

Success Metrics in Arctos

(and what we hope to build)

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and

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SPNHC 2019



Website: <http://arctosdb.org>
Search: <http://arctos.database.museum>



Metrics Dashboards

Collection Summary Metrics

Control-Click in order of desired result to sort by multiple columns

Specimen Summary: 84403 Specimens grouped into 99 records.

Count	Specimens	FormattedScientificName
43760	specimens	<i>Peromyscus maniculatus</i>
13000	specimens	<i>Peromyscus maniculatus sonoriensis</i>
9361	specimens	<i>Peromyscus maniculatus rufinus</i>
5662	specimens	<i>Peromyscus maniculatus gambelii</i>
5375	specimens	<i>Peromyscus maniculatus nebrascensis</i>
1123	specimens	<i>Peromyscus maniculatus rubidus</i>
662	specimens	<i>Peromyscus maniculatus luteus</i>
506	specimens	<i>Peromyscus maniculatus blandus</i>
501	specimens	<i>Peromyscus maniculatus artemisiae</i>

See results as:

- Specimen Summary
- Specimen Records
- HTML Specimen Records
- BerkeleyMapper Map
- KML
- Specimen Summary**
- Graph

Group by:

Select options

- Check all Uncheck all
- Sex
- Specific Locality
- Year
- IndividualCount
- IsPublished
- sex
- Collection

TABLES

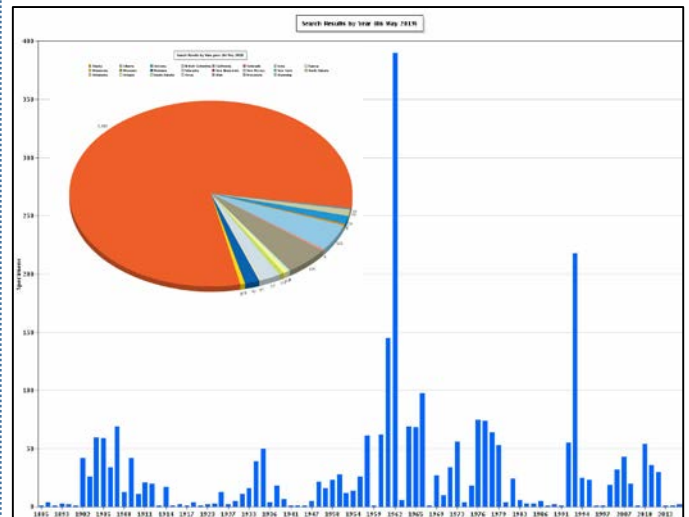


Chart Settings

Format: Size: Dimensions: Type:

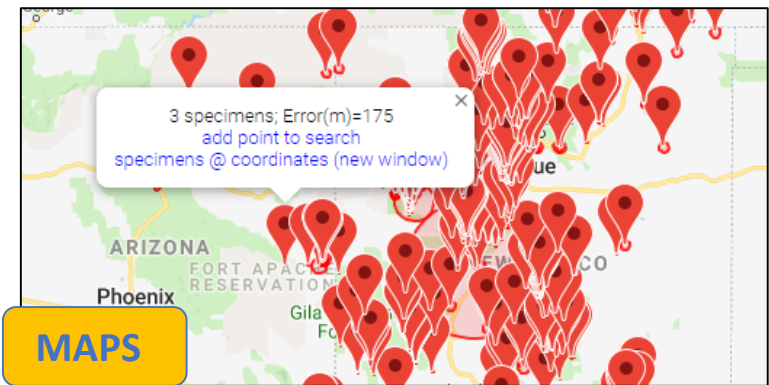
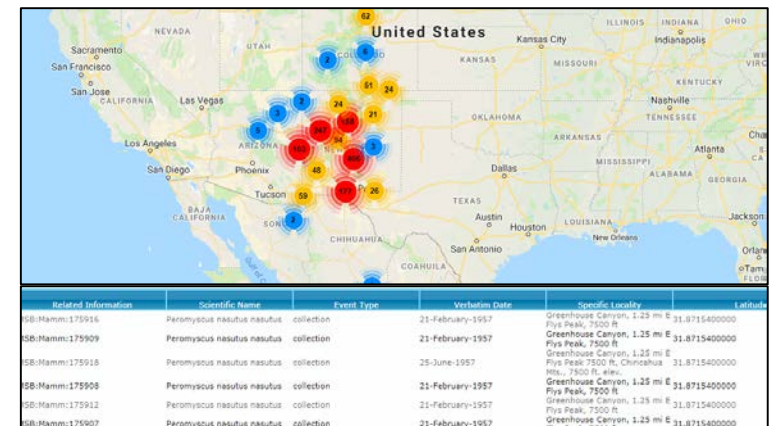
Chart Data¹

- Specimens by Country
- Specimens by State
- Specimens by Identification
- Specimens by Genus
- Specimens by Family
- Specimens by Order
- Specimens by Year**

OrderBy

Parameter Ascending

CHARTS



MAPS

Current Capabilities:

- Public-facing
- Quickly visualize & summarize holdings
- Easy report generation
- Multiple resolutions
- Dynamic links

Challenges:

- Limited parameters
- Query-based
- Static graphs
- Dispersed

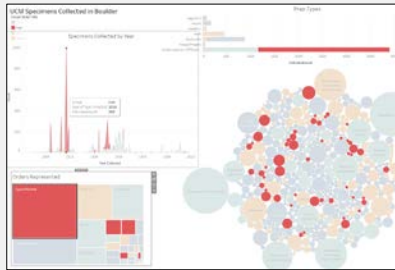
Wish List...

Dashboard Dreams

Centralized

Interactive

- Data filters, multiple modalities



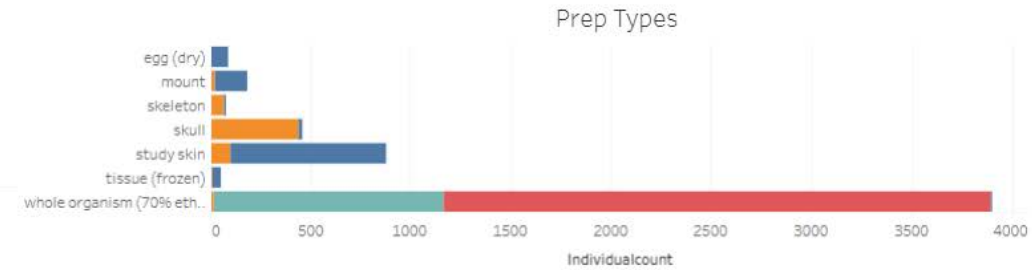
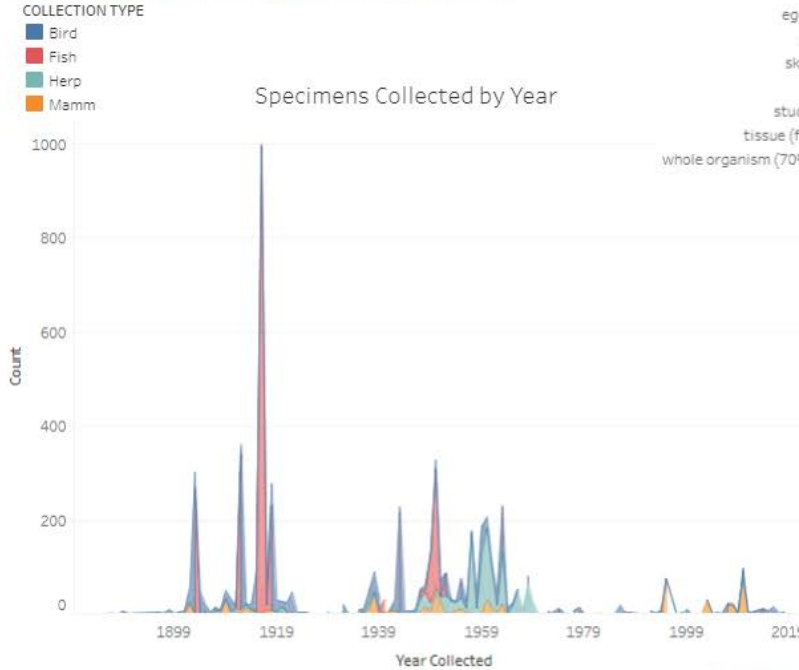
Diverse end users

- Admins, museum staff, researchers, educators/students

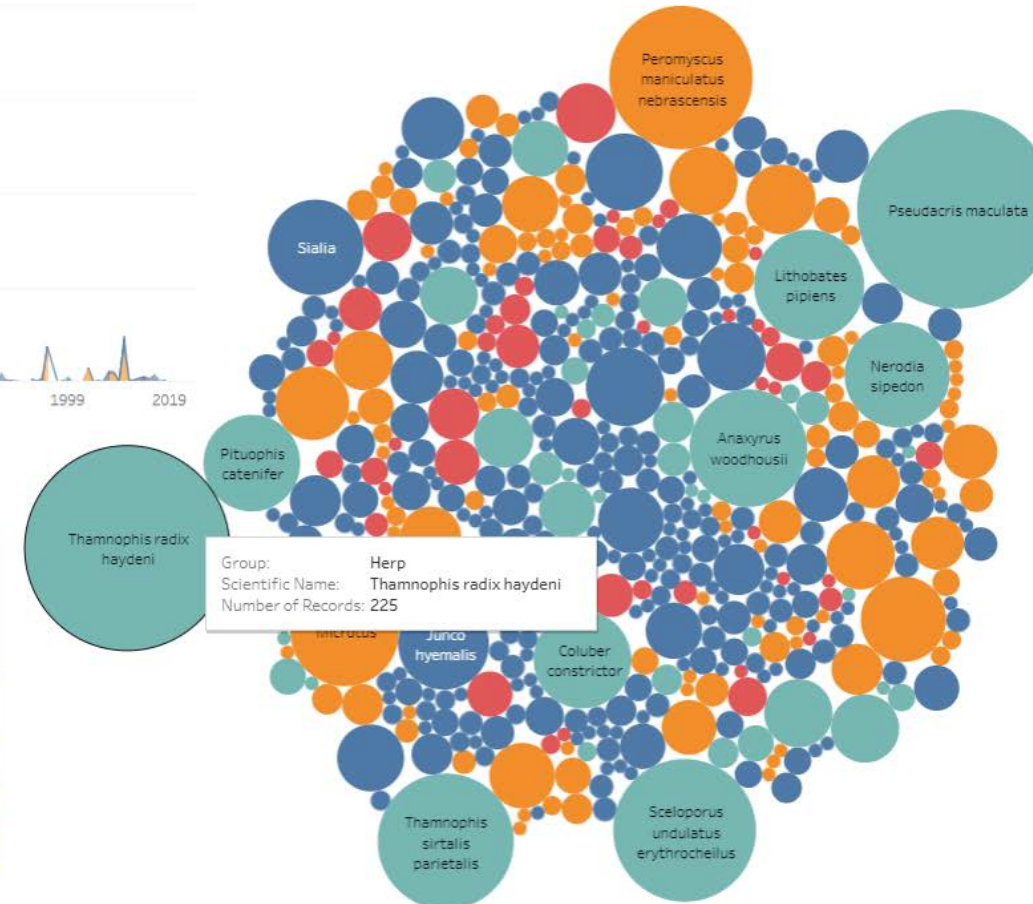
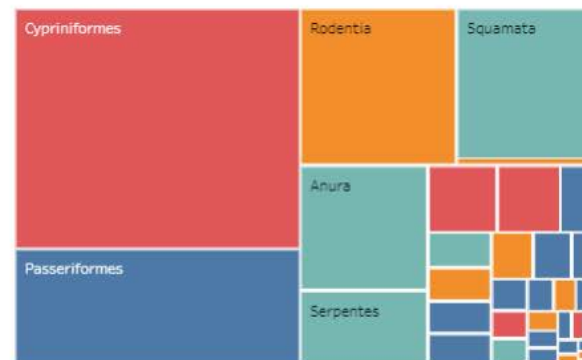
Multiple attribute handling

- Beyond holdings data, e.g., loans, agents, citations, georeferences, gap analytics, system analytics
- Meaningfully aid staff in error detection and improving data

UCM Specimens Collected in Boulder



Orders Represented





Non-Specimen Dashboards

Agent Activity

Joseph Grinnell (person)

DOB 1877-02-27 DOD 1939-05-29

Agent Names:

- Grinnell J. (aka)
- Joseph (first name)
- Grinnell (last name)
- J. Grinnell (aka)
- Grinnell, Joseph (aka)
- Joseph Grinnell (preferred)

Remarks:

Museum of Vertebrate Zoology's founding director in 1908

Agent Relationships:

- spouse of [Hilda W. Grinnell](#)
- employee of [Museum of Vertebrate Zoology, University of California](#)
- grandparent of [June R. Grinnell](#)

- [Willard F. Grinnell](#) is child of
- [Hilda W. Grinnell](#) is spouse of
- [Richard A. Grinnell](#) is child of
- [Stuart W. Grinnell](#) is child of
- [Molly Grinnell](#) is child of
- [June R. Grinnell](#) is grandchild of

Groups:

- [Grinnell Historic Yosemite Survey](#)

Address: ***Supports**  

- url: <https://lccn.loc.gov/n83064222>
- url: https://en.wikipedia.org/wiki/Joseph_Grinnell
- Wikidata: <https://www.wikidata.org/wiki/Q927582>

Identification:

- 57 identifications for [57 MVZ:Mamm](#) specimens
- 83 identifications for [83 MVZ:Bird](#) specimens
- 31 identifications for [31 UCM:Mamm](#) specimens
- 1 identifications for [1 UCM:Bird](#) specimens

Collector [Define]

Role ↓	Collection	SpecimenCount	Link
collector	(all)	19855	Open Specimen Results
collector	CHAS:Bird	2	Open Specimen Results
collector	DMNS:Egg	6	Open Specimen Results
collector	MVZ:Bird	13020	Open Specimen Results
collector	MVZ:Egg	484	Open Specimen Results
collector	MVZ:Herp	1337	Open Specimen Results
collector	MVZ:Mamm	4963	Open Specimen Results
collector	UCM:Bird	1	Open Specimen Results
collector	UCM:Egg	3	Open Specimen Results
collector	UCM:Mamm	33	Open Specimen Results

Publications

- [Joseph Grinnell](#). 1912. A name for the Hawaiian Linnet. *Auk* 29:24-25.
 - 1 citations
- [Joseph Grinnell](#). 1931. A new pocket gopher from southeastern California. *University of California Publications in Zoology* 1:1-12.
 - 1 citations
- [Joseph Grinnell](#). 1915. Field Notes: Grinnell J. 1914-15.
 - 0 citations
- [Joseph Grinnell](#), [Frank Stephens](#), [Joseph S. Dixon](#), [Edmund Heller](#). 1909. Birds and mammals of the Yosemite region. *University of California Publications in Zoology* 1:1-12.
 - 12 citations
- [Joseph Grinnell](#). 1937. A new race of Brown Towhee, from the Kern Basin of California. *Auk* 54:1-12.
 - 1 citations
- [Joseph Grinnell](#). 1917. The subspecies of *Hesperiphona vespertina*. *Condor* 19:17-22.
 - 2 citations
- [Joseph Grinnell](#). 1902. The Western Barn Swallow. *Condor* 4:71-71.
 - 1 citations
- [Joseph Grinnell](#). 1909. Three new Song Sparrows from California. *University of California Publications in Zoology* 1:1-12.
 - 2 citations
- [Joseph Grinnell](#). 1920. The California race of the Brewer Blackbird. *Condor* 22:152-155.
 - 1 citations

Collections

Pubs  Specimens

Transactions

- authorized by for Loan [MVZ:Bird 1917.400.Bird](#)
- authorized by for Loan [MVZ:Bird 1917.413.Bird](#)
- authorized by for Loan [MVZ:Bird 1917.414.Bird](#)
- authorized by for Accession [MVZ:Bird -99999](#)

Specimen Attribute Determiner:

- 6 attributes for [6 UWYMV:Bird](#) specimens
- 3 attributes for [3 DMNS:Egg](#) specimens
- 149 attributes for [31 UCM:Mamm](#) specimens
- 3 attributes for [2 CHAS:Bird](#) specimens

Entry, Edits:

- Entered Specimens: 0
- Edited Specimens: 0
- Specimen Encumbrances: 0
- Geology Edits: 0
- Collecting Event Edits:
 - 0 edits to 0 Collecting Events
- Locality Edits:
 - 0 edits to 0 localities

Total View

- Captures agent effort, products, ownership, etc.
- Based on deeply structured data and resolved names
- Wish List: visual dashboard to synthesize info, facilitate attribution

Media

Media:

- 625 created by agent entries.
- 24 shows agent entries.
- [Media from 1525 collected/prepared specimens](#)
- Assigned 0 Media Relationships.
- Assigned 0 Media Labels.



Projects

Projects

- [Historic Grinnell Survey: Yosemite Transect](#)
- [Historic Grinnell Survey: Joshua Tree National Park](#)
- [Historic Grinnell Survey: Southern Sierra Nevada Transect](#)
- [Historic Grinnell Survey: Lassen Transect](#)
- [Historic Grinnell Survey: I-80 Corridor](#)
- [Historic Grinnell Survey: Warner Mountains](#)
- [Historic Grinnell Survey: Mojave National Preserve](#)
- [Historic Grinnell Survey: Coast Range Transect](#)
- [Historic Grinnell Survey: Death Valley National Park](#)
- [Historic Grinnell Survey: San Jacinto Mountain region](#)

Aliases

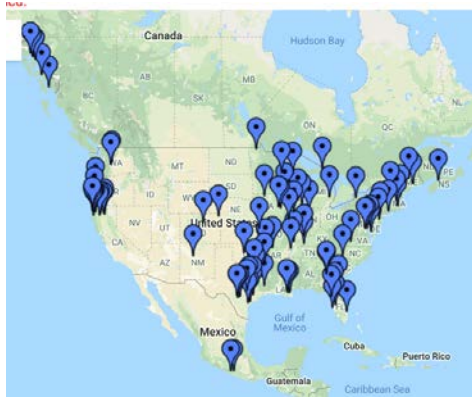
Relationships

Effort

Taxon Activity

Taxonomy Details for *Strix varia*

Mapping



Classifications Global Names

Data from source [Arctos](#)
 display_name: *Strix varia*
 nomenclatural_code: ICZN
 scientific_name: *Strix varia*
 source_authority: University of Alaska Museum
 taxon_status: valid

Animalia (kingdom)
 Chordata (phylum)
 Aves (class)
 Strigiformes (order)
 Strigidae (family)
 Strix (genus)
 Strix varia (species)

Data from source [Catalogue of Life](#)

canonical name: *Strix varia*
 name string: *Strix varia* Barton, 1799

Classification:
 Animalia (kingdom)
 Chordata (phylum)
 Aves (class)
 Strigiformes (order)
 Strigidae (family)
 Strix (genus)
 Strix varia (species)

CITES

Data from source [Arctos Legal](#)

CITES Annotation: (Appendix II): [ORDER listing Strigiformes spp.] Except *Sceloglaux albifacies* and the species included in Appendix I.
 CITES Appendix: II
 author_text: Barton, 1799
 citation: UNEP (2019). The Species+ Website. Nairobi, Kenya. Compiled by UNEP-WCMC, Cambridge, UK. Available at: www.speciesplus.net. Accessed 2019-05-17.
 source_authority: [Species+](#)

Total View

- Captures taxon representation, Global Names classifications, synonyms, etc.
- Based on deeply structured data and resolved names
- Wish List: visual dashboard to synthesize info, facilitate use of current taxonomy

Relationships

Related Taxa

- *Strix varia* → potential alternate spelling → *Strix varius*
- *Strix varius* → potential alternate spelling → *Strix varia*

Common Name(s)

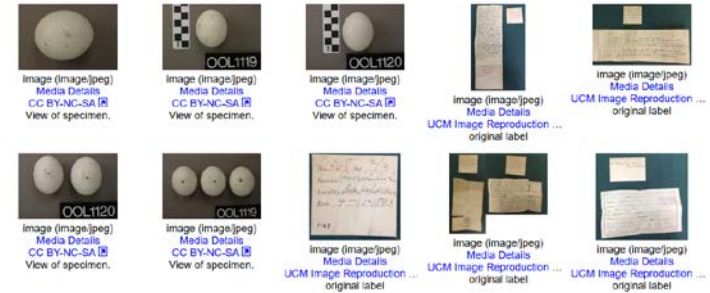
- Barred Owl
- Búho barrado
- Búho listado
- Chouette rayée
- Chouette raye
- Cáрабо norteamericano
- amerikansk skogsuggla

Media

Specimens

Found 295 specimens. About Tools: Map, Customize, or Download HTML version Comment or report bad data

Specimen Results	GUID	Identified As	country	state/province	specific locality	verbatim date	Decimal Latitude	Decimal Longitude	Coordinate Error (m)
<input type="checkbox"/>	COA:Bird:127	<i>Strix varia</i>			"S" written on skull	unknown			
<input type="checkbox"/>	MVZ:Egg:14294 Media	<i>Strix varia georgica</i>	United States	Texas	0.5 mi S of Refugio	16-Feb-1950	28.285533	-97.27427	117
<input type="checkbox"/>	MVZ:Bird:96605	<i>Strix varia sartorii</i>	Mexico	Guerrero	1 mi E Omiltemi	22 Jul 1946	17.5566666666	-99.6702777777	5172.431616
<input type="checkbox"/>	UMZM:Bird:15710	<i>Strix varia</i>	United States	Montana	1 mi W of Bowman's Corner	13-Apr-74			
<input type="checkbox"/>	UMZM:Bird:17146	<i>Strix varia</i>	United States	Montana	1 mi of Polomic Bor NWR	4-Oct-81			
<input type="checkbox"/>	DMNS:Bird:39362	<i>Strix varia</i>	United States	Kentucky	1 mile east of Hopkinsville	23 November 1982	36.866658	-87.466707	1000





Participant Poll

The Extended Specimen Network:

“A powerful new source of knowledge to address national priorities”

From

Extending U.S. Biodiversity Collections to Promote Research and Education

Thiers et al. 2019

Extended specimen = physical specimen

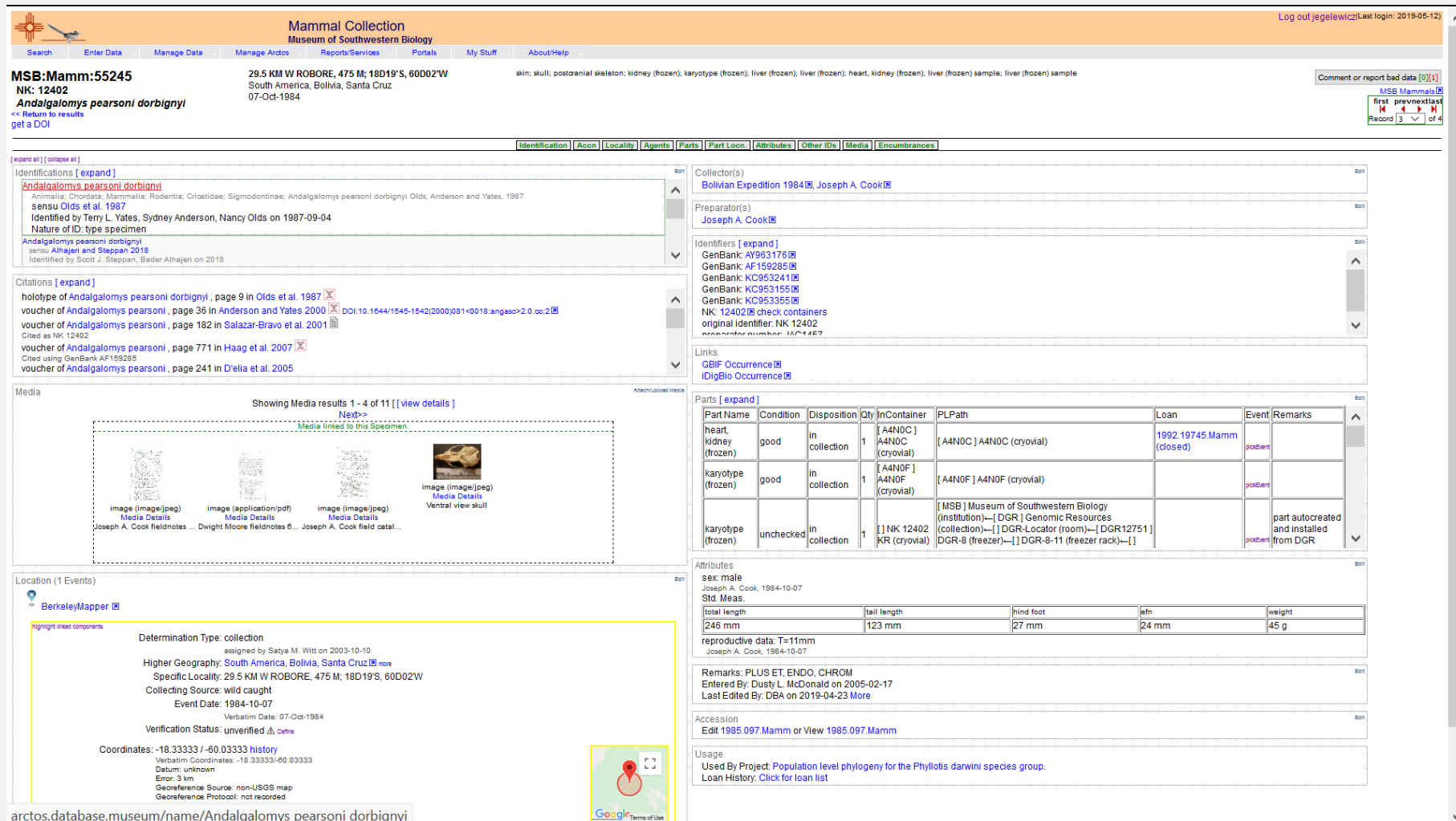
- + physical specimen data
- + molecular data
- + phenotypic data
- + environmental data



Thiers et al. 2019, Fig 1

How do we define Success?

Capture the most complete representation of a collection object and use standardized data to quantify impact.



The screenshot shows the rctos database interface for specimen MSB:Mamm:55245. The header includes the Mammal Collection logo and navigation tabs like Search, Enter Data, Manage Data, etc. The specimen details include its name, *Andalgalomys pearsoni dorbignyi*, and collection data from 1984. The interface is divided into several sections: Identifications, Citations, Media, Location, and Attributes. The Media section shows a map and several image thumbnails. The Attributes section includes a table for parts and a table for measurements.

Part Name	Condition	Disposition	Qty	In Container	PLPath	Loan	Event	Remarks
heart, kidney (frozen)	good	in collection	1	[A4NOC] A4NOC (cryovial)	[A4NOC] A4NOC (cryovial)	1992.19745.Mamm (closed)	postEvent	
karyotype (frozen)	good	in collection	1	[A4NOF] A4NOF (cryovial)	[A4NOF] A4NOF (cryovial)		postEvent	
karyotype (frozen)	unchecked	in collection	1	[NK 12402] KR (cryovial)	[MSB] Museum of Southwestern Biology (institution)—[DGR] Genomic Resources (collection)—[DGR-Locator (room)—[DGR12751] DGR-8 (freezer)—[DGR-8-11 (freezer rack)—[postEvent	part autocreated and installed from DGR

total length	tail length	hind foot	efn	weight
246 mm	123 mm	27 mm	24 mm	45 g

Identification

Citations

Media

Locality and Mapping

Relationships and external links

Parts

Attributes

Usage



Low Quality Data Dashboard

Most Complete Specimen Representation “Un-Metrics”



Low Quality Data Dashboard

Collection	Report	Link	Detail	CacheDate
UTEP:Herp	cite_no_loan	/info/undocumentedCitations.cfm?action=citsnoloan&collectionid=121	7 UTEP:Herp specimens have citations and do not have a loan history.	2019-05-07 00:00:00.0
UTEP:Herp	genbank_mia	/info/mia_in_genbank.cfm	158 UTEP:Herp specimens have unlinked data in GenBank.	2019-04-02 00:00:00.0
UTEP:Herp	genbank_no_cite	/info/undocumentedCitations.cfm?action=genbanknocite&collectionid=121	972 UTEP:Herp specimens have GenBank numbers and do not have a citation.	2019-05-06 00:00:00.0
UTEP:Herp	genbank_no_loan	/info/undocumentedCitations.cfm?action=genbanknocite&collectionid=121	1 UTEP:Herp specimens have GenBank numbers and do not have a loan history.	2019-05-05 00:00:00.0
UTEP:Herp	overdue_loan	/Loan.cfm?action=listLoans&collection_id=121~Closed=true&return_due_date=1400-01-01&to_return_due_date=2019-05-09	6 UTEP:Herp loans are not closed and have a due date before 2019-05-09.	2019-05-09 00:00:00.0
UTEP:Herp	specimen_annotation	/info/reviewAnnotation.cfm?action=show&atype=specimen&guid_prefix=UTEP:Herp&reviewer_comment=NULL	183 unreviewed annotations refer to UTEP:Herp specimens.	2019-05-12 00:00:00.0
UTEP:HerpOS	bare_names	https://github.com/ArctosDB/arctos/issues/1894	3 taxa are used by UTEP:HerpOS and do not have a preferred classification.	2019-05-10 00:00:00.0



Data Improvement Tools

Standardized Data “Un-Metrics”

Duplicate Agent Discovery

Find Agents that share a name

Find Person agents that share first and last name

Find Person agents that share first and last name, no dots in first name

Find Person agents that share first and last name, no dots in first name, no relationships

Find Agents by name variations

Taxon Name Validator

Anomoeodus

gbif='found', eol='found', wiki='found', gni='found', worms='not_found', consensus='might_be_valid'

Anomoeodus phaseolus

gbif='found', eol='found', wiki='not_found', gni='found', worms='not_found', consensus='might_be_valid'

Anomoeodus phasolus

gbif='not_found', eol='found', wiki='not_found', gni='not_found', worms='not_found', consensus='might_be_valid'

Annotations – Locality & Georeferences

Review locality annotations – e.g., validation errors

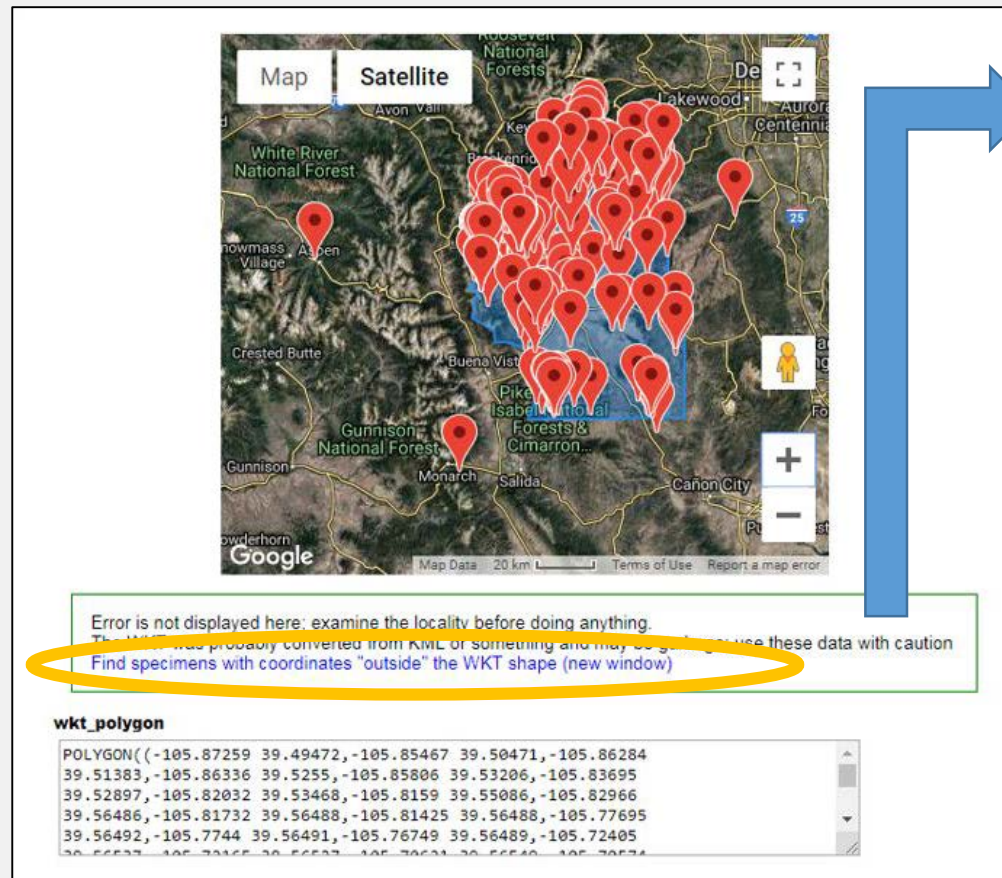
UCM:Fish	specimen_annotation	/info/reviewAnnotation.cfm?action=show&atype=specimen&guid_prefix=UCM:Fish&reviewer_comment=NULL	3 unreviewed annotations refer to UCM:Fish specimens.
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Crowdsourced

Automated

“Hey, your Kansas record is mapping to China”

Find georeferencing errors outside of a defined polygon based on assigned Higher Geography



Error is not displayed here: examine the locality before doing anything.
 The WKT was probably converted from KML or something and may be off. Use these data with caution.
 Find specimens with coordinates "outside" the WKT shape (new window)

```

wkt_polygon
POLYGON((-105.87259 39.49472, -105.85467 39.50471, -105.86284 39.51383, -105.86336 39.5255, -105.85806 39.53206, -105.83695 39.52897, -105.82032 39.53468, -105.8159 39.55086, -105.82966 39.56486, -105.81732 39.56488, -105.81425 39.56488, -105.77695 39.56492, -105.7744 39.56491, -105.76749 39.56489, -105.72405 39.56503, -105.7215 39.56503, -105.72021 39.56503, -105.72021 39.56503, -105.72021 39.56503)
    
```

Annotation

Annotation by **d1m dustymc@gmail.com** on 2019-04-29

Does not map to Park County

Review Comment

Annotated Object(s) [view all specimens](#)

- DMNS:Bird:42392 (Poecile gambeli)
- DMNS:Bird:39992 (Poecile gambeli)
- UCM:Fish:6723 (Oncorhynchus clarkii)
- DMNS:Bird:38859 (Lagopus leucurus)
- DMNS:Bird:14577 (Junco hyemalis aikenii)
- DMNS:Mamm:7663 (Cynomys gunnisoni gunnisoni)
- DMNS:Bird:42842 (Lagopus leucurus)
- DMNS:Bird:2184 (Vireo gilvus)
- UMNH:Mamm:17917 (Urocitellus elegans elegans)
- DMNS:Bird:39578 (Troglodytes troglodytes hiemalis)
- DMNS:Bird:39295 (Selasphorus rufus)
- DMNS:Bird:38858 (Lagopus leucurus)
- UWBM:Mamm:35284 (Spermophilus spilosoma)
- DMNS:Bird:14578 (Junco hyemalis aikenii)

Loan Activity

Loan/Citation Statistics

Collection
UCM:Bird ▼

Loaned To Person

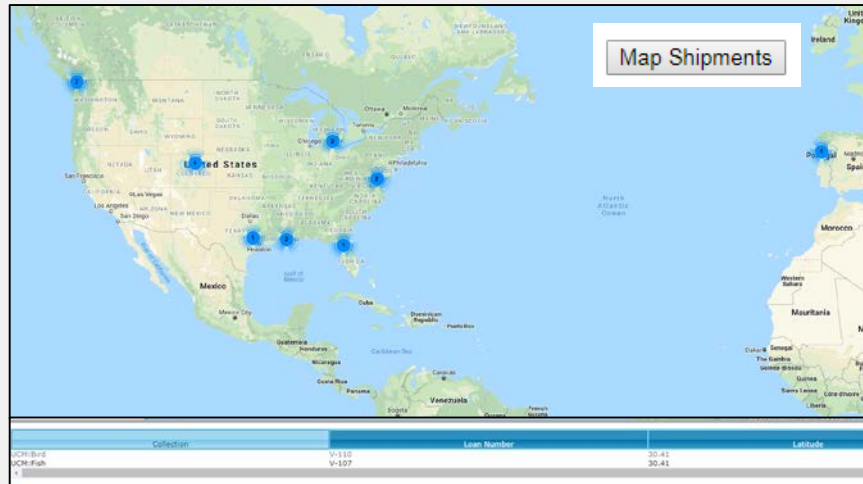
Loan Type
consumable ▼

Loan Status
in process ▼

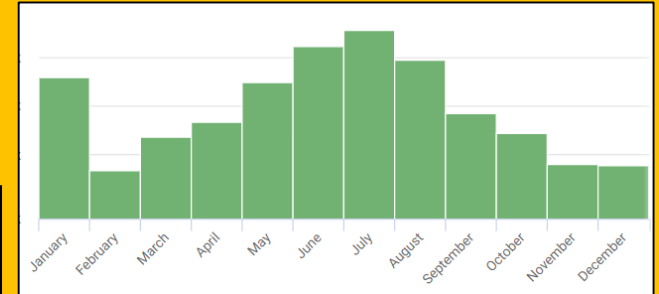
Citations
has some ▼

Items Loaned
has some ▼

Shipment Mapping



Wish List
Explorable
loan statistics



COLLECTION	#LOANS	TOTAL SPECIMENS	#BORROWERS	YEAR

Dashboard Notifications

Projects with Loans and without Publications
Loans without Specimens

UCM:Bird	overdue_loan	/Loan.cfm?action=listLoans&collection_id=96-Closed=true&return_due_date=1400-01-01&to_return_due_date=2019-04-29	1 UCM:Bird loans are not closed and have a due date before 2019-04-29.
UCM:Bird	cite_no_loan	/info/undocumentedCitations.cfm?action=citsnoloan&collectionid=96	12 UCM:Bird specimens have citations and do not have a loan history.
UCM:Bird	genbank_no_loan	/info/undocumentedCitations.cfm?action=genbanknocite&collectionid=96	3 UCM:Bird specimens have GenBank numbers and do not have a loan history.

Overdue notices, citations & GenBank numbers without loan history, loans without specimens, loans without publications

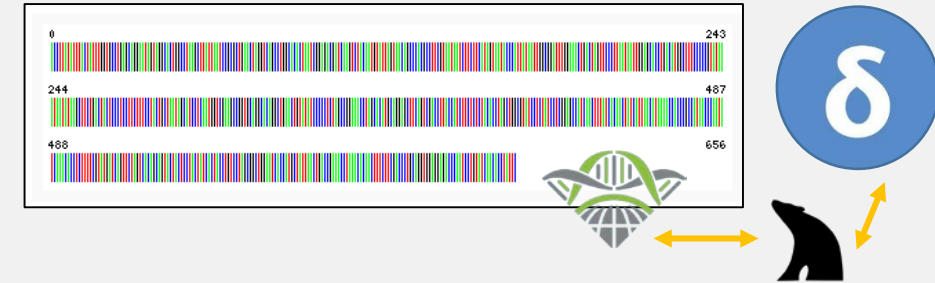


Data Integration Tools

GenBank Discovery Tool

- GenBank autolinks to Arctos when researchers submit the correct GUID
- If NOT...an automated discovery tool tracks down “orphaned” sequences

reciprocal linkages with BoLD and IsoBank



Owner	Count	Run Date	Query Type	Link
UAM:Mamm	34	07 May 2019	specimen_voucher.collection	open GenBank

Run Query

Search Details

Query Translation:

```
((specimen[All Fields] AND voucher[All Fields] AND UAM[All Fields]) AND (mamm[text word] OR mamm01[text word] OR mamm01000001[text word] OR mamm01000002[text word] OR mamm01000003[text word] OR mamm01000004[text word] OR mamm01000005[text word] OR mamm01000006[text word] OR mamm01000007[text word] OR mamm01000008[text word] OR mamm01000009[text word] OR mamm01000010[text word] OR mamm01000011[text word] OR mamm01000012[text word] OR mamm01000013[text word] OR mamm01000014[text word] OR mamm01000015[text word] OR mamm01000016[text word] OR ...))
```

Result: 35

Database: Nucleotide

User query: specimen voucher UAM Mamm*[text word] NOT !provarctos[filter]

specimen voucher UAM Mamm*[text word] NOT !provarctos[filter]

Items: 1 to 20 of 35

1. **Delphinapterus leucas voucher UAM:Mamm:11801** rRNA-Pro gene and D-loop, partial sequence: mitochondrial

2. **Delphinapterus leucas voucher UAM:Mamm:99603** rRNA-Pro gene and D-loop, partial sequence: mitochondrial

3. **Delphinapterus leucas voucher UAM:Mamm:96002** rRNA-Pro gene and D-loop, partial sequence: mitochondrial

4. **Delphinapterus leucas voucher UAM:Mamm:96081** rRNA-Pro gene and D-loop, partial sequence: mitochondrial

5. **Delphinapterus leucas voucher UAM:Mamm:91765** rRNA-Pro gene and D-loop, partial sequence: mitochondrial

Verify Matches

Mammal Collection
Museum of Southwestern Biology

MSB:Mamm:110372
Sorex cinereus cinereus
near Fool Creek
North America, United States, Colorado, Grand County, Fraser Experimental Forest
24-Aug-1982

Identifiers
GenBank: [JN889590](#)
USGS: U.S. Geological Survey: BS/FC 10372
preparator number: VS 1632

Balaena mysticetus voucher UAM:Mamm:86892
(COI) gene, partial cds; mitochondrial
GenBank: EU139271.1

FASTA Graphics PopSet

LOCUS EU139271 657 bp DNA linear HAM 20
DEFINITION Balaena mysticetus voucher UAM:Mamm:86892 cytochrome oxidase subunit I (COI) gene, partial cds; mitochondrial.
ACCESSION EU139271
VERSION EU139271.1
KEYWORDS BARCODE.
SOURCE mitochondrial Balaena mysticetus (bowhead whale)
ORGANISM Balaena mysticetus
Eukaryota; Metazoa; Chordata; Craniata; Vertebrata; Euteleostomi; Mammalia; Eutheria; Laurasiatheria; Cetartiodactyla; Cetacea; Mysticeti; Balenidae; Balaena.
REFERENCE 1. (bases 1 to 657)
Zhang, J., Borisevko, A., Ivanova, N., Hanner, R. and Hebert, P. DNA Barcoding Alaskan Marine Mammals Unpublished
REFERENCE 2. (bases 1 to 657)
Zhang, J., Borisevko, A., Ivanova, N., Hanner, R. and Hebert, P. Direct Submission Submitted (08-SEP-2008) Biodiversity Institute of Ontario, University of Guelph, 50 Stone Road East, Guelph, Ontario N1G 2W1, Canada

LinkOut to external resources
UAM:Mamm:86892 [Arctos Specimen Database]
BOLD Link [ABUAM088-07] [Barcode of Life]

Deep-Linking Citations

Publication Record

John R. Demboski and Joseph A. Cook. 2001. Phylogeography of the dusky shrew (Soricidae): insight into deep and shallow history in northwestern North America

- Report Problem
- 52 Cited Specimens
- 52 *sensu* Identifications
- <http://dx.doi.org/10.1046/j.1365-294x.2001.01260.x>
 - References Count: 100
 - Referenced By Count: 77
 - CrossRef Data
- Edit
- Manage Citations
- Publication Agents
 - John R. Demboski
 - Joseph A. Cook

Media Details
Demboski_and_Cook_2001...

Leverage external tools to document research impacts

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- Specimens identified
- Pubs referenced (via Crossref)
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Low Quality Pub Data Services

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Project Publications lacking DOI
Specimens with GenBank IDs and no citations

DOI Finder

Find DOI

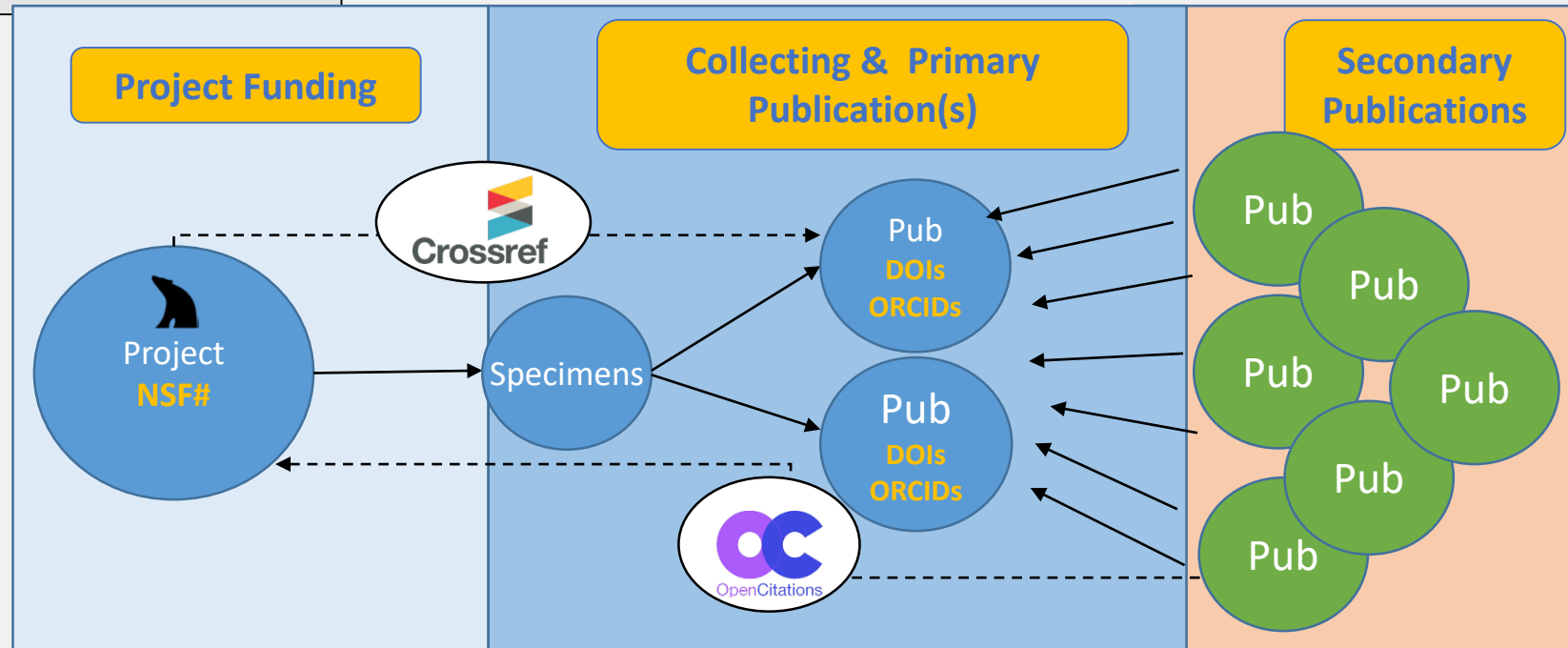
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Carla Cicero, 2004, 'BARRIERS TO SYMPATRY BETWEEN AVIAN SIBLING SPECIES BAEOLOPHUS) IN LOCAL SECONDARY CONTACT', *Evolution*, vol. 58, no. 7, pp. 157

- Check [10.1111/j.0014-3820.2004.tb01737.x](http://dx.doi.org/10.1111/j.0014-3820.2004.tb01737.x)
- [Use This DOI](#)



Summary

Arctos needs more [dynamic, explorable, prettier] dashboards!

Metrics beget Metrics

- As we grow our ability to integrate diverse data types we ↑ **connectivity** and our ability to **detect gaps** in connectivity
- Standardized data are essential to achieving a holistic view and precise metrics (as are integration tools and the community)

Quality over Quantity

- Capturing *extended specimen* data to the fullest degree possible helps us to **quantify impacts and maximize benefits**....aka express **SUCCESS**



Thank you!

All opinions expressed are our own. We would like to thank

Everyone in the **Arctos Working Group** for putting up with multiple requests and issues on the Arctos GitHub. You all make our life so much richer!

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References

Thiers, Barbara, Anna Monfils, Jennifer Zaspel, Elizabeth Ellwood, Andrew Bentley, Katherine Levan, John Bates, David Jennings, Dori Contreras, Laura Lagomarsino, Paula Mabee, Linda Ford, Robert Guralnick, Robert Gropp, Marcy Revelez, Neil Cobb, James Lendemer, Katja Seltmann and Mary Catherine Aime. 2019. Extending U.S. Biodiversity Collections to Promote Research and Education

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