



# Detailed ecology survey data can be captured using a general purpose ontology

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TERN, University of Queensland, Brisbane, Australia



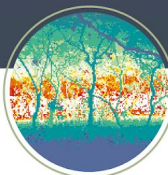
# TERN

Australia's land ecosystem observatory

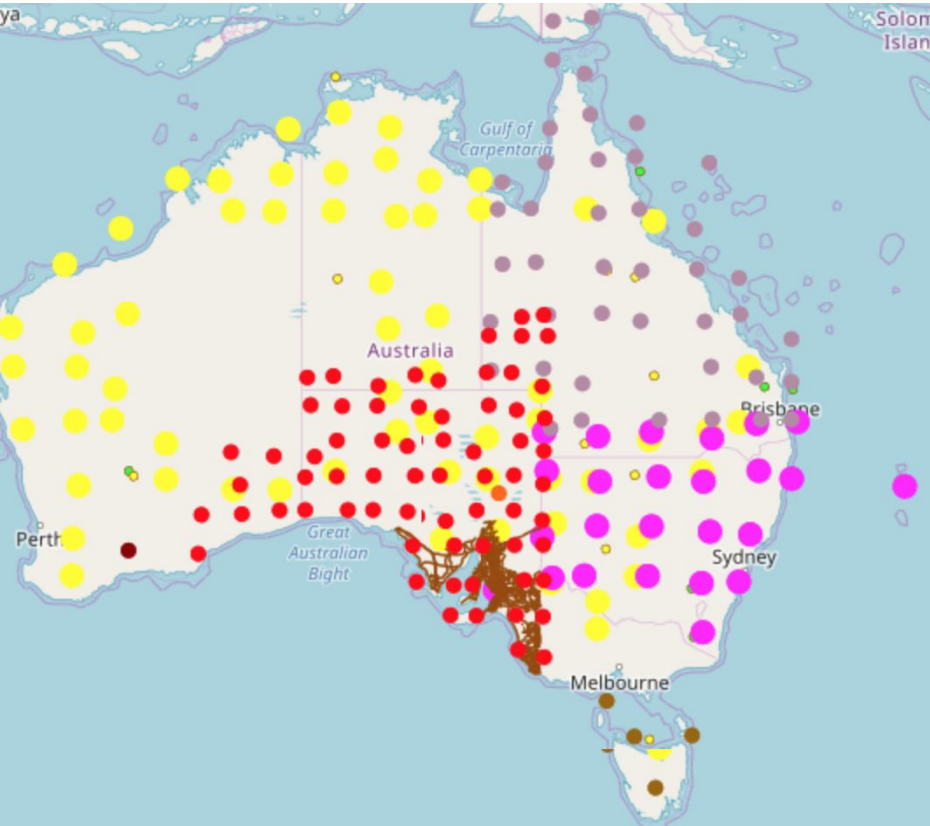


TERN's ecosystem observing sites

- ▲ ecosystem surveillance monitoring plots
- ecosystem processes monitoring SuperSites and eddy covariance towers
- landscape scale monitoring calibration and validation sites



# Aggregator of plot-based ecology data across state agencies

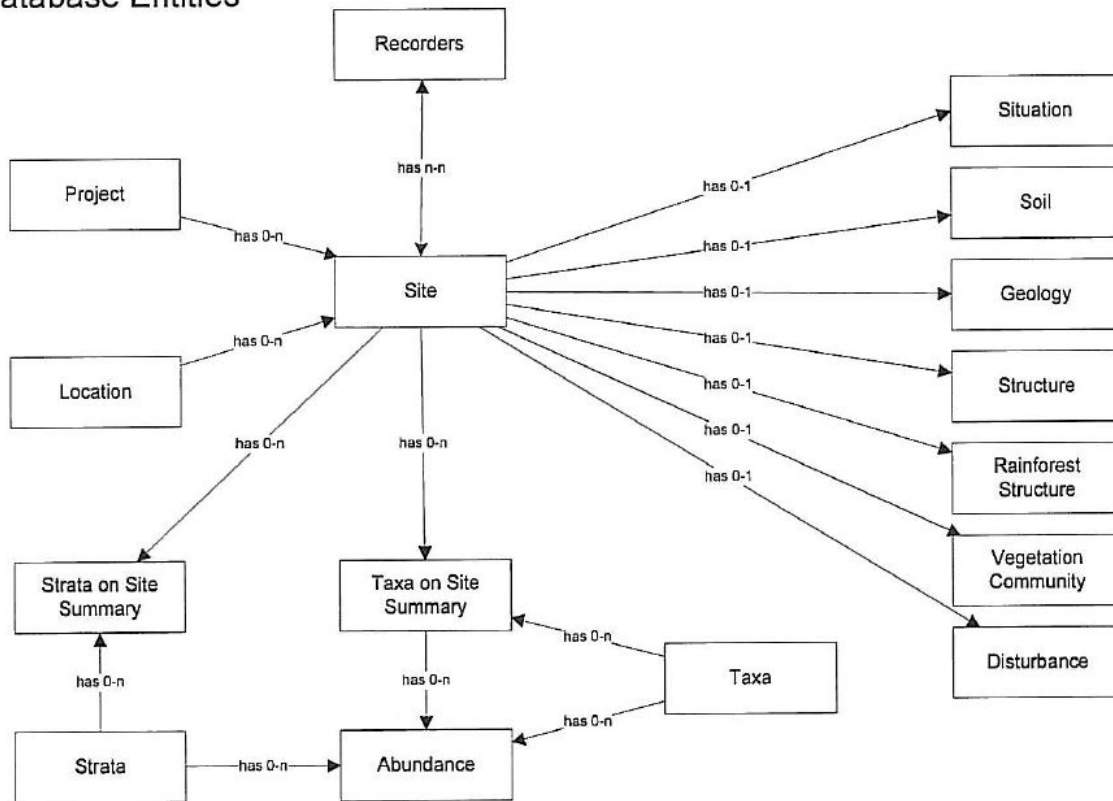


## Aggregate plot-based ecology data

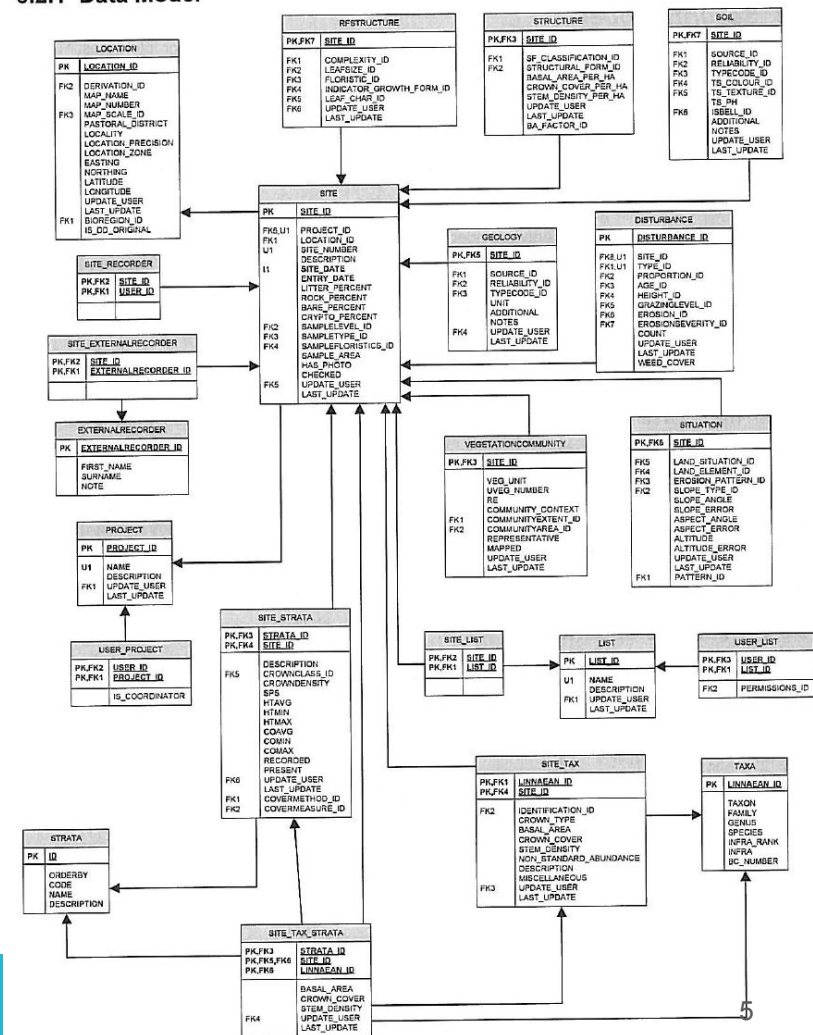
- Over 96000 plots from all the states of Australia
- Cover over 250 ecology attributes
- Contributing towards vegetation data exchange standard

# Qld (CORVEG)

## Database Entities

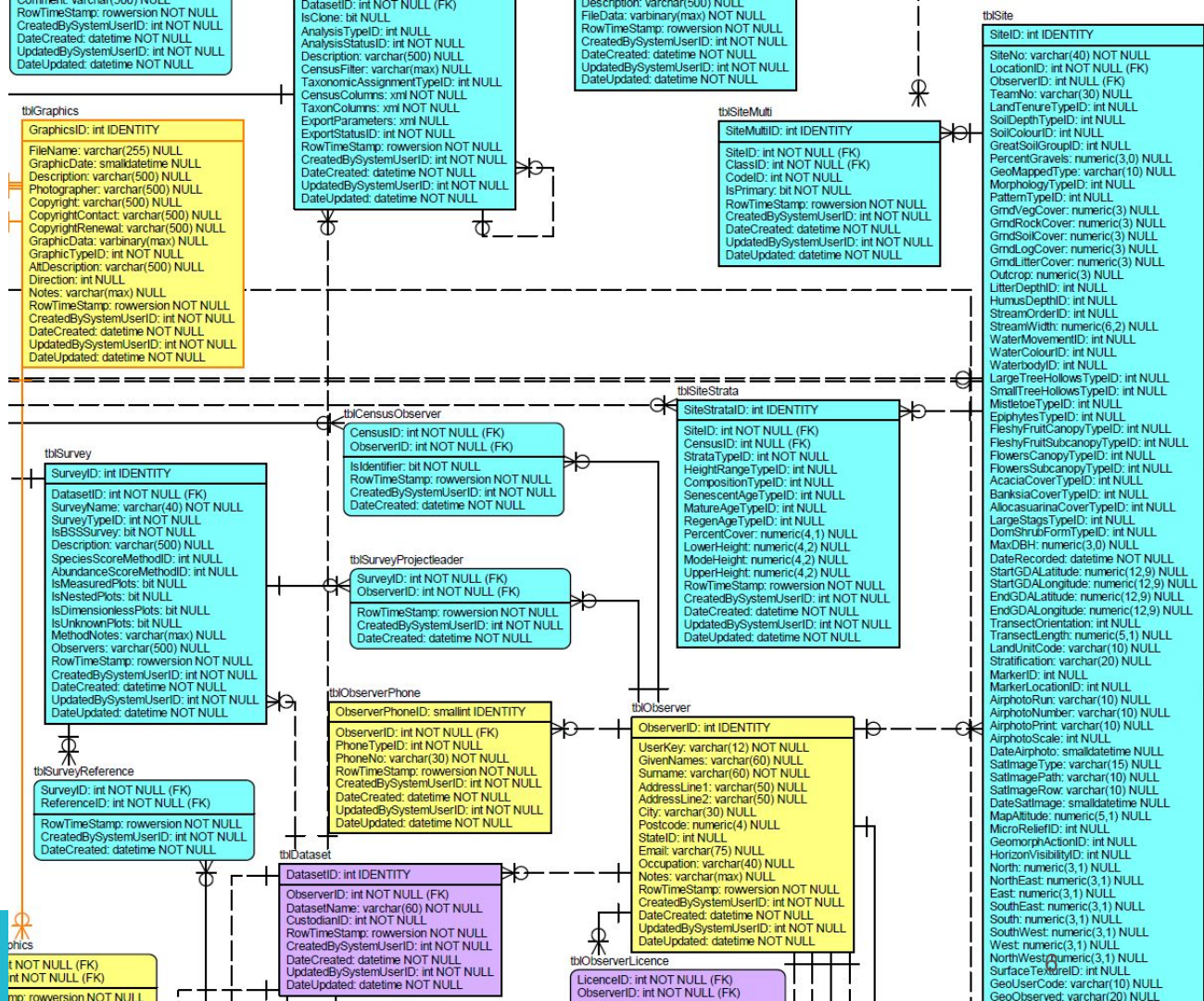


# CORVEG details

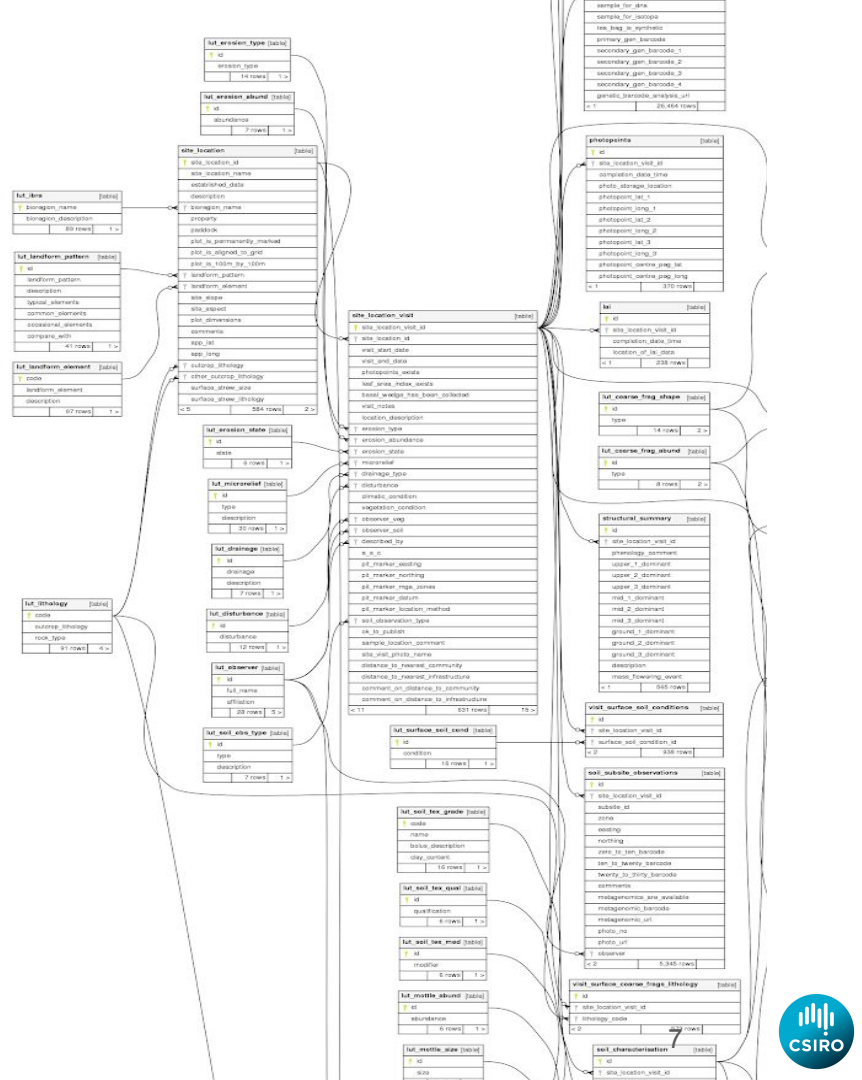


# NSW

## (OEH Bionet Atlas)

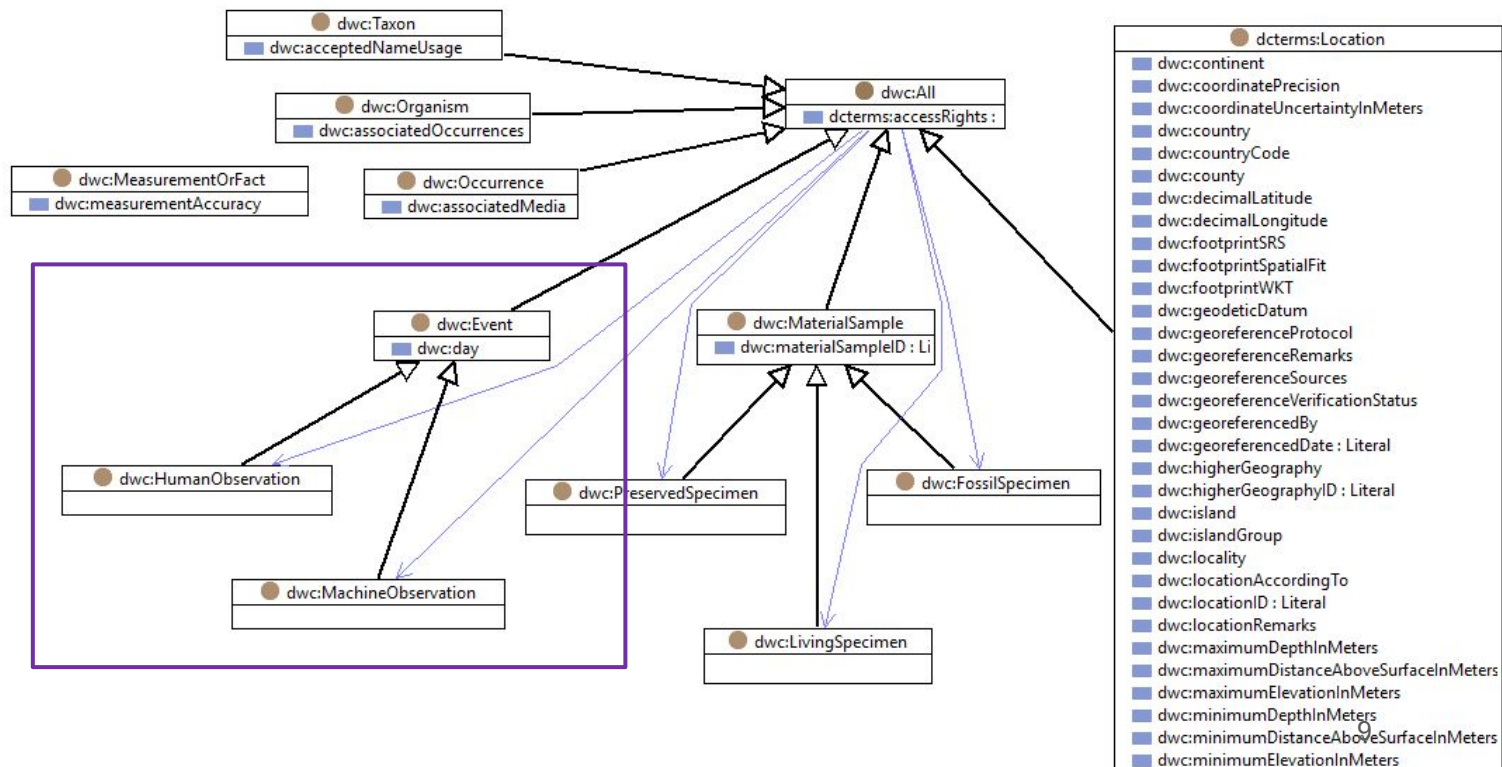


# TERN AusPlots



# How do we harmonize these?

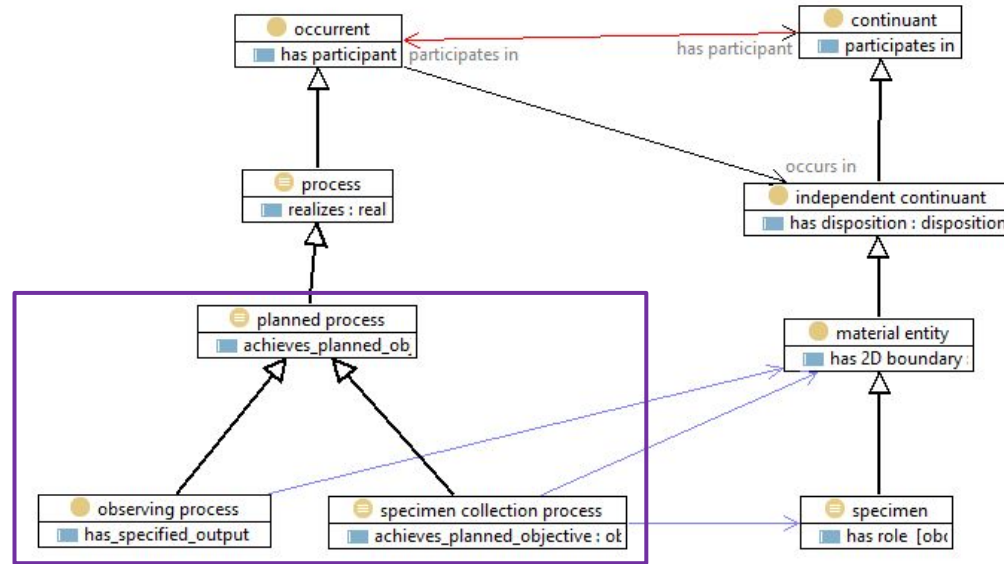
# Darwin Core - biodiversity



# OBO - Open Biological and Biomedical Ontologies



OBI/BCO

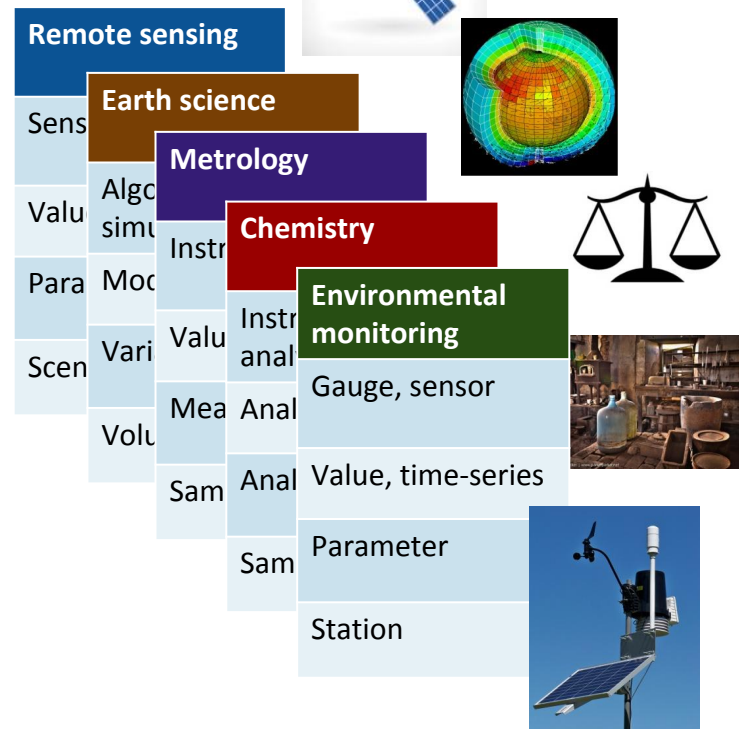


# Common model for observations?

## Cross-disciplinary terminology

| Observations & Measurements |
|-----------------------------|
| procedure                   |
| result                      |
| observed property           |
| feature of interest         |

An **Observation** is an action whose **result** is an estimate of the value of some **property** of the **feature-of-interest** that applied at the **stated phenomenon-time**, obtained using a specified **procedure**, completed at the recorded **result-time**



# Implementations

## INTERNATIONAL STANDARD

ISO  
19156

First edition  
2011-12-15

### Open Geospatial Consortium

Submission Date: 2016-02-23

Approval Date: 2016-02-23

Publication Date: 2016-09-09

this OGC® document: <http://www.opengis.net/doc/IS/timeseries-profile-om/1.0>

### Environmental Modelling & Software

Volume 79, May 2016, Pages 55-74



### Observations Data Model 2: A community information model spatially discrete Earth observations

S. Horsburgh <sup>a</sup> , Anthony K. Aufdenkampe <sup>b</sup> , Emilio Mayorga <sup>c</sup> , Kerstin A. Lehnert <sup>d</sup> , Leslie  
Lulin Song <sup>d</sup> , Amber Spackman Jones <sup>e</sup> , Sara G. Damiano <sup>b</sup> , David G. Tarboton <sup>e</sup> , David  
e <sup>f</sup> , Ilya Zaslavsky <sup>f</sup> , Tom Whitenack <sup>f</sup> 

more

[doi.org/10.1016/j.envsoft.2016.01.010](https://doi.org/10.1016/j.envsoft.2016.01.010)

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      - 4.5.2.5 *sosa:Sampler*
      - 4.5.2.6 *sosa:madeSampling*
      - 4.5.2.7 *sosa:madeBySampler*
  - 4.6 Features of Interest and Properties
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    - 4.6.2 Specification
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      - 4.6.2.2 *sosa:hasFeatureOfInterest*
      - 4.6.2.3 *sosa:isFeatureOfInterestOf*
      - 4.6.2.4 *ssn:Property*

### Semantic Sensor Network Ontology

W3C Recommendation 19 October 2017 (Link errors corrected 08 December 2017)



#### This version:

<https://www.w3.org/TR/2017/REC-vocab-ssn-20171019/>

#### Latest published version:

<https://www.w3.org/TR/vocab-ssn/>

#### Latest editor's draft:

<https://w3c.github.io/ssdw/ssn/>

#### Implementation report:

<https://w3c.github.io/ssdw/ssn-usage/>

#### Previous version:

<https://www.w3.org/TR/2017/PR-vocab-ssn-20170907/>

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#### Repository:

GitHub  
Issues

#### OGC Document Number:

OGC 16-079

Please check the [errata](#) for any errors or issues reported since publication.

#### See also translations

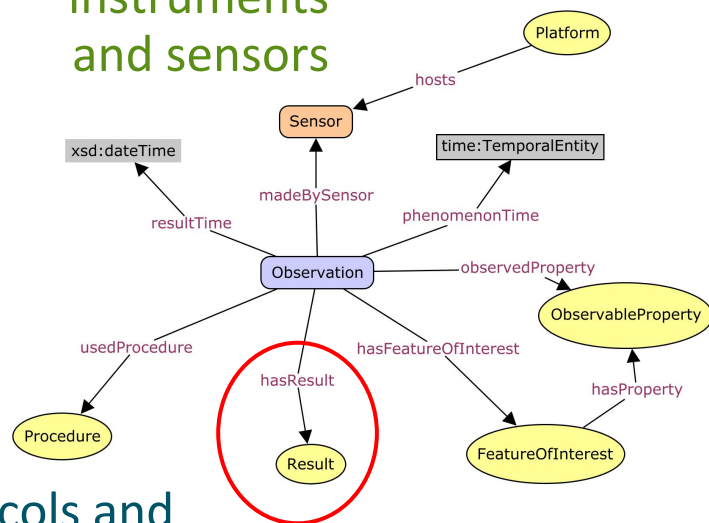
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#### Abstract

The Semantic Sensor Network (SSN) ontology is an ontology for describing sensors and their observations, the involved procedures, the studied features of interest, the samples used to do so, and the observed properties, as well as actuators. SSN follows a horizontal and vertical modularization architecture by including a lightweight but self-contained core ontology called SOSA (Sensor, Observation, Sample, and Actuator) for its elementary classes and properties. With their different scope and different degrees of axiomatization, SSN and SOSA are able to support a wide range of applications and use cases, including satellite imagery, large-scale scientific monitoring, industrial and household infrastructures, social sensing, citizen science, observation-driven ontology engineering, and the Web of Things. Both ontologies are described below, and examples of their usage are given.

# O&M / SSN

instruments  
and sensors



protocols and  
procedures

object types (features)

observable properties

W3C®

OGC®  
Making location count.

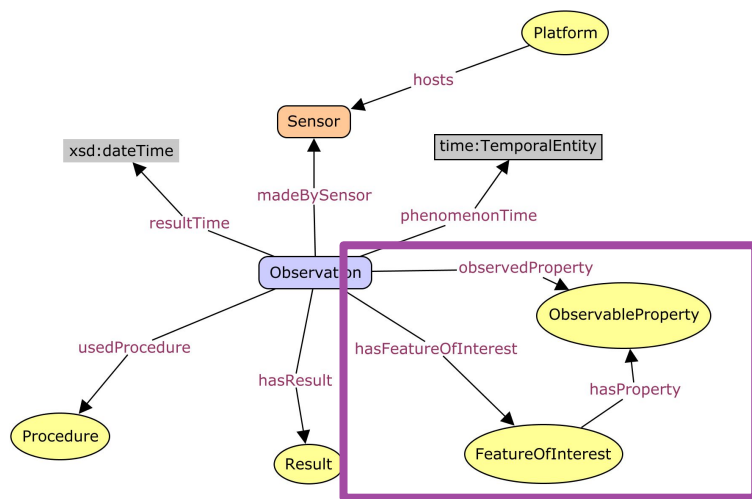
ISO  
International  
Organization for  
Standardization

## Observation

- resultTime
- madeBySensor
- usedProcedure
- hasFeatureOfInterest
- hasResult
- phenomenonTime
- observedProperty

| s.Action                                                                                                                |
|-------------------------------------------------------------------------------------------------------------------------|
| s:endTime<br>s:instrument<br>s:measurementTechnique<br>s:object<br>s:result<br>s:temporalCoverage<br>s:variableMeasured |

# O&M / SSN



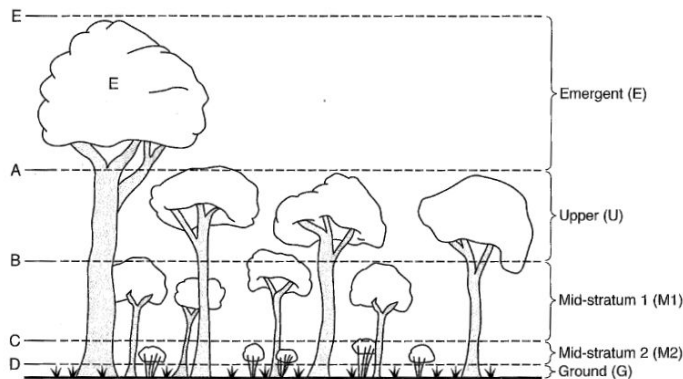
observable properties

the application-domain

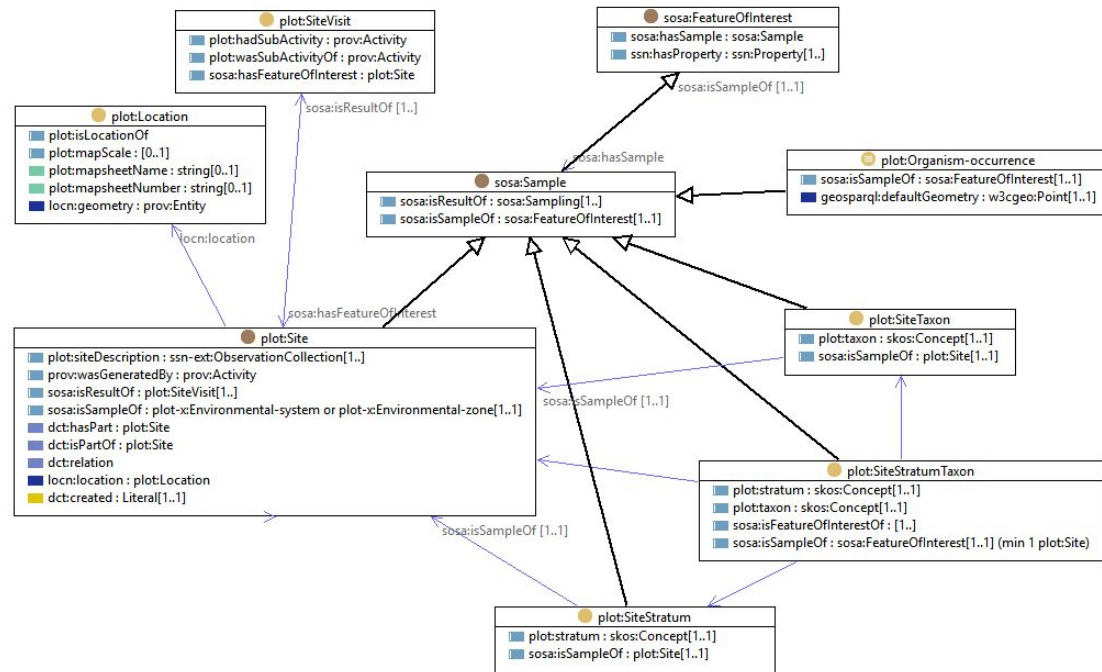
object types (features)

# TERN-Plot domain model

Australian Soil and Land Survey Field Handbook

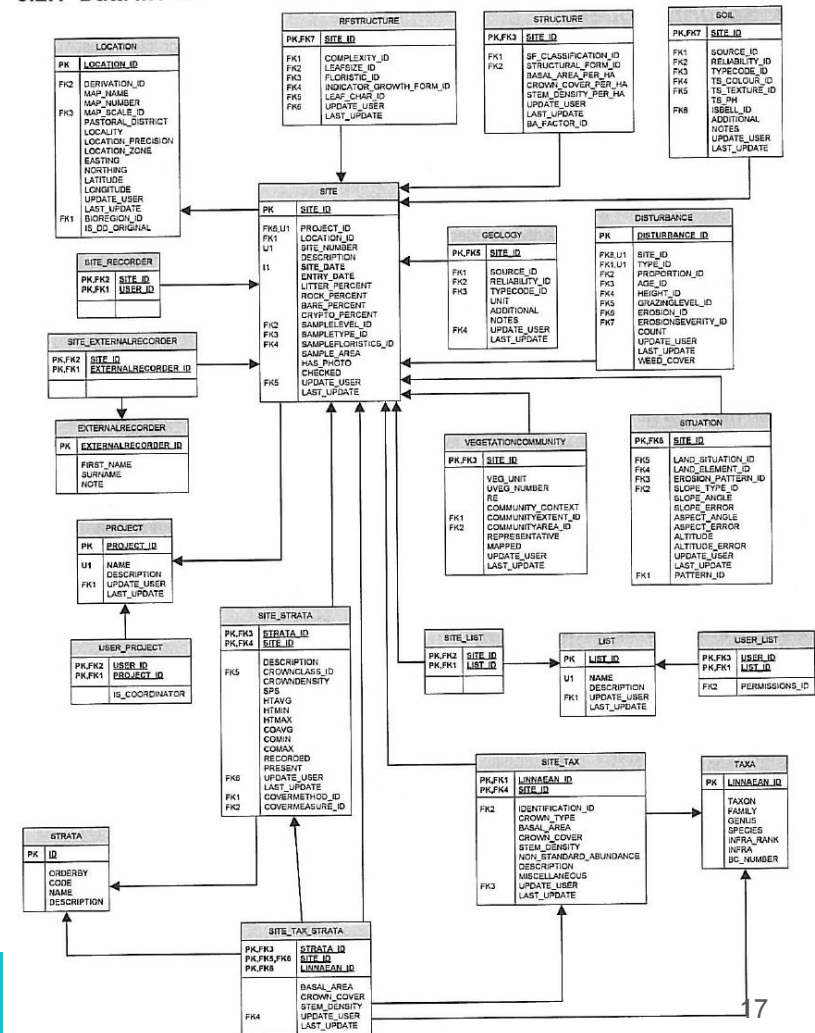


**Figure 8** A hypothetical site with four strata (top heights A, B, C and D) and emergent trees (top height E). Refer to text (page 103) and the table opposite for the full codes and names at four levels of classification for this example.



# CORVEG details

Observations are organized in thematic groups





# In practice

URIs for terms

Standard resource types

Links between related resources

Small datatype vocabulary

```
corveg-site:site-29099 a plot:Site ;
  rdfs:label "Site 29099" ;
  plot:floristics <http://linked.data.gov.au/def/corveg-cv/site-sample-floristics/c> ; # "Woody Species And Perennial Herbs"
  plot:sampleLevel <http://linked.data.gov.au/def/corveg-cv/site-sample-level/q> ; # "Quaternary Site"
  plot:sampleType <http://linked.data.gov.au/def/corveg-cv/site-sample-type/a> ; # "square"
  plot:siteDescription corveg-site:d-29099-1 ;
  dct:identifier "29099"^^corveg-def:site-id,
    "618_455029"^^corveg-def:site-number ;
  dct:modified "2015-10-20T08:44:07"^^xsd:dateTime ;
  locn:Location corveg-location:l-28966 ;
  prov:wasGeneratedBy corveg-site:p-287 ;
  ssn-ext:hasUltimateFeatureOfInterest <http://linked.data.gov.au/def/corveg-cv/miscellaneous/87> .

corveg-site:d-29099-1 a ssn-ext:ObservationCollection ;
  rdfs:label "Site 29099 observation collection." ;
  dct:type <http://linked.data.gov.au/def/corveg-cv/ogroup/4> ; # "sampling-site (description)"
  sosa:hasFeatureOfInterest corveg-site:site-29099 ;
  sosa:phenomenonTime corveg-site:t1995-10-13-h0-m0-s0 ;
  sosa:resultTime "2015-10-20T00:00:00"^^xsd:dateTime ;
  ssn-ext:hasMember corveg-site:d-29099-1-1 .

corveg-site:d-29099-1-1 a sosa:Observation ;
  rdfs:label "Site 29099 area measurement observation" ;
  sosa:hasFeatureOfInterest corveg-site:site-29099 ;
  sosa:hasResult [ a data:QuantitativeMeasure ;
    data:standard unit:M2 ;
    rdf:value 400 ] ;
  sosa:observedProperty <http://linked.data.gov.au/def/corveg-cv/op/1> ; # "area"
  sosa:phenomenonTime corveg-site:t1995-10-13-h0-m0-s0 ;
  sosa:resultTime "2015-10-20T00:00:00"^^xsd:dateTime ;
  sosa:usedProcedure <http://linked.data.gov.au/def/corveg-cv/common-method/s> ; # "Site Layout Method"

corveg-site:t1995-10-13-h0-m0-s0 a time:Instant ;
  time:inXSDDateTime "1995-10-13T00:00:00"^^xsd:dateTime .
```

# Controlled vocabularies

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About   Vocabularies   Concepts   Observable Properties   Observation Groups   Methods ▾

## Vocabularies

Register of all vocabularies in this system.

Alternate views of this register are available [here](#)

**Search for Vocabularies:**

Search register

### Common Methods

---

created : 2019-05-15  
modified : 2019-06-04  
description : Queensland CORVEG database's controlled vocabularies for plot-based ecological data.

### Community Area Concepts

---

created : 2019-04-28  
modified : 2019-05-27  
description : The community area are estimates of the pre-clear extent of the vegetation community in the immediate area that the site represents (derived from observation travelling to and...

### Community Extent Concepts

---

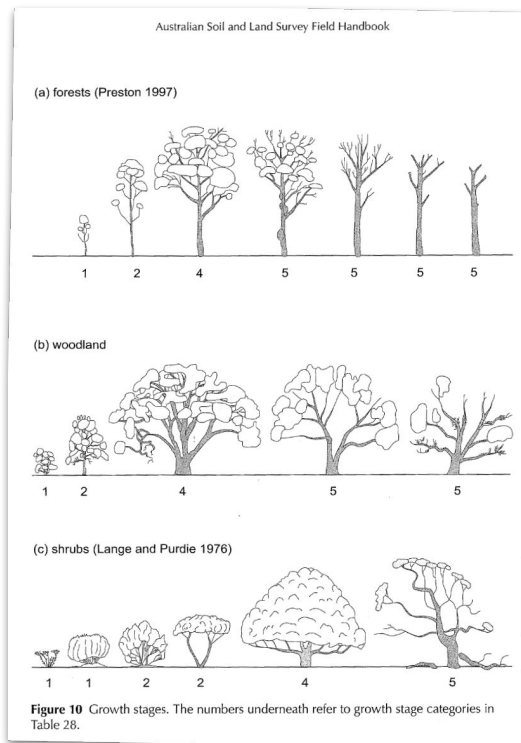
created : 2019-04-28  
modified : 2019-05-23  
description : The estimation of the width of the pre-clear extent of the vegetation community in the immediate area that the site represents.

### Cover Estimation Methods

---

created : 2019-04-28

# From printed page to web



Structural Formation Classes Concepts

Not secure | linkedata.tern.org.au/viewer/corveg/id/http://li...

Pers GvDx Mindly Apps E2SIP tools Proj SemWeb CSIRO GeoStds Collab Bookmarks Other bookmarks

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About Vocabularies Concepts Observable Properties Observation Groups Methods

Concept Scheme | Resource |

html turtle rdf+xml json n3 n-triples | Alternates view

## Structural Formation Classes Concepts

Date created: 2019-04-28  
Date modified: 2019-06-12

**Description**

All structural formation classes are qualified by height of the corresponding vegetation growth form and the crown cover classes (e.g. Growth form Trees >30m = structural formation class: 1) tall closed forest (crown cover = dense/closed), 2) tall open forest (crown cover = mid-dense), 3) tall woodland (crown cover = sparse), 4) tall open woodland (crown cover = very sparse).

**Concept Hierarchy** expand all

- Closed-Forbland
- Closed-Forest
- Closed-Heath
- Closed-Herbland
- Closed-Scrub
- Closed-Sedgeland
- Closed-Tussock Grassland
- Dwarf Open-Heath
- Dwarf Open-Shrubland
- Dwarf Shrubland
- Forbland
- Herbland
- Hummock Grassland
- Low Closed-Forest
- Low Open-Forest
- Low Open-Woodland
- Low Woodland
- Open Hummock Grassland
- Open Succulent Shrubland
- Open-Forbland
- Open-Forest
- Open-Heath
- Open-Herbland
- Open-Scrub
- Open-Sedgeland
- Open-Shrubland
- Open-Tussock Grassland
- Open-Woodland
- Sedgeland
- Shrubland

Last updated 1 minutes ago.

# Key semantics

Observable Properties

Not secure | linkeddata.tern.org.au/viewer/corveg/id/http://linked.data.gov.au/def/corveg-cv/op

Pers GvDx Mndly Apps E2SIP tools Proj SemWeb CSIRO GeoStds Collab Bookmarks Pirchiner temp https://bitbucket.or... Other bookmarks

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[Concept Scheme](#) | [Resource](#) | [html](#) [turtle](#) [rdf+xml](#) [ld+json](#) [n3](#) [n-triples](#) | [Alternates view](#)

## Observable Properties

Date created: 2019-04-30  
Date modified: 2019-06-04

**Description**

CORVEG observable properties.

**Concept Hierarchy** expand all

- Altitude
- Area
- Aspect Angle
- Basal Area
- Crown Cover
  - Crown Cover Class
  - Crown Density
  - Density
  - Disturbance - Proportion
  - Disturbance Age
  - ▼ Disturbance Type
    - Erosion Severity
    - Erosion Type
    - Grazing Level
    - Ground Cover - Weed
    - Height Of Fire Impact
    - Ringbarked Stem Count
    - Stumps Count
  - Erosional Landform Pattern
  - Geology - Lithology
  - Geology - Stratigraphic Unit
  - Ground Cover
    - Landform Element

Last updated 2 minutes ago.

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# An individual concept

Denoted by a URI

The screenshot shows a web browser displaying the Queensland Government's Linked Data viewer for the concept 'Erosion Severity'. The browser's address bar shows the URI <http://linked.data.gov.au/def/corveg-cv/op/29>, which is highlighted with a red box. The page header includes the Queensland Government logo and navigation links for 'For Queenslanders', 'Business and industry', and 'Government employees'. A blue navigation bar contains links for 'About', 'Vocabularies', 'Concepts', 'Observable Properties', 'Observation Groups', and 'Methods'. The main content area displays the concept 'Erosion Severity' with its creation and modification dates, its definition as 'Severity of accelerated erosion', and its broader category 'Disturbance Type'. It also lists related resources and a source citation. The footer features a dark blue section with links for 'Queensland Government', 'For Queenslanders', and 'Business and industry', along with a page number '23' and a 'Last updated just now.' notice.

Erosion Severity

Not secure | [linked.data.gov.au/def/corveg-cv/op/29](http://linked.data.gov.au/def/corveg-cv/op/29)

Pers GvDx Mindly Apps E2SIP tools Proj SemWeb CSIRO GeoStds Collab Bookmarks Pirchiner temp Other bookmarks

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About Vocabularies Concepts Observable Properties Observation Groups Methods

Concept | Resource | ObservableProperty | [html turtle rdf+xml id+json n3 n-triples](#) | [Alternates view](#)

### Erosion Severity

Date created: 2019-04-30  
Date modified: 2019-06-04

In concept scheme

Observable Properties

Definition

Severity of accelerated erosion.

Broaders

- Disturbance Type

Related

<http://linked.data.gov.au/def/corveg-cv/disturbance-assessment/1>

Related Match

<http://vocabs.lter-europe.net/EnvThes/21285>

Source

Neldner, V.J., Wilson, B.A., Dillewaard, H.A., Ryan, T.S., Butler, D.W., McDonald, W.J.F, Addicott, E.P. and Appelman, C.N. (2019) Methodology for survey and mapping of regional ecosystems and vegetation communities in Queensland. Version 5.0. Updated March 2019. Queensland Herbarium, Queensland Department of Environment and Science, Brisbane.

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Parents and families  
People with disability

Starting a business  
Running a business

23

Last updated just now.

# Value space for this property

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[Concept Scheme](#) | [Resource](#) | [html](#) [turtle](#) [rdf+xml](#) [ld+json](#) [n3](#) [n-triples](#) | [Alternates view](#)

## Erosion Severity Concepts

Date created: 2019-04-28  
Date modified: 2019-05-22

**Description**

Severity of erosion due to disturbance

**Concept Hierarchy** expand all

- Minor
- Moderate
- None
- Severe

**Version Info**

v0.02010

Issued

2019-06-20

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- [Community support](#)
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- [Running a business](#)
- [Employing people](#)
- [Payroll tax](#)
- [Industries](#)
- [Investing in Queensland](#)
- [昆士兰州的投资机会](#)
- [昆士蘭州的投資機會](#)
- [クイーンズランド州への投資機会](#)
- [퀸즈랜드 투자 기회](#)
- [Oportunidades de inversión en Queensland](#)

 Cox & Guru | TERN-Plot | ESIIP Summer Meeting 2019



# Many other potential sources



v3.8.3 Help Contact us  
Home Term Search SPARQL Search

<http://sweetontology.net/phenSystem/Disturbance> View/download as ▾

## Disturbance

| property                                                                                                      | value                                                                                                     |
|---------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|
| <a href="http://www.w3.org/1999/02/22-rdf-syntax-ns#type">http://www.w3.org/1999/02/22-rdf-syntax-ns#type</a> | <a href="http://www.w3.org/2002/07/owl#Class">http://www.w3.org/2002/07/owl#Class</a>                     |
| <a href="http://www.w3.org/2000/01/rdf-schema#label">http://www.w3.org/2000/01/rdf-schema#label</a>           | "disturbance"@en                                                                                          |
| <a href="http://www.w3.org/2000/01/rdf-schema#subClassOf">http://www.w3.org/2000/01/rdf-schema#subClassOf</a> | <a href="http://sweetontology.net/phenSystem/Variation">http://sweetontology.net/phenSystem/Variation</a> |

The ESIP Community Ontology Repository is operated by MMI with funding from the ESIP Federation.  
Funding for the latest modifications to ORR System has been provided by the Cross-Domain Observational Metadata for Environmental Sensing project (X-DOMES).

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- Help
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### Concept Hierarchy

disturbance pattern

- envthes
  - constraint
  - deprecated concept
  - infrastructure
  - method
  - object of interest
  - parameter
    - agricultural parameter
    - atmospheric parameter
    - biological parameter
    - chemical parameter
    - ecosystem parameter
      - above ground net primary production
      - air carbon dioxide concentration
      - algae species abundance
      - algae species presence
      - ammonium content
      - ammonium nitrate concentration
      - animal species abundance
      - animal species presence
      - annelida presence
      - bacillariophyceae abundance
      - bacillariophyceae presence
      - bacillariophyceae species richness
      - bacteria abundance
      - bacteria presence
      - bacterial diversity
      - bacterial respiration
      - bare soil cover
      - basal metabolic rate
      - below ground autotrophic respiration
      - benthic invertebrates abundance
      - benthic invertebrates drift rates
      - benthic invertebrates presence
      - beta diversity
      - biodiversity loss
      - biomass allocation
      - biomass moisture content
      - birds abundance
      - birds presence
      - birth date
      - breeding success
      - bryophytes cover
      - bryophytes presence
      - bryophytes species coverage
      - canopy aerodynamic resistance

### disturbance pattern (Concept)

<http://vocabs.lter-europe.net/EnvThes/21473>

#### Labels and Description

preferred label: disturbance pattern (en)

type: [Concept](#) ▶

#### Metadata

creator: herbert.schentz@umweltbundesamt.at

created: 2016-03-31T00:00:00Z

modified: 2018-12-18T08:53:13.492+00:00

#### Standard Relationships

broader concept: [ecosystem parameter](#) ▶

related concept: [disturbance \(event\)](#) ▶

#### Notes

scope note: US LTER controlled vocabulary (en)

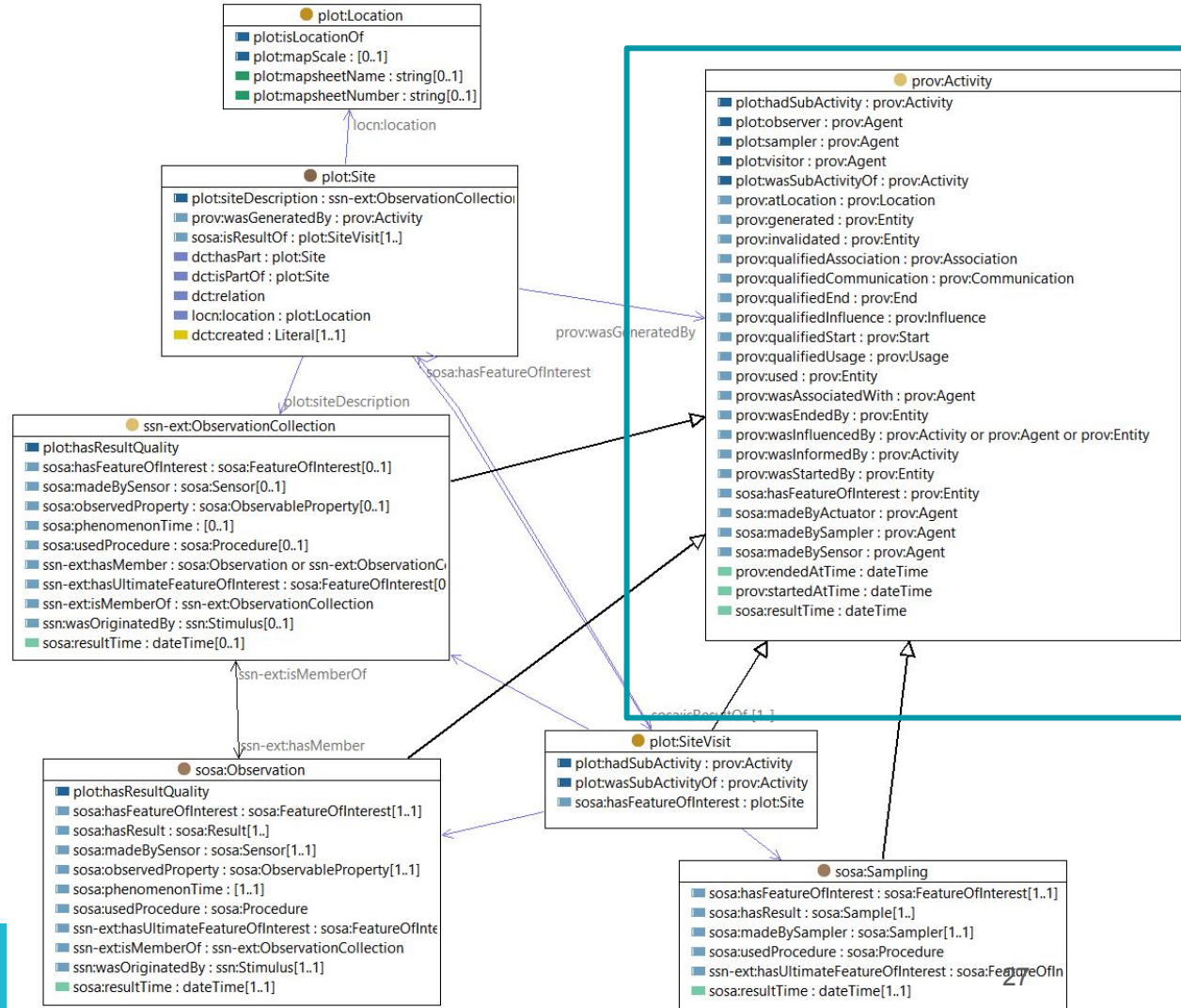
#### Matching Relationships

has exact match: <https://vocabs.lternet.edu/vocab/vocab/?tema=165> ▶

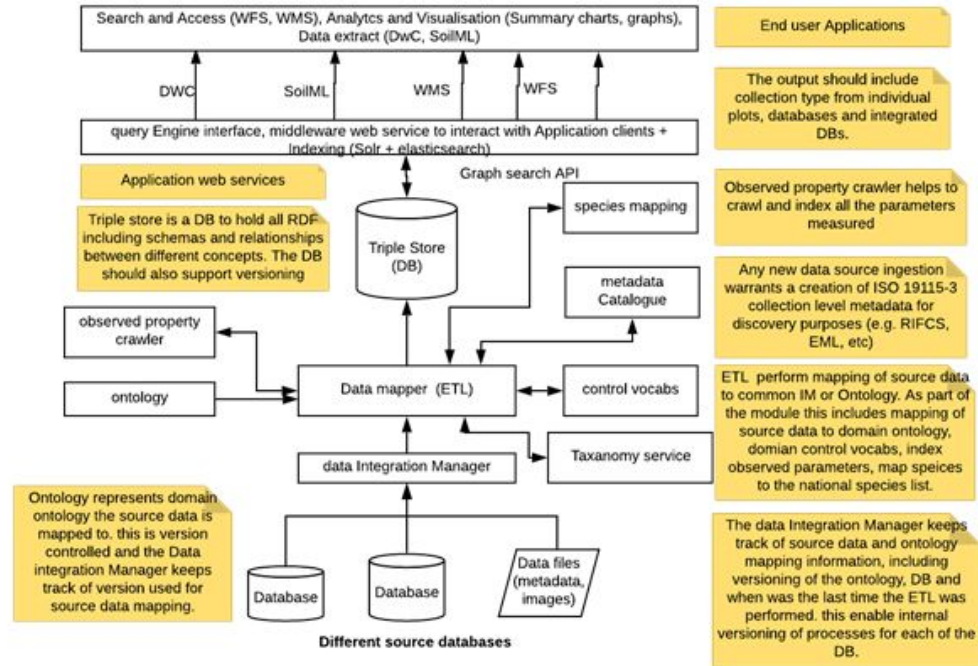
# What have we learned?

- SSN + SSN-ext almost enough ...
- ... if supplemented by
  - small domain model (TERN-Plot)
  - lots of controlled vocabularies
- Separate maintenance of
  - data structure (ontology)
  - semantics (vocabularies)
- RDF Triples are a scalable/flexible data storage option
- Newbies find the abstract model hard to grok ... at first
- Many pieces  $\Rightarrow$  a lot of choreography
- Data structures are stable, but alignment of controlled vocabularies is needed
- Additional potential alignments will support additional potential entailments

# Example: PROV-O



# TERN-Plot architecture



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