA-relevant data sets that you would be willing to archive at the appropriate NOAA data centers.
2. Decide on which level of data management support will be required for your expedition and discuss the next steps.
3. Discuss proprietary and intellectual rights associated with the data and metadata, time frames for submitting the data and metadata to the IPT, and time frames for making the data available to the public.
4. Introduce the CIMS tool for documenting data collection activities during the expedition.

5. Introduce the MERMAid tool for metadata creation and publishing and describe how it can be utilized in the process.
6. Introduce the Digital Atlas, an interactive GIS application, through which your expedition may be discoverable in a geospatial environment with other related NOAA and non-NOAA data sets.
7. Introduce the Video Data Management System (VDMS), the NOAA Central Library's application for cataloguing copies of video from your expedition, which can be protected in the library in a climate-controlled, state-of-the-art video archive.
8. Introduce NODC's Ocean Archive System and describe its capabilities and recommended archival data formats.
9. Introduce NGDC's Archive System and describe its capabilities and recommended archival data formats.
10. Discuss any concerns regarding specific archaeological site information that is considered sensitive material under Section 304 of the National Historic Preservation Act of 1966 (as amended) or other concerns about limiting access to sensitive information (e.g., location and type of endangered biological resources).

By the end of our conference call, OER expects a shared understanding of all our data management goals and an agreement between OER and the science party as to the process for data management.

NOAA Central Library (NCL)
Video Data Management System (VDMS) and
Library Online Catalog (NOAALINC)

Overview:

The NOAA Central Library, located in Silver Spring, Maryland, provides information and research support to NOAA staff and the public. The library also networks with over 30 NOAA libraries across the nation. Disciplines covered include weather and atmospheric sciences, oceanography, ocean engineering, nautical charting, marine ecology, marine resources, ecosystems, coastal studies, aeronomy, geodesy, cartography, mathematics and statistics.

The NCL is interested in archival the following types of data sets.

Check if Included	Proprietary Period	Data	Preferred Formats
		Copies of the original dive video	MiniDV, DVD or DVCAM
		Video Annotations (spreadsheet of video tape details)	Microsoft Excel, Comma delimited, or Text file format on CD-ROM, DVD, or online file for grab
X		Video Highlights	MiniDV, DVD or DVCAM (highlight video clips selected by PI; approx. 10-30 min. runtime)
X		Digital Image Highlights	HR resolution still images in JPEG **and** TIFF formats on CD-ROM, DVD, or zip file online for grab (20-30 images selected by PI)
		Digital Images Collections	HR resolution still images in JPEG **and** TIFF formats organized into albums/folders on CD-ROM, DVD, or zip file online for grab
X		Digital Image Collections/Digital Image Highlights annotations	Microsoft Excel, Word, or PDF document; Photo and Video Catpions and Credits information for the highlights and the entire image collection on CD-ROM, DVD, or online file for grab
X		Reports (Cruise Summary, Quick Look Report, Dive Summaries, etc.)	Microsoft Excel, Word, or PDF document on CD-ROM, DVD, or online file for grab
		Educational lesson plans	Web applications, such as HTML, Word, PDF, etc.
		Promotional post-expedition products	CD-ROM, DVD, video tapes, Websites, brochures, posters, etc.

Additional considerations: _____

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NOAA National Geophysical Data Center (NGDC)
Geophysical Data System (GEODAS)

Overview:

NGDC provides archival service for relevant geologic, seismic, magnetic, gravitational, and/or bathymetric data collected and products generated in association with OER-sponsored expeditions. Metadata accompanying these data are required in order to effectively provide discovery of these data and products to diverse user communities.

NGDC is interested in archival the following types of data sets.

Check if Included	Proprietary Period	Data
X		Multibeam Bathymetric Raw Data[1]
X		Image Files[2]
		Grid Files[3]
		Gravity, Magnetic, Seismic, or single beam bathymetric data[4]
		Geology Grain Size Analysis
		Core descriptions & analyses

If data sets are identified for archival, a more detailed discussion regarding appropriate formatting will follow. An overview regarding currently supported formats by data type is below.

[1]NGDC currently accepts raw geophysical data in a variety of formats readable by MBSystem software.   At present, formats associated with the following sonars are supported.

- Sea Beam "classic" multibeam sonar
- Hydrosweep DS multibeam sonar
- Hydrosweep DS2 multibeam sonar
- Hydrosweep MD multibeam sonar
- Sea Beam 2000 multibeam sonar
- Sea Beam 2112 and 2136 multibeam sonars
- Sea Beam 2120 multibeam sonars
- Simrad EM12, EM121, EM950, and EM1000 multibeam sonars
- Simrad EM120, EM300, EM302, and EM3000 multibeam sonars
- Simrad Mesotech SM2000 multibeam sonar
- Hawaii MR-1 shallow tow interferometric sonar
- ELAC Bottomchart and Bottomchart MkII shallow water multibeam sonars
- Reson Seabat multibeam sonars (e.g. 9001, 8081, 7125)
- WHOI DSL AMS-120 deep tow interferometric sonar
- Sea Scan sidescan sonar
- Furuno HS-1 multibeam sonar
- Edgetech sidescan and subbottom profiler sonars

See http://www.ldeo.columbia.edu/res/pi/MB-System/html/mbsystem_formats.html for more details.

[2]Preferred formats are Tagged Image File Format (tiff) and/or Graphic Interchange Format (gif)

[3]Preferred format is Network Common Data Form (NetCDF). Additional information about NetCDF can be found at http://www.unidata.ucar.edu/software/netcdf.

[4]Preferred formats are the Marine Geophysical Data (MGD-2000) formats, MGD77, HYD93, ARO88, GRD98, VCT00, and XYZ03. Details about these formats can be found at http://www.ngdc.noaa.gov/mgg/gdas/hg_mgd2000.Html).

Quality Information:

A dataset must include parameters for depth, latitude, and longitude.

Depth should be within the range of 0-11,000 meters and should contain only one sign.   The method used to derive depth (sound velocities or 1500 m/sec) should be indicated and if sound velocity profiles exist, they should accompany the data. If tide corrections are applied to the data, these data should also accompany the data.

Latitude and longitude points should be located over areas of water or within the boundaries of a particular body of water. The datums used to determine position should be indicated.

Additional considerations: _____
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NOAA National Oceanographic Data Center (NODC)
Ocean Archive System (OAS)

Overview:

NODC provides archival service for global oceanographic data in order to preserve a historical record of the Earth's changing environment. These archival data may be used for operational applications and ocean climate research. In a collaborative effort with NOAA's Office of Ocean Exploration and Research (OER), NODC archives relevant oceanographic, biological, chemical, environmental, and meteorological data and products generated in association with OER-sponsored expeditions. Metadata accompanying these data are required in order to effectively enable discovery of these data and products to diverse user communities.

NODC is interested in archiving the following types of data.

Check if Included	Proprietary Period	Data Type	Preferred Formats	Acceptable Formats	Unacceptable Formats
		Physical Oceanographic Data[1]	comma delimited ASCII, netCDF, HDF5	MS Excel	[6]
		Chemical Oceanographic Data[2]	comma delimited ASCII, netCDF, HDF5	MS Excel	[6]
		Biological Oceanographic Data[3]	Comma Delimited ASCII, netCDF, HDF5	MS Excel	[6]
		Data Products[4]	native GIS (.e00), PDF/A, JPEG, mov	PDF, MS Word	[6]
		Cruise Products[5]	PDF/A	PDF, MS Word	[6]

[1] The NODC acquires physical oceanographic data of value for a broad spectrum of secondary users. These include measured values of temperature, salinity, ocean currents, winds and wave spectra, pressure, light transmission, fluorescence, sea level, etc. These measurements are taken from a variety of instruments (e.g. XBT, CTD, and ADCP), sensors (e.g., thermistor, transmissometer, inverted echo sounder), and platforms (e.g., moored current meters, drifting buoys, subsurface floats, tide stations, and earth orbiting satellites).

[2] The NODC acquires data on naturally-occurring and anthropogenic chemical substances. These data include observations from the water column, biota, and interstitial waters of marine sediments.

Principal data parameters of interest include dissolved gases, pH, alkalinity, nutrients, dissolved organic and inorganic matter, particulate organic and inorganic matter, trace metals, and marine pollutants.

[3]The NODC archives a diverse range of biological data, including geographic and temporal distribution of all groups of marine plant and animal biota, primary organic production, plant pigment concentrations and distributions, and metabolic products in seawater (e.g. ATP and urea). Other parameters of interest include identity, geographic/temporal/vertical distribution, abundance and biomass of marine organisms (all taxonomic groups from virus particles to marine mammals) and population, community and ecosystem surveys and monitoring program collections.

Except when required by special NOAA program interest, NODC does not acquire biological data that are not directly related to ecosystem dynamics (e.g., cell and molecular biology, physiology, fisheries statistics, embryology and development, and morphometry). Data on substratum characteristics are acquired and archived by NODC only when they are included as habitat descriptors of benthic communities or as part of water column related studies.

[4] The NODC acquires products in many diverse formats that are wholly dependent on the product type. Internationally- or industry-recognized standards are always preferred over locally-created formats. Recommended formats for still and moving image files, GIS maps, and other product types should be discussed in pre-cruise planning meetings to ensure timely inclusion in NODC archival collections.

[5] The NODC acquires summary products produced as a result of the expedition (e.g. Cruise Summary reports, Dive Summary reports, journal articles, and publications). Summary products should use internationally- or industry-recognized standards, such as Adobe Acrobat PDF/A for documents.

[6] NODC does not accept many formats that are readable only by proprietary software (e.g., Seabird CTD hex format). Contact NODC.DataOfficer@noaa.gov for more information.

Quality Information:

Data quality and detailed documentation of quality assessment techniques is critical for long-term preservation of irreplaceable observation data. Quality assessment techniques can be documented using MERMAid tools, in external publications that are archived with data holdings, or other mechanisms discussed during pre-cruise planning meetings.

Additional considerations: _____
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NOAA National Coastal Data Development Center (NCDDC) Geospatial Data Discovery, Visualization, Integration and Analysis Tools

Overview:

A key goal of the OER data management initiative is to integrate exploration data with other NOAA and non-NOAA data to meet NOAA's mission goals. NCDDC hosts a geospatial data base of coastal and ocean data, and has developed applications to make this data available to the public through geo-web services. Using both Google and ESRI ArcServer technology, NCDDC has developed the Digital Atlas Portal, a map-based index for OER explorations. This data discovery tool is backed by a series of Regional Atlases that offer web-based GIS tools for data visualization, data integration and analysis.

Geospatial data provided to NCDDC will be hosted in the geospatial data base and made accessible to the public through one or more Regional Atlases. In addition, related, geo-referenced data products may be linked to the GIS display. For example, images may be linked to a location on the dive track; similarly, static products such as water column profiles, charts, dive reports and so on may be linked to specific map locations.

NCDDC can assist users in archiving their geospatial data products at the appropriate NOAA Data Center. The NCDDC geo-database is archived periodically at NODC.

NCDDC is interested in hosting the following types of data.

Check if Included	Proprietary Period	Data Type	Preferred Formats	Acceptable Formats	Unacceptable Formats
X		Vessel and submersible navigational data	shapefiles, KML	comma delimited ASCII, MS Excel, *.e00, netCDF, HDF5	
X		Data Products[1]	shapefiles, KML, PDF, JPEG, GeoTiff, png	MS Word	
X		Cruise Products[2]	PDF/A	MS Word	

[1] The NCDDC acquires products in many diverse formats that are wholly dependent on the product type. Internationally- or industry-recognized standards are always preferred over locally-created formats. Recommended formats for still and moving image files, GIS maps, and other product types (e.g. geo-referenced charts, plots, etc) should be discussed in pre-cruise planning meetings to ensure timely inclusion in NCDDC archival collections.

[2] The NCDDC acquires summary products produced as a result of the expedition (e.g. Cruise Summary reports, Dive Summary reports, journal articles, and publications). Summary products

should use internationally- or industry-recognized standards, such as Adobe Acrobat PDF/A for documents.

Additional considerations:
1. Organizations that host their own web accessible GIS tools have the option of providing a link to their web site or maps. This information will be referenced from the OER Digital Atlas GIS Tools link.
2. Organizations that use ESRI ArcServer technology have the option of integrating remotely hosted data directly into a Regional Atlas.
3. FGDC metadata is required for geospatial data (e.g. shapefiles) but is not necessarily required for information products (e.g. dive reports, charts, etc)

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