# Semantic Challenges and Opportunities in DataONE

Presented by

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DataONE Integration and Semantics Working Group co-founder

Scientific Data Group

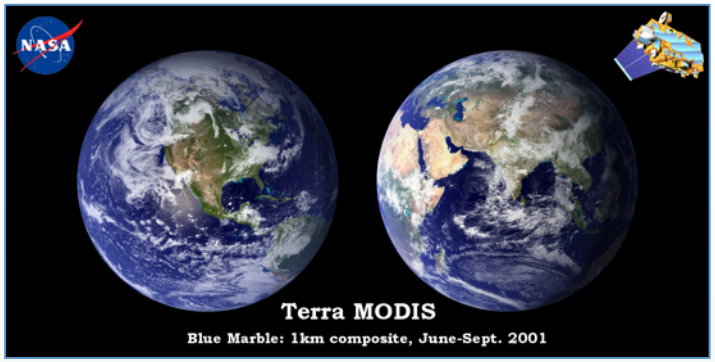
Oak Ridge National Laboratory

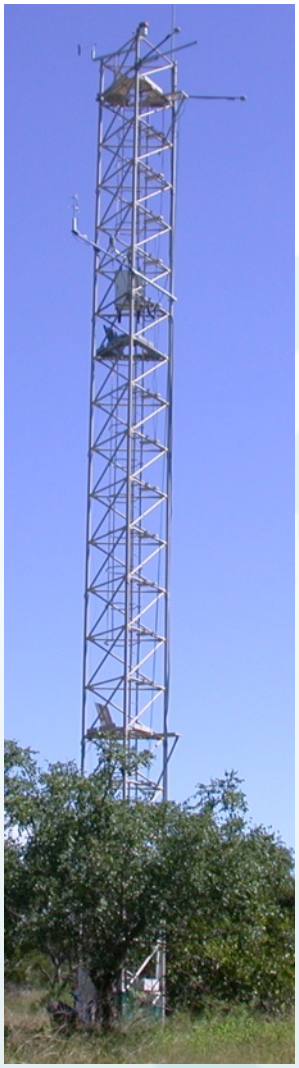
DataONE

Linked Science Workshop Keynote, Boston, November 12, 2012

# Data deluge

Sensors, sensor networks, and
remote sensing gather observations;
Data management and stewardship



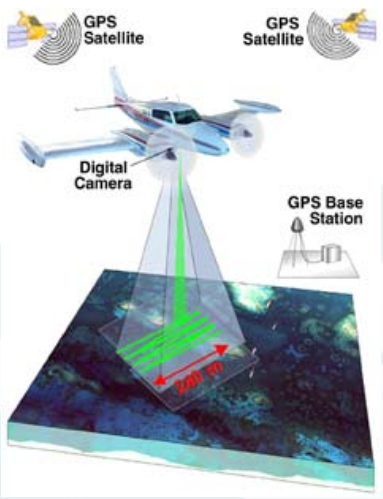
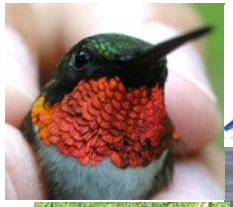
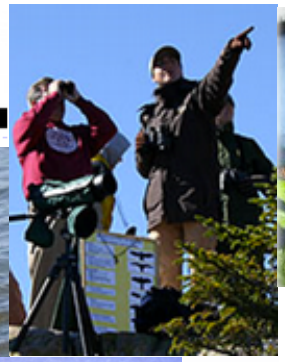
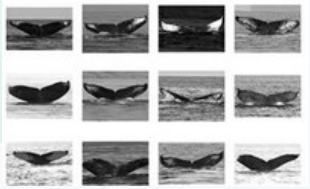


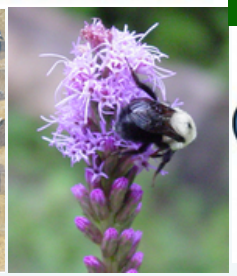
Photo courtesy of www.carboafrica.net

# Proliferation of citizen science









# DataONE is Foremost a Federation

## Member Nodes (MNs)

- Heart of the federation
- Harness the power of local curation

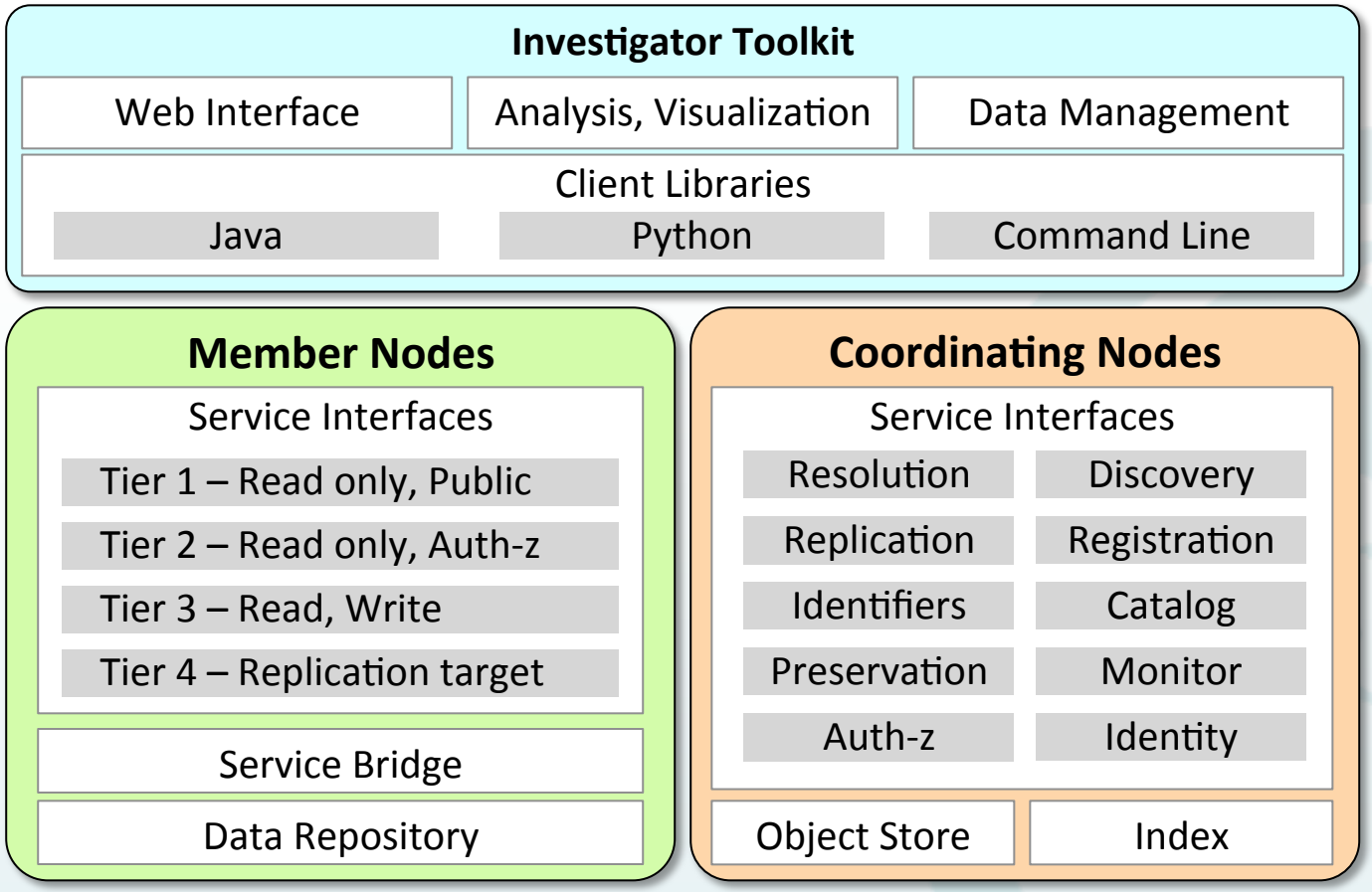
## Coordinating Nodes (CNs)

- Services to link Member Nodes

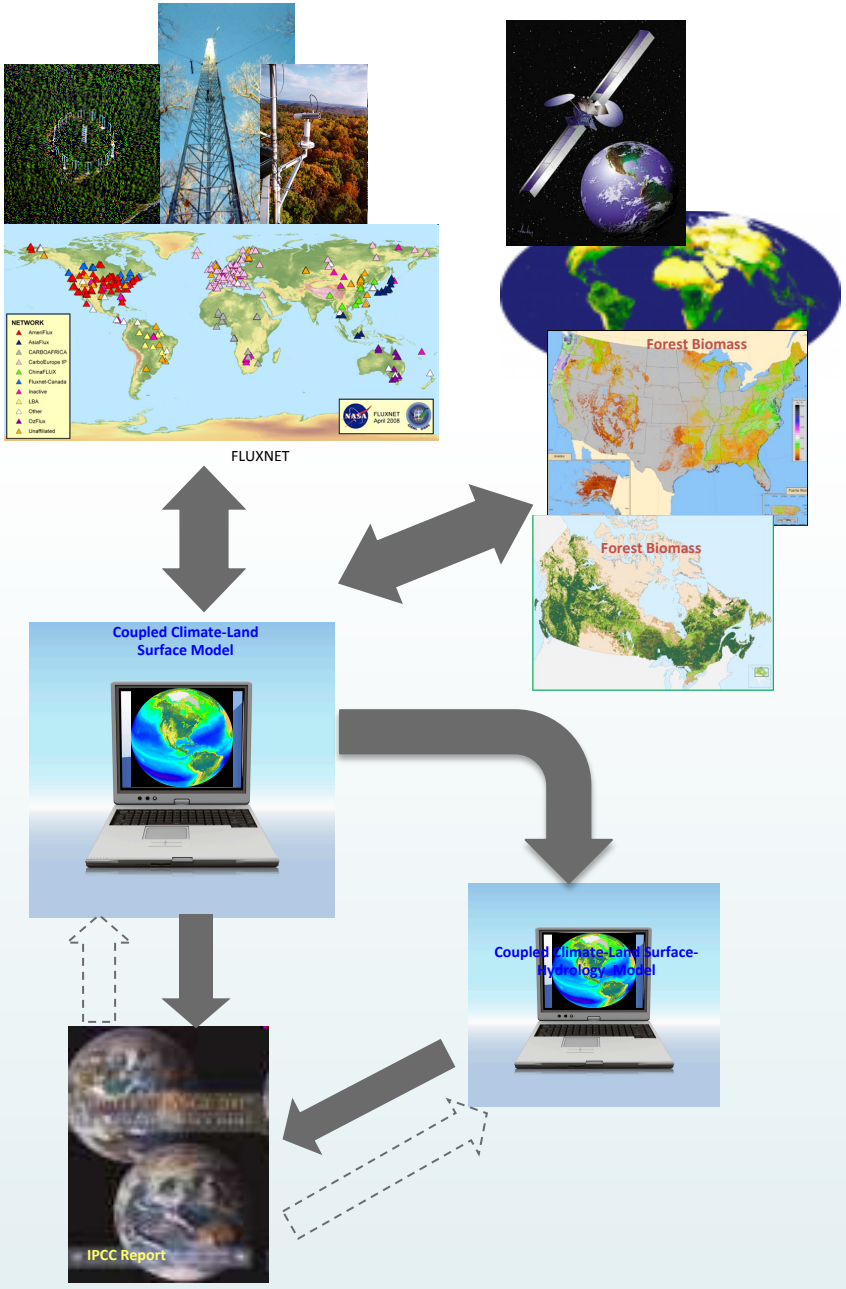
## Investigator Toolkit (ITK)

- Tools for the whole data lifecycle

# Three Major Components



# DataONE as Linked Science




- Discovery and access from heterogeneous sources
  - Simulations, models, experiments, remote sensing, GIS, molecular and omics databases, publications
- Metadata and semantics integration
- Workflows, scenario development, data and process re-use, provenance
- Engaging communities of scientists, educators, librarians, developers, volunteers
- Relies upon cyber-infrastructure promoting open source
- Complex systems of systems, networks of projects, repositories, archives, publishers

# Deployed Infrastructure

## Coordinating Nodes

- ORC: ORNL + UTK
- UCSB
- UNM

## Investigator Toolkit

- Java and Python libs
- Command line
- ONEMercury
- (R plugin)
- (Morpho)
- (ONEDrive)

## Member Nodes

### Production

- KNB
- ESA
- SANParks
- USGS CSAS
- ORNL DAAC
- LTER
- CDL
- PISCO

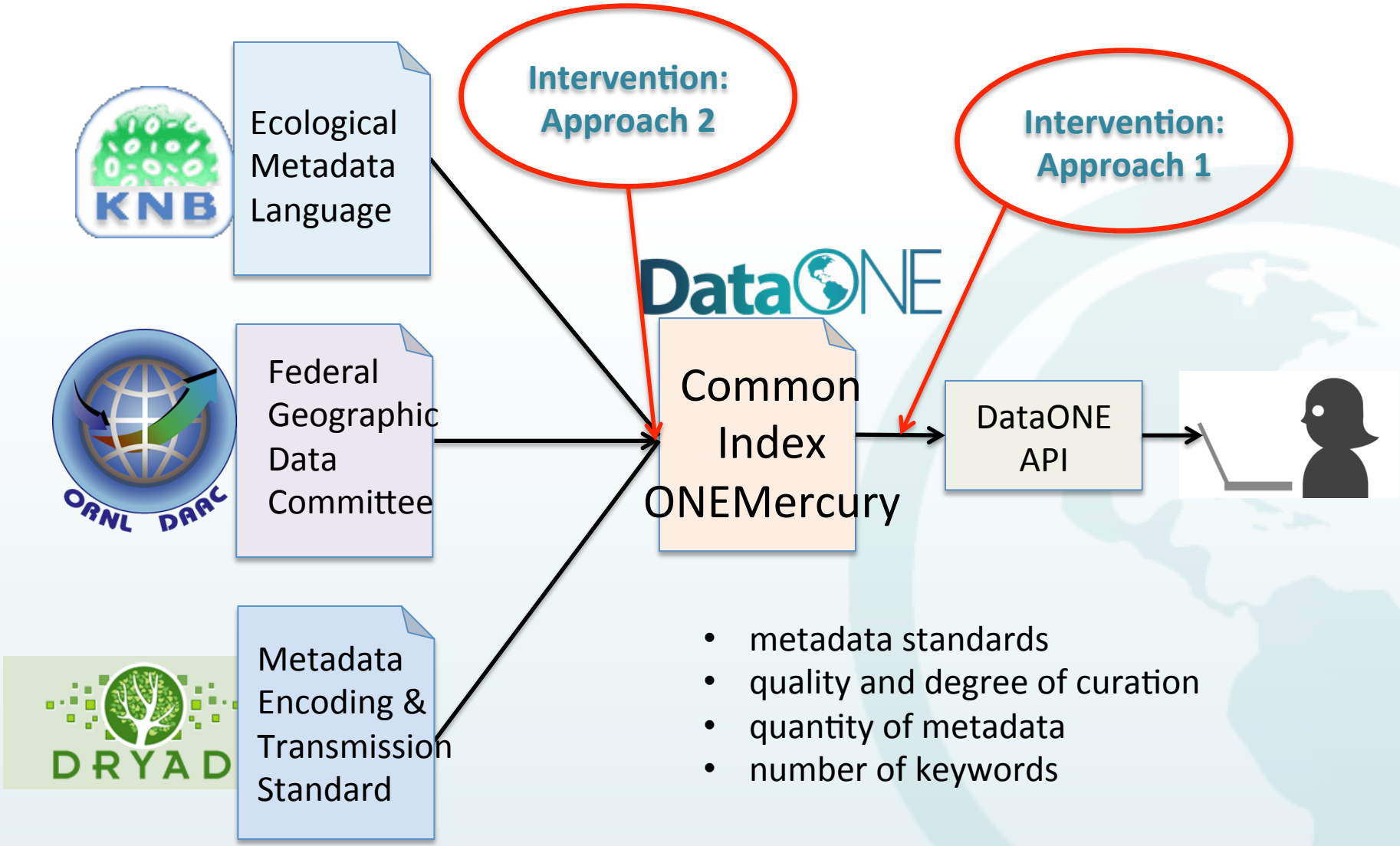
### Testing

- AKN
- TFRI
- Dryad
- EDAC
- KUBI

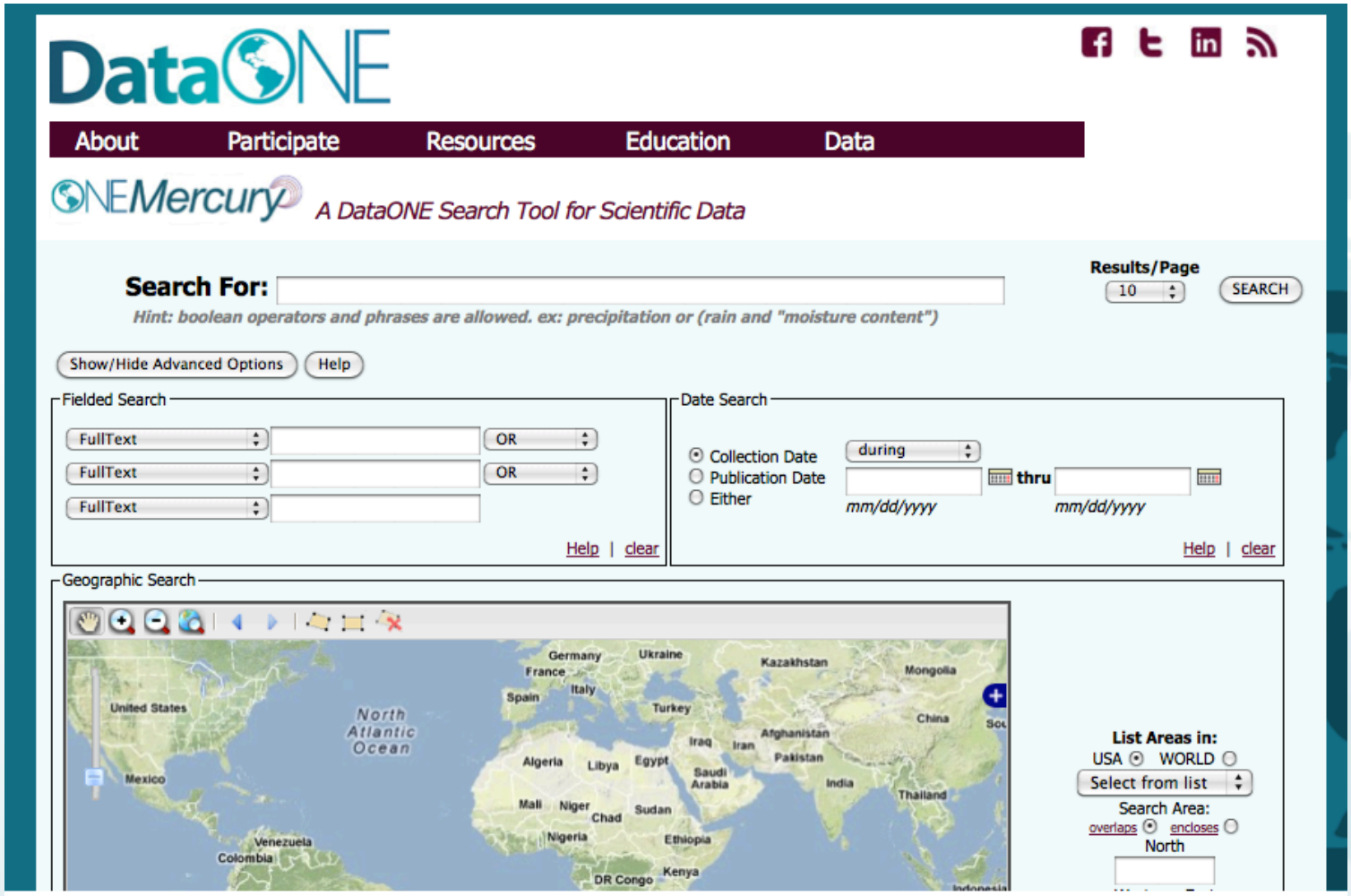
# Diversity of Member Nodes: a Key Factor

| | ORNL-DAAC | Dryad | KNB |
|---|---|---|---|
| Community | Agency repository | Journal consortium | Research network |
| Data | Ecology and biogeochemical dynamics | Biosciences | Biodiversity, ecology, environment |
| Size | ~ 1,000 data products, ~ 1 TB | ~ 1,000 data products, ~ 5 GB | 25,000 data products, 100s GBs |
| Services | Tools for data preservation, replication, discovery, access, subsetting, and visualization | Tools for data preservation, replication, discovery and access | Tools for data preservation, replication, discovery, access, management, and visualization |
| Metadata stds. | FGDC subset | Dublin Core application profile | EML, FGDC |
| Degree of curation | High | Medium | Low |
| Data submission | Staff-assisted submission and curation of final data product | Web-based data submission at time of journal article submission | Self-submission via desktop tool at any time |
| Sponsor | NASA | NSF/JISC, societies, publishers | NSF |

# Goal: Improve DataONE Discovery Services



# Discovery Services based upon ONE Mercury



ONEMercury *A DataONE Search Tool for Scientific Data*

Return to Search | Email Query | Bookmark Query | RSS Feed for Query | Help

**Query: text : water**

Hide Filters

| Filter by author | Filter by project | Filter by keywords | Filter by Originator |
|---|---|---|---|
| Bruce Menge (6459) | Partnership for Interdisciplinary (14809) | temperature (15631) | Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) (14777) |
| Margaret McManus (3465) | Florida Coastal Everglades (512) | Oceanographic Sensor Data (15359) | PISCO (1309) |
| Libe Washburn (3112) | Olympic Coast National (510) | continental shelf (15359) | Monterey Bay National Marine Sanctuary (952) |
| Jack Barth (1612) | Arctic Long-Term Ecological (339) | Temperature (15275) | Olympic Coast National Marine |
| Mary Sue Brancato (510) | | United States of America (15146) | |
| Anne Giblin (298) | | | |
| Pete Raimondi (237) | | | |

**Sort By:** Relevance | Date | Member Node

Viewing Documents 1 - 10 out of 22815
Prev 1 2 3 4 5 6 7 8 9 10 Next

**Filter by Member Node**

- PISCO MN (15460)
- LTER Network Member Node (4289)
- Merritt D1 Member Node (1845)
- Knowledge Network for Biocomplexity (764)
- ORNL DAAC (378)
- SANParks Data Repository (42)
- ESA Data Registry (21)
- USGS Core Sciences Clearinghouse (16)

**THE EFFECT OF OVERLAPPING PIOSPHERES ON LANDSCAPE HETEROGENEITY** 02/09/2004 - 05/09/2004

*Datasource:* SANPARKS DATA REPOSITORY

In 1933, Kruger National Park implemented artificial sources of surface water. Many studies have been conducted on the effect these waterholes have on herbivore distribution and the related impacts. One such finding is that piospheres, patches created by herbivores through their grazing, browsing and trampling activities focusing around a water source (Owen-Smith 1996 cited in Gaylard et al 2002) occur around waterholes and contribute to the patchiness in the landscape. The aim of this study was to determine if the proportion of increaser II grass species would drop below 50% and be replaced b...

View full metadata | Data Files (0)

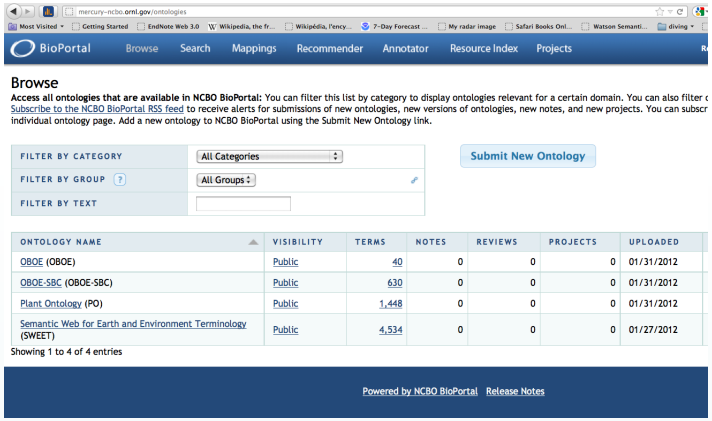
**POD! WATER-QUALITY_DAILY WATERTEMP (1984-06) AND EMP WATER QUALITY** 01/01/1975 - 01/01/2007

*Datasource:* KNOWLEDGE NETWORK FOR BIOCOMPLEXITY

Daily Water Temp 1984-2006 %26#226;%26#128;%26#147; average daily water temperature at three locations. EMP water quality parameters: EMP continuous %26#226;%26#128;%26#147; continuous sampling data available since 1998 EMP discrete %26#226;%26#128;%26#147; monthly sampling data available since 1975 The study area includes the Delta within its legal boundaries, Suisun Bay and Suisun Marsh, and northeastern San Pablo Bay bounded by a line between Pinole Point on the east and the Solano County line on the north shore. The EMP sampling sites range from San Pablo Bay east through the upper Estua...

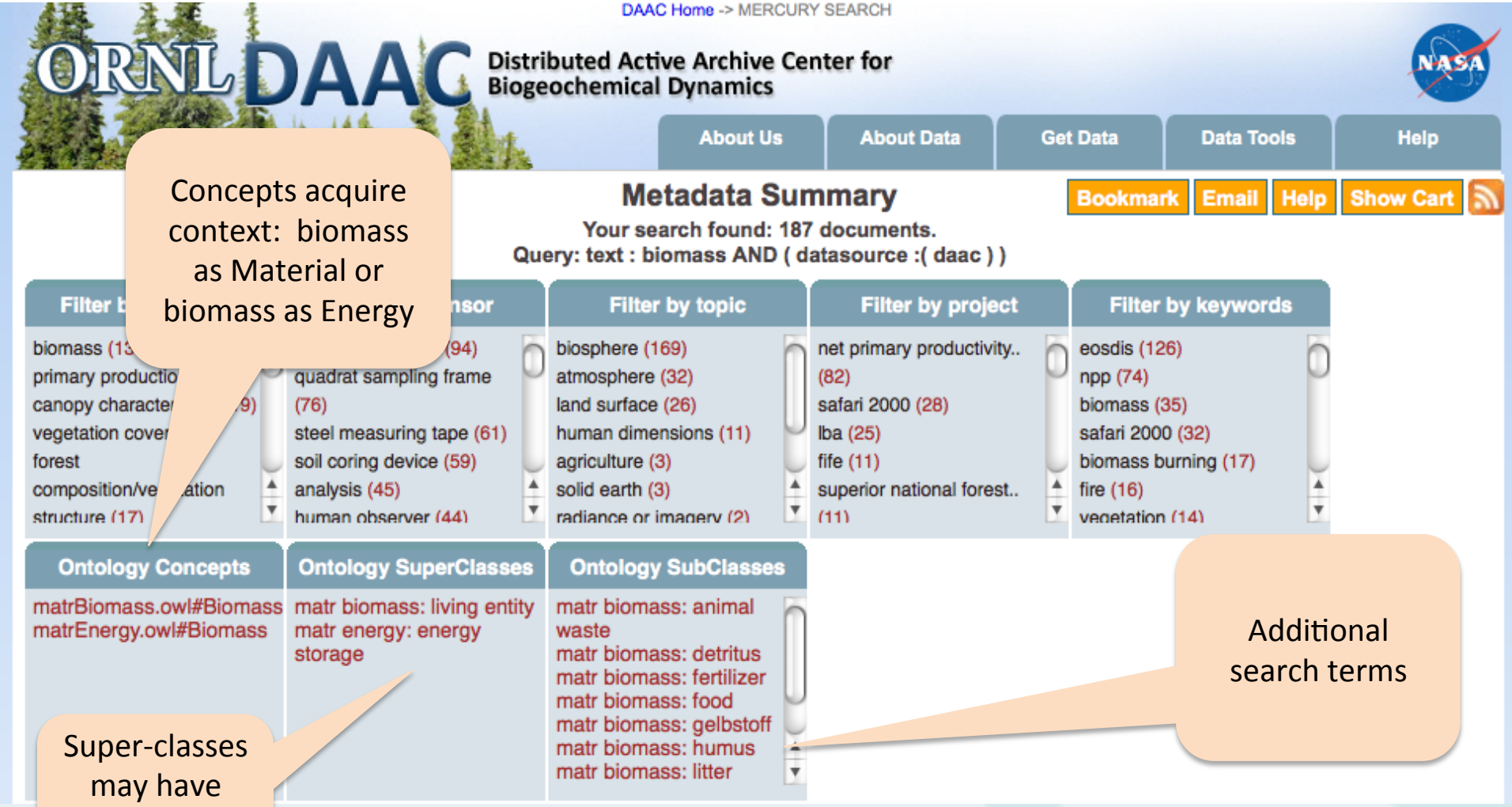
View full metadata | Data Files (2)

# Ontology-based Discovery: Ontology integration into query-results



1. we had a metadata collection and discovery engine (Mercury)
2. we installed the NCBO ontology repository instance on a DataONE node
3. we populated it with Earth Sciences ontologies
    - the NASA-JPL Semantic Web for Earth and Environmental Terminology
4. we queried the ontologies and returned results using REST services

# Ontology-based search results

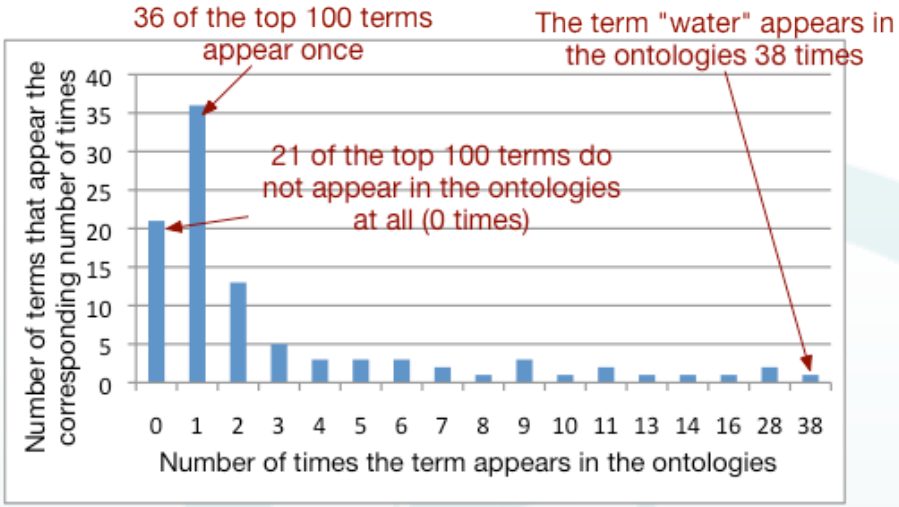


# Limitations and remaining challenges

Display is confusion, too many facets

SWEET provides a good basis but further extensions are needed

Many ontologies provide too few relationships

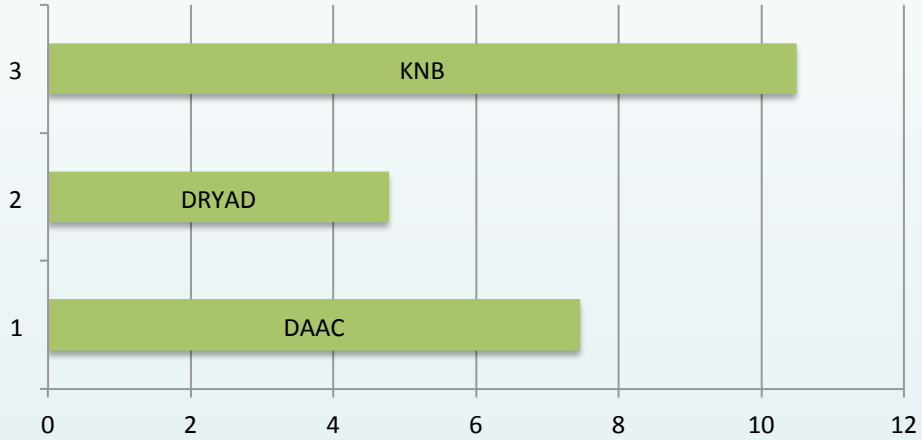



**Conclusion:**

**Adding ontology entities to a keyword index helps with recall but cannot substitute for semantic annotations of the metadata documents themselves**

# Approach 2: Enrich MN Metadata

| | DAAC | DRYAD | KNB |
|---|---|---|---|
| Number of Documents | 978 | 1,729 | 24,249 |
| Total Number of Keywords | 7,294 | 8,266 | 254,525 |
| Average Number of Keyword/ Document | 7.46 | 4.78 | 10.49 |




- Each MN provides keywords
- Suggest additional keywords for each document
- Treated like a tag recommendation problem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# Example Scenario- Hydro-Eco Use Case

- *"I want data for streamflow and water quality constituent concentrations co-located with fish and aquatic macroinvertebrate species occurrence observations to inform studies of hydrology and water quality impacts on aquatic organisms."*
- Requires location and access of data from many sources (KNB/LTER, CUAHSI, ORNL DAAC, Dryad)


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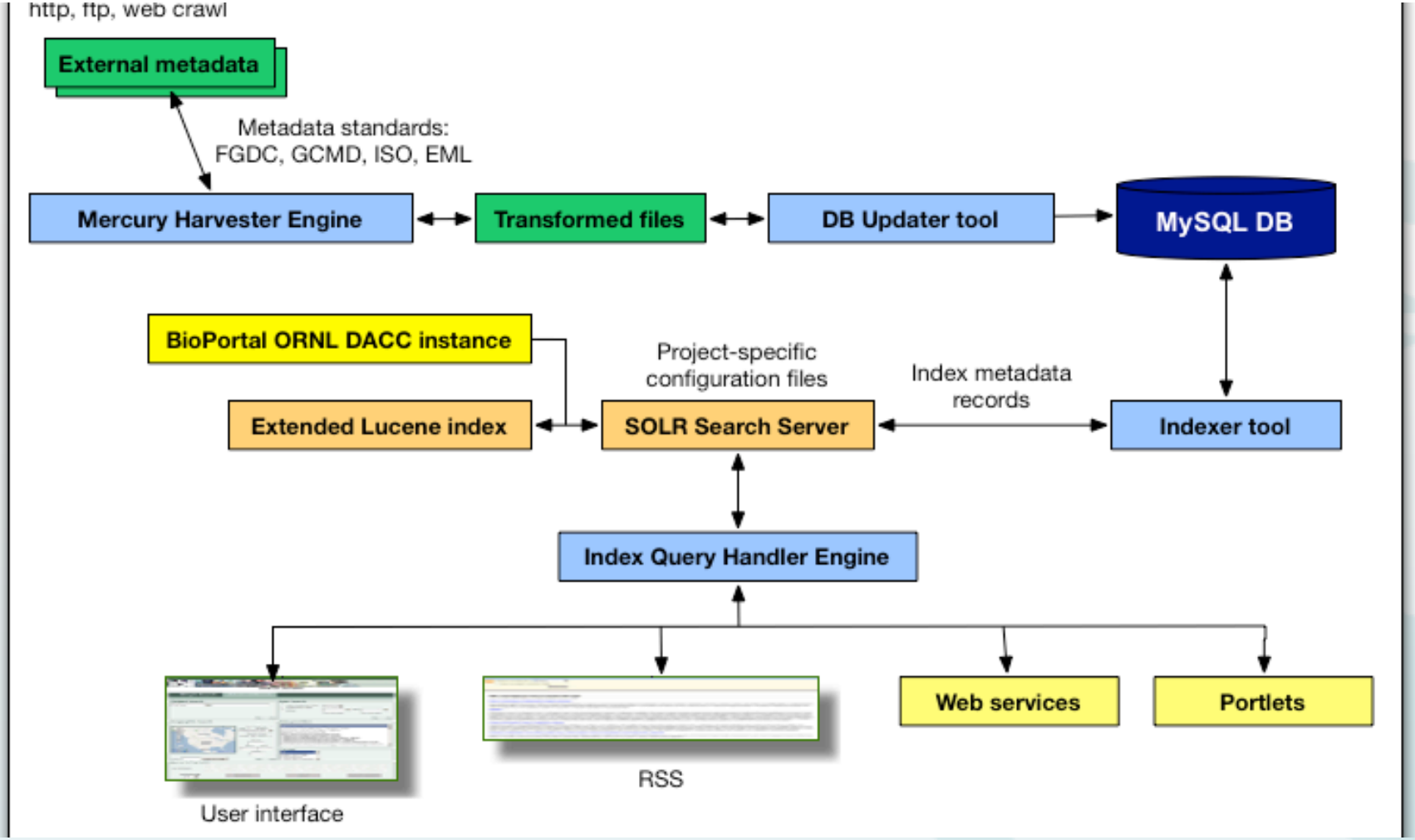
# Integration and Semantics Working Group

Jeff Horsburgh, USU
Deborah McGuinness, RPI
Luis Bermudez, OGC
Damian Gessler, iPlant
Carl Lagoze, U. Michigan
Hilmar Lapp, NESCENT
Carlos Rueda, MMI
Natasha Noy, Stanford
Paulo Pinheiro Da Silva, PNNL
Line Pouchard, ORNL
Mark Schildhauer, NCEAS
Patrice Seyed, UNM / RPI

DataONE

# Acknowledgements

# Architecture: Ontology-based discovery



# Precision and recall

| | Actual Positive | Actual Negative |
|---|---|---|
| Predicted Positive | Tp | Fp |
| Predicted Negative | Fn | Tn |

Precision: $Tp/Tp+Fp$

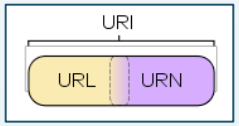
Recall: $Tp/■Tp+Fn$

- Precision: the proportion of Actual positive in the recommended set
- Recall: the proportion of Actual that are recommended over the entire dataset

# CN Services: Identify objects

Goal: Uniquely identify data or metadata objects

- Support the several identifier types widely used
- Identifiers assigned by Member Nodes
- Uniqueness ensured by Coordinating Nodes
- Resolution through Coordinating Nodes

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# Value of DataONE

- Discovery and access: Enabling discovery and universal access to data about life on earth from around the world
- Data integration and synthesis: Providing transformational tools that enable cross-cutting research
- Education and training: Providing essential skills (e.g., data management training, best practices) for scientific enquiry
- Building community: Combining expertise and resources across diverse communities to collectively educate, advocate, and support stewardship of scientific data
- Data Sharing: Providing incentives and infrastructure for sharing data from federally funded researchers



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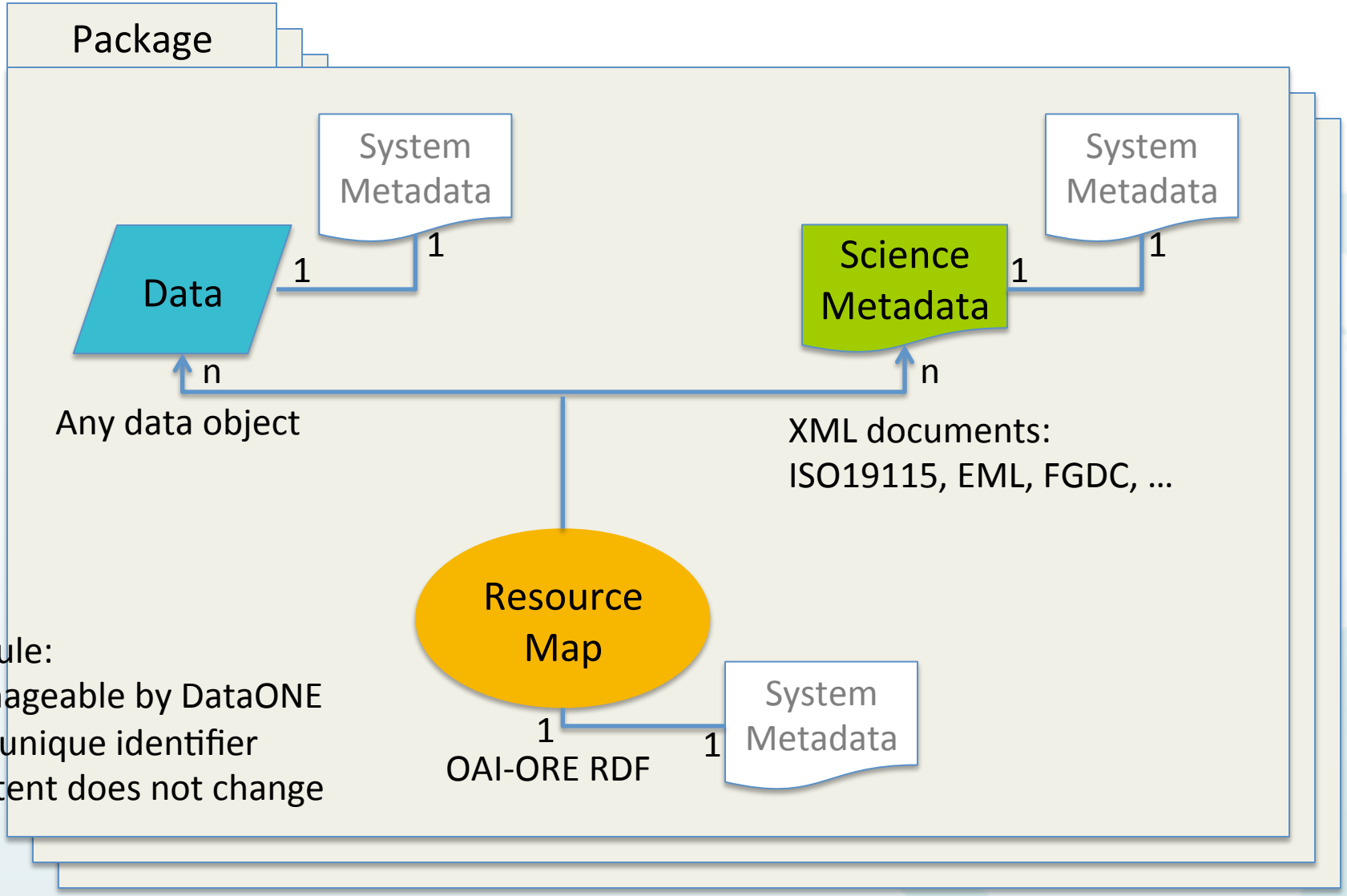
# DataONE Team and Sponsors

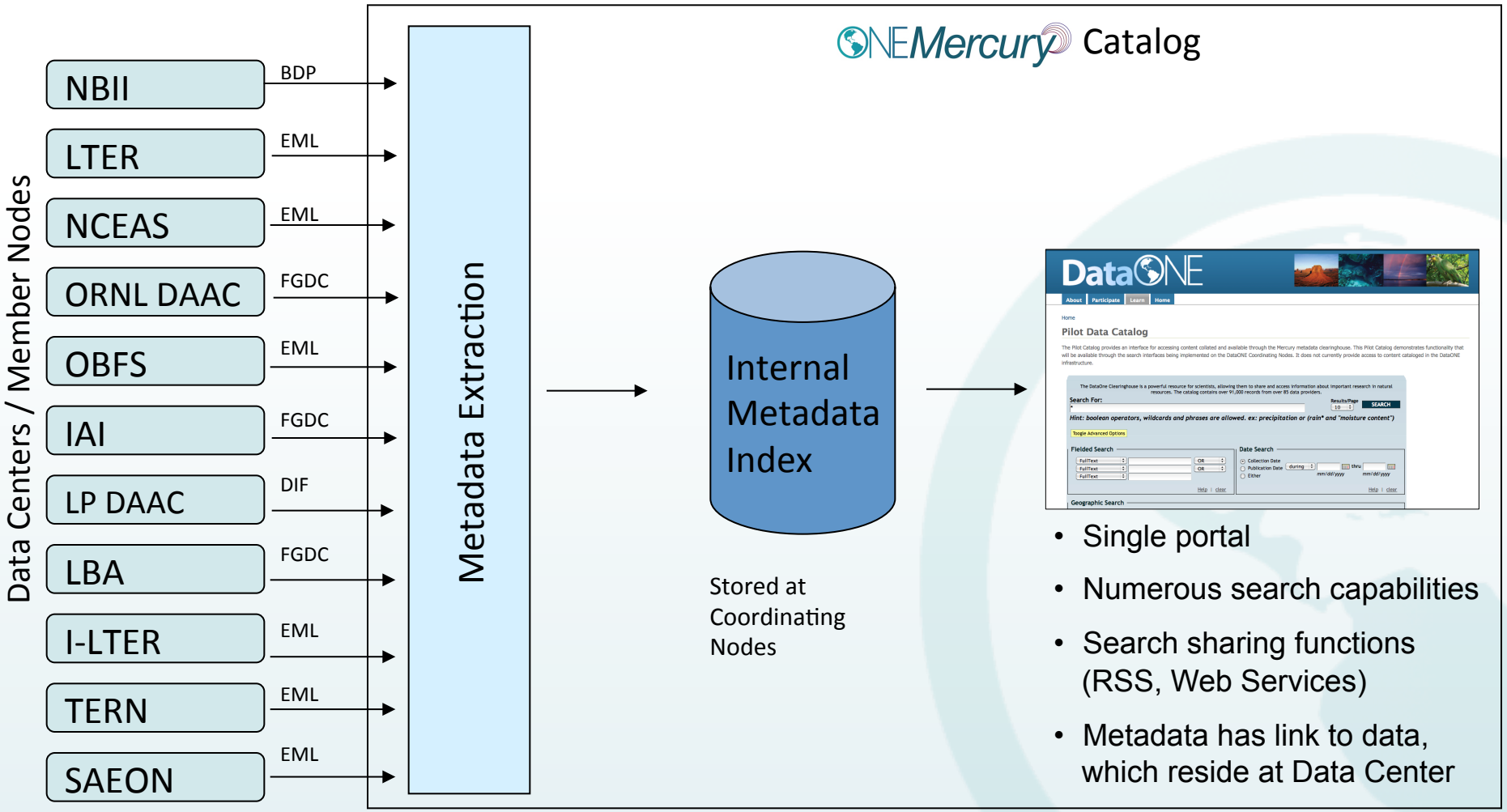
- Amber Budden, Roger Dahl, Rebecca Koskela, Bill Michener, Robert Nahf, Mark Servilla
- Dave Vieglais
- Suzie Allard, Carol Tenopir, Maribeth Manoff, Robert Waltz, Bruce Wilson
- John Cobb, Bob Cook, Giri Palanismy, Line Pouchard
- Patricia Cruse, John Kunze
- Sky Bristol, Mike Frame, Richard Huffine, Viv Hutchison, Jeff Morisette, Jake Weltzin, Lisa Zolly
- Chad Berkley, Stephanie Hampton, Matt Jones
- Paul Allen, Rick Bonney, Steve Kelling
- Ryan Scherle, Todd Vision
- Randy Butler
- Ewa Deelman
- Peter Honeyman
- Jeff Horsburgh
- Robert Sandusky
- Bertram Ludaescher
- Peter Buneman
- Cliff Duke
- Carole Goble
- Donald Hobern
- David DeRoure

# What is an object? DataONE Data Model




Granule:
- Manageable by DataONE
- Has unique identifier
- Content does not change

# ONEMercury Architecture



ONEMercury
Results/Page
10
SEARCH
Search For:
Hint: boolean operators, wildcards and phrases are allowed. ex: precipitation or (rain* and "moisture content")
Show/Hide Advanced Options
HELP
Fielded Search
FullText
OR
FullText
OR
FullText
Help | clear
Date Search
Collection Date
Publication Date
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during
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Help | clear
Geographic Search
North America
Atlantic Ocean
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Asia
Africa
South America
Pacific Ocean
Indian Ocean
Australia
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POWERED BY Google
Terms of Use
List Areas in:
USA
WORLD
Select from list
Search Area:
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North
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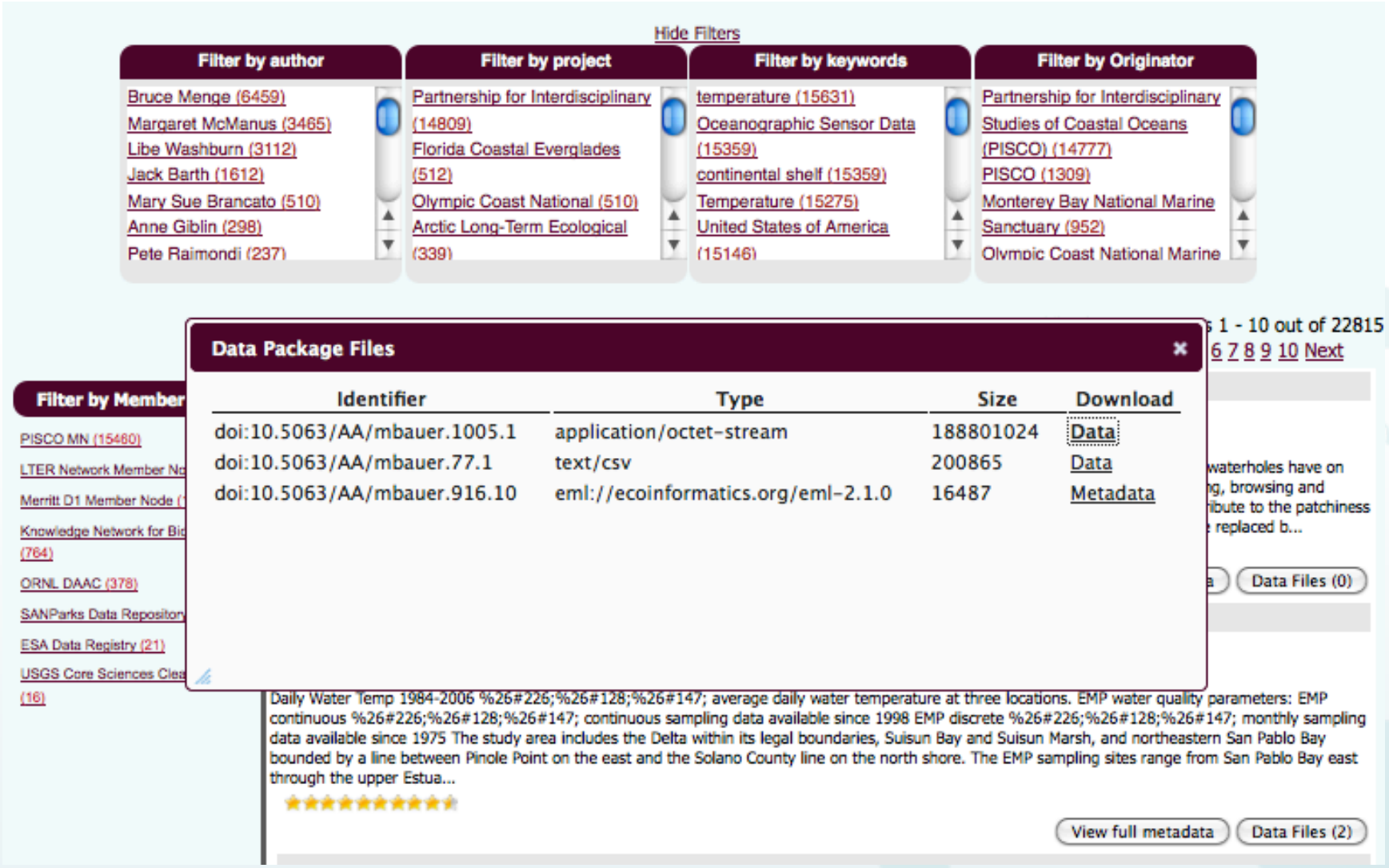
East
South
Place Name:
view on map
Help | clear
Content Type
All
Maps and Data
Publications
Tools and Software
Member Nodes
All
ORNL Distributed Active Archive Center for Biogeochemical Dynamics (ORN
Dryad
NBII Metadata Clearinghouse
All NBII Partner Nodes
NBII Metadata Clearinghouse Principal Node
Selected Query (Not Editable)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Monterey Bay National Marine Sanctuary (952)
Olympic Coast National Marine
Data Package Files
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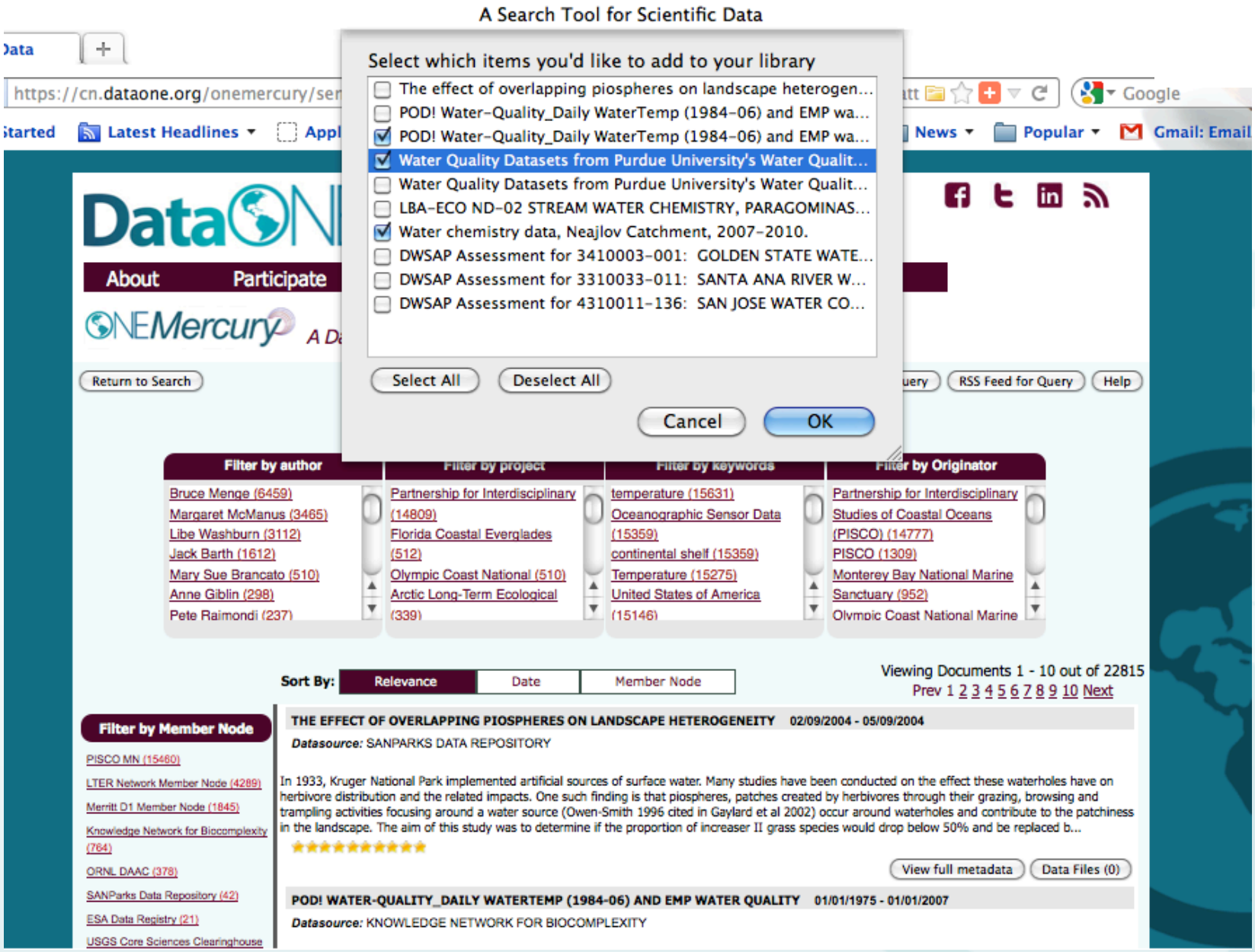
A Search Tool for Scientific Data
Select which items you'd like to add to your library
The effect of overlapping piospheres on landscape heterogen...
POD! Water-Quality_Daily WaterTemp (1984-06) and EMP wa...
POD! Water-Quality_Daily WaterTemp (1984-06) and EMP wa...
Water Quality Datasets from Purdue University's Water Qualit...
Water Quality Datasets from Purdue University's Water Qualit...
LBA-ECO ND-02 STREAM WATER CHEMISTRY, PARAGOMINAS...
Water chemistry data, Neajlov Catchment, 2007-2010.
DWSAP Assessment for 3410003-001: GOLDEN STATE WATE...
DWSAP Assessment for 3310033-011: SANTA ANA RIVER W...
DWSAP Assessment for 4310011-136: SAN JOSE WATER CO...
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Member Node
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Datasource: SANPARKS DATA REPOSITORY
In 1933, Kruger National Park implemented artificial sources of surface water. Many studies have been conducted on the effect these waterholes have on herbivore distribution and the related impacts. One such finding is that piospheres, patches created by herbivores through their grazing, browsing and trampling activities focusing around a water source (Owen-Smith 1996 cited in Gaylard et al 2002) occur around waterholes and contribute to the patchiness in the landscape. The aim of this study was to determine if the proportion of increaser II grass species would drop below 50% and be replaced b...
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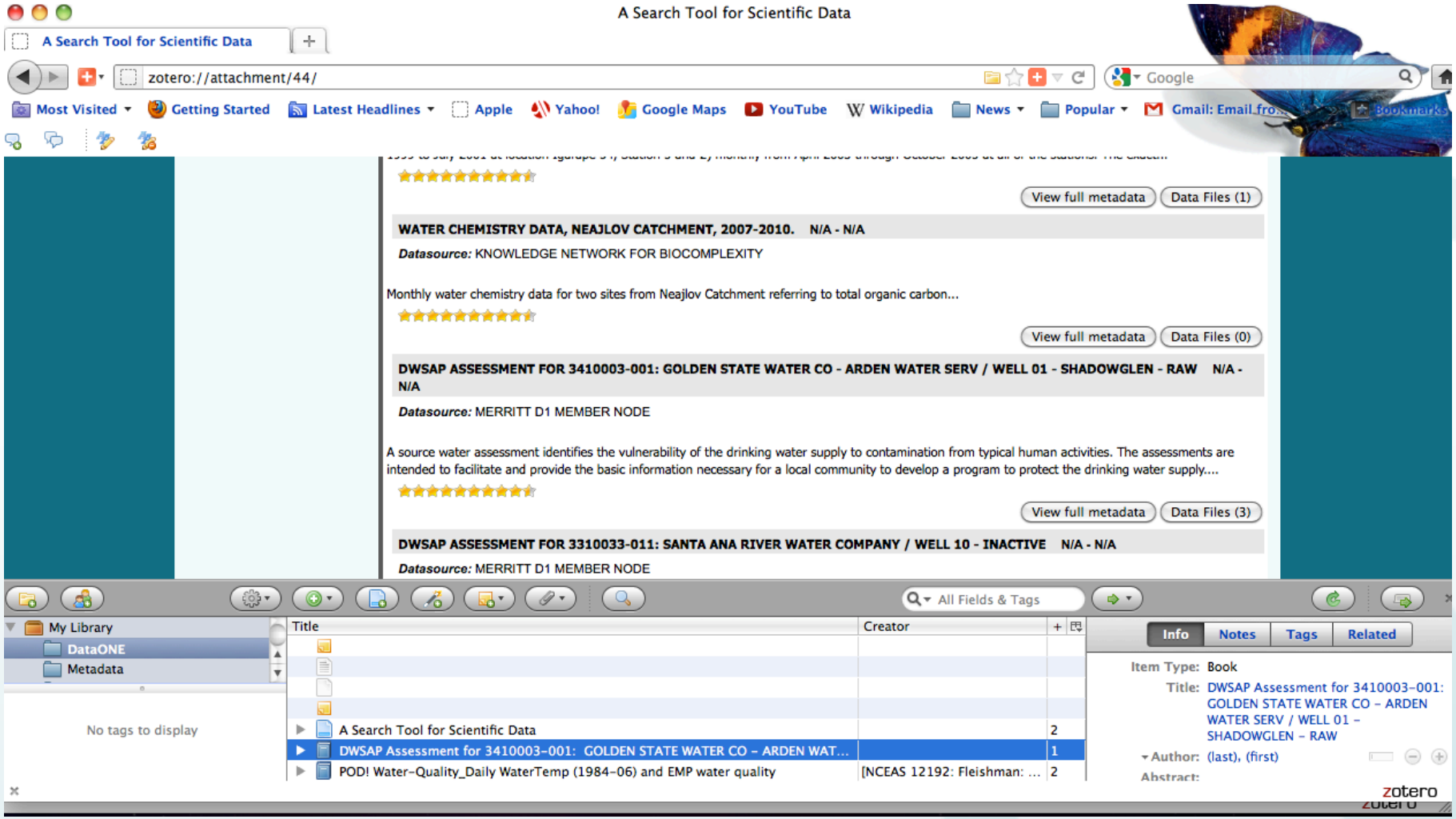
Data Files (0)
POD! WATER-QUALITY_DAILY WATERTEMP (1984-06) AND EMP WATER QUALITY 01/01/1975 - 01/01/2007
Datasource: KNOWLEDGE NETWORK FOR BIOCOMPLEXITY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A Search Tool for Scientific Data
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Apple
Yahoo!
Google Maps
YouTube
Wikipedia
News
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Data Files (1)
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Datasource: KNOWLEDGE NETWORK FOR BIOCOMPLEXITY
Monthly water chemistry data for two sites from Neajlov Catchment referring to total organic carbon...
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DWSAP ASSESSMENT FOR 3410003-001: GOLDEN STATE WATER CO - ARDEN WATER SERV / WELL 01 - SHADOWGLEN - RAW N/A - N/A
Datasource: MERRITT D1 MEMBER NODE
A source water assessment identifies the vulnerability of the drinking water supply to contamination from typical human activities. The assessments are intended to facilitate and provide the basic information necessary for a local community to develop a program to protect the drinking water supply....
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Datasource: MERRITT D1 MEMBER NODE
All Fields & Tags
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DataONE
Metadata
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Creator
A Search Tool for Scientific Data
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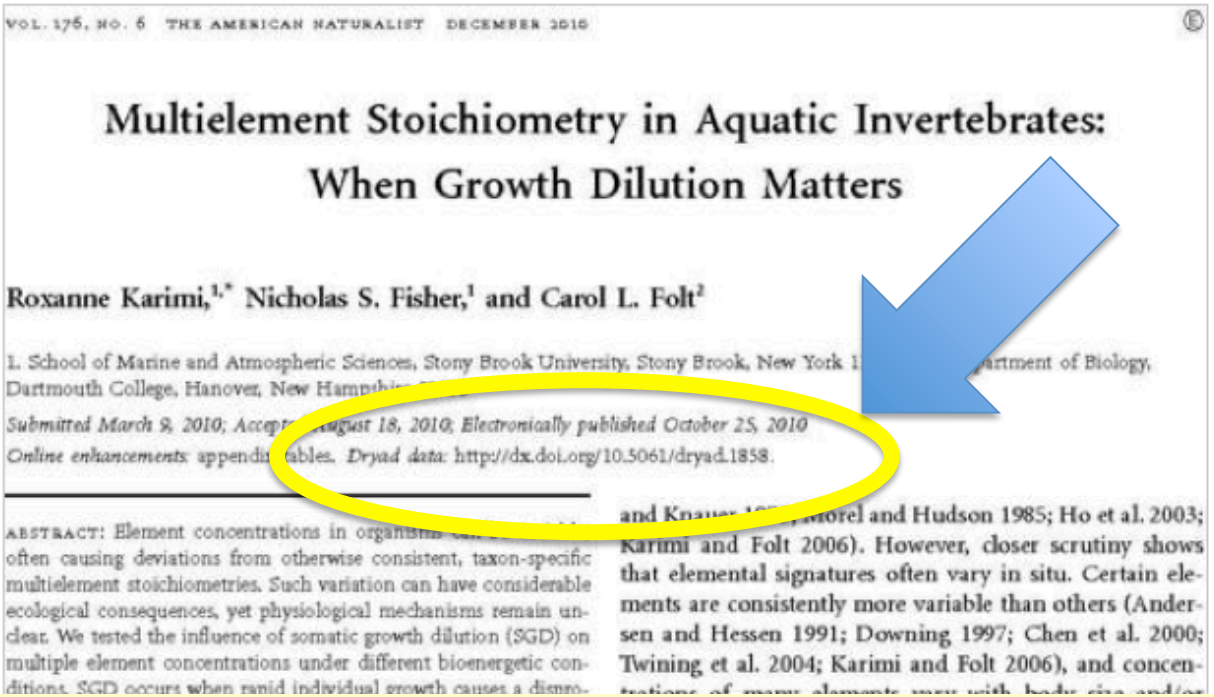

VOL. 176, NO. 6 THE AMERICAN NATURALIST DECEMBER 2010

## Multielement Stoichiometry in Aquatic Invertebrates: When Growth Dilution Matters

Roxanne Karimi,[1,*] Nicholas S. Fisher,[1] and Carol L. Folt[2]

1. School of Marine and Atmospheric Sciences, Stony Brook University, Stony Brook, New York 1... Department of Biology, Dartmouth College, Hanover, New Hampshi...

*Submitted March 9, 2010; Accept... August 18, 2010; Electronically published October 25, 2010*

*Online enhancements:* appendi... tables. *Dryad data:* http://dx.doi.org/10.5061/dryad.1858.

ABSTRACT: Element concentrations in organisms... often causing deviations from otherwise consistent, taxon-specific multielement stoichiometries. Such variation can have considerable ecological consequences, yet physiological mechanisms remain unclear. We tested the influence of somatic growth dilution (SGD) on multiple element concentrations under different bioenergetic conditions. SGD occurs when rapid individual growth causes a dispro...

...and Knauer 19... Morel and Hudson 1985; Ho et al. 2003; Karimi and Folt 2006). However, closer scrutiny shows that elemental signatures often vary in situ. Certain elements are consistently more variable than others (Andersen and Hessen 1991; Downing 1997; Chen et al. 2000; Twining et al. 2004; Karimi and Folt 2006), and concentrations of many elements may with body size and/or

When using this data, please cite the original article:

> Ally D, Ritland K, Otto SP (2008) Can clone size serve as a proxy for clone age? An exploration using microsatellite divergence in Populus tremuloides. Molecular Ecology 17(22): 4897-4911. doi:10.1111/j.1365-294X.2008.03962.x

Additionally, please cite the Dryad data package:

> Ally D, Ritland K, Otto SP (2008) Data from: Can clone size serve as a proxy for clone age? An exploration using microsatellite divergence in Populus tremuloides. Dryad Digital Repository. doi:10.5061/dryad.7898

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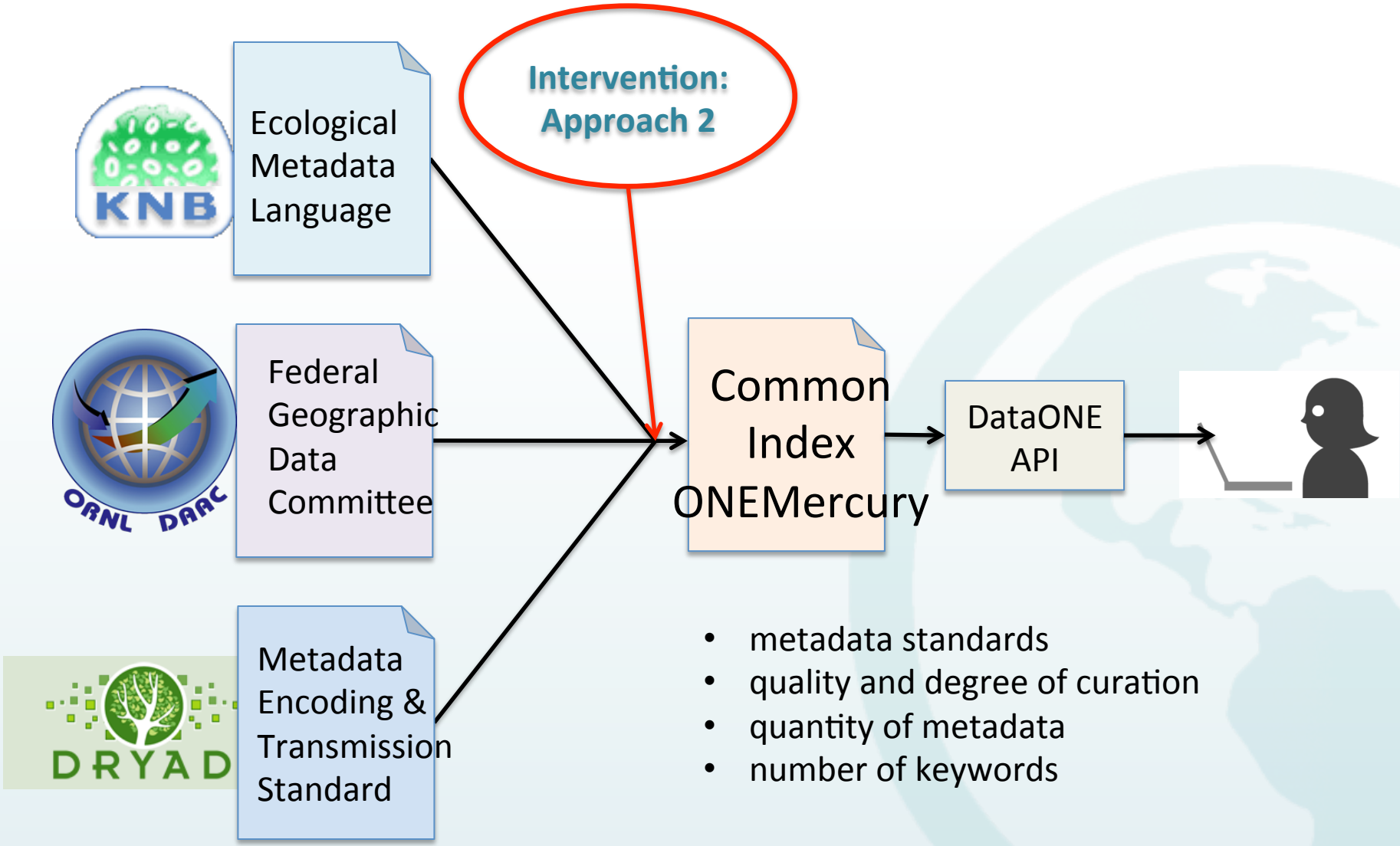

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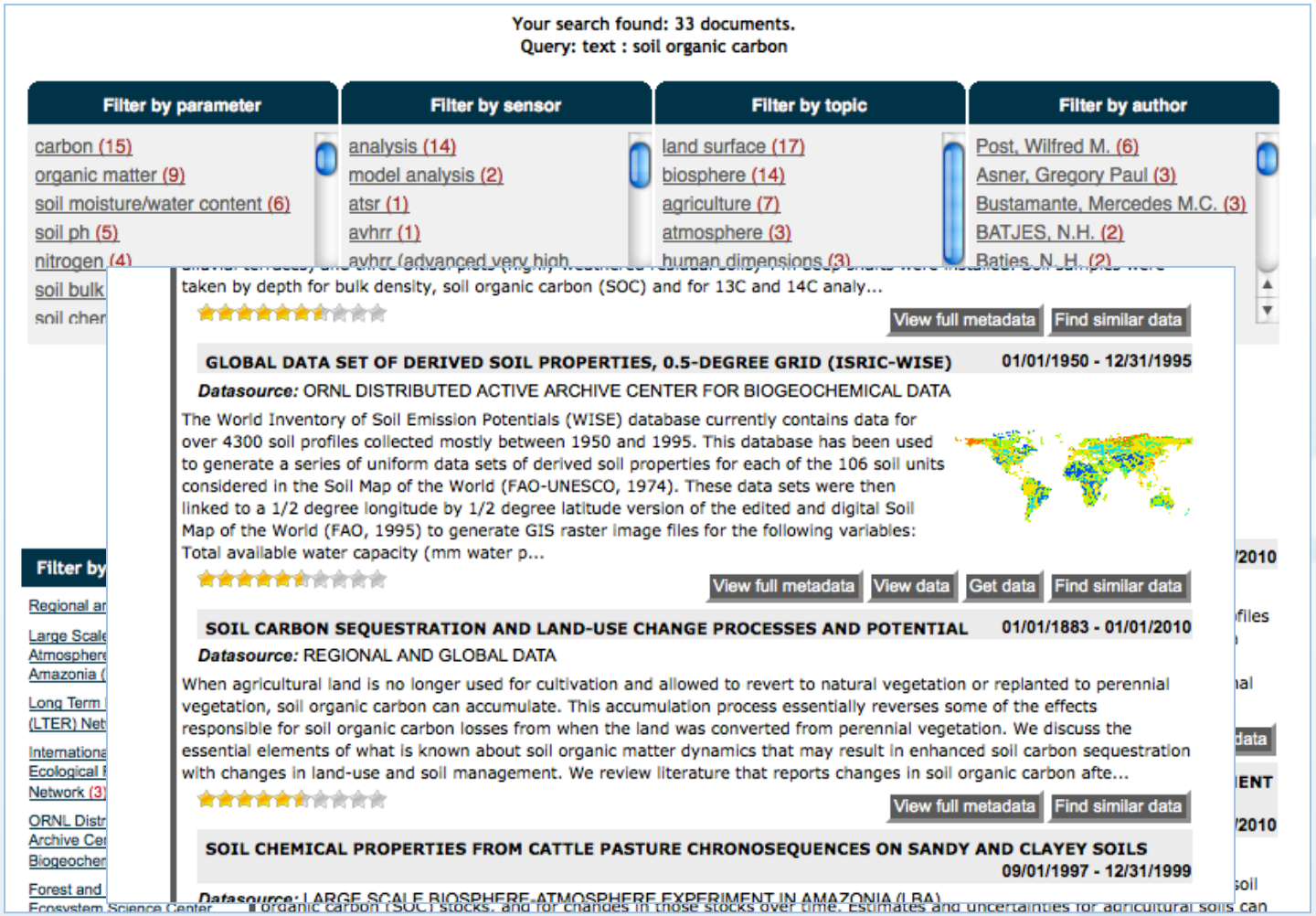

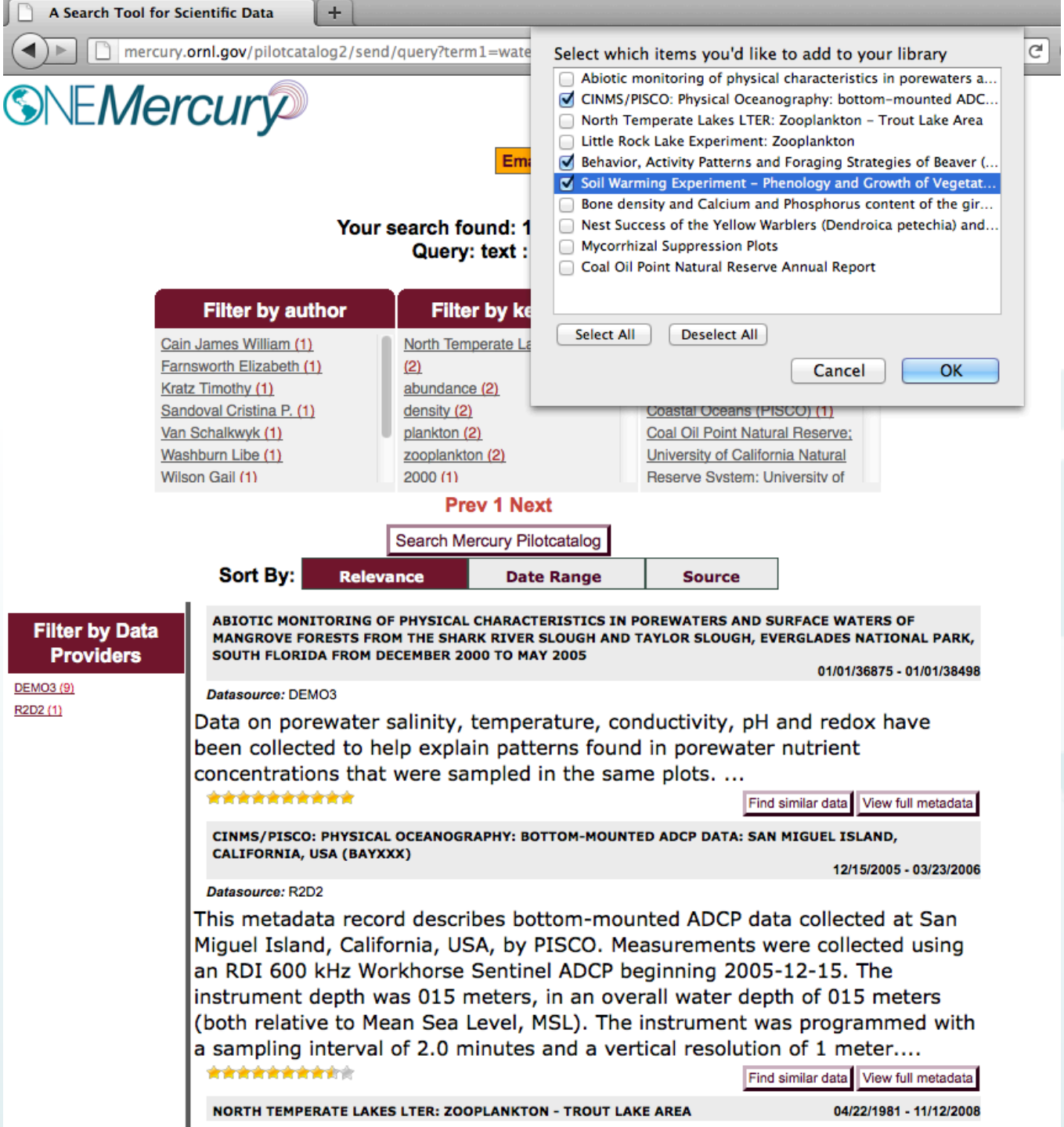
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