PROJECT CASE STUDY

Dig To Display:

Transforming Dinosaur Bone Asset Management with InfraMarker RFID and GIS

TECHNOLOGY:
GIS + RFID

INDUSTRIES:
Palentology / Archeology / Curation

SPONSORS:

Earth Sciences Foundation, Inc.

Standing Rock Sioux Tribe

Berntsen International, Inc.
Esri
HID

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Abstract

Tracking and managing artifacts at archaeological excavations, through transport to research facilities, museum display and storage has been a persistent issue with no universal solution. This study examines the novel application of existing technologies to track, manage and share data from 347 dinosaur bone fossils from dig to display.

Radio Frequency Identification (RFID), used with Geographic Information Systems (GIS). was used to track 347 dinosaur bone fossils from dig to display. This approach was found to reduce field data collection time by 80 percent, deliver nearly perfect accuracy in artifact tracking and significantly reduce administrative burden while being user-friendly in the field.

The study's authors concluded that this approach has the potential to transform paleontology's current method for fossil management, while delivering completely new benefits.

1. RFID tagging means that each fossil can be immediately and accurately identified and its data accessed for updating at any time during the research and curation process.

2. Instant access to real-time artifact data is available to related organizations, such as site managers or fossil owners.

The RFID/GIS approach has clear benefits for any industry that must manage thousands of discrete assets through space and time, from agriculture to manufacturing to utility management.

Overview

Headlines about long-lost museum artifacts suddenly re-discovered in storage at the same museum appear regularly. This speaks to a pervasive problem with discovery and curation – keeping track of thousands of different kinds of artifacts through time and space.

The problem can be addressed by applying asset management techniques used in many industries today. In this study, the participants combined Radio Frequency Identification (RFID) asset identification technology and Geographic Information Systems (GIS) to capture bone data and track dinosaur fossils from discovery in the field to display in a museum.

Specifically, this case study examines the results of this approach when applied to the collection of 347 specimens discovered on Standing Rock Sioux lands in South Dakota. Berntsen International provided the equipment and software to manage the process, while The Earth Science Foundation (ESF) Inc. conducted the in-field excavation, documentation and handling of paleontological specimens located on the land of the Standing Rock Nation in South Dakota.

The bone tracking and management process is simple. Each discovered fossil was 'tagged' in the field with a tiny HID RFID marker to establish a unique digital and physical ID. That ID, and contemporaneous information, was captured by a field tech using a tablet with data collection software connected to a GIS platform. RFID scans of the bone's tag tracked the bone as it moved through various zones from field to storage to cleaning to display, adding data to its GIS record. Simultaneously, hundreds of miles from the dig site, the contractor's GIS platform displayed a map of original and current bone location and status as it moved from field to institute. Throughout the process, all RFID interrogation data was collected in the cloud, providing near real-time visibility of bone status by auditors hundreds of miles from the dig site.

The study found that the RFID/GIS asset management process reduced field data collection time by 80 percent, created authoritative tracking of bones through the cycle from field to museum, and enabled easy data sharing and auditing of field work by related organizations, in this case, the Standing Rock Sioux Tribe. Additionally, the use of RFID/GIS hardware/software in the tracking and preservation of fossils reduced the administrative burden of fossil inventory management and expanded data accessibility through sharing of GIS access.

Results found a reduction of field data collection time by 80 percent, nearly perfect tracking of bones through the cycle from field to museum, and enabled easy data sharing and auditing of field work by related organizations.

Background

Traditional practices of managing paleontological specimens are fraught with inefficiency and error, leading to problems in asset tracking and future analysis, as demonstrated by ESF's workflow.

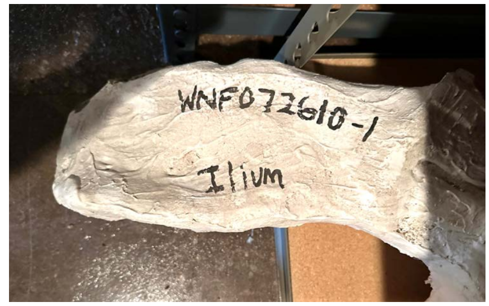
Previously, during excavation, fossils were identified with a field number that included the site, discovery date, anatomical features and species information. Then each fossil was packed in foil, plaster, or bags for shipment and future classification, analysis and research.

Simultaneously, fossil details were recorded in a field notebook alongside coordinates, a sketch, and the field number. However, once the fossil left the field, the notebook was often separated from the specimen resulting in data loss during transfer to storage.

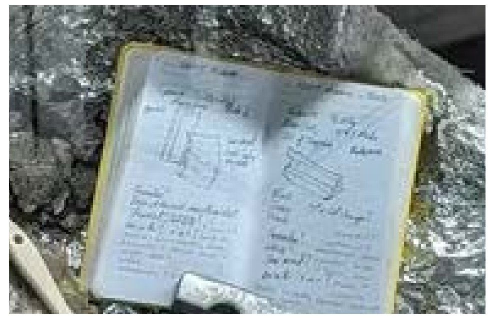
In the storage facility, fossils were placed on numbered shelves and tracked using a paper spreadsheet. This manual system caused inconsistencies and obscured fossil location, hindering research.

Further exacerbating the tracking issue, preparing fossils for study detached their protective jackets, breaking the link to their field numbers and critical context.

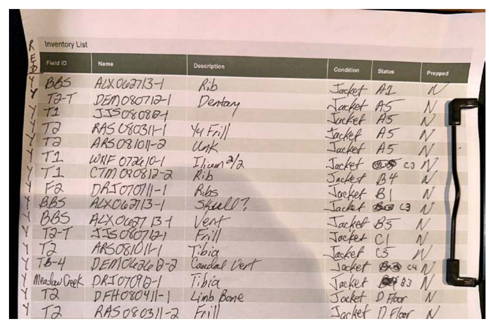
The reliance on basic identification, paper records, and physical separation hindered classification, retrieval, and analysis. Berntsen's RFID marking products and InfraMarker software integrated with ESRI's ArcGIS platform addressed these challenges and introduced an organized workflow for enhanced data management in paleontology.



Traditional identification method: Jacketed fossil marked with field number and species anatomy name.



Typical field notebook.


Inventory List

Field ID	Name	Description	Condition	Status	Prepped
BBS	ALX062713-1	Rib	Jacket	A1	N
T2-T	DEM080712-1	Dentary	Jacket	A5	N
T1	JJS080812-1		Jacket	A5	N
T2	RAS080311-1	1/4 Frill	Jacket	A5	N
T2	ARS081011-2	Unk	Jacket	A5	N
T1	WNF072610-1	Ilium 2/2	Jacket	C3	N
T1	CTM080812-2	Rib	Jacket	B4	N
F2	DRJ070711-1	Ribs	Jacket	B1	N
BBS	ALX062713-1	Skull?	Jacket	C3	N
BBS	ALX062713-1	Vert	Jacket	B5	N
T2-T	JJS080712-1	Frill	Jacket	C1	N
T2	ARS081011-1	Tibia	Jacket	C5	N
TB-4	DEM062612-2	Caudal Vert	Jacket	C4	N
Meadow Creek	DRJ070912-1	Tibia	Jacket	B3	N
T2	DFH080411-1	Limb Bone	Jacket	D Floor	N
T2	RAS080311-2	Frill	Jacket	D Floor	N

Traditional inventory tracking sheet.

Shelved fossils after inventory.

Methodology

Equipment and software from Berntsen International, HID, TSL, Apple and Esri were used for RFID tagging and mobile data collection.

Hardware:

- HID Slimflex RFID tags
- TSL RFID Readers connected via Bluetooth to
- iPads ruggedized for field work

Software:

- Esri's Survey123 survey data collection app integrated with InfraMarker RFID software
- ArcGIS Online, the data repository for all field information.

Hardware used: TSL RFID Reader, HID zip-tie RFID tag and ruggedized iPad loaded with InfraMarker RFID middleware and Esri's Survey123 data collection software.

Procedure for bone tracking from field to display

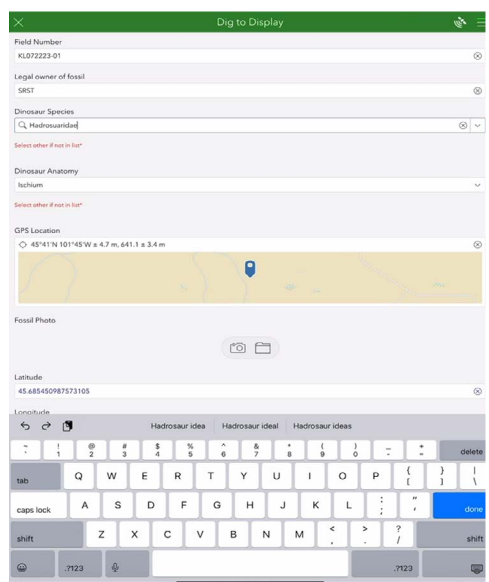
Once a specimen is identified and prepared to be removed from the ground, the field technician executes the following steps.

Step 1: 'Tagging' the fossil with a unique RFID bone identifier

When the fossils are ready to be lifted from the ground, the field technician accesses the ESF "Dig to Display" Survey123 form on a mobile device. The survey form includes a standardized set of questions to complete for each fossil.

The questions include specific identifying information about the fossil, including precise location, owner, species, anatomical part and so on. Photos of the fossil in situ (in its original location including a scale), along with field notes, schematics, other data or files, and metadata such as date/time of action are added to the fossil record through the survey form.

Preparing the specimen to be lifted from the ground.



Screen capture of the custom "Dig to Display" form displayed in Survey123

Step 2: Adding paleontology data to the tag and GIS asset record.

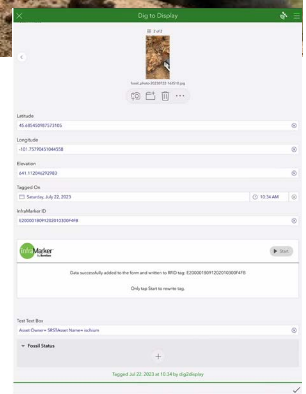
A TSL RFID scanner is used to write basic fossil data to the tag using the InfraMarker functionality integrated with the Survey123 mobile app. The field tech activates the scanner to write to the tag through the app, writing the tag.

The data included on the tag is:

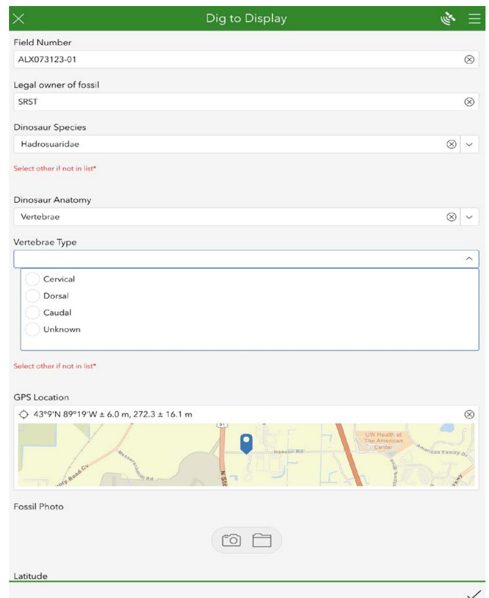
- Asset owner
- Asset description
- Original asset coordinates
- The unique identification number

Additional information such as field notes, photos are captured by the field tech and using the Survey123 data collection form.

The tag data and related information are then associated with the fossil's related record in Survey123, and the field process is complete.



In the field, the technician scans the RFID tag and writes identifying data to it using the InfraMarker middleware.



The EFS "Dig to Display" Survey123 form includes a specific set of questions for each fossil. Photos and other files can be added through this app.

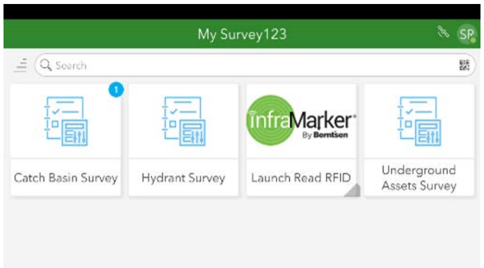
Step 3: Prepping the bone and RFID tag for travel.

Once the bone data is captured to tag and GIS, the RFID asset identifier is zip-tied to the bone or sealed with the bone in a foil package assuring that the physical ID always stays with the related fossil.

Examples of the types of HID RFID used for fossil tagging:

Tracking the bones from field to display

The project team wished to have auditable tracking and real-time location of each fossil as it moved through standard workflow 'zones' such as storage, prep, study, and display. That process was executed using the RFID reader and the Survey123 mobile application with InfraMarker.



Screen capture of surveys and access to the InfraMarker RFID read tool.

Locating a Bone and Updating Status/Location

A technician launches the Survey123 software and executes an InfraMarker RFID 'read' action to display the tag information of each bone located within a zone (e.g. on a shelf in storage). The RFID scan may read and display one or multiple RFID tags in the zone.

The technician uses the displayed tag information to identify the presence of and confirm the identity of the bone. Once confirmed, the tech selects the desired record to launch the associated record or form and undertake any action related to the bone (e.g. cleaning).

After work completed, the tech scans the bone tag, completes the form, adds any desired information such as new photos, and updates the zone pick list to indicate where the bone is currently located.

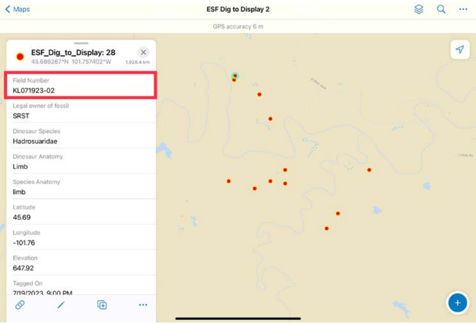
The RFID scan is recorded with a date/time stamp to provide an auditable record and provide a 'last read' lat-long location of the bone action.

Scanned list of specimens on shelf, creating an instant, accessible inventory.

Managing and sharing bone data

ESF manages the progress of their field operations using their ArcGIS online platform. With ArcGIS online, ESF can view a map of bones (original and current location), a complete record of each bone, and a dashboard of daily/weekly/monthly actions.

In addition, third party organizations can be granted access to the login portal of ESF InfraMarker cloud and ingest RFID interrogation data that displays near real-time data on the status and location of their assets managed by ESF. This feature allows organizations such as Standing Rock (bone owners) the ability to 'see' the bone assets and work product of ESF in a dashboard without having to be on-site.



A view of the bones and a snapshot of the associated data in GIS.

Results

The dig staff quickly recognized the benefits of this approach and within 5 days had catalogued 347 fossils using the InfraMarker RFID/GIS approach. The combination of ArcGIS, HID RFID tags and InfraMarker integration improved field efficiency, accuracy, and collaboration among stakeholders.

Key Success Metrics:

99% Accuracy in Artifact Tracking: The InfraMarker RFID system, in conjunction with HID RFID tags, has enabled near-perfect accuracy in tracking the movement and location of dinosaur fossils throughout the preservation process.

80% Reduction in Administrative Efforts: Integration with Esri GIS has led to a significant reduction in manual data entry and administrative tasks, allowing the team to allocate more time to research and conservation activities. Additionally, the same types of data are captured about every fossil, allowing for better analysis.

Enhanced Collaboration and Accessibility: The utilization of these technologies has fostered enhanced collaboration among multidisciplinary teams by providing real-time data access, resulting in an increase in data sharing and joint research initiatives.

Conclusion

Management of paleontological specimens presents persistent problems related to fossil tracking and data sharing. This study found that applying basic RFID/GIS asset management principles significantly improves fossil life cycle management from the dig to the display. Near perfect data accuracy, real-time data accessibility for stakeholders in a simple system can transform current methods of fossil management.

RFID tagging of each fossil, combined with GIS, improves field operations by eliminating the challenge of fossil identification and significantly reducing record keeping errors that had been caused by paper files becoming disassociated from the fossil. Field work is improved by having the entire history of a fossil available to the tech in the field through their mobile device. The system is intuitive and training is minimal.

Stakeholder benefits of transparency (viewing field operations in near real time) and traceability (audit trail of RFID interrogation reads). Correct identification of fossils in storage is simple, quick and accurate.

Expanded use of the system is recommended to quantify long-term benefits of RFID/GIS management of fossil artifacts.

Partners

Earth Sciences Foundation, Inc. (ESF): This non-profit supplied the people and paleontology expertise for the study. The Earth Sciences Foundation Inc. is focused on raising awareness about Earth Sciences and providing the public with opportunities to get involved in field work and study. This organization led the field implementation for the study. Their knowledge of excavation and fossil preservation helped integrate new tech while respecting specimens' delicacy.

Standing Rock Sioux Tribe: The paleontological site location lies on Standing Rock Sioux land and the tribe was a key supporter of the study. The project aligned with their key goals of preserving history and science while honoring cultural significance.

Berntsen International, Inc.: The central solution provider and integrator of RFID and GIS. For more than 50 years, Berntsen has manufactured survey and utility marking products and has been a leader in RFID connected marking. Berntsen's proprietary InfraMarker software and RFID-enabled marking products were used for this case study.

Esri: Esri is a leading global GIS provider. ESRI's ArcGIS is the system of record used for fossil tracking. Its field data collection platforms (Survey123 and Field Maps) enhanced with InfraMarker RFID software was used for the field data collection.

HID: HID is the global expert in secure identity solutions. HID provided advanced RFID tags that were integrated into fossil jackets. These unique tags communicated with the InfraMarker platform, enhancing security and tracking accuracy. Its subsidiary, TSL, provided the RFID readers used to read the HID RFID tags.

For more information about the study, email info@inframarker.com.

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