

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



Linked Science Workshop Keynote, Boston, November 12, 2012

Data deluge

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

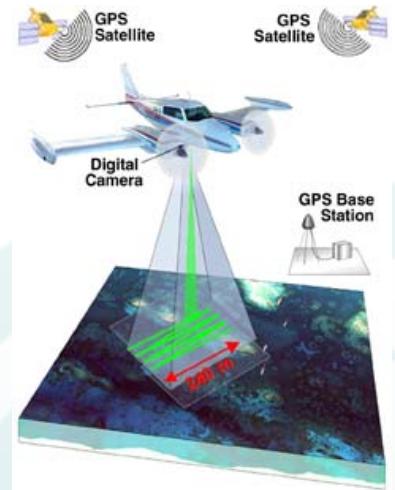
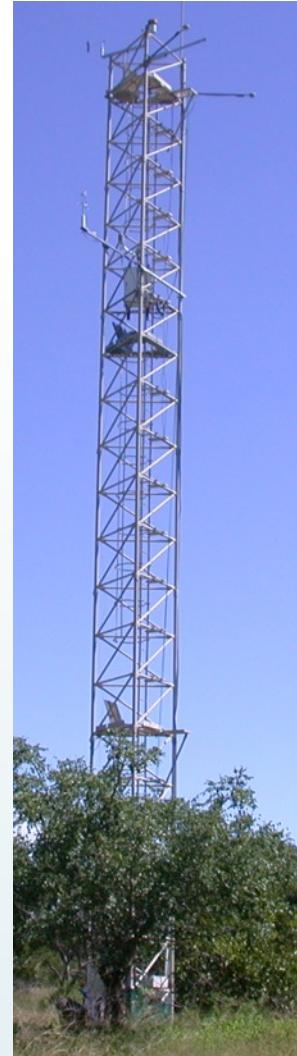
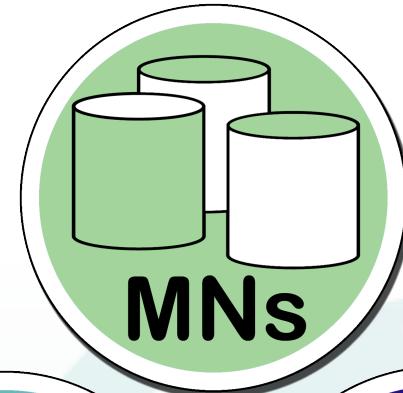


Photo courtesy of www.carboafrica.net

DataONE is Foremost a Federation

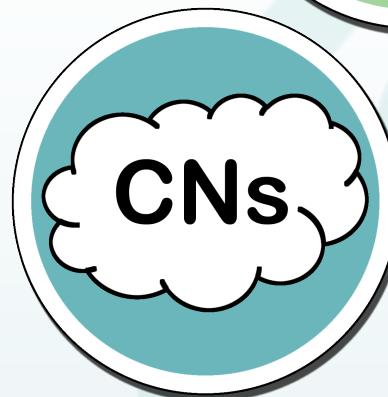
Member Nodes (MNs)

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



Coordinating Nodes (CNs)

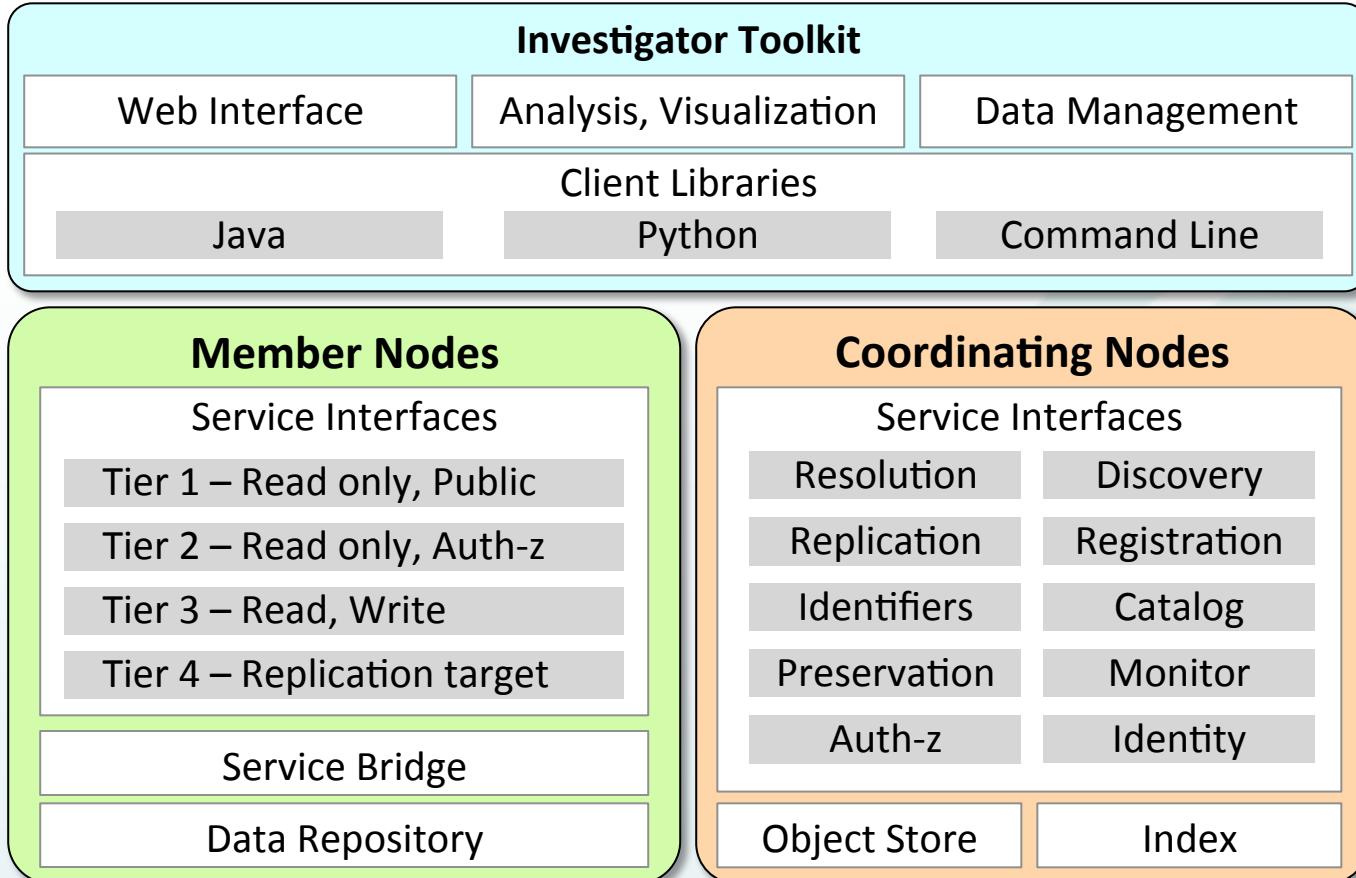
- Services to link Member Nodes



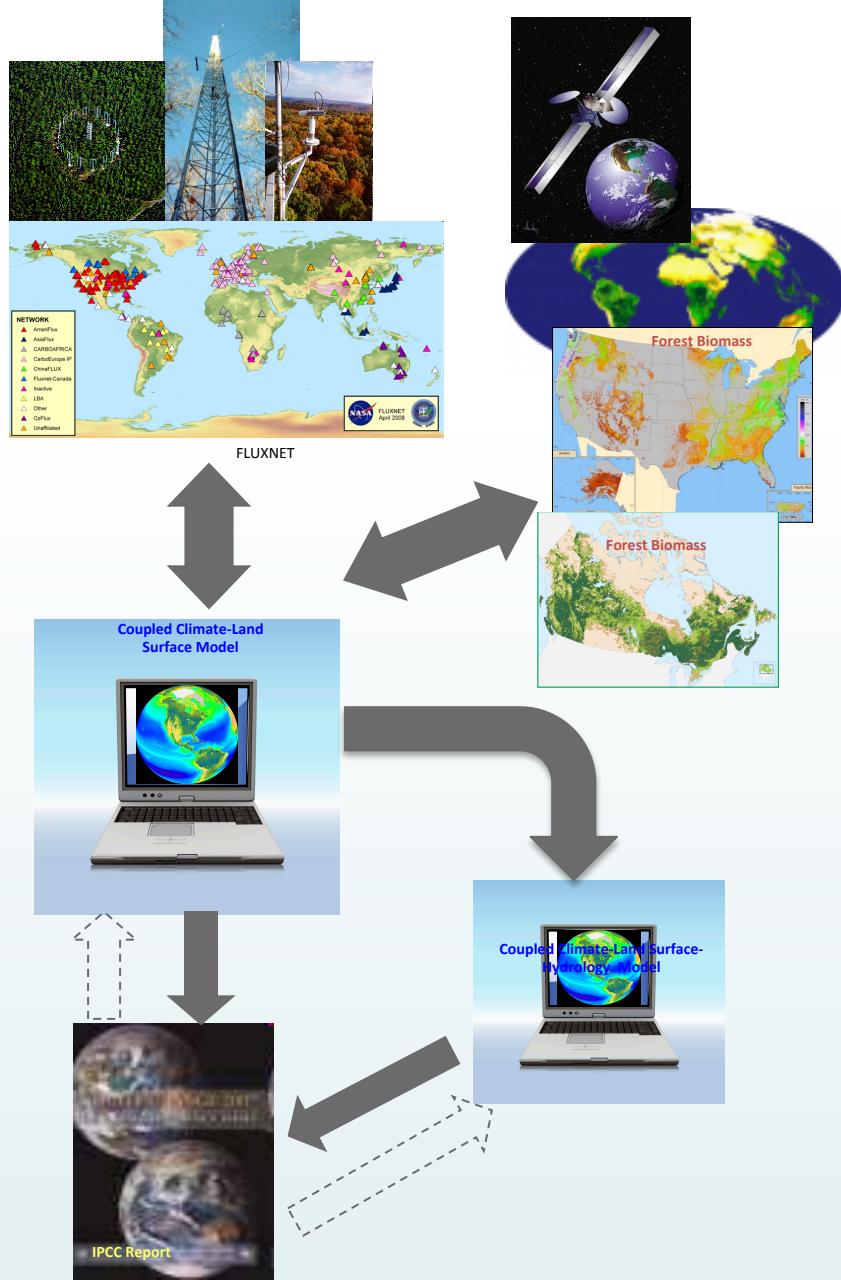
Investigator Toolkit (ITK)

- 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

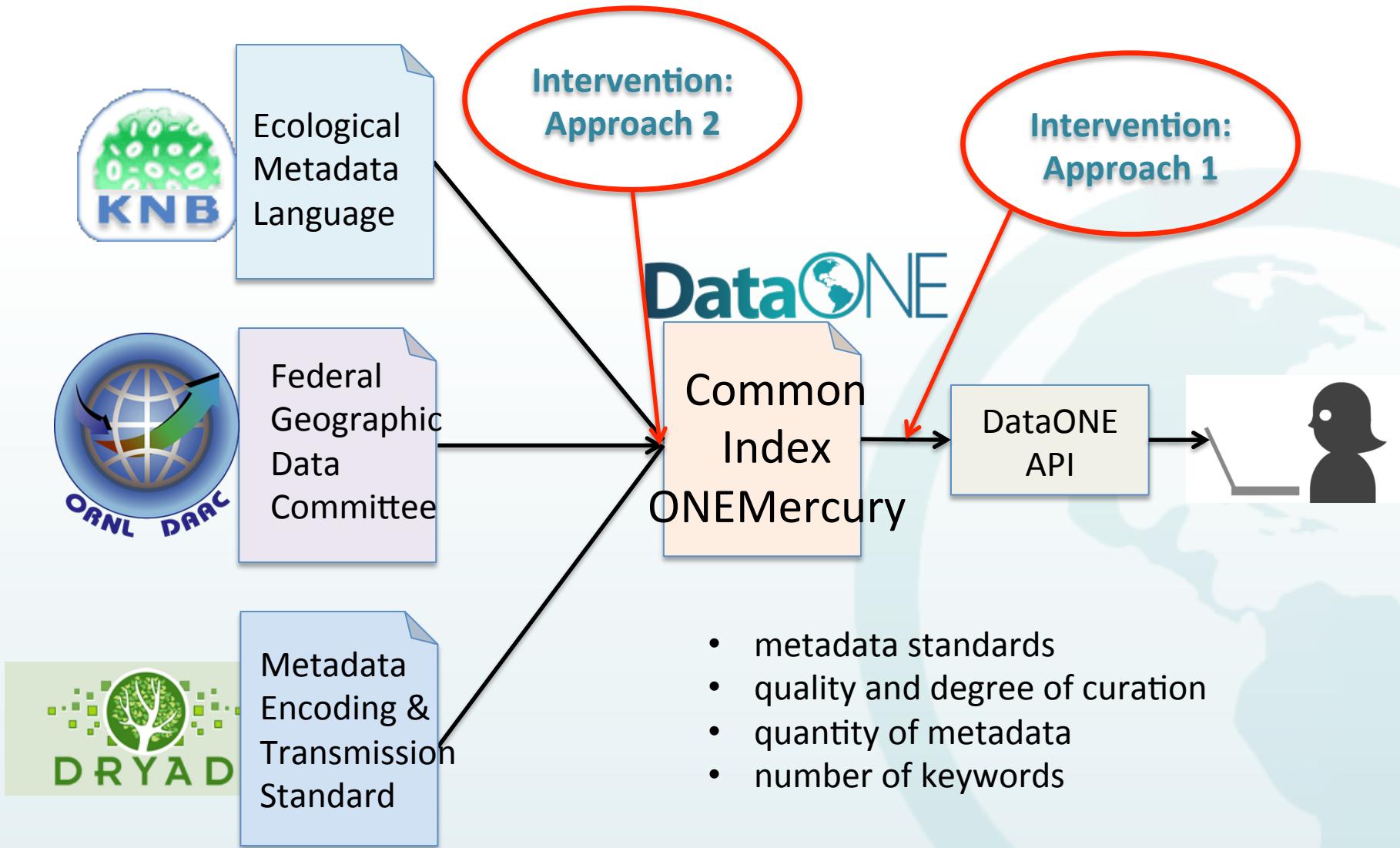
Testing

- 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

DataONE

About Participate Resources Education Data

ONEMercury A DataONE Search Tool for Scientific Data

Search For: Results/Page
10

Hint: boolean operators and phrases are allowed. ex: precipitation or (rain and "moisture content")

[Show/Hide Advanced Options](#) [Help](#)

Fielded Search

<input type="button" value="FullText"/> <input type="button" value="OR"/>	<input type="button" value="FullText"/> <input type="button" value="OR"/>	<input type="button" value="FullText"/>
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[Help](#) | [clear](#)

Date Search

Collection Date thru
 Publication Date
 Either
mm/dd/yyyy *mm/dd/yyyy*

[Help](#) | [clear](#)

Geographic Search

List Areas in:
 USA WORLD
[Select from list](#)
Search Area:
[overlaps](#) [encloses](#)
 North

[Return to Search](#)[Email Query](#)[Bookmark Query](#)[RSS Feed for Query](#)[Help](#)

Query: text : water

[Hide Filters](#)**Filter by author**

- [Bruce Menge \(6459\)](#)
- [Margaret McManus \(3465\)](#)
- [Libe Washburn \(3112\)](#)
- [Jack Barth \(1612\)](#)
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Filter by project

- [Partnership for Interdisciplinary \(14809\)](#)
- [Florida Coastal Everglades \(512\)](#)
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- [Arctic Long-Term Ecological \(339\)](#)

Filter by keywords

- [temperature \(15631\)](#)
- [Oceanographic Sensor Data \(15359\)](#)
- [continental shelf \(15359\)](#)
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Filter by Originator

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- [PISCO \(1309\)](#)
- [Monterey Bay National Marine Sanctuary \(952\)](#)
- [Olympic Coast National Marine](#)

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 piospores, 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 increase in grass species would drop below 50% and be replaced by...

[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 \(2\)](#)

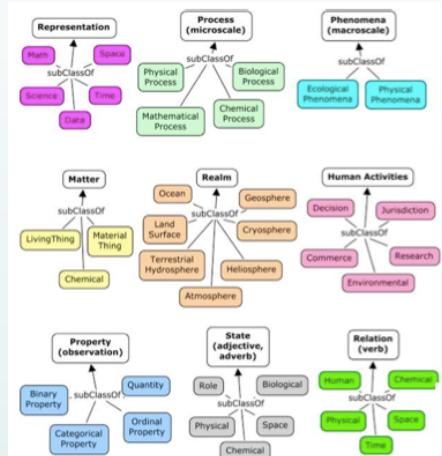
Ontology-based Discovery: Ontology integration into query-results

The screenshot shows the NCBO BioPortal interface. At the top, there's a navigation bar with links for 'BioPortal', 'Browse', 'Search', 'Mappings', 'Recommender', 'Annotator', 'Resource Index', and 'Projects'. Below the navigation bar, there's a search bar and a 'Submit New Ontology' button. A message at the top says: 'Access all ontologies that are available in NCBO BioPortal: You can filter this list by category to display ontologies relevant for a certain domain. You can also filter by group or by text. Subscribe to the NCBO BioPortal RSS feed to receive alerts for submissions of new ontologies, new versions of ontologies, new notes, and new projects. You can subscribe to individual ontology page. Add a new ontology to NCBO BioPortal using the Submit New Ontology link.' Below this, there are three filtering sections: 'FILTER BY CATEGORY' (with dropdowns for 'All Categories' and 'Submit New Ontology'), 'FILTER BY GROUP' (with dropdowns for 'All Groups' and a help icon), and 'FILTER BY TEXT' (with a text input field). The main content area displays a table of ontologies:

ONTOLOGY NAME	VISIBILITY	TERMS	NOTES	REVIEWS	PROJECTS	UPLOADED
OBOE (OBOE)	Public	40	0	0	0	01/31/2012
OBOE-SBC (OBOE-SBC)	Public	630	0	0	0	01/31/2012
Plant Ontology (PO)	Public	1,448	0	0	0	01/31/2012
Semantic Web for Earth and Environment Terminology (SWET)	Public	4,534	0	0	0	01/27/2012

Below the table, it says 'Showing 1 to 4 of 4 entries'. At the bottom of the page, there's a footer with 'Powered by NCBO BioPortal' and 'Release Notes'.

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

DAAC Home -> MERCURY SEARCH

ORNL DAAC Distributed Active Archive Center for Biogeochemical Dynamics NASA

About Us About Data Get Data Data Tools Help

Bookmark Email Help Show Cart

Metadata Summary
Your search found: 187 documents.
Query: text : biomass AND (datasource :(daac))

Filter by Sensor Filter by topic Filter by project Filter by keywords

Filter by Sensor	Filter by topic	Filter by project	Filter by keywords	
biomass (13) primary productio... canopy character... vegetation cover... forest composition/veg... structure (17)	quadrat sampling frame (94) steel measuring tape (76) soil coring device (61) analysis (45) human observer (44)	biosphere (169) atmosphere (32) land surface (26) human dimensions (11) agriculture (3) solid earth (3) radiance or imagery (2)	net primary productivity.. (82) safari 2000 (28) iba (25) fife (11) superior national forest.. (11)	eosdis (126) npp (74) biomass (35) safari 2000 (32) biomass burning (17) fire (16) vegetation (14)

Ontology Concepts Ontology SuperClasses Ontology SubClasses

Ontology Concepts	Ontology SuperClasses	Ontology SubClasses
matrBiomass.owl#Biomass matrEnergy.owl#Biomass	matr biomass: living entity matr energy: energy storage	matr biomass: animal waste matr biomass: detritus matr biomass: fertilizer matr biomass: food matr biomass: gelbstoff matr biomass: humus matr biomass: litter

Concepts acquire context: biomass as Material or biomass as Energy

Super-classes may have different properties

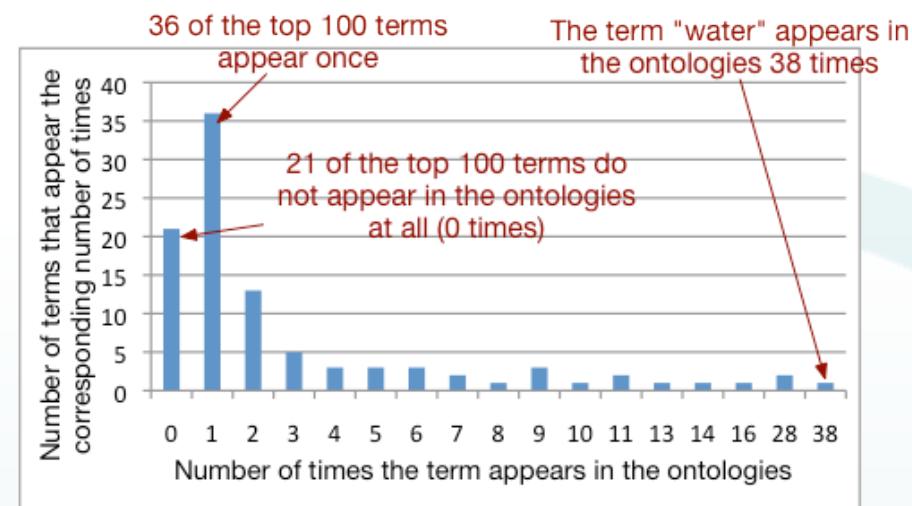
Additional search terms

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

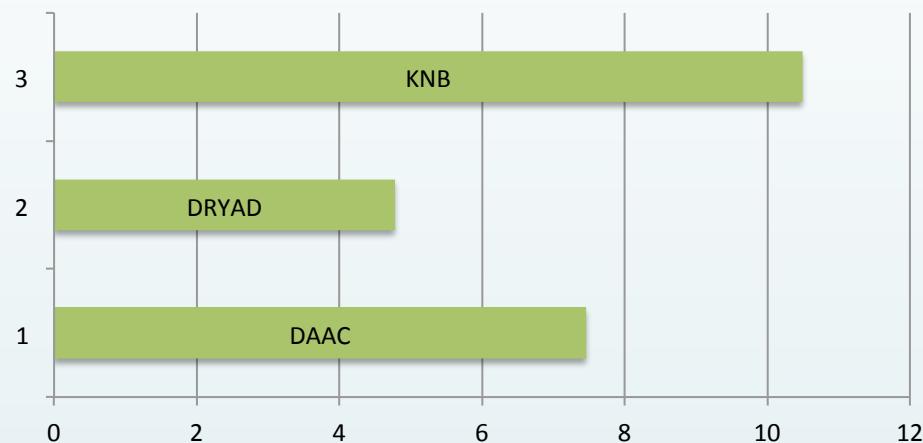


Conclusion:

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

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)

Integration and Semantics Working Group

Jeff Horsburgh, USU

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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

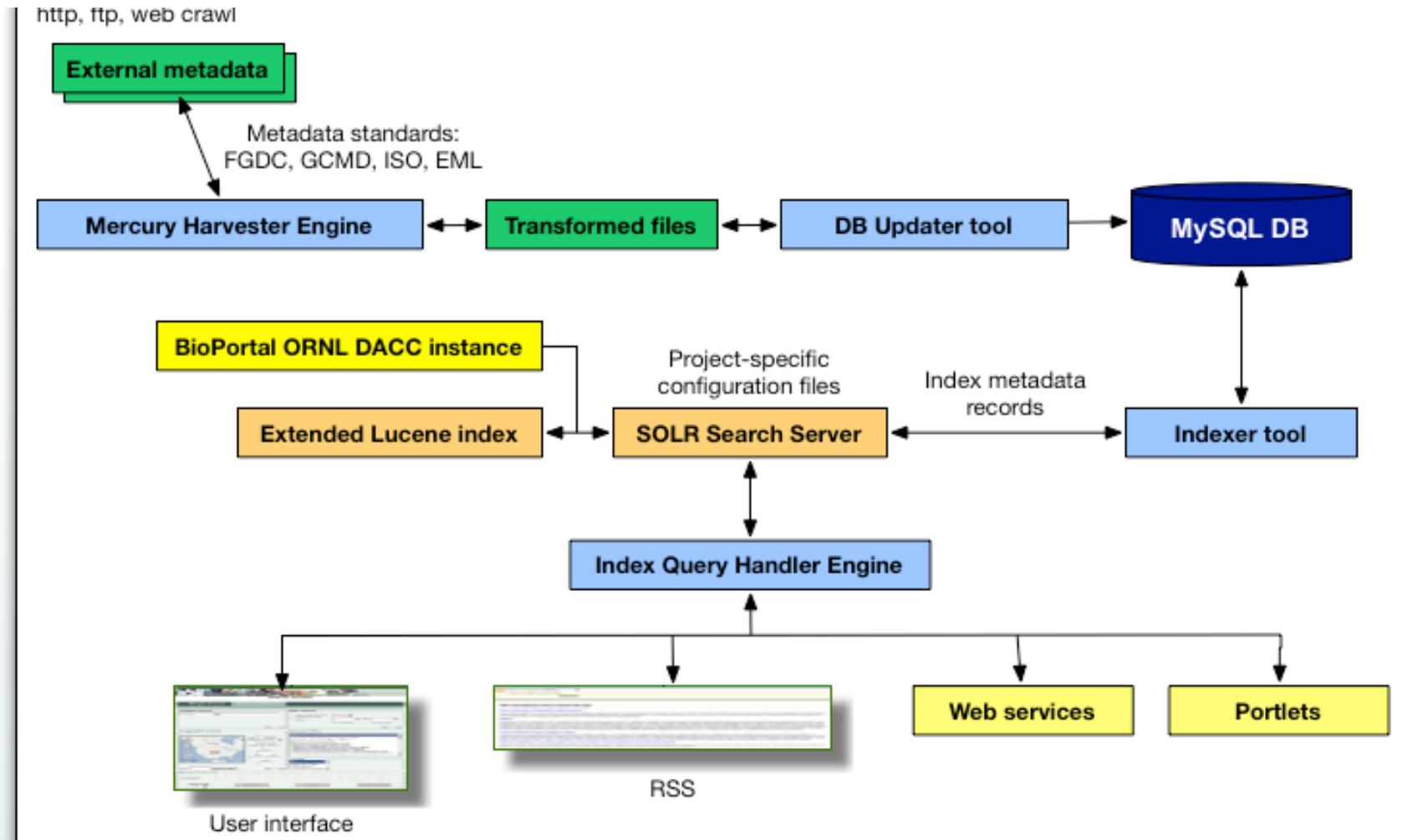




Acknowledgements



Architecture: Ontology-based discovery



Precision and recall

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

Precision: $Tp/Tp+Fp$

Recall: $Tp/\blacksquare Tp+Fn$

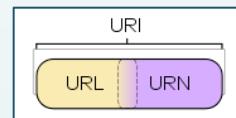
- Precision: the proportion of Actual positive in the recommended set
- Recall: the proportion of Actual that are recommended over the entire dataset

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



GUID

{3F2504E0-4...

LSID



PURL

Handle System®

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

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 Palanisamy, 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 Buneman



- Cliff Duke

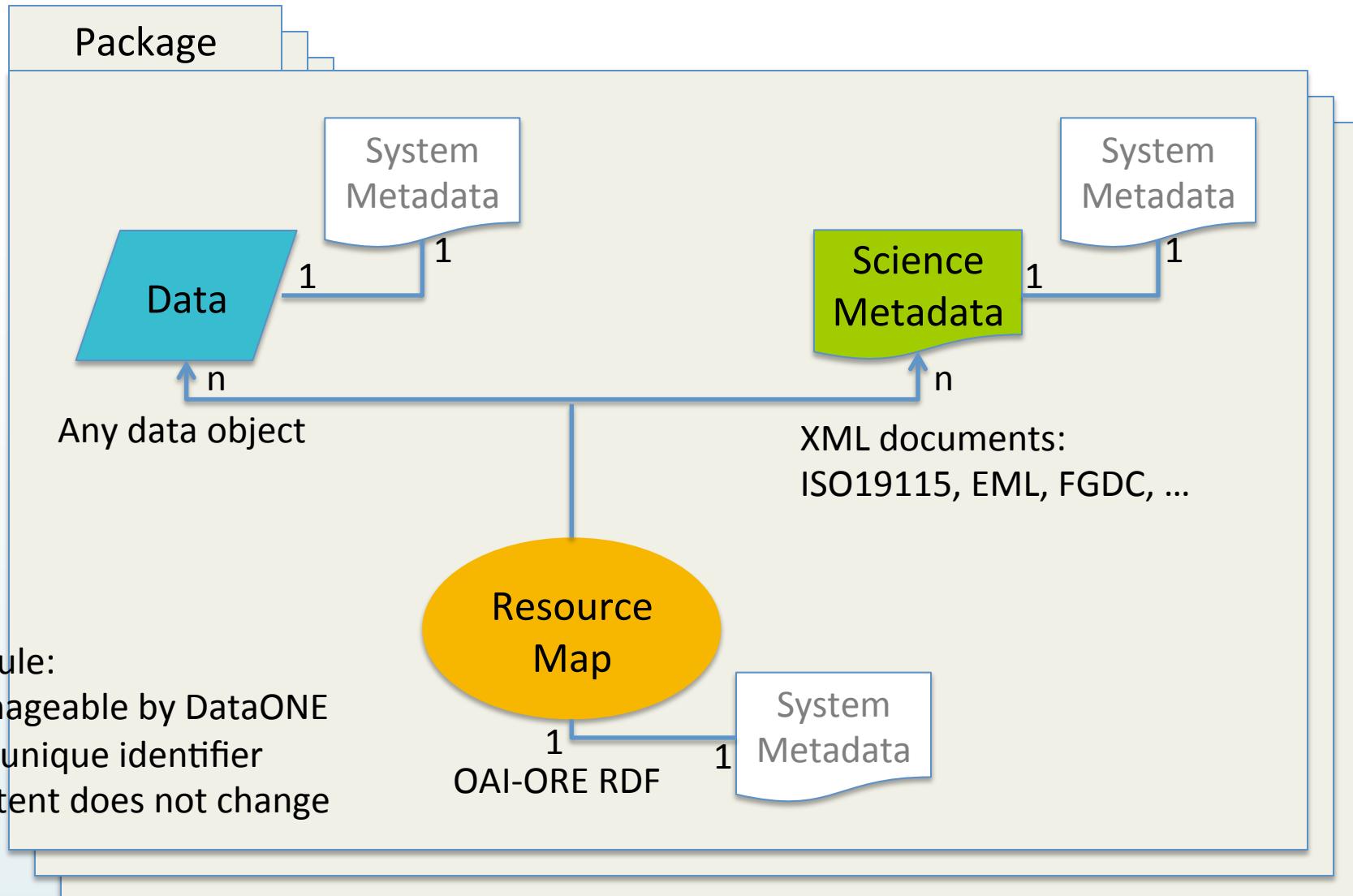
- Carole Goble

- Donald Hobern

- David DeRoure

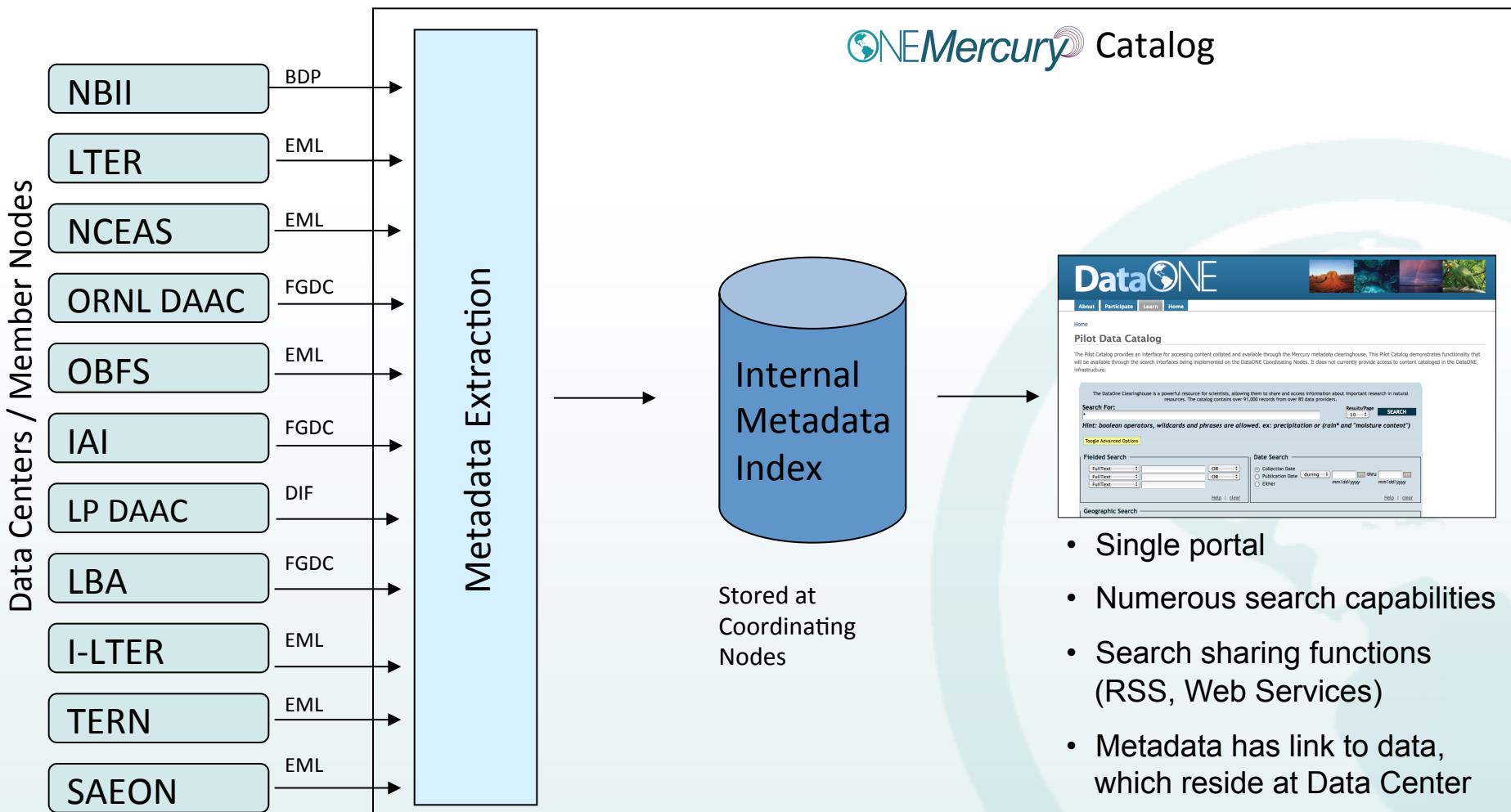


What is an object? DataONE Data Model





Architecture



Results/Page

Search For:
Hint: boolean operators, wildcards and phrases are allowed. ex: precipitation or (rain* and "moisture content")

Show/Hide Advanced Options

Fielded Search

FullText <input type="button" value="▼"/>	<input type="text"/>	OR <input type="button" value="▼"/>	
FullText <input type="button" value="▼"/>	<input type="text"/>	OR <input type="button" value="▼"/>	
FullText <input type="button" value="▼"/>	<input type="text"/>		

[Help](#) | [clear](#)

Date Search

Collection Date Publication Date Either

during thru

mm/dd/yyyy mm/dd/yyyy

[Help](#) | [clear](#)

Geographic Search

List Areas in:
 USA WORLD Select from list

Search Area:
 overlaps encloses

North
West East
South



POWERED BY

[Terms of Use](#)

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 (ORI)
Dryad
NBII Metadata Clearinghouse
All NBII Partner Nodes
NBII Metadata Clearinghouse Principal Node

Selected Query (Not Editable)

[Hide Filters](#)

Filter by author

- [Bruce Menge \(6459\)](#)
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- [Monterey Bay National Marine Sanctuary \(952\)](#)
- [Olympic Coast National Marine](#)

Data Package Files

1 - 10 out of 22815

6 7 8 9 10 Next

Filter by Member

- [PISCO MN \(15480\)](#)
- [LTER Network Member Node \(1\)](#)
- [Merritt D1 Member Node \(1\)](#)
- [Knowledge Network for Biogeography \(764\)](#)
- [ORNL DAAC \(378\)](#)
- [SAN Parks Data Repository \(1\)](#)
- [ESA Data Registry \(21\)](#)
- [USGS Core Sciences Clearinghouse \(16\)](#)

Identifier	Type	Size	Download
doi:10.5063/AA/mbauer.1005.1	application/octet-stream	188801024	Data
doi:10.5063/AA/mbauer.77.1	text/csv	200865	Data
doi:10.5063/AA/mbauer.916.10	eml://ecoinformatics.org/eml-2.1.0	16487	Metadata

waterholes have on the distribution of browsing and grazing animals. 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...

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...

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Data +

<https://cn.dataone.org/onemercury/search>

Started Latest Headlines Applied



About

Participate



[Return to Search](#)

A Search Tool for Scientific Data

Select which items you'd like to add to your library

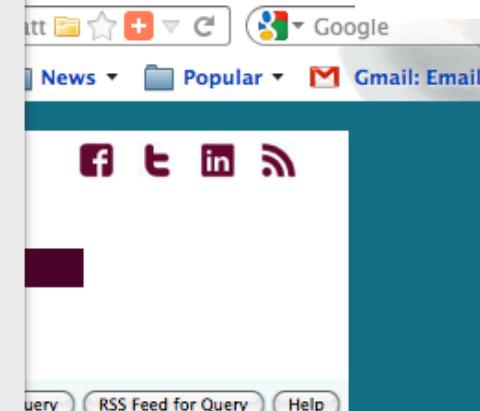
- The effect of overlapping piospheres on landscape heterogeneity
- POD! Water-Quality_Daily WaterTemp (1984-06) and EMP wa...
- POD! Water-Quality_Daily WaterTemp (1984-06) and EMP wa...
- Water Quality Datasets from Purdue University's Water Qualit...
- Water Quality Datasets from Purdue University's 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...

Select All

Deselect All

Cancel

OK



Filter by author

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Relevance

Date

Member Node

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Prev 1 2 3 4 5 6 7 8 9 10 Next

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

Datasource: SANPARKS DATA REPOSITORY

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★★★★★ ★★★★★

[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

A Search Tool for Scientific Data

zotero://attachment/44/

Most Visited Getting Started Latest Headlines Apple Yahoo! Google Maps YouTube Wikipedia News Popular Gmail: Email from Google Bookmarks

WATER CHEMISTRY DATA, NEAJLOV CATCHMENT, 2007-2010. N/A - N/A

Datasource: KNOWLEDGE NETWORK FOR BIOMOLECULAR COMPLEXITY

Monthly water chemistry data for two sites from Neajlov Catchment referring to total organic carbon...

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...

DWSAP ASSESSMENT FOR 3310033-011: SANTA ANA RIVER WATER COMPANY / WELL 10 - INACTIVE N/A - N/A

Datasource: MERRITT D1 MEMBER NODE

View full metadata Data Files (1)

View full metadata Data Files (0)

View full metadata Data Files (3)

All Fields & Tags

Info Notes Tags Related

Item Type: Book
 Title: DWSAP Assessment for 3410003-001: GOLDEN STATE WATER CO - ARDEN WATER SERV / WELL 01 - SHADOWGLEN - RAW
 Author: (last), (first)
 Abstract:

My Library DataONE Metadata

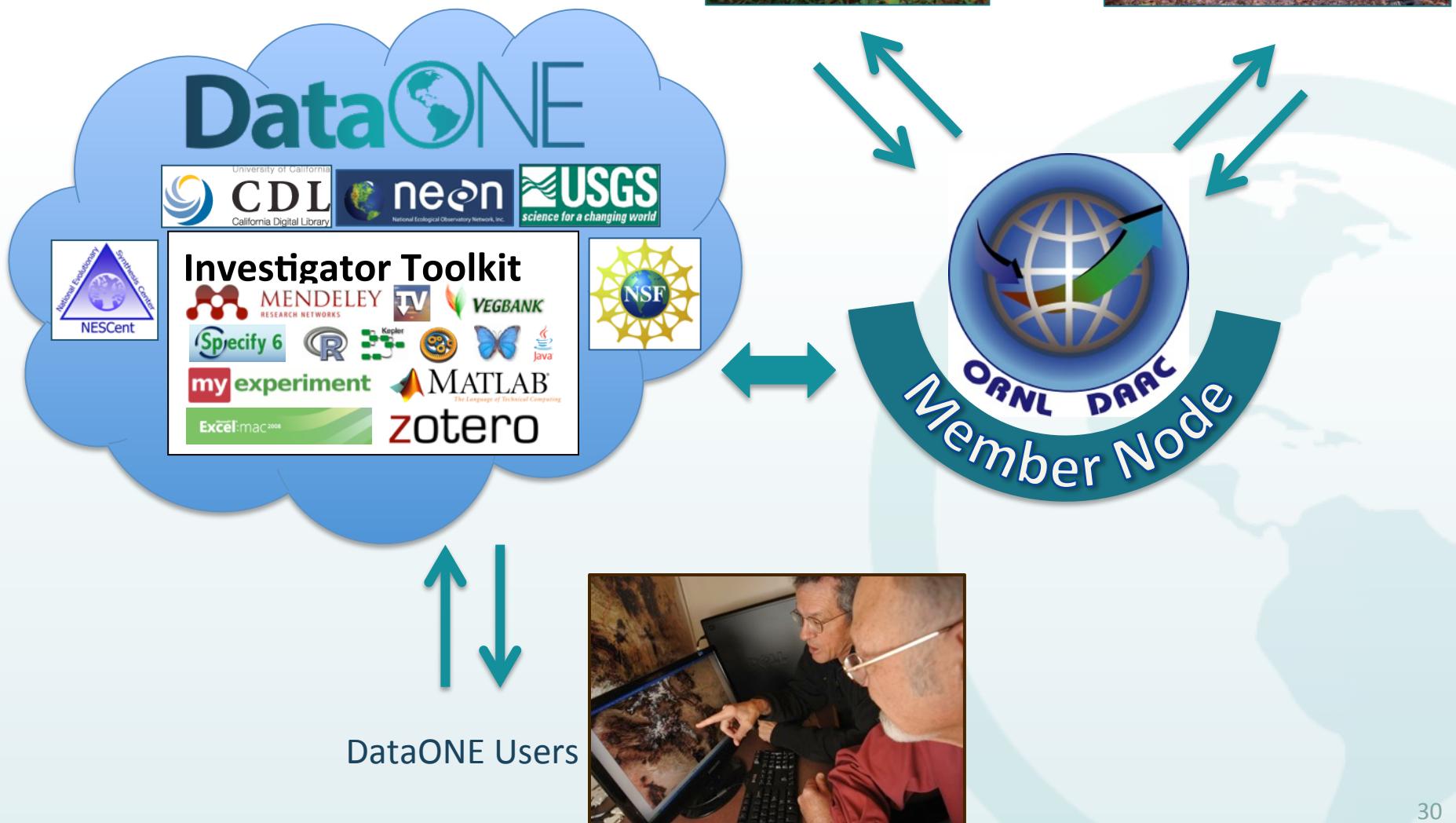
No tags to display

Title Creator

Title	Creator
A Search Tool for Scientific Data	2
DWSAP Assessment for 3410003-001: GOLDEN STATE WATER CO - ARDEN WAT...	1
POD! Water-Quality_Daily WaterTemp (1984-06) and EMP water quality	[NCEAS 12192: Fleishman: ...] 2

zotero

ORNL DAAC as a DataONE Member Node



Provide credit for data publication



VOL. 175, NO. 6 THE AMERICAN NATURALIST DECEMBER 2010

Multielement Stoichiometry in Aquatic Invertebrates:
When Growth Dilution Matters

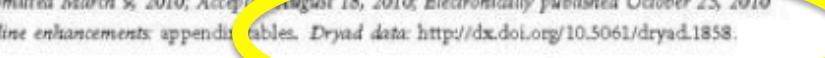
Roxanne Karimi,^{1,*} Nicholas S. Fisher,¹ and Carol L. Folt²

¹ School of Marine and Atmospheric Sciences, Stony Brook University, Stony Brook, New York 11747; ² Department of Biology, Dartmouth College, Hanover, New Hampshire 03755

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Online enhancements: appendix tables. Dryad data: <http://dx.doi.org/10.5061/dryad.1858>.

ABSTRACT: Element concentrations in organisms often cause 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 dilution of elements associated with body size and/or

and Knauer 1977; 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 vary with body size and/or



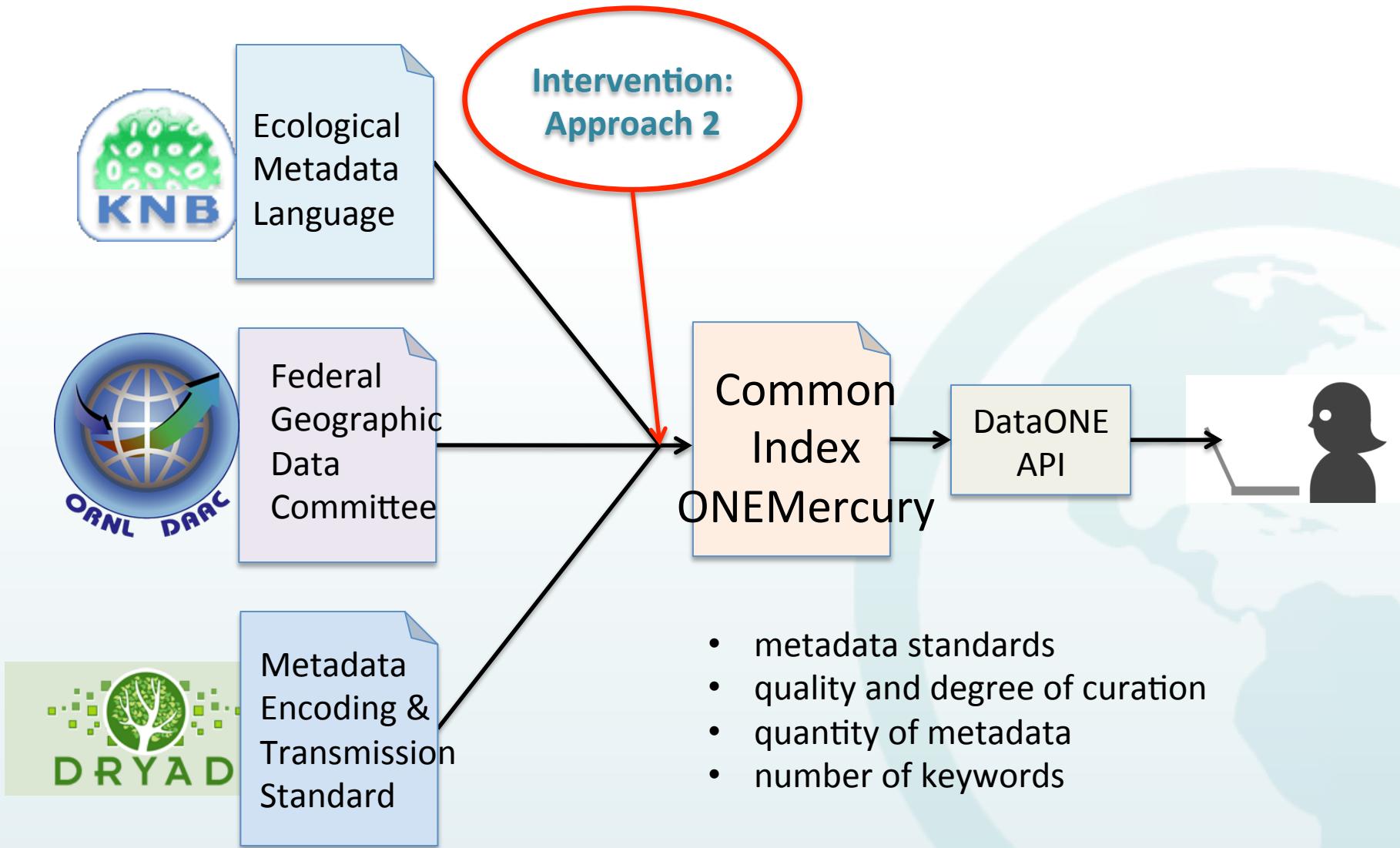
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[doi:10.1111/j.1365-294X.2008.03962.x](https://doi.org/10.1111/j.1365-294X.2008.03962.x)

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