Development and Implementation of an Efficient, Accessible Online Museum Site and Database with Open Access

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The Research

- Conducting a taphonomic study
- Upper Cretaceous dinosaur fossils
- Eastern Wyoming
- Excavation began in 1995, using traditional methods
- On-site for one month every summer

Data Collection

- In 2000, we adopted Real-Time Kinematic Differential GPS data collection for every fossil
    - Eliminate traditional string grid
    - Eliminate measurement and transcription error
    - Enabled accurate 3D renderings of quarries
- Since 2000, we have collected 20,000 specimens using these techniques

Effective Paleontology Digitization Programs

- We believe that truly effective programs have the three following characteristics:
    - The primary objective is to faithfully and consistently record all observable specimen metadata
    - Provide open access to the data to all interested parties, with the express purpose of advancing the knowledge of the scientific community
    - Encourage interest in paleontology by non-scientists

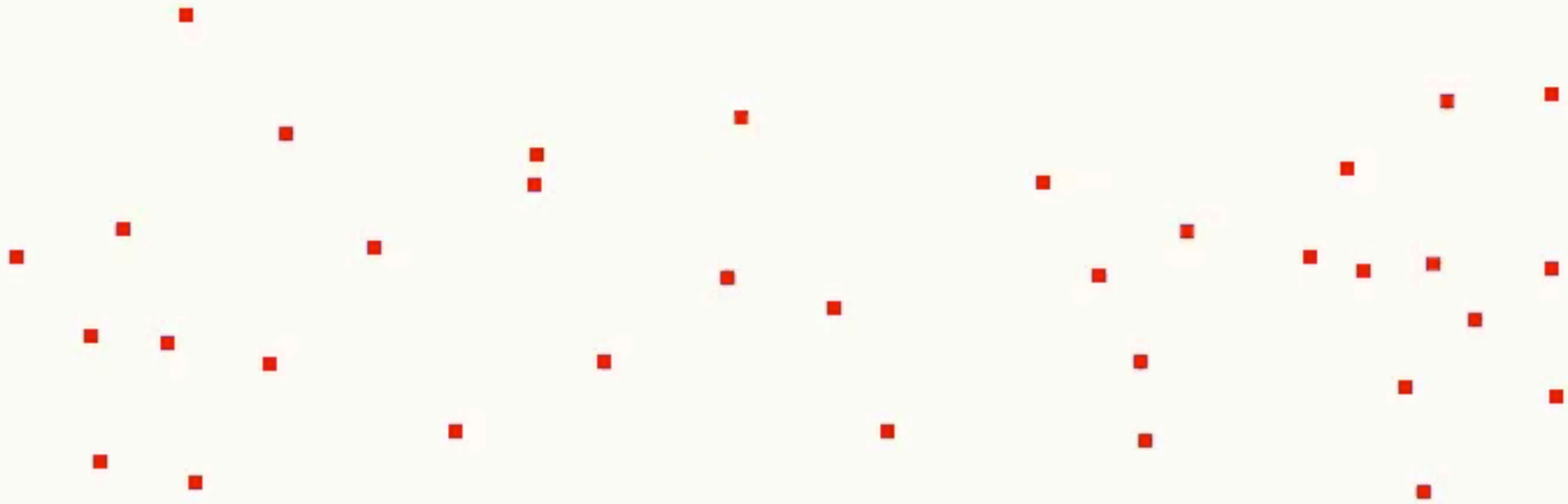
Data Collection Techniques

- To meet these objectives, we have implemented the following specific field methods

    - Specimen numbers immediately assigned to fossils upon discovery, and are referenced in every following stage
    - Specimens are excavated on all sides and pedestaled, keeping them *in situ* for recording
    - Record minimum of three GPS points, or as many as are necessary to reproduce the general shape of each specimen
    - Digital photographs taken of each specimen maintain a visually accurate record

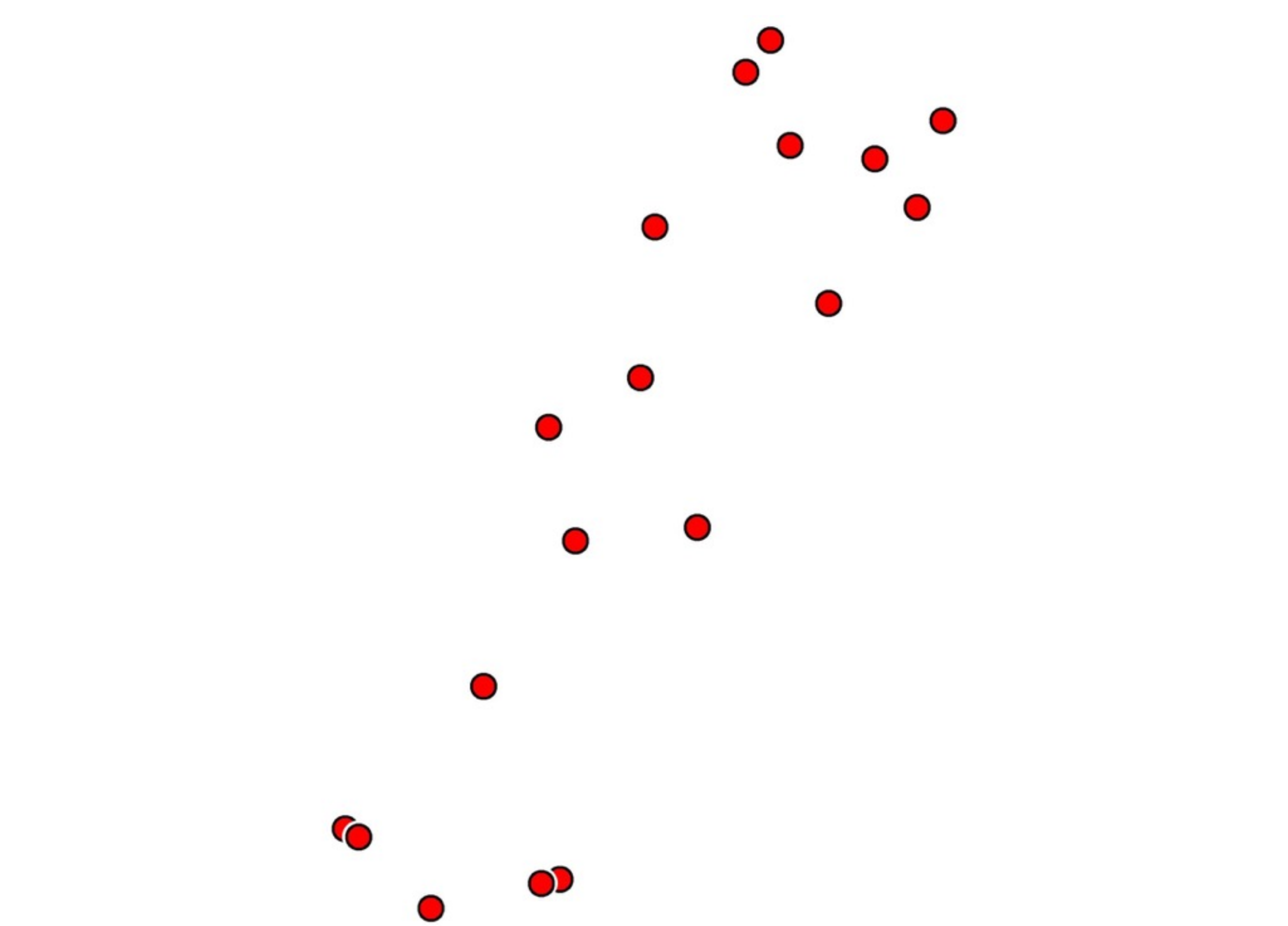
Georeferencing

- Every specimen photograph is georeferenced to its 3D positional data
    - Background image elements removed
    - Correlate each point in the photograph to corresponding point in the positional data set
    - Repeat for every fossil found
    - Render 3D views of resulting fossil assemblage




HRS05331


HRS05331



Curation Process

- Each specimen is curated into our collection, and passes through a well-defined workflow
    - Fossils are cleaned, repaired, and stabilized using standard methods and consolidants
    - Imaged using a special rotating photographic table, which automatically triggers photos from 32 angles
    - All observable metadata entered into database

The Online Database

- The online database consists of two parts
  - The backend database engine
  - The frontend website

Backend Database

- Consists of 46 relationally interlinked tables
- Of those, 17 tables contain fossil data
- Normalized using standard techniques
  - “Fourth Normal Form” *(Ronald Fagin, 1977)*
  - No duplicated data between tables

GIS Tables

quarry
- id INT(10)
- name TINYTEXT
- description TEXT
- site_number TINYTEXT
- image_file TINYTEXT
- tfw_file TINYTEXT
- Indexes

gps_data
- id INT(10)
- specimen_number VARCHAR(20)
- longitude DOUBLE(16,4)
- latitude DOUBLE(16,4)
- elevation DOUBLE(16,4)
- Indexes

Classification Tables

taxon
- id INT(10)
- name TEXT
- level_id INT(10)
- common_name TEXT
- parent_taxon_id INT(10)
- Indexes

taxon_level
- id INT(10)
- name TINYTEXT
- plural TINYTEXT
- Indexes

identification
- id INT(10)
- name TEXT
- description TEXT
- Indexes

specimen
- id INT(10)
- specimen_number VARCHAR(20)
- field_number VARCHAR(20)
- quarry_id INT(10)
- museum_location TINYTEXT
- checked_in_box TEXT
- taxon_id INT(10)
- taxon_certain TINYINT(4)
- date_recovered DATE
- date_prepared DATE
- notes TEXT
- notebook_page INT(10)
- identification_field TEXT
- identification_lab TEXT
- identification_lab_id INT(10)
- identification_lab_certain TINYINT(4)
- description TEXT
- hardener_id INT(10)
- length DECIMAL(6,2)
- width DECIMAL(6,2)
- thickness DECIMAL(6,2)
- side ENUM(...)
- position TINYTEXT
- utm_zone TINYTEXT
- stratigraphy TEXT
- formation TEXT
- collector_person_id INT(10)
- identifier_person_id INT(10)
- preparator_person_id INT(10)
- condition_abrasion_id INT(10)
- condition_fracture_id INT(10)
- condition_pathology_id INT(10)
- 4 more...
- Indexes

Condition Tables

condition_completion
- id INT(10)
- name TINYTEXT
- description TEXT
- notes TEXT
- Indexes

condition_fracture
- id INT(10)
- name TINYTEXT
- description TEXT
- notes TEXT
- Indexes

condition_weathering
- id INT(10)
- name TINYTEXT
- description TEXT
- notes TEXT
- Indexes

condition_crushing
- id INT(10)
- name TINYTEXT
- description TEXT
- notes TEXT
- Indexes

condition_abrasion
- id INT(10)
- name TINYTEXT
- description TEXT
- notes TEXT
- Indexes

condition_marks
- id INT(10)
- name TINYTEXT
- description TEXT
- notes TEXT
- Indexes

condition_pathology
- id INT(10)
- name TINYTEXT
- description TEXT
- notes TEXT
- Indexes

Imaging Tables

image
- id INT(10)
- specimen_id INT(10)
- type ENUM(...)
- 7 more...
- Indexes

image_qtvr
- id INT(10)
- specimen_id INT(10)
- number TINYINT(4)
- caption TEXT
- file TEXT
- Indexes

Database Normalization

- Any piece of data that appears more than once has been put into its own separate parent table and linked to from one or more child tables
- Normalization is absolutely vital for maintaining data integrity
- Requires deep understanding of dataset
- Results in clean data, easily expandable schema, and fast operation

Frontend Website

- Multiple frontends
  - One for data-entry and administration
  - One for public browsing and research

Website Features

- Browse and search all specimens on any criteria
- View all specimen metadata
- Positional mapping of every specimen with respect to others found in same quarry
- Photographic 360 degree viewing of most specimens

Southwestern Adventist University
Online Fossil Museum

Welcome!

This collection has been developed to fulfill the mission and purposes of the Departments of Geology and Biology and the *Hanson Research Station* in harmony with the University's mission of education, research and service.

The SWAU collections are the property of *Southwestern Adventist University*, the EHRC collection is the property of the *Earth History Research Center*, and the HRS collection is the property of the *Hanson Research Station*.

Approximately ninety percent of the entire paleontological collection are fossil vertebrates. The most significant part of the vertebrate collection is the HRS vertebrate collection from the Upper Cretaceous Lance Formation of Wyoming.

The Collection houses type specimens and makes them accessible to the scientific community as prescribed by the *International Code of Zoological Nomenclature* (Recommendation 72F). The University is committed to maintaining the Repository as a permanent educational and research facility. Collection Policy [Word DOC]

Specimens are collected, prepared, and curated in accordance with the Society of Vertebrate Paleontology Statement of Ethics [External Link].

Featured Specimen

HRS08438 - Maxillary

- View in 3D
- View Data

Menu

- Browse Collection
- Login
- Comments / Suggestions
- 3D Fossils

Southwestern Adventist University
Online Fossil Museum

Home Browse Login

Quick Search
maxillary

Thumbnails
Show Thumbnails

3D Fossils
Show 3D Only

Per Page Page Jump
10 7

Add Column
-- Choose --

Go

Browse

Map

[1] « 7 » [8]

	Specimen [x]	Taxon [x]	Lab Identification [x]	Recovered [x]	Quarry [x]
 1	HRS11116		--	2009-06-10	Southeast
 2	HRS11262	*Edmontosaurus annectens*	maxillary	2009-06-23	Southeast
 3	HRS11530		maxillary	2010-06-10	Southeast
 4	HRS08438	*Nanotyrannus lancensis*	maxillary	--	Stair
 5	HRS02293	*Edmontosaurus annectens*	maxillary	2002-06-30	Teague
 6	HRS03433	*Edmontosaurus annectens*	maxillary	2003-06-18	Teague

Map

Specimen Number: HRS08438
Field Number: HRS08438
Museum Location: 24G SWAU

Date Recovered:
Date Prepared:
Quarry: Stair

Taxon: *Nanotyrannus lancensis*

Field Identification: maxillary

Lab Identification: maxillary

Description:

Notebook Page: 49

Notes: From N. lancensis "Zury" found by Zury Franco in 2001

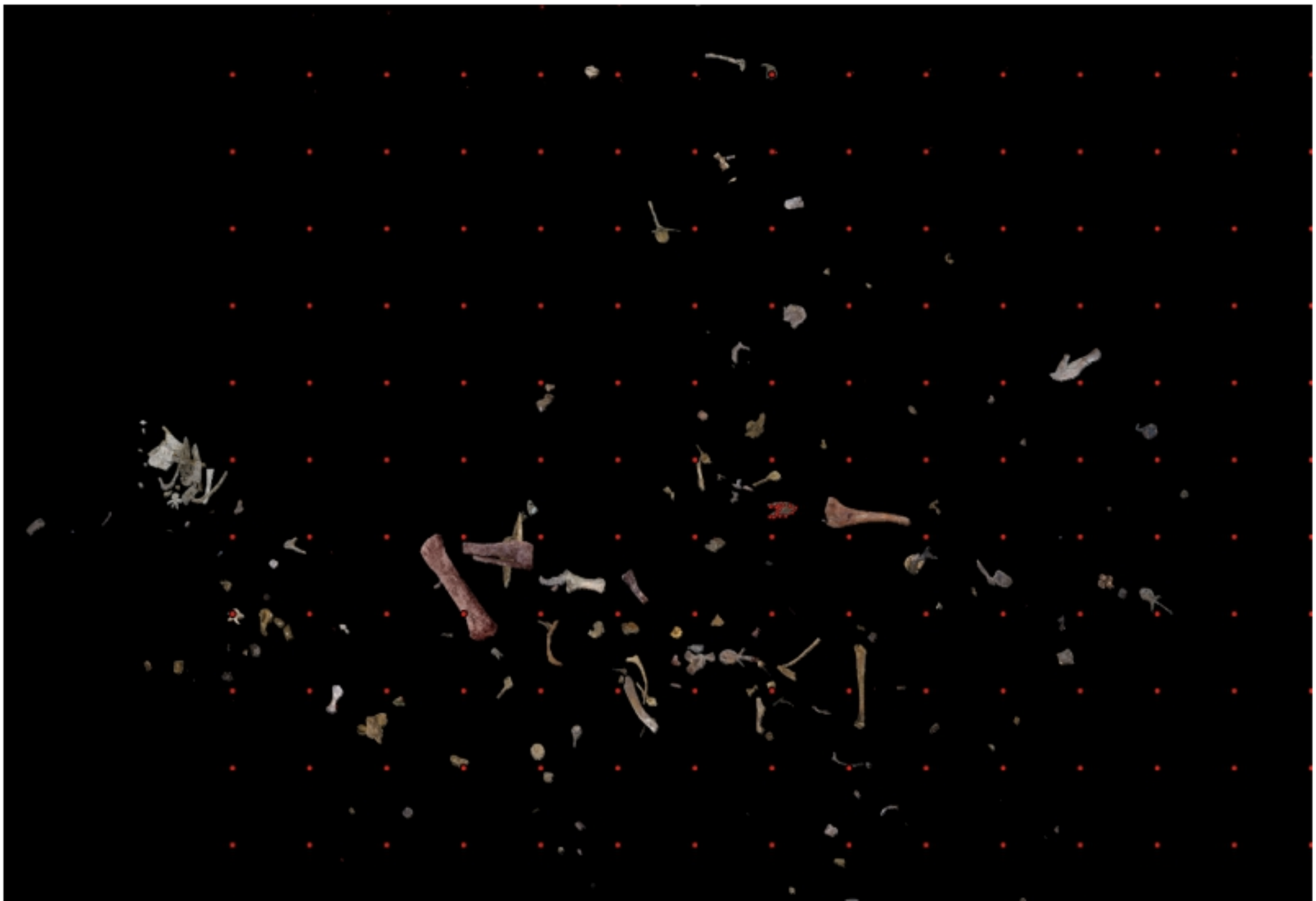
Stratigraphy: Maastrichtian
Formation: Lance

Length [cm]	Width [cm]	Thickness [cm]	Side	Position
38.00	17.00	4.00	R	

Collected By
Identified By
Prepared By

View in 3D

Stair [Stair Quarry]



Online Fossil Museum

- Browse Collection
- Research Query
- Login

About Us

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Featured Specimen

More Info

Turtle scapula

The unusual shape of the turtle scapula reflects the unusual function required in an animal whose pectoral and pelvic girdles are inside its ribcage (shell).

Click image to Zoom.

3D Viewer

Menu | **Search Conditions** | Search

Matches All the conditions.

Returns 500 rows per page.

Conditions

New Edit Del

Identification Matches femur

Clean Condition List

Column List

- **Check the Columns to be displayed.**

- [x] Specimen Number
- [x] Field Number
- [x] Museum Location
- [ ] Quarry
- [ ] Taxon
- [ ] Identification
- [ ] Description
- [ ] Notebook Page
- [ ] Notes
- [ ] Stratigraphy
- [ ] Formation
- [ ] Length
- [ ] Width
- [ ] Thickness

Search Result

Export CSV

64 Specimens Found | 1 Pages

1

#	Specimen Number	Field Number	Museum Location
1	HRS00001	N118E846-1999-2	37D SWAU
2	HRS00159	947-138-2C9	23 SWAU
3	HRS00182	none	23 SWAU
4	HRS00186	none	23 SWAU
5	HRS00262	none	SWAU
6	HRS00602	HRS00602	12G SWAU
7	HRS00779	HRS00779	37E SWAU
8	HRS00845	HRS00845	37C SWAU
9	HRS01065	HRS01065	38E SWAU
10	HRS00561	HRS00561	37C SWAU
11	HRS00520	HRS00520	(37B SWAU) Newcastle Museum - 6/08
12	HRS01507	HRS01507	37B SWAU
13	HRS00597	HRS00597	22 SWAU
14	HRS00596	HRS00596	22 SWAU
15	HRS00595	HRS00595	22 SWAU
16	HRS00594	HRS00594	22 SWAU
17	HRS00593	HRS00593	22 SWAU
18	HRS00592	HRS00592	22 SWAU
19	HRS00499	HRS00499	37C SWAU
20	HRS02213	HRS02213	

Back

Browse

HRS08438

Taxon: lancensis
Name: maxillary
Recovered:
Quarry: Stair
Collector: Karen Boich
Identifier: Art Chadwick

HRS16780

Taxon:
Name:
Recovered:
Quarry:
Collector:
Identifier:

HRS18438

Taxon:
Name:
Recovered:
Quarry:
Collector:
Identifier:

HRS28438

Taxon:
Name:
Recovered:
Quarry:
Collector:
Identifier:

Taxon:
Name:

Specimen

Specimen Number	HRS08438
Field Number	HRS08438
Museum Location	24G SWAU
Date Recovered	
Date Prepared	
Quarry	Stair
Taxon	lancensis
Taxon Certain	✔
Identification Field	maxillary
Lab Identification	maxillary
Lab Identification Certain	✔
Description	
Notes	From N. lancensis "Zury" found by Zury Franco in 2001
Notebook Page	49
Stratigraphy	Maastrichtian
Formation	Lance
Length	38
Width	17
Thickness	4
Side	R
Position	
Hardener	Cyanoacrylate

Media

Map

360 View

Click images to zoom

Media

Map

360 View

Click images to zoom

What We Have Learned

- For fifteen years, our techniques have enabled us to work more quickly, efficiently, and accurately than older methods would allow

- As we have developed, we have gradually altered criteria for collection, so that we are not inundated with irrelevant data

- We have expanded our fleet of GPS “rover” units to four, allowing us to keep up with as many as eight quarries over a wide area

Converting to Digital

- Cost to convert to digital is decreasing every year
- Complete RTK GPS systems under $15,000
- GIS software is available with academic pricing
- Georeferencing 2,000 fossils takes two weeks of focused labor

Outreach and Education

- We have capitalized on the interest of young people in dinosaurs to make science attractive

- Presently building a new science museum showcasing every step from “bones in ground” to “data in computer”

- Our goal is to encourage interest in paleontology by non-scientists.

Conclusion

Over the last 15 years, we have collected 20,000 specimens using these techniques.

The data we collect are available to anyone wishing to study dinosaur taphonomy.

We are endeavoring to preserve the data as faithfully and completely as current technology allows.