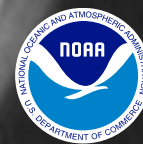


# Evolving Requirements for Data and Information Management

David McKinnie  
Office of Ocean Exploration and Research

Sharon Mesick  
National Centers for Environmental Information

Megan Cromwell  
Northern Gulf Institute/Mississippi State University  
National Centers for Environmental Information

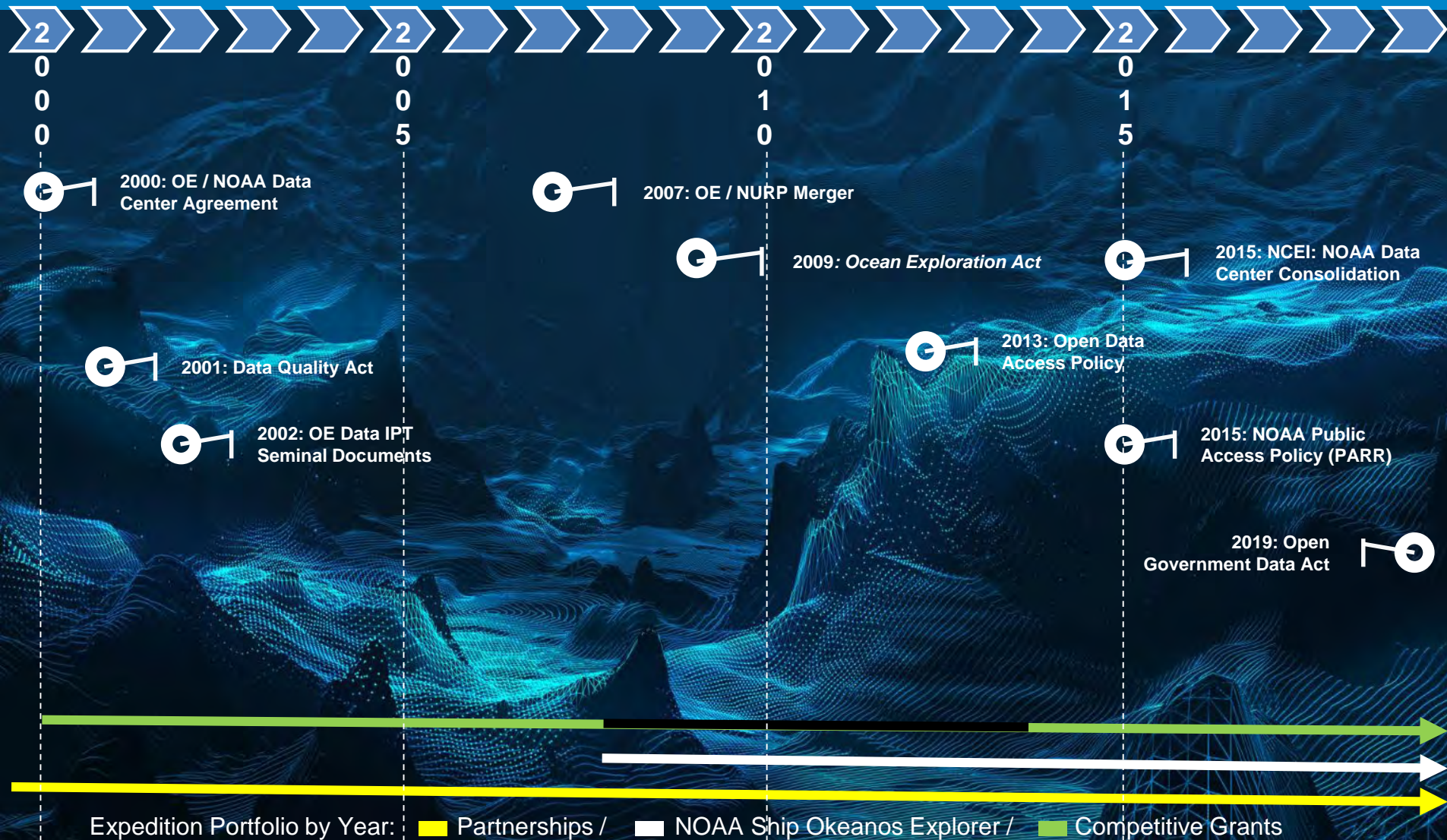


**Ocean Exploration  
and Research**

# OER Mission and the Data Imperative

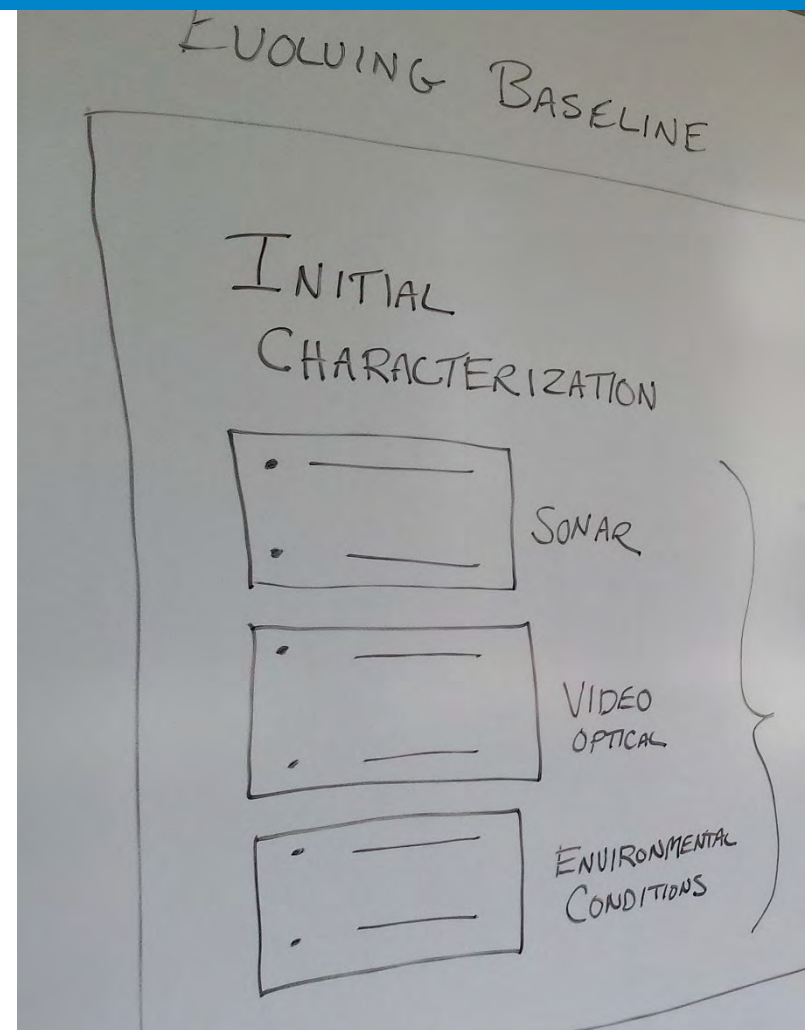
- OER's mission is to explore the deep ocean:
  - map to modern standards
  - conduct baseline characterization
  - make that data and information available *and accessible* to whomever needs it in a form that is *useful* for science, for decisions, for general information about the ocean
- If ocean exploration results are not available, accessible, and reusable, we have not succeeded in our mission

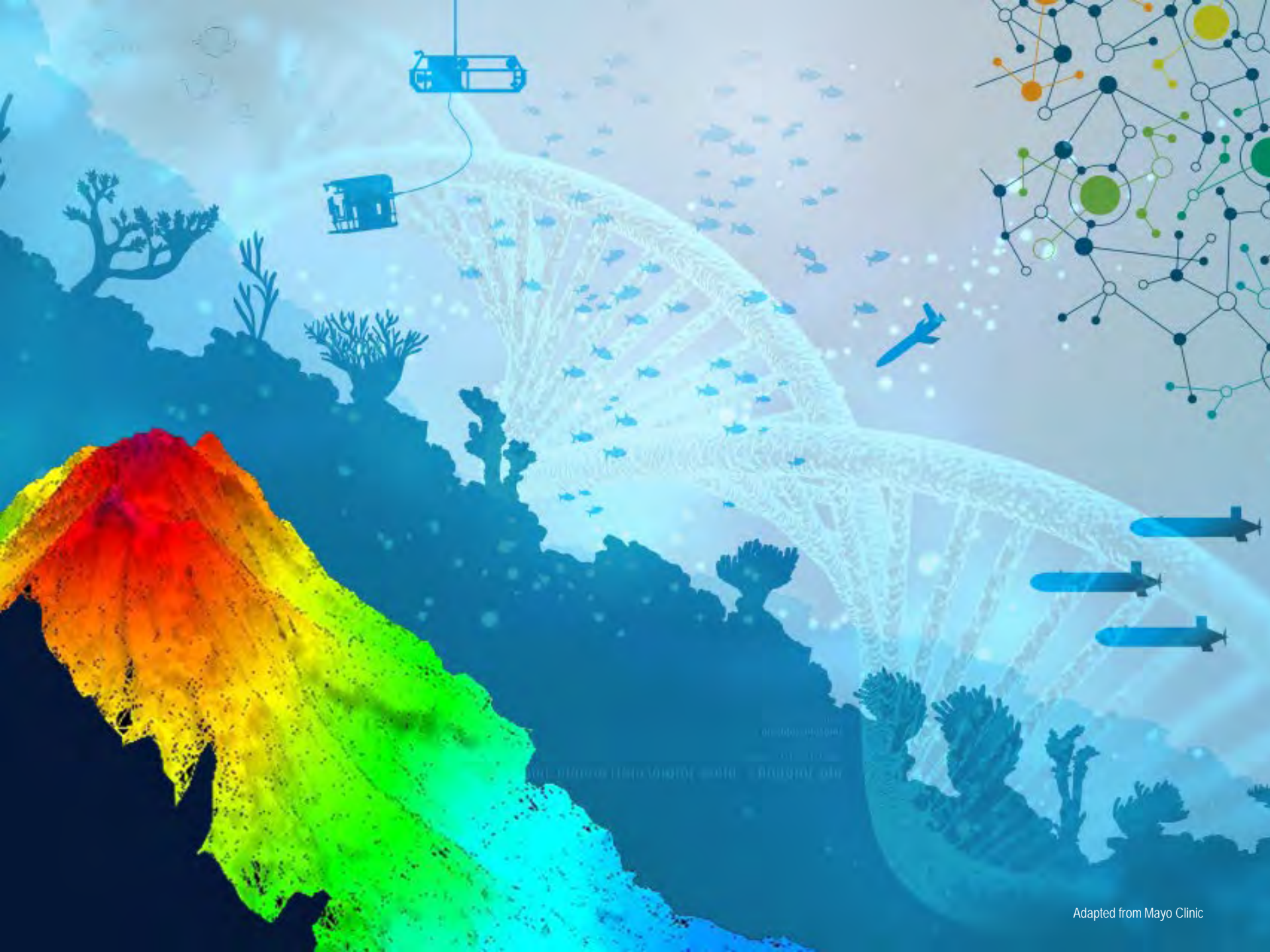
# Data Management: *Evolution in a changing landscape*



# Evolving View of Characterization

- 2008-2015
  - Sonar (multibeam/mapping operations)
  - Video (ROV operations)
  - Some oceanographic data
- 2015-2018
  - Water Column?
  - Acoustics?
  - Other measurements?
- 2019
  - Processes
  - Connectivity
  - Rapid evolution





# OER's conceptual model for an expedition

- We explore a 3-D polygon
- We need to think in terms of:
  - How all data collected by the expedition in that polygon might relate
  - Developing new CONOPS using gliders, other platforms and sensors (Deep Argo? Saildrone? Silixia?)
  - Integrating data collected in that polygon in an extended time domain (e.g. moored arrays, Argo floats).

# OER's Data Access and Use Requirement

- NOAA Ship *Okeanos Explorer* retires in 2023-24. There is no dedicated replacement; OER will begin operate from multiple platforms soon
- By 2025, OER must be heavily invested in autonomy
- The new CONOPS that will result mean much more complex and diverse data work flows, more diverse data types, and radically increased data volume

# THE PAST

SCIENCE  
AT SEA



SCIENTIFIC  
PAPERS

DATA AVAILABILITY: **2+ YEARS**



# THE PRESENT



REAL-TIME  
SCIENCE ON  
SHORE

The diagram illustrates a data flow from a satellite to a NOAA ship (R-337) and then to a shore-based facility. A double-headed arrow connects the ship and the shore facility, indicating bidirectional communication. The shore facility includes a large red brick building and a smaller white house with a red roof. Dotted lines represent data transmission paths from the satellite to both the ship and the shore facility.

OPEN ACCESS DATA



The diagram shows a vertical data path from the NOAA ship (R-337) down to an underwater autonomous underwater vehicle (AUV). The AUV is emitting a light beam and is connected to a surface buoy or platform. This represents the collection of data from the ocean floor.

DATA AVAILABILITY: **6 WEEKS**

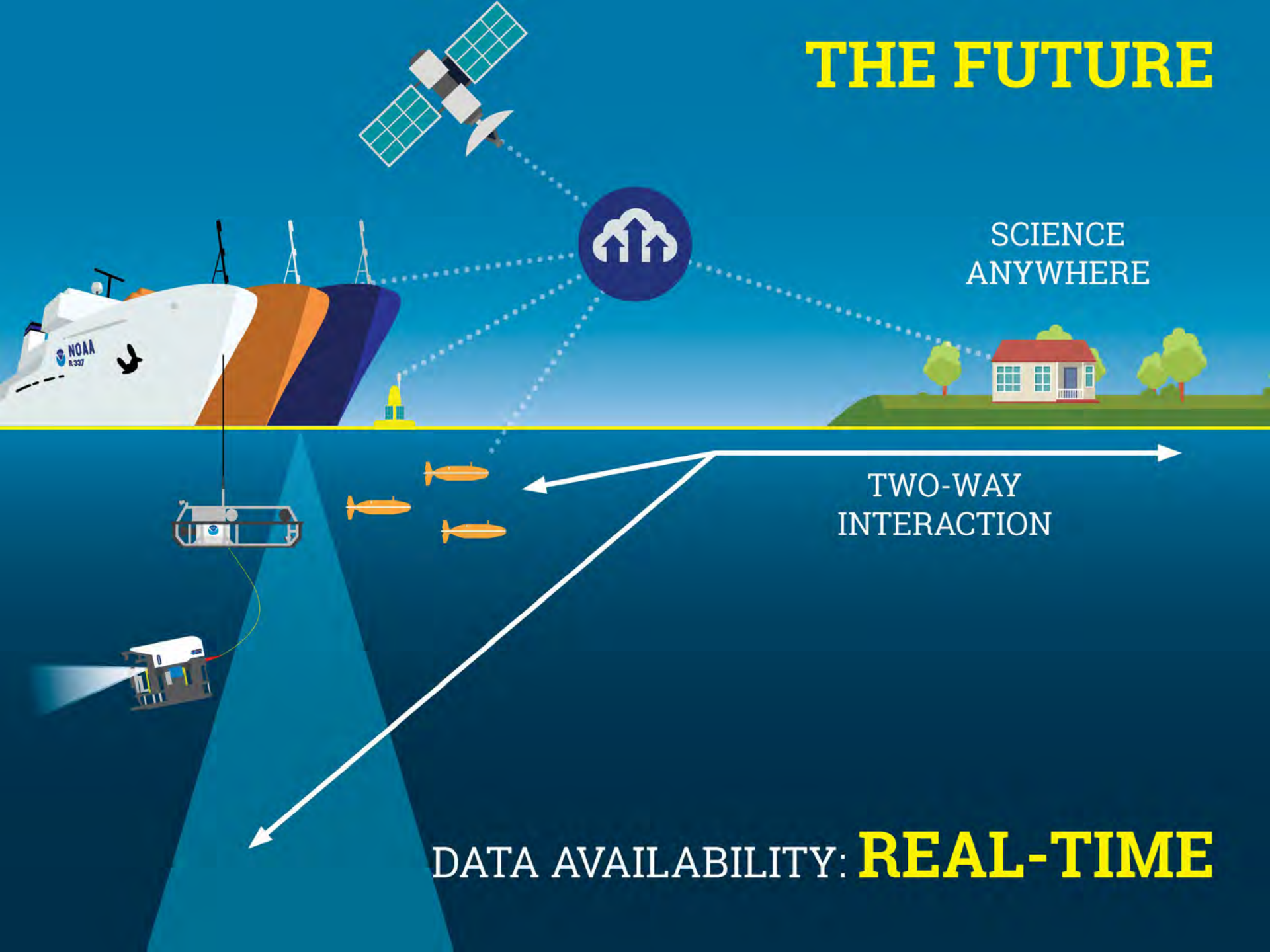
# THE FUTURE

SCIENCE  
ANYWHERE



TWO-WAY  
INTERACTION

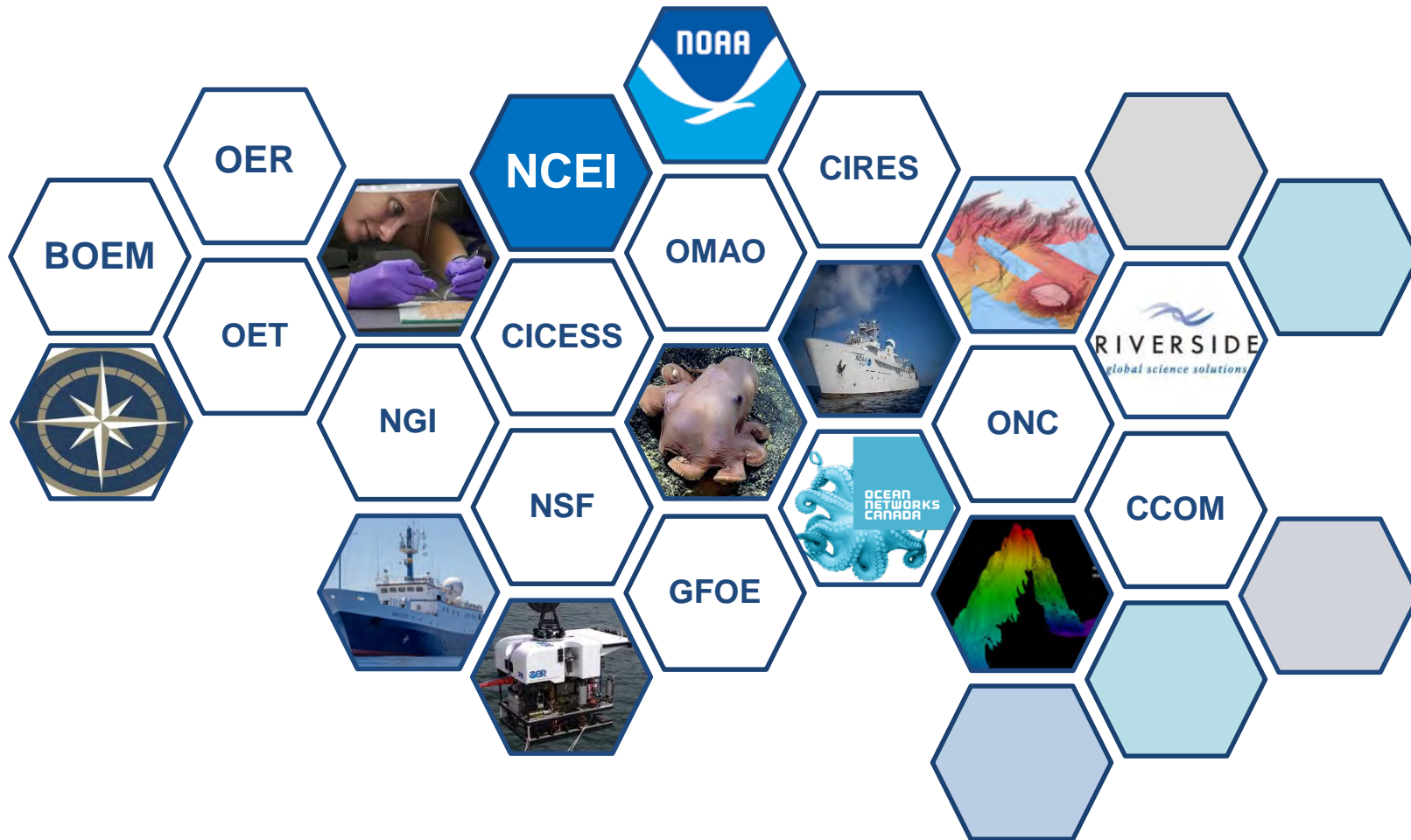
DATA AVAILABILITY: **REAL-TIME**

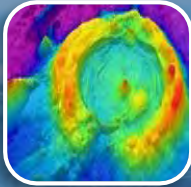




National Centers for Environmental Information:  
Making Ocean Exploration Data  
Available, Accessible, and Useful

# Outward-facing Data Management





# National Centers for Environmental Information

## *Scientific Data Stewardship*

Digital  
Atlas

*Okeanos  
Explorer  
Atlas*

OER  
Video  
Portal

Water  
Column  
Sonar  
Portal

Deep Sea  
Coral Data  
Portal

World  
Ocean  
Database

Regional  
Climatology

Bathymetric  
Data  
Viewer

TSG  
Database

Joint  
Archive  
for Sea  
Level

Benthic  
Animal  
Identification  
Guide

NASA  
Maritime  
Aerosol  
Network

# Community of Practice



**LEARN**



**INNOVATE**



**DEVELOP**



**LEVERAGE  
TECHNOLOGY**



**COLLABORATE**

# *Learn: Creating and Archiving Born-Digital Video*

## Federal Agency Digitization Guidelines Initiative Audio-Visual Working Group

- Library of Congress
- National Archives and Records Administration
- Smithsonian Institution

### Fiscal '15 Report

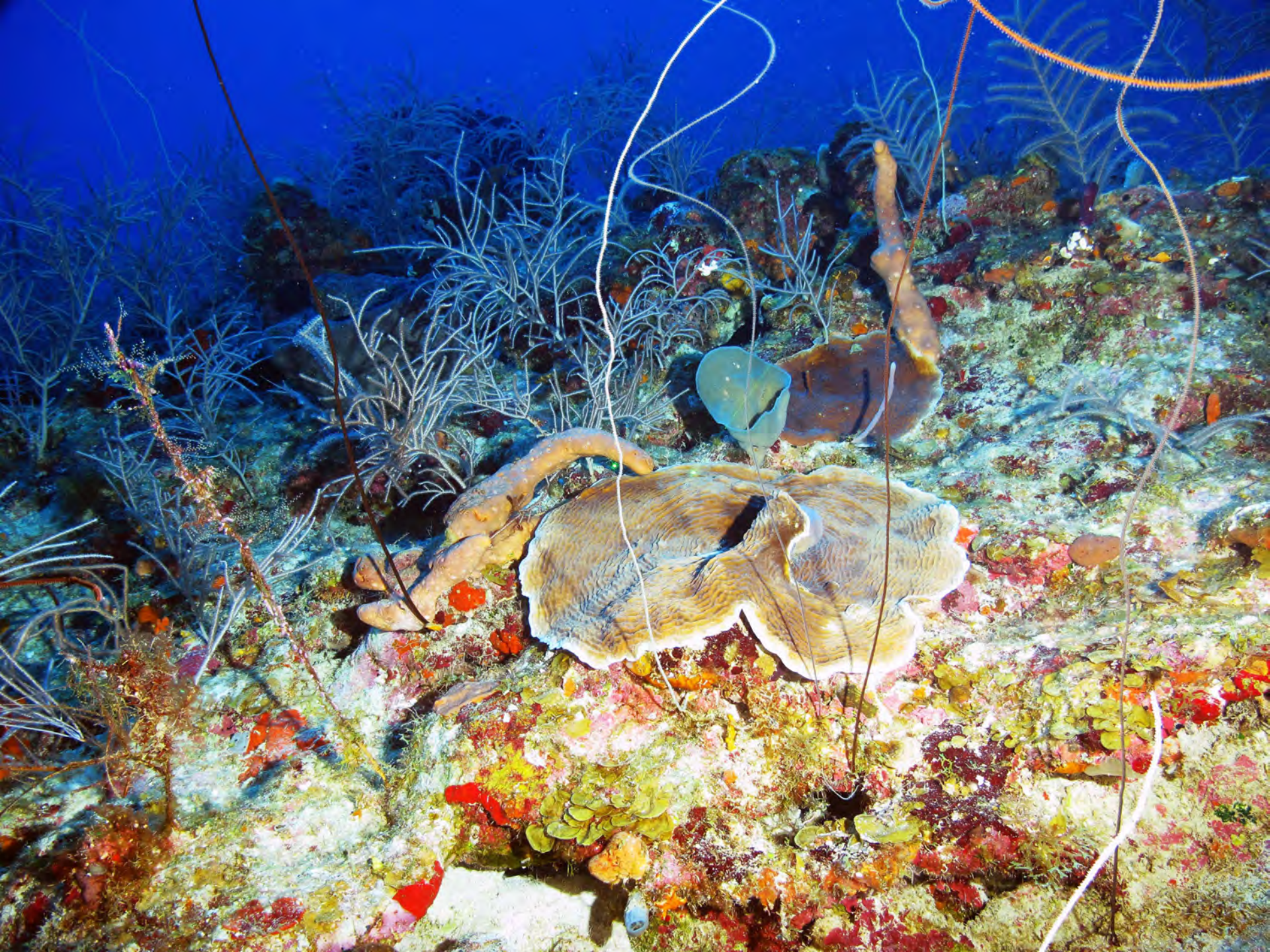
- Federal Case Studies (OER one of eight case studies)
- Recommendations
- Resources

[http://www.digitizationguidelines.gov/guidelines/video\\_bornDigital.html](http://www.digitizationguidelines.gov/guidelines/video_bornDigital.html)



W  
WRESTLEMANIA

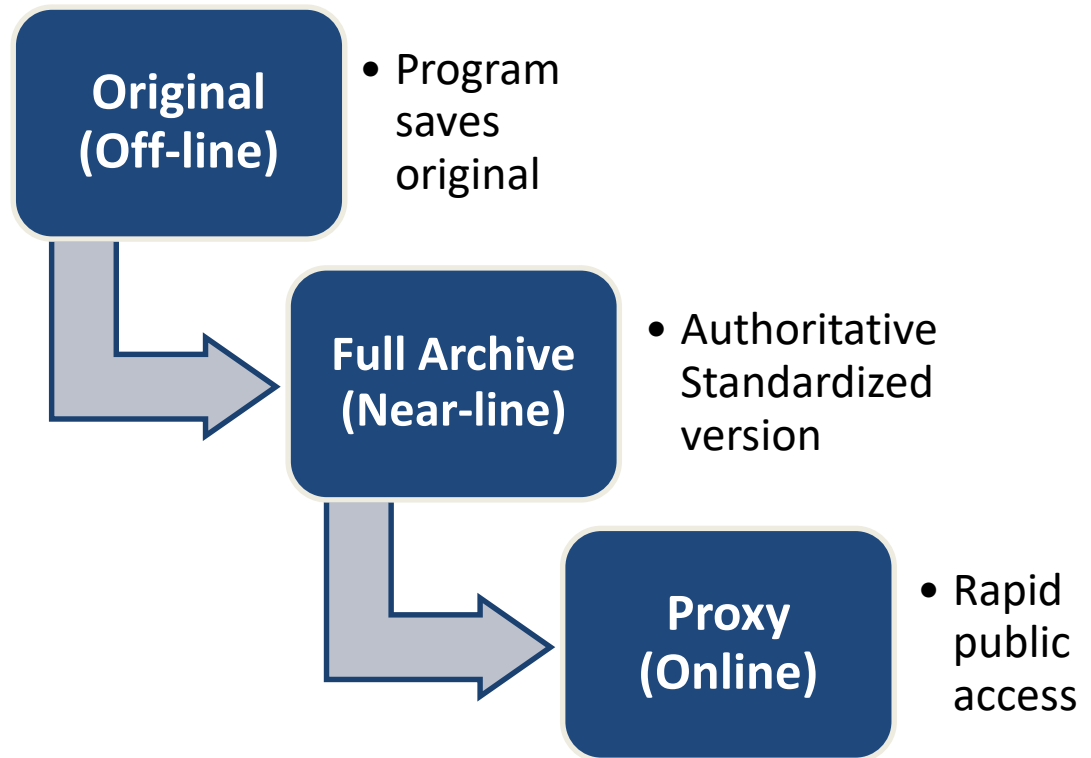




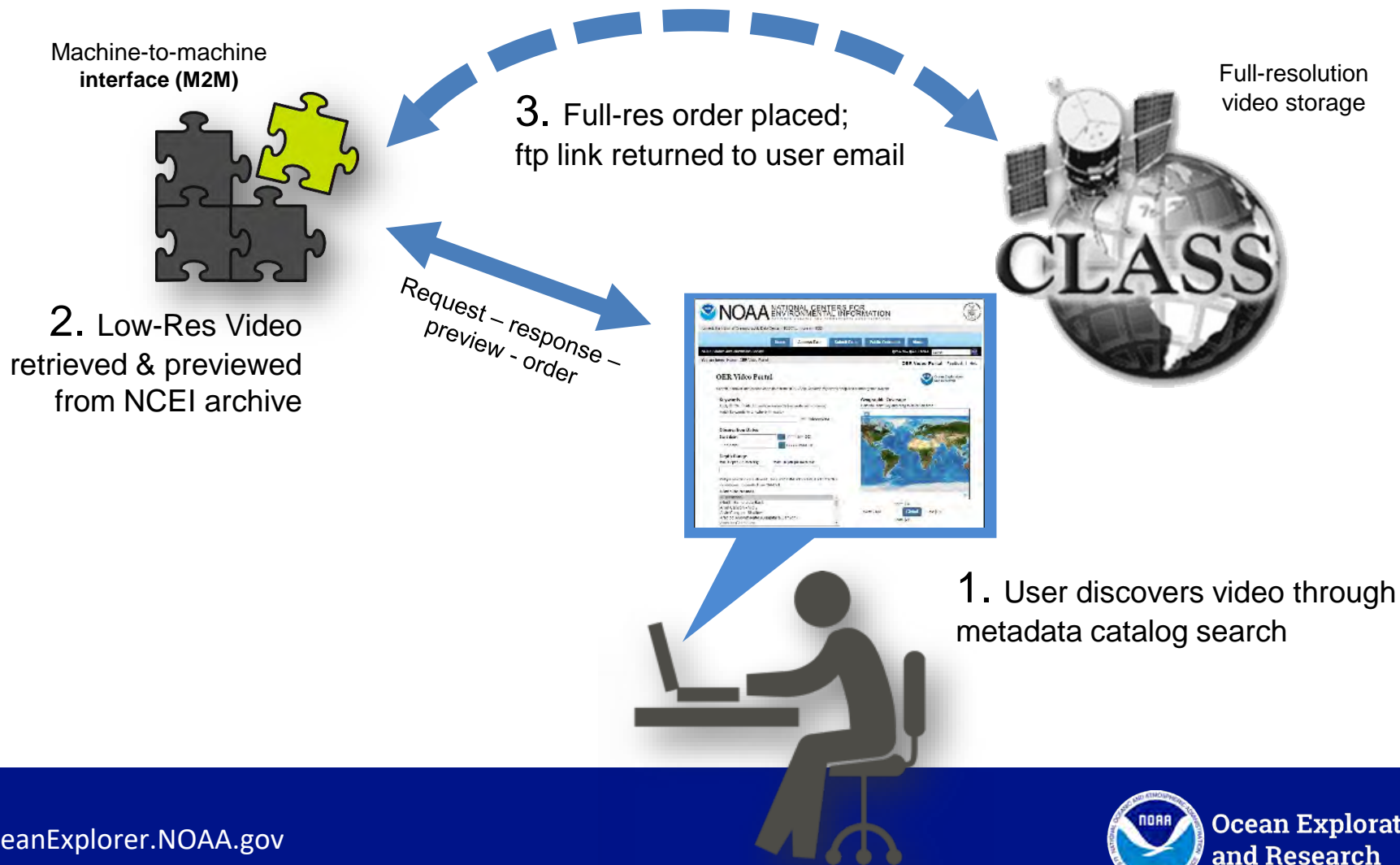
# Learn: National Science Foundation

## 2016 Video Workshop: *Establishing Community Standards for Underwater Video Acquisition, Tagging, Archiving, Access*

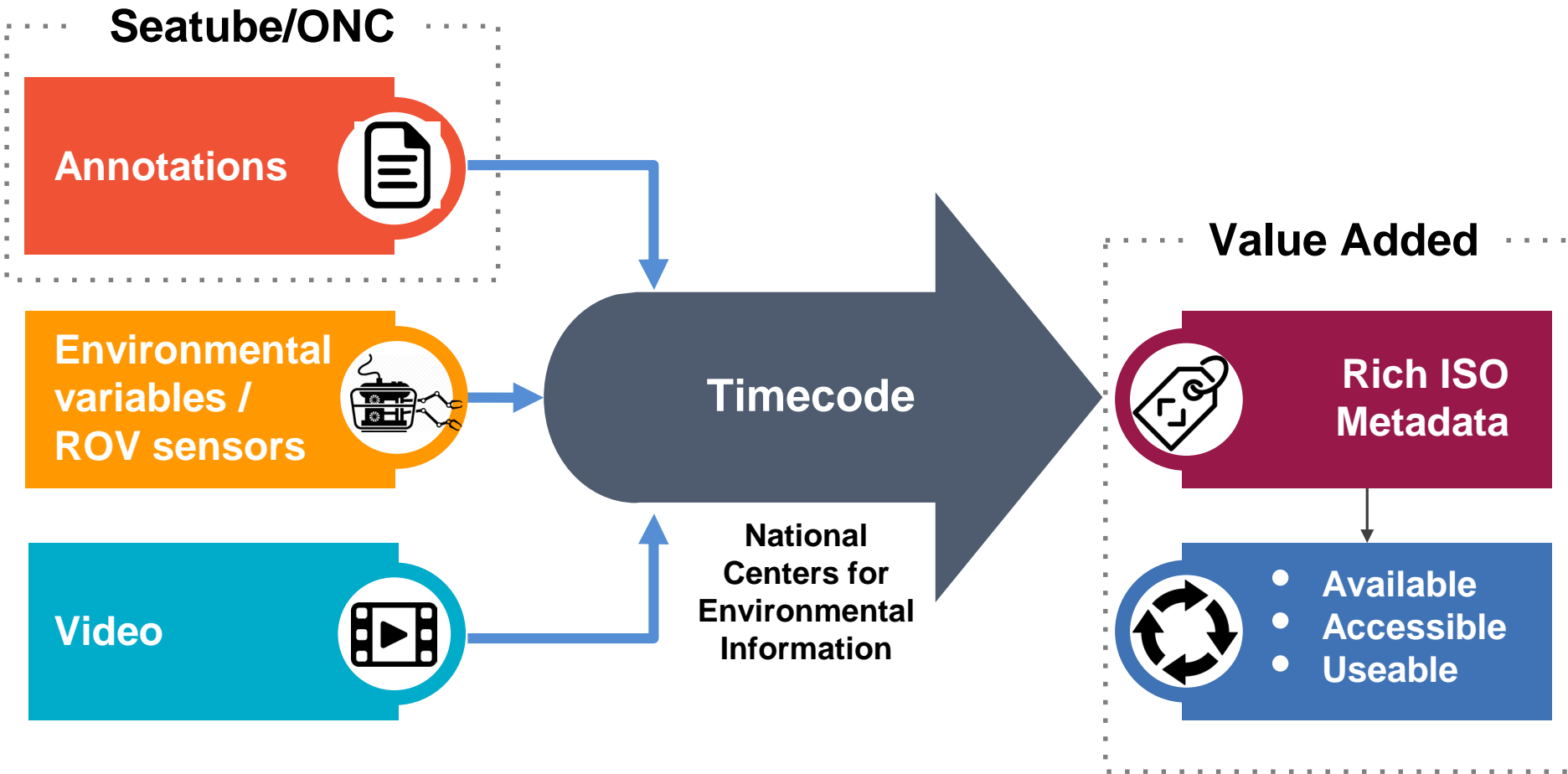
- Recording
- File Naming Conventions
- Video Formats
- Compression
- Metadata Priorities
- Timecode embedding
- Audio Channels
- Annotation / Event Logs
- Archive / Open Access



# Innovate: Video Data Management



# Innovate: Video Data Management



# Innovate: Video Data Management

## SEARCH

### OER Video Portal

Search, discover and access video data from OER sponsored missions on NOAA Ship *Okeanos Explorer* and other vessels. Please use [this form](#) to share your feedback on the OER Video Portal.

#### Keywords

Apply  OR  AND to multiple keywords (separate with commas)

Match keywords  anywhere  exactly

To choose from a specific dive NN use DIVENN.

octopus  Autocomplete

#### Observation Dates

Start date:  (YYYY-MM-DD)

End date:  (YYYY-MM-DD)

#### Depth Range

Min. Depth (in meters):  Max. Depth (in meters):

4000

#### Video Type

Segment  Stream  Highlight

#### Camera Location (for Segments)

Camera Platform  ROV  Other

Multiple selections are allowed. Use Click/Shift-Click for lists, Click/Ctrl-Click for multiples. To unselect use Ctrl-Click.

#### Dive Site Names

All locations  
AT 251  
Ahihi Seamount  
Alba Seamount in Russian Federation Mn Crust Lease Block 65  
Alvin Canyon - Mid 2  
Alvin Canyon - Shallow 1

#### Cruises

All  Okeanos Explorer  Other vessels

All cruises  
Mid and Southeast US ROV and Mapping (EX1903L2)  
2019 Field Season Shakedown (EX1902)  
Puerto Rico and Virgin Islands (EX1811)  
Mid and Southeast US (EX1806)

Search

Reset

OER Video Portal [Feedback](#) | [Help](#)



View Basket

#### Geographic Coverage

Hold the "shift" key and drag to select an area.



Intersecting  Full

West [-180

## RESULTS

Refine Search

New Search

Searching for:

Keywords: octopus

Depth Range: At 4000m or below

1 to 8 of 8

Put 8 records into Basket

Video segment from DIVE01 of ROV Exploration at 2016-02-27T22:32:08Z for 219 seconds  
EX1603\_VID\_20160227T223208Z\_ROVHD\_OCTOPUS recorded at East of Necker between 4289.1 m and 4290.3 m. Keywords include: OCTOPUS

Video segment from DIVE01 of ROV Exploration at 2016-02-27T22:32:16Z for 248 seconds  
EX1603\_VID\_20160227T223216Z\_PTMAN\_OCTOPUS recorded at East of Necker between 4288.4 m and 4290.3 m. Keywords include: OCTOPUS

Video segment from DIVE01 of ROV Exploration at 2016-02-27T22:33:15Z for 176 seconds  
EX1603\_VID\_20160227T223315Z\_CPHD\_ROV\_VIEW recorded at East of Necker between 4289.4 m and 4273.7 m. Keywords include: OCTOPUS

Video segment from DIVE10 of ROV Exploration at 2016-02-27T22:33:44Z for 49 seconds  
EX1404L3\_VID\_20140930T195844Z\_CPHD\_OCTOPUS recorded at East of Necker between 4595.3 m and 4597.5 m. Keywords include: OCTOPUS

Video segment from DIVE19 of Puerto Rico and



View Basket

## ACCESS

View Basket



Video segment from DIVE01 of ROV Exploration of the Papahānaumokuākea Marine National Monument (EX1603) recorded at 2016-02-27T22:32:08Z for 219 seconds

EX1603\_VID\_20160227T223208Z\_ROVHD\_OCTOPUS.mov recorded by the HD camera on the ROV at East of Necker between 4289.1 m and 4290.3 m. Keywords include: OCTOPUS

[Video Details](#) [Dive Summary](#) [Feedback](#)

Search videos from this Dive

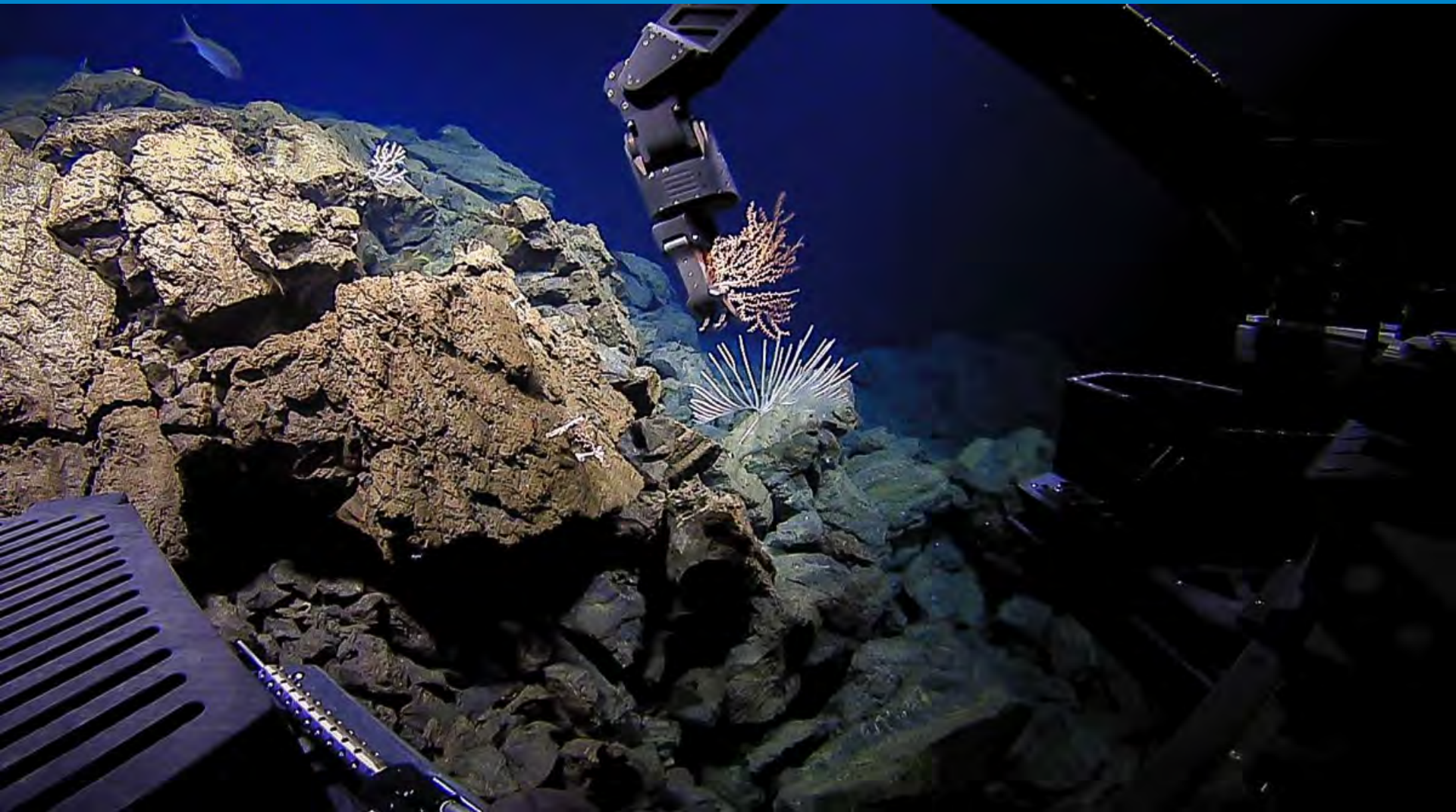
Add file to Basket

# *Innovate: Sharing Video Management Approaches*

- Lessons learned
  - Video guidance shared across NOAA
  - Best practices and templates
- Legacy data integration
  - Career collections and key expeditions available online
  - Recovery from disparate media
  - Data now available in standard formats
- Benefits for Future
  - Legacy data recovery has implications for machine learning
  - Reinforces need for data architecture in advance

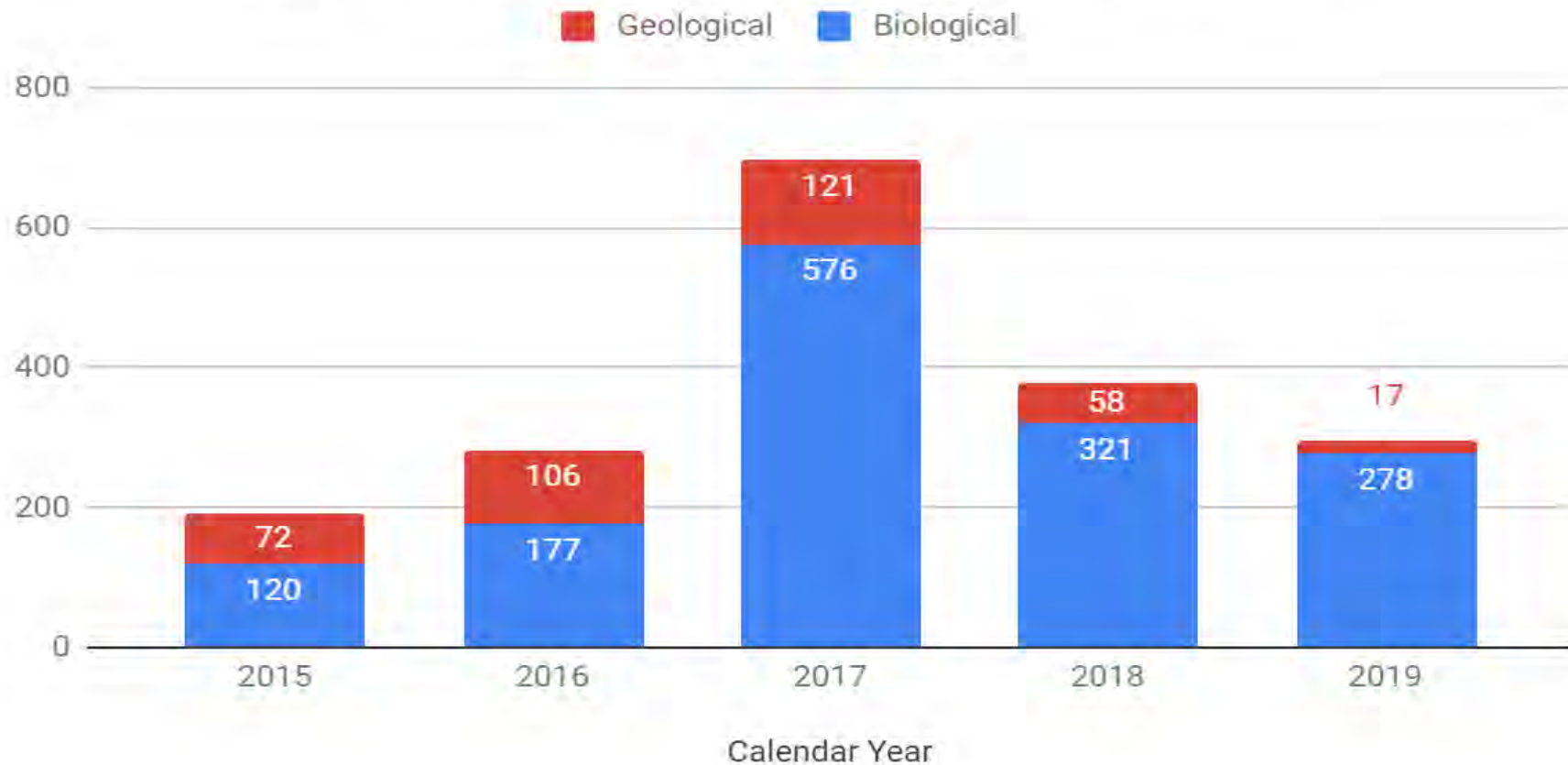


# *Develop:* End-to-end Sample Data Management



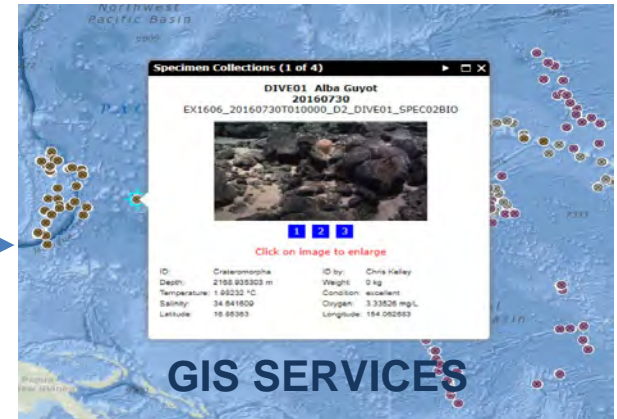
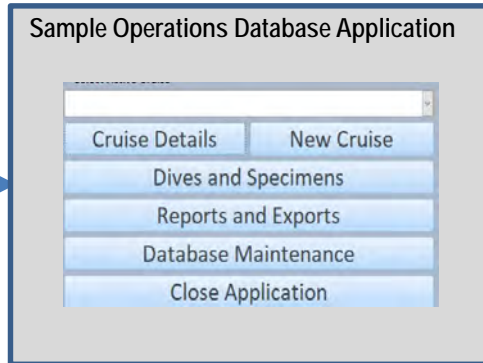
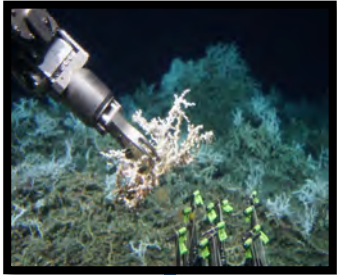
# *Develop:* End-to-end Sample Data Management

## Specimens Collected on Okeanos Explorer





# Develop: End-to-end Sample Data Management



Sample management

Electronic records

Public access to physical and digital data

# Develop: Sample Data Access

## Search the Department of Invertebrate Zoology

### Keyword Search Results - Grid View

<input type="checkbox"/>	Catalog#	Kind of Object	Scientific Name	Family	Phylum
<input type="checkbox"/>	1424234	Specimen/Lot	Victorgorgia sp.	Anthothelidae	Cnidaria
<input type="checkbox"/>	1453702	Specimen/Lot	Victorgorgia sp.	Anthothelidae	Cnidaria
<input type="checkbox"/>	1453729	Specimen/Lot	Walteria sp.	Euplectellidae	Porifera
<input type="checkbox"/>	1453785	Specimen/Lot	Walteria sp.	Euplectellidae	Porifera
<input type="checkbox"/>	1453738	Specimen/Lot	Walteria sp.	Euplectellidae	Porifera
<input type="checkbox"/>	1453775	Specimen/Lot	Walteria sp.	Euplectellidae	Porifera
<input type="checkbox"/>	1465275	Specimen/Lot	Walteria sp.	Euplectellidae	Porifera
<input type="checkbox"/>	1507320	Specimen/Lot	cf. Aphanipathes sp.	Aphanipathidae	Cnidaria
<input type="checkbox"/>	1292604	Specimen/Lot	cf. Bathycrinus sp.	Bathycrinidae	Echinodermata
<input type="checkbox"/>	1424212	Specimen/Lot	cf. Jasonisis sp.	Isididae	Cnidaria

Page 158 of 159 Clear Selections Export as KML Export Selected Results

Invertebrate Zoology Collections Keyword Search Search by Field Help Feedback

### Victorgorgia sp. : Anthothelidae : Gorgonacea : Anthozoa : Cnidaria

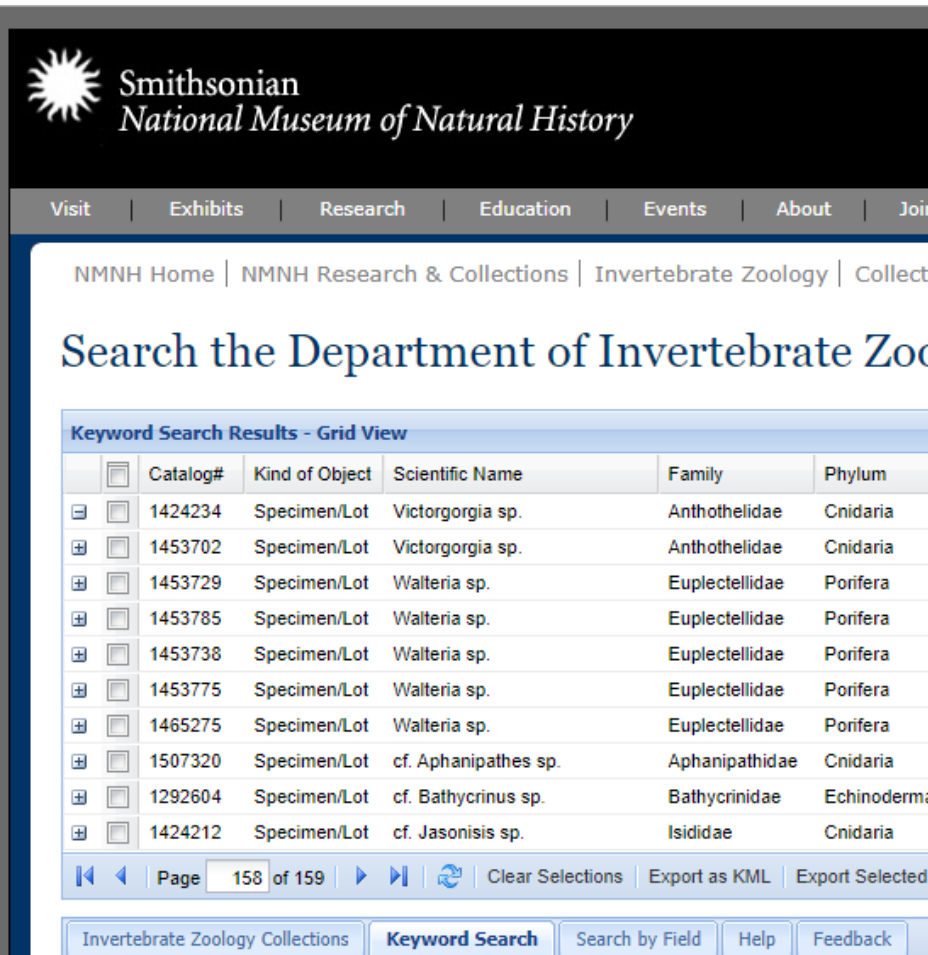
#### Specimen/Lot

Catalog Number: USNM 1424234  
 Scientific Name: Victorgorgia sp.  
 Identified By: Kelley, Christopher, University of Hawaii at Manoa (UNITED STATES)  
 Date Identified: 2016  
 Classification: Animalia, Cnidaria, Anthozoa, Octocorallia, Gorgonacea, Scleraxonia, Anthothelidae

Common Name: Octocorals  
 Collection Name: NOAA Collections  
 Specimen Count: 1  
 Preparation: Ethanol - 95%  
 Date Collected: 16 Aug 2016 (UTC\_DateTime 20160816T004623)  
 Ocean: North Pacific Ocean  
 Country: United States  
 Precise Locality: Southwestern most seamount from Wake  
 Centroid Latitude: 16.5591  
 Centroid Longitude: 165.345  
 Expedition Name: Deepwater Wonders of Wake  
 Vessel: Deep Discoverer ROV; Okeanos Explorer R/V  
 Cruise: EX1606  
 Depth (m): 1215.48  
 Notes: Genomic DNA from this specimen has been deposited in the Ocean Genome Legacy (OGL) collection at Northeastern University. See "Other Numbers" for OGL Extract ID(s).

Other Numbers (Type | Value):  
 Specimen Number EX1606\_20160816T004623\_D2\_DIVE14\_SPEC03BIO  
 Extract ID (DNA) E26091  
 Extract ID (DNA) E26696  
 Primary Collector #: EX1606\_20160816T004623\_D2\_DIVE14\_SPEC03BIO  
 Accession Number: 2078414  
 EZID: <http://n2t.net/ark:/65665/339470450-4010-4941-9b24-c676ff43b531>

# Develop: Sample Data Access



Smithsonian  
National Museum of Natural History

Visit | Exhibits | Research | Education | Events | About | Join

NMNH Home | NMNH Research & Collections | Invertebrate Zoology | Collections

## Search the Department of Invertebrate Zoology

Keyword Search Results - Grid View

<input type="checkbox"/>	Catalog#	Kind of Object	Scientific Name	Family	Phylum
<input type="checkbox"/>	1424234	Specimen/Lot	Victorgorgia sp.	Anthothelidae	Cnidaria
<input type="checkbox"/>	1453702	Specimen/Lot	Victorgorgia sp.	Anthothelidae	Cnidaria
<input type="checkbox"/>	1453729	Specimen/Lot	Walteria sp.	Euplectellidae	Porifera
<input type="checkbox"/>	1453785	Specimen/Lot	Walteria sp.	Euplectellidae	Porifera
<input type="checkbox"/>	1453738	Specimen/Lot	Walteria sp.	Euplectellidae	Porifera
<input type="checkbox"/>	1453775	Specimen/Lot	Walteria sp.	Euplectellidae	Porifera
<input type="checkbox"/>	1465275	Specimen/Lot	Walteria sp.	Euplectellidae	Porifera
<input type="checkbox"/>	1507320	Specimen/Lot	cf. Aphanipathes sp.	Aphanipathidae	Cnidaria
<input type="checkbox"/>	1292604	Specimen/Lot	cf. Bathycrinus sp.	Bathycrinidae	Echinodermata
<input type="checkbox"/>	1424212	Specimen/Lot	cf. Jasonisis sp.	Isididae	Cnidaria

Page 158 of 159 | Clear Selections | Export as KML | Export Selected

Invertebrate Zoology Collections | **Keyword Search** | Search by Field | Help | Feedback

Museum samples are only as valuable as the data associated with them.

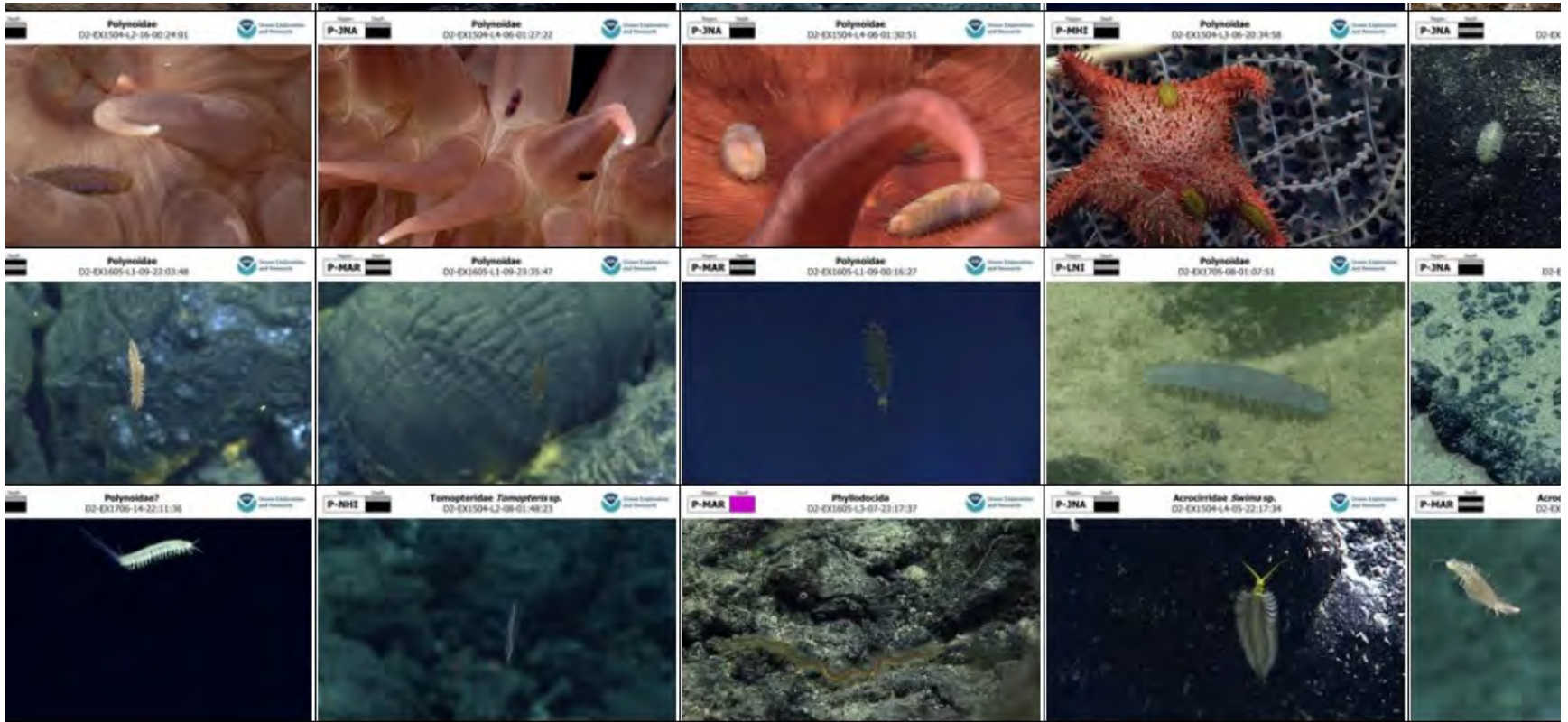
The *Okeanos* collected material has extremely high scientific value because of the finely detailed electronic data associated with it.

SODA ensures that all this data remains associated with the proper samples, and streamlines importing that information to the Smithsonian National History Museum catalog with minimal (if any) errors, where that data is publicly available to anyone interested.

As a result, the *Okeanos* samples remain high quality for scientific studies performed now and well into the future.

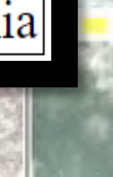
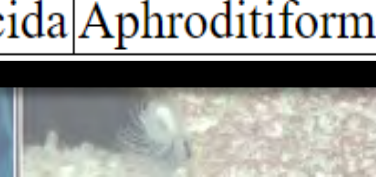
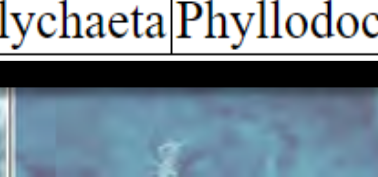
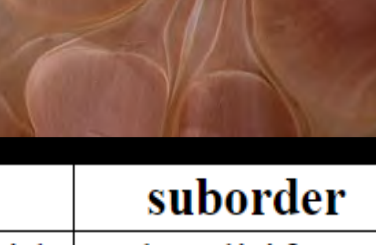
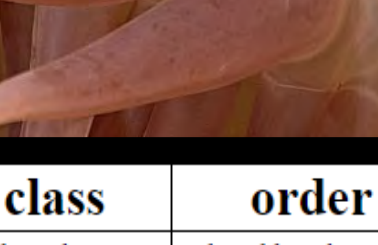
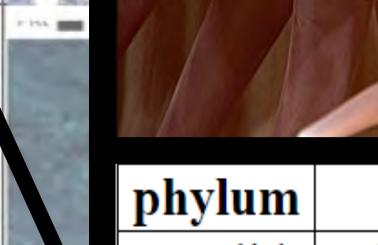
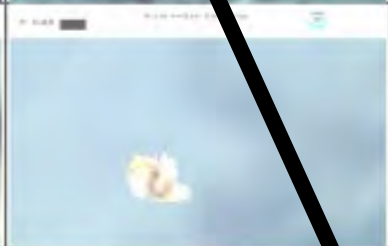
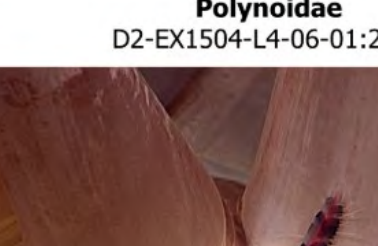
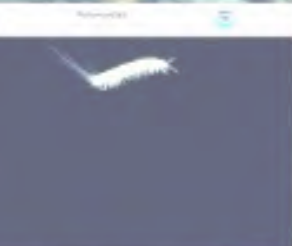
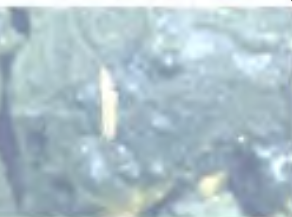
*Dr. Abigail Reft,  
Smithsonian National Museum  
of Natural History*

# Develop: Sample Data Analysis




[https://oceanexplorer.noaa.gov/oceanos/animal\\_guide/animal\\_guide.html](https://oceanexplorer.noaa.gov/oceanos/animal_guide/animal_guide.html)

# Benthic Deepwater Animal Identification Guide



Region Depth  
**P-JNA**

**Polynoidea**  
D2-EX1504-L4-06-01:27:22

 Ocean Exploration and Research



phylum	class	order	suborder
Annelida	Polychaeta	Phyllodocida	Aphroditiformia

# The Value of Collaboration

OER is a key partner for the DSCRTP. As the major NOAA funder of deep-sea exploration and research, OER's expertise, research, and information products are central to the DSCRTP mission. As a management-oriented research program, the DSCRTP complements OER's work and directly links it to resource managers' needs.

Together, our programs have been able to leverage additional ship time, make connections between exploration and management needs, and achieve more together than either program could alone.

***Thomas Hourigan, Ph.D.***

*Chief Scientist,*

*Deep Sea Coral Research and Technology Program*

# Leverage: NOAA's GeoPlatform



The screenshot shows the NOAA's GeoPlatform homepage. At the top left is the NOAA logo. To its right, the text reads "WELCOME TO NOAA's GeoPlatform" followed by "Providing geospatial data, maps, and analytics in support of NOAA's mission". Below this are four featured tiles: "Digital Elevation Models Global Mosaic (Color Shaded Relief)", "Get Into Your Sanctuary" (with a California sign), "Marine Debris Removal & Assessment in the Northwestern Hawaiian" (with a bird), and "National Storm Surge Hazard Maps". A blue arrow points to the right. Below the tiles is a paragraph of text: "NOAA's GeoPlatform is a GIS application using Esri's ArcGIS Online. The website is available to the public for browsing. Only NOAA staff have the ability to create accounts and may create their own account by logging in using their NOAA CAC or LDAP credentials. If you need help please submit a request on the NOAA Esri Central Support website." Below the text is a grid of ten icons representing different categories: Charting Geodesy, Climate, Education, Fisheries, Marine Aviation, Oceans Coasts, Research, Sanctuaries, Satellites, and Weather.

WELCOME TO  
**NOAA's GeoPlatform**  
Providing geospatial data, maps, and analytics in support of NOAA's mission

**Digital Elevation Models Global Mosaic (Color Shaded Relief)**

**Get Into Your Sanctuary**

**Marine Debris Removal & Assessment in the Northwestern Hawaiian**

**National Storm Surge Hazard Maps**

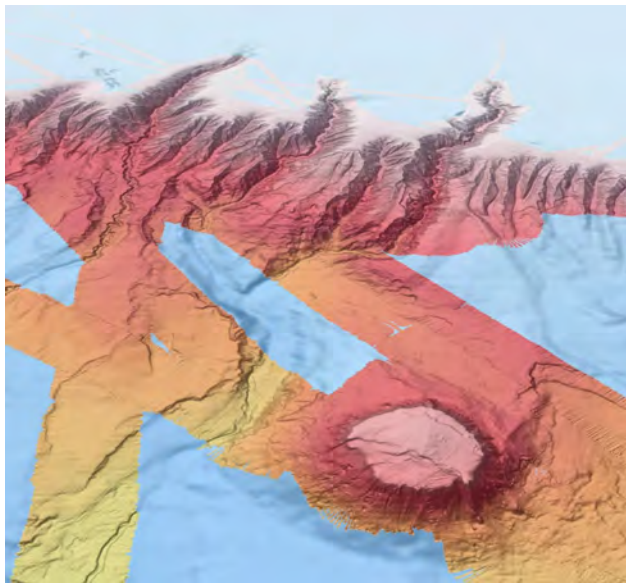
NOAA's GeoPlatform is a GIS application using Esri's ArcGIS Online. The website is available to the public for browsing. Only NOAA staff have the ability to create accounts and may create their own account by logging in using their NOAA CAC or LDAP credentials. If you need help please submit a request on the NOAA Esri Central Support website.

- Charting Geodesy
- Climate
- Education
- Fisheries
- Marine Aviation
- Oceans Coasts
- Research
- Sanctuaries
- Satellites
- Weather

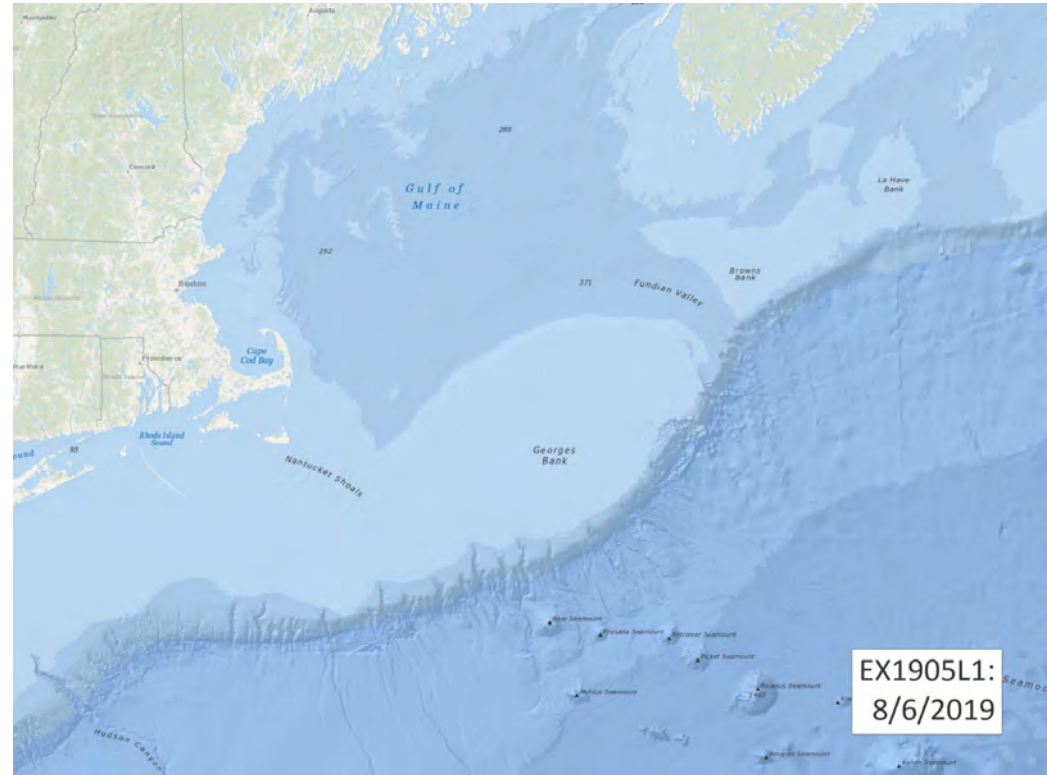
<https://noaa.maps.arcgis.com/home/index.html>

# Leverage: NOAA's GeoPlatform

New geospatial web services



Shaded relief imagery,  
3D visualization



Near real-time updates, automatically  
updated when ship is at sea

Web Services: Okeanos Explorer Bathymetric Grids



# Leverage: NOAA's GeoPlatform

Content Groups

1 - 20 of 22 Filters Type: Layers X Clear filters

Filters

Only search in NOAA GeoPlatform

Item Type Clear

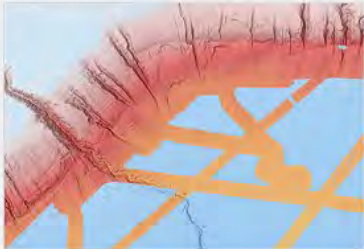
- Maps
- Layers
  - Feature Layers
  - Tile Layers
  - Map Image Layers
  - Imagery Layers
  - Scene Layers
  - Tables
  - Layer Files
- Scenes
- Apps
- Tools
- Files

> Location

> Date Modified

> Tags

> Shared



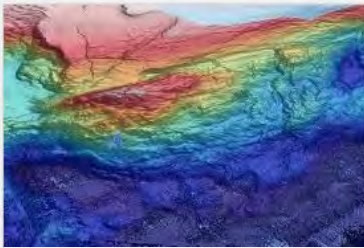
### Okeanos Explorer Bathymetric Grids

Imagery Layer by ncei\_noaa

An image service providing access to multibeam bathymetric products collected by the NOAA Ship Okeanos Explorer.

Created: Apr 4, 2016 Updated: Sep 17, 2019 View Count: 2,065

🔄 ☆ ⋮




### Multibeam and Okeanos Mosaics 3D

Web Scene by Jesse.Varner\_noaa

Created: Sep 25, 2019 Updated: Sep 25, 2019 View Count: 5

📄 ☆ ⋮



### NOAA Office of Ocean Exploration and Research 2018 Call for Input Results (Southeast U.S. Region)

Web Map by kasey.cantwell\_noaa

Areas submitted for consideration as part of the NOAA Office Of Ocean Exploration and Research's 2018 Call for Input in the Southeast U.S. Region

Created: Apr 16, 2019 Updated: Apr 19, 2019 View Count: 414

🔄 ☆ ⋮

# Leverage: NOAA's GeoPlatform

Home ▾ My Map New Ma

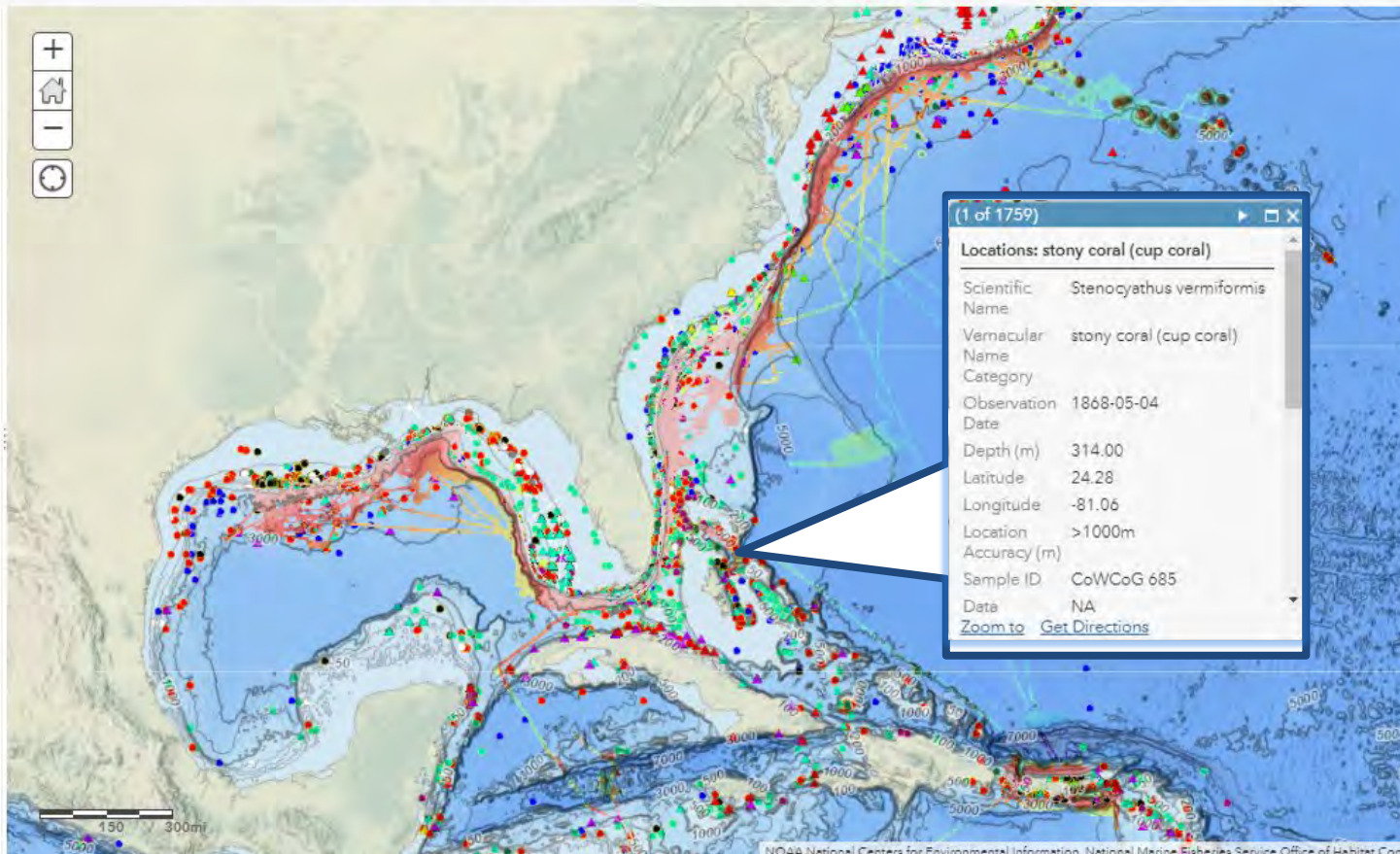
Details Add ▾ Basemap

Save ▾ Share Print ▾ Directions Measure Bookmarks Find address or place

About Content Legend

Contents

- Okeanos Explorer Ship Tracks - Stennis Map Service
- Okeanos Explorer Bathymetric Grids
- Deep-Sea Corals
- GEBCO 2019 Basemap (NOAA NCEI Visualization)



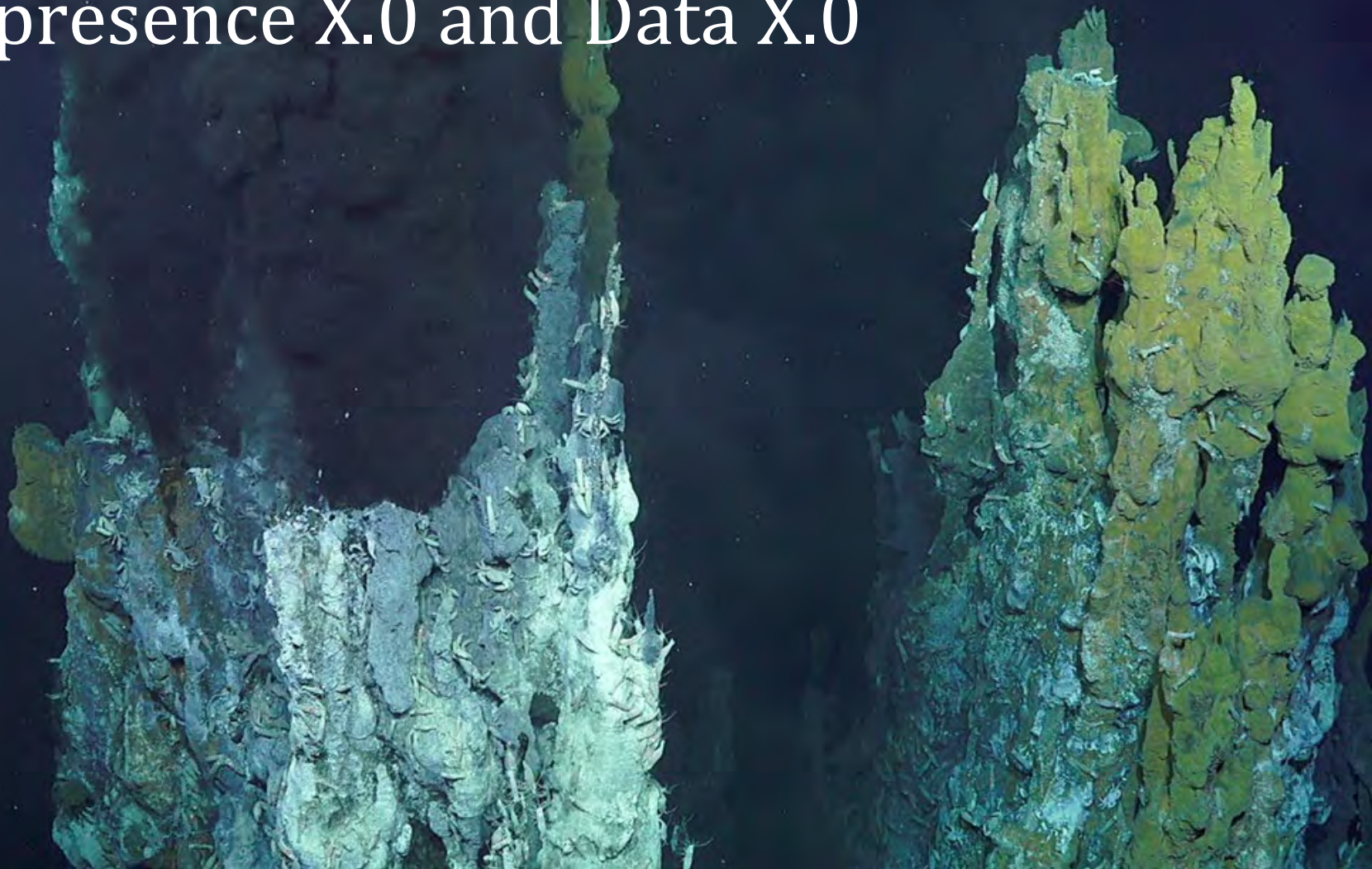
The screenshot displays the NOAA GeoPlatform interface. The main map shows a bathymetric view of the Gulf of Mexico, with ship tracks overlaid in various colors (red, blue, green, yellow). A pop-up window titled '(1 of 1759) Locations: stony coral (cup coral)' provides detailed information for a specific observation. The pop-up window contains the following data:

Locations: stony coral (cup coral)	
Scientific Name	Stenocyathus vermiformis
Vernacular Name	stony coral (cup coral)
Category	
Observation Date	1868-05-04
Depth (m)	314.00
Latitude	24.28
Longitude	-81.06
Location	>1000m
Accuracy (m)	
Sample ID	CoWCoG 685
Data	NA
Zoom to	<a href="#">Get Directions</a>

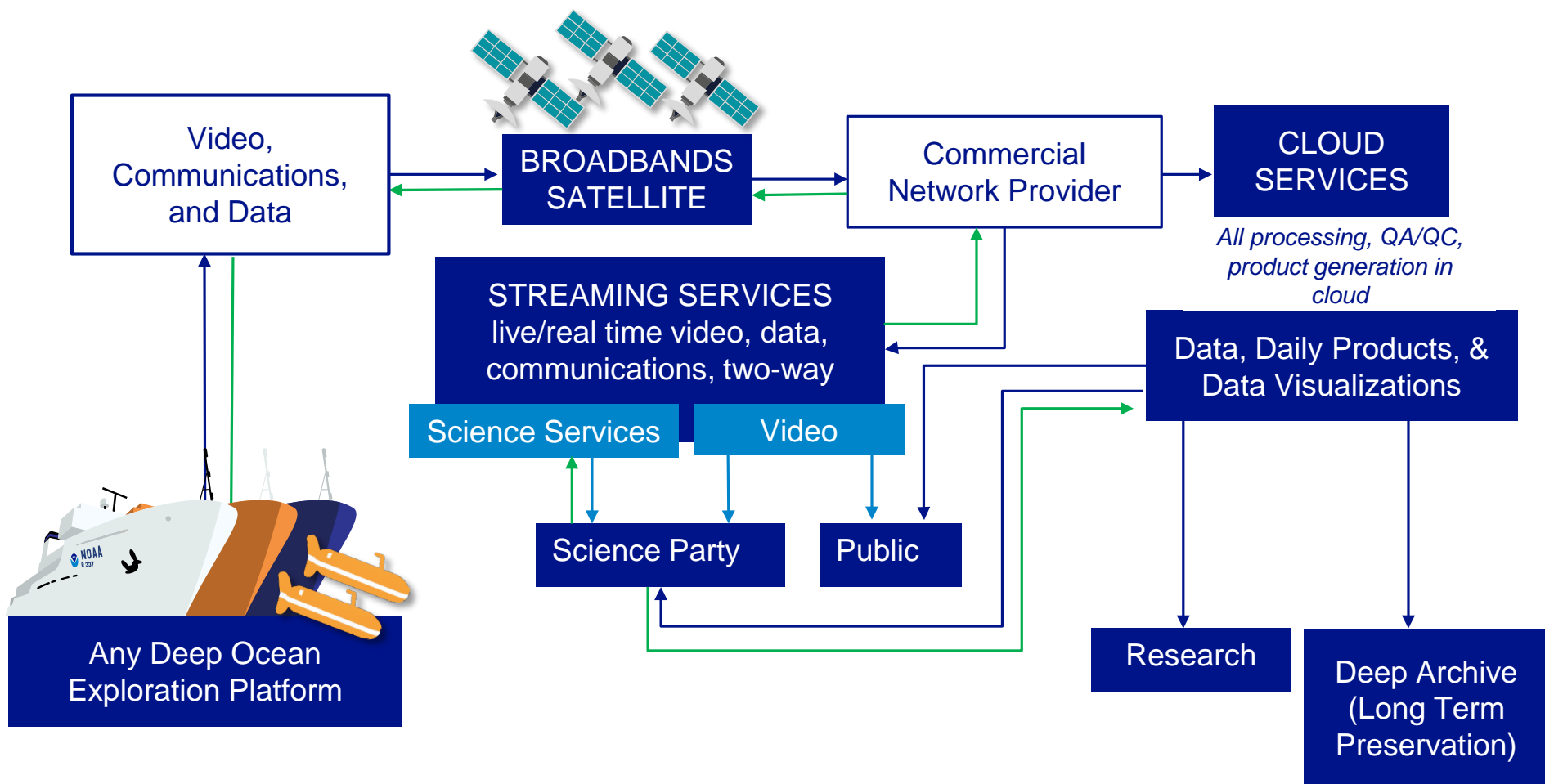
Trust Center Contact Us Report Abuse Contact Us

NOAA National Centers for Environmental Information, National Marine Fisheries Service Office of Habitat Conservation

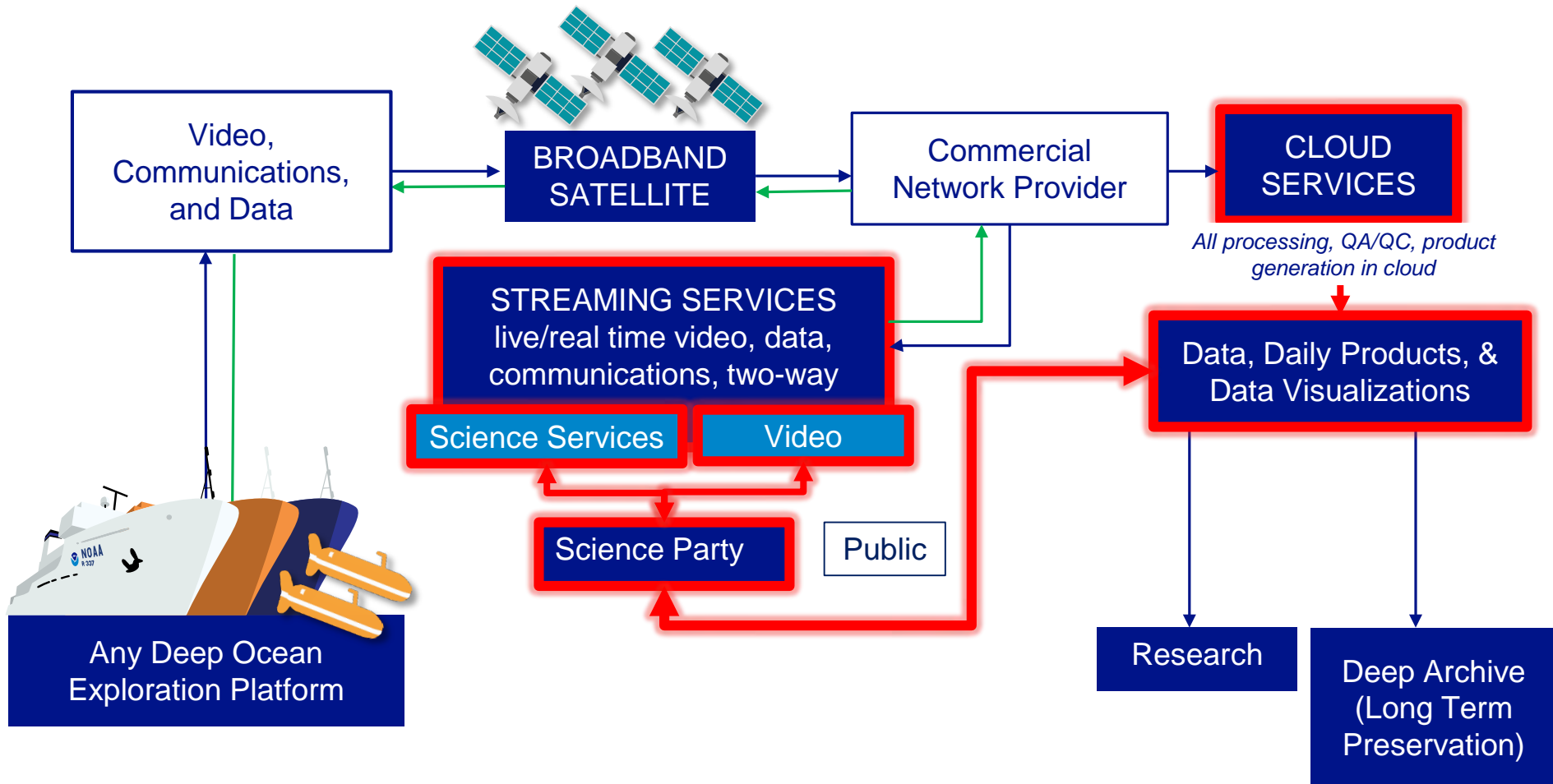
# The Future of Data: Direct-to-Cloud-to-Users with Telepresence X.0 and Data X.0



# Future: Telepresence X.0 and Data X.0



# Science Benefits: Telepresence X.0 and Data X.0



# Interactive Science Tools from Web Services



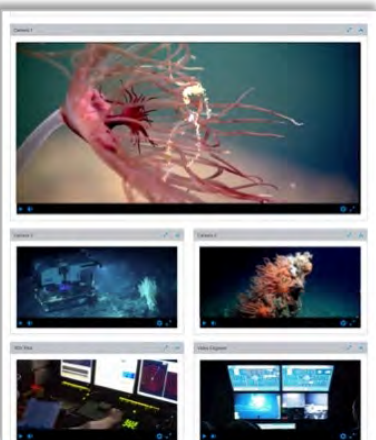
**VIRTUAL WHITEBOARD**

Combining output from multiple web services to:

- drive operations;
- verify data quality; and,
- develop intelligent data in near-real time



**CHAT LOG**



**VIDEO CAMERA DISPLAYS**



**ENVIRONMENTAL VARIABLES**

Time Log Entry	My Observations	Station	Longitude	Depth	Action	
17-Nov-2018 18:05:45	17-Nov-2018 18:05:45	berger1	-117.8429	-07.5855	700.0	See Station
17-Nov-2018 18:04:30	17-Nov-2018 18:04:30	andy_wan@uclaer1: Look 2 min	17.8422	-07.5843	700.0	See Station
17-Nov-2018 18:18:24	17-Nov-2018 18:18:24	berger1	17.8422	-07.5840	700.0	See Station
17-Nov-2018 18:18:51	17-Nov-2018 18:18:51	back 1 min -> camera	17.8422	-07.5841	700.0	See Station
17-Nov-2018 18:18:42	17-Nov-2018 18:18:42	shywater@uclaer1	17.8424	-07.5841	700.0	See Station
17-Nov-2018 18:18:40	17-Nov-2018 18:18:40	andy	17.8421	-07.5842	700.0	See Station
17-Nov-2018 18:20:12	17-Nov-2018 18:20:12	berger1	17.8426	-07.5832	700.0	See Station
17-Nov-2018 18:22:02	17-Nov-2018 18:22:02	berger1	17.8425	-07.5824	700.0	See Station
17-Nov-2018 18:23:32	17-Nov-2018 18:23:32	berger1	17.8426	-07.5801	700.0	See Station
17-Nov-2018 18:28:11	17-Nov-2018 18:28:11	mysser1	17.8426	-07.5802	700.0	See Station
17-Nov-2018 18:27:34	17-Nov-2018 18:27:34	ant	17.8426	-07.5803	700.0	See Station
17-Nov-2018 18:28:05	17-Nov-2018 18:28:05	berger1	17.8425	-07.5846	700.0	See Station
17-Nov-2018 18:28:18	17-Nov-2018 18:28:18	berger1	17.8425	-07.5849	700.0	See Station
17-Nov-2018 18:29:40	17-Nov-2018 18:29:40	mysser1	17.8424	-07.5808	700.0	See Station
17-Nov-2018 18:31:08	17-Nov-2018 18:31:08	satyash@uclaer1	17.8426	-07.5807	700.0	See Station
17-Nov-2018 18:31:17	17-Nov-2018 18:31:17	MUJO pyroline	17.8425	-07.5803	700.0	See Station
17-Nov-2018 18:31:15	17-Nov-2018 18:31:15	oktyash@uclaer1	17.8426	-07.5812	700.0	See Station
17-Nov-2018 18:34:32	17-Nov-2018 18:34:32		17.8422	-07.5803	700.0	See Station

**ANNOTATION LOG**



**3D VISUALIZATIONS**

# Science Benefits: the Virtual Whiteboard

The screenshot displays a virtual whiteboard interface within a web browser window. On the left, three video thumbnails show participants. The main area is divided into two sections:

- Stratigraphic Site:** A photograph of an excavation site with several layers labeled with blue boxes and yellow arrows:
  - Layer 6: 10,100 calBP
  - Ocean: 100 m
  - Layers 11,12: 10,250 BP
  - Marine supra-tidal berm deposit
  - sterile silts
  - Layer 26: 10,490 calBP
  - Richardson Island Site, S Wall of EU 13
- Scientific Workflow Diagram:** A flowchart illustrating a process:
  - Inputs: temperature 20 °C, photoperiod 12 hours.
  - Process: "each group" (represented by a scallop icon x5).
  - Output: "hepatopancreas dissection and RNA extraction" (represented by a syringe icon).
  - Two experimental conditions are shown below:
    - Condition 1: *Tetraselmis suecica* and *Isochrysis galbana* with *Prorocentrum lima* (200 cells/mL) for 24 hours exposure in aerated seawater.
    - Condition 2: *Tetraselmis suecica* and *Isochrysis galbana* in aerated seawater.

Envisioning the **Virtual Whiteboard** for collaborative scientific analysis

- Support annotations and future data accessibility and usability
- Contributes to scientific understanding

# Operational Guidance: 3D Chemistry Model





# Integrated GIS Analysis Tools

Office of Ocean Exploration and Research    Prototype Data Discovery and Access App    OER Website

**Left Sidebar:**

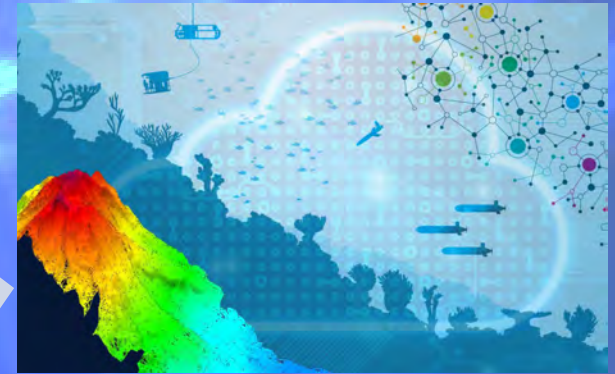
- OER Expedition Information 19
- Okeanos Explorer Ship Tracks 22
- OER Submersible Dives 41
- OER CTD Collection 83
- OER Sampling Activities 0
- OER Geological Samples Collection 0
- OER Biological Specimens Collection 0
- OER Images and Videos 0

**Map:** Shows the Gulf of Maine and Georges Bank area with various data layers overlaid, including ship tracks and submersible dive locations. A scale bar indicates 60 miles. Coordinates: -70.968 43.061 Degrees.

**Right Sidebar (Add Data):**

Search	URL	File
My Organization	sea surface	Q
<input checked="" type="checkbox"/> Within map...	Type	Relevance
	Near-Real-Time Surface In-Situ Observati...	REMOVE DETAILS
	Sea Surface Temperature Monthly Avera...	REMOVE DETAILS
	Gridded Surface Weather and Marine W...	ADD DETAILS
	S7CAs for WebApp v1c 20180301	ADD DETAILS
	Section 7 Consultation Areas v1c 201803...	ADD DETAILS

# Data Management Evolution



## EXPLORE:

2002: Archive

Define and document best data management practices

## EXPERIENCE:

2010: Access

Best practices implemented and refined aboard NOAA Ship *Okeanos Explorer*

## UNDERSTAND:

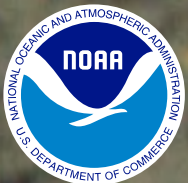
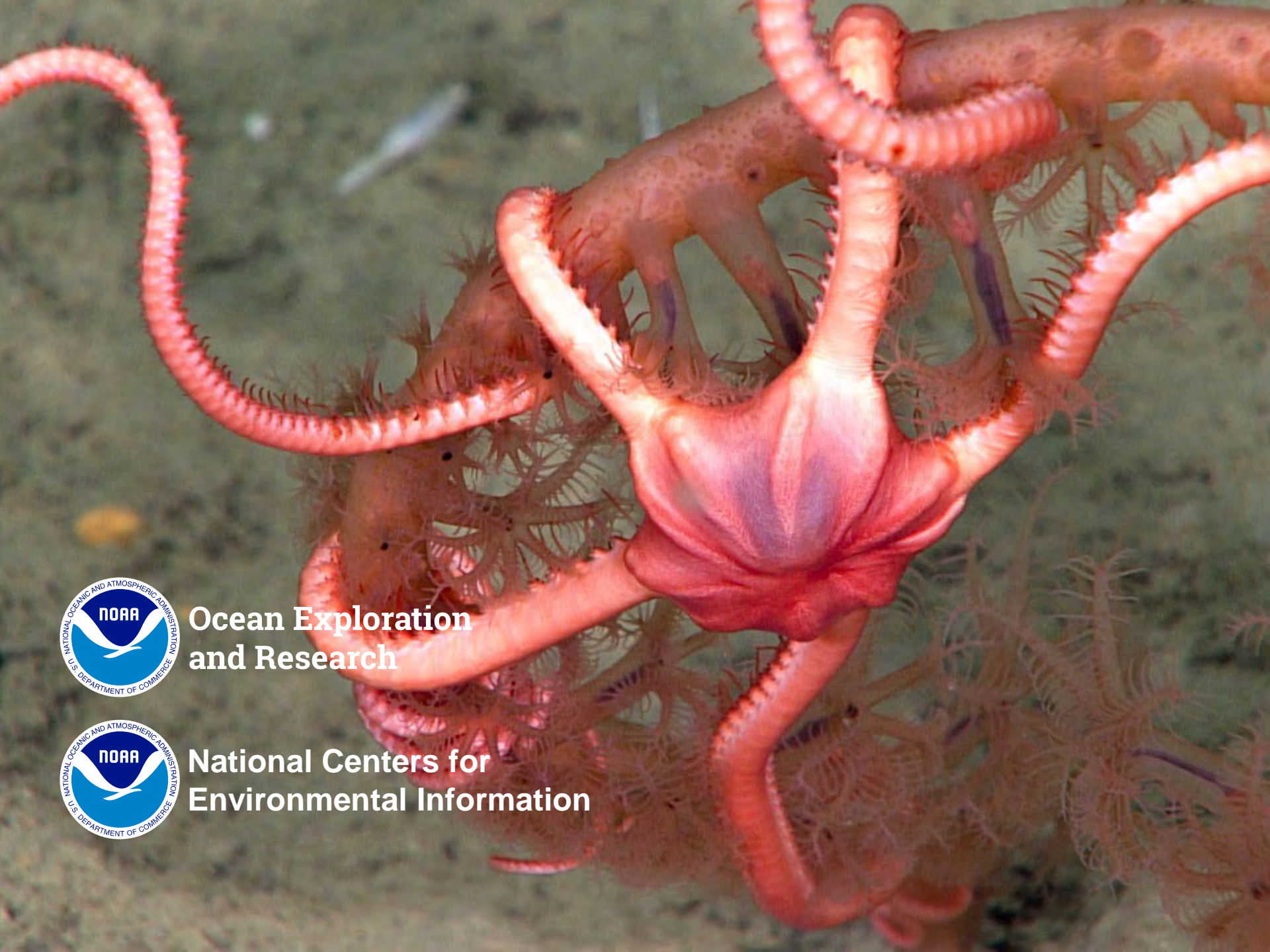
2019: Reuse

Ocean Exploration data readily accessible and usable

## EMPOWER USERS:

2024: Service Economy

Telepresence X.0 and Data X.0 will empower users to build their own experience



**Ocean Exploration  
and Research**



**National Centers for  
Environmental Information**