Image credit: Mark Witton

The relative "value" & potential of the UK's *in-situ* dinosaur track sites

Kirsty Edgar (k.m.edgar@bham.ac.uk), Richard Butler, Jonathan Larwood, Joshua Smith, Luke Meade, Harry Jones, Lewis Haller, Dan Cashmore, Emma Dunne, Sam Scriven & Chris Reedman

UNIVERSITY OF BIRMINGHAM

The skeletal record is incomplete

Sophie the Stegosaurus (NHM, London) = ~85% intact

https://www.nhm.ac.uk/discover/how-to-find-a-dinosaur.html

Why look at dinosaur tracks/trackways?

- In-situ
- More abundant
- Different preservation biases
- Highly complimentary to body fossil record

Life position	Ecology
Distribution	Anatomy
Locomotion	Behaviour
Life history	Interactions

Image credit: US Geological Survey

Skin impression


Image credit: Neil Davies

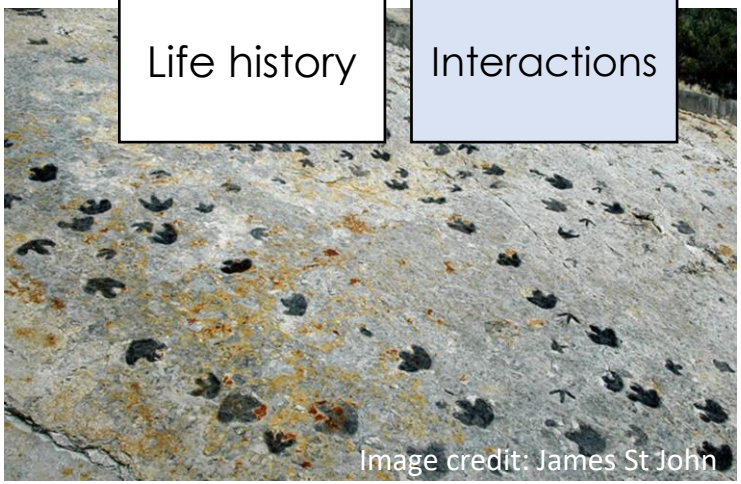
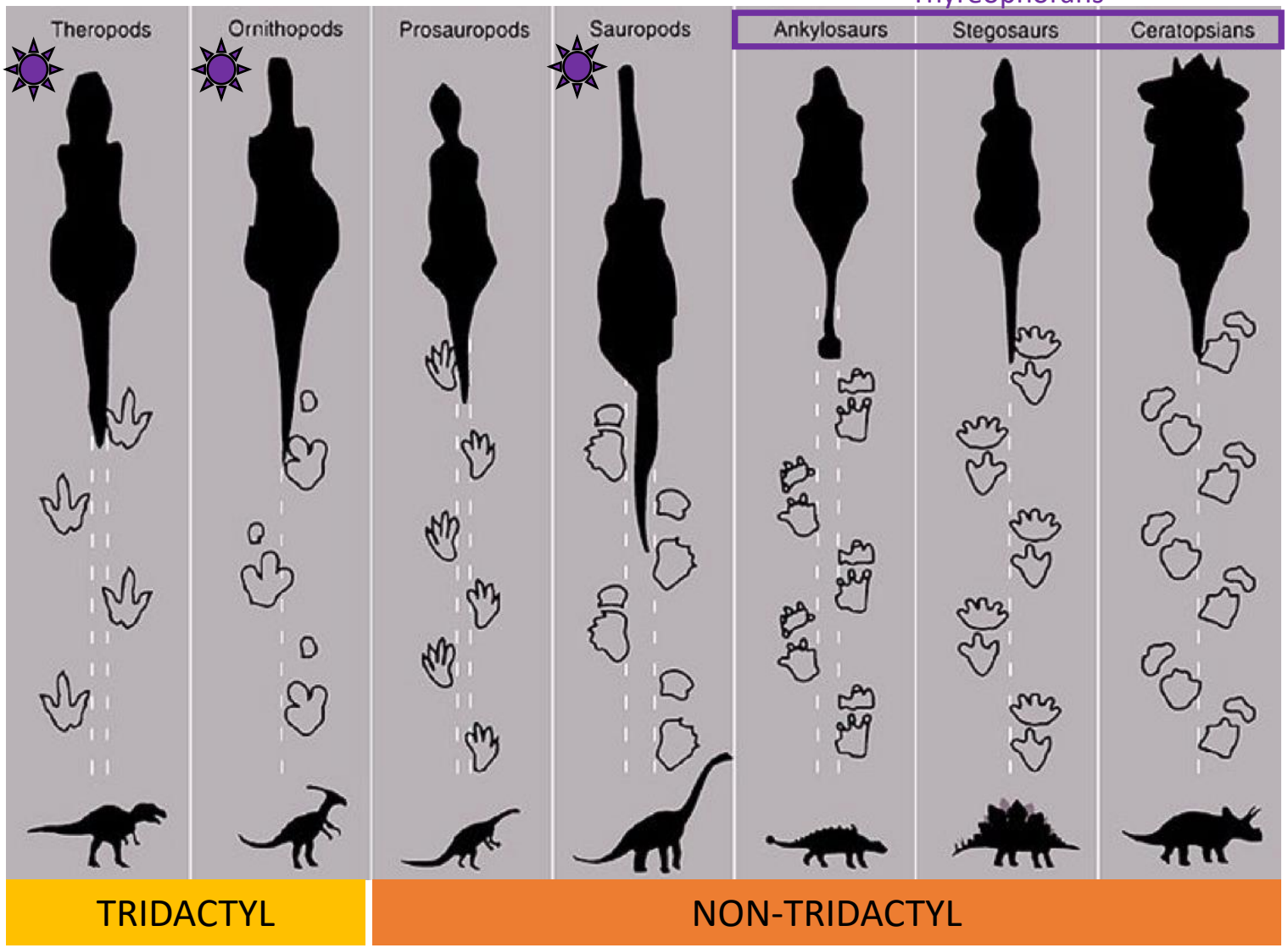


Image credit: James St John

Interactions

Caveats: identifying the trackmaker

https://www.fossilhunters.xyz/defining-dinosaurs/info-veg.html



Rarely find a fossil at the end of the trail…

World’s longest fossilised death track (9.7 m)

Lomax & Racay (2012)

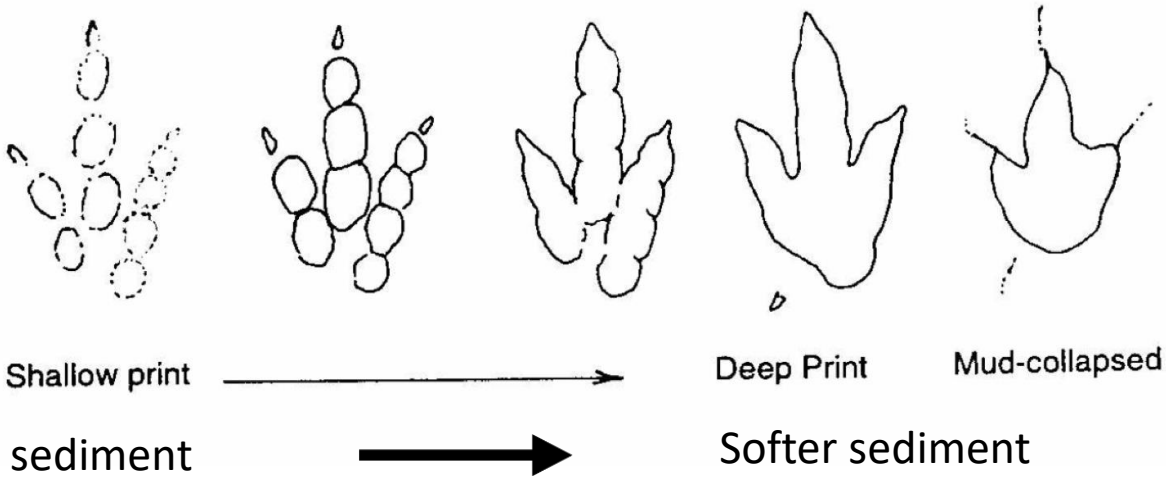
Caveats: identifying the trackmaker

- Sediment (grain size, type & consistency)
- Environmental biases
- Preservation

Conglomerate

Mudstone

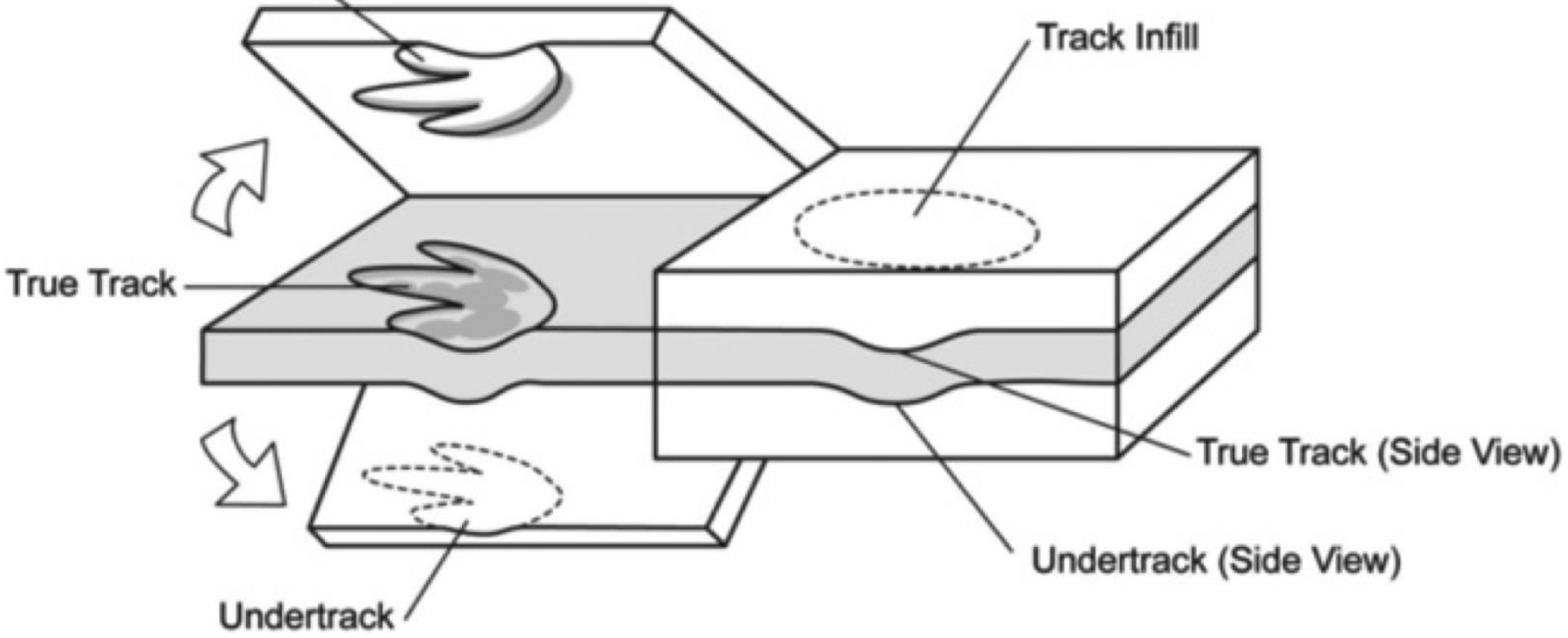
https://geologyscience.com/rocks/sedimentary-rocks/conglomerate/



Thulborn (1990)

Caveats: identifying the trackmaker

Image credit: Neil Davies



https://ucmp.berkeley.edu/science/trackways/trackways2.php adapted from Lockley & Hunt, 1995.

Rich UK dinosaur legacy

2024 is the 200-year anniversary since the first dinosaur, *Megalosaurus was* described by scientists in the 1800s

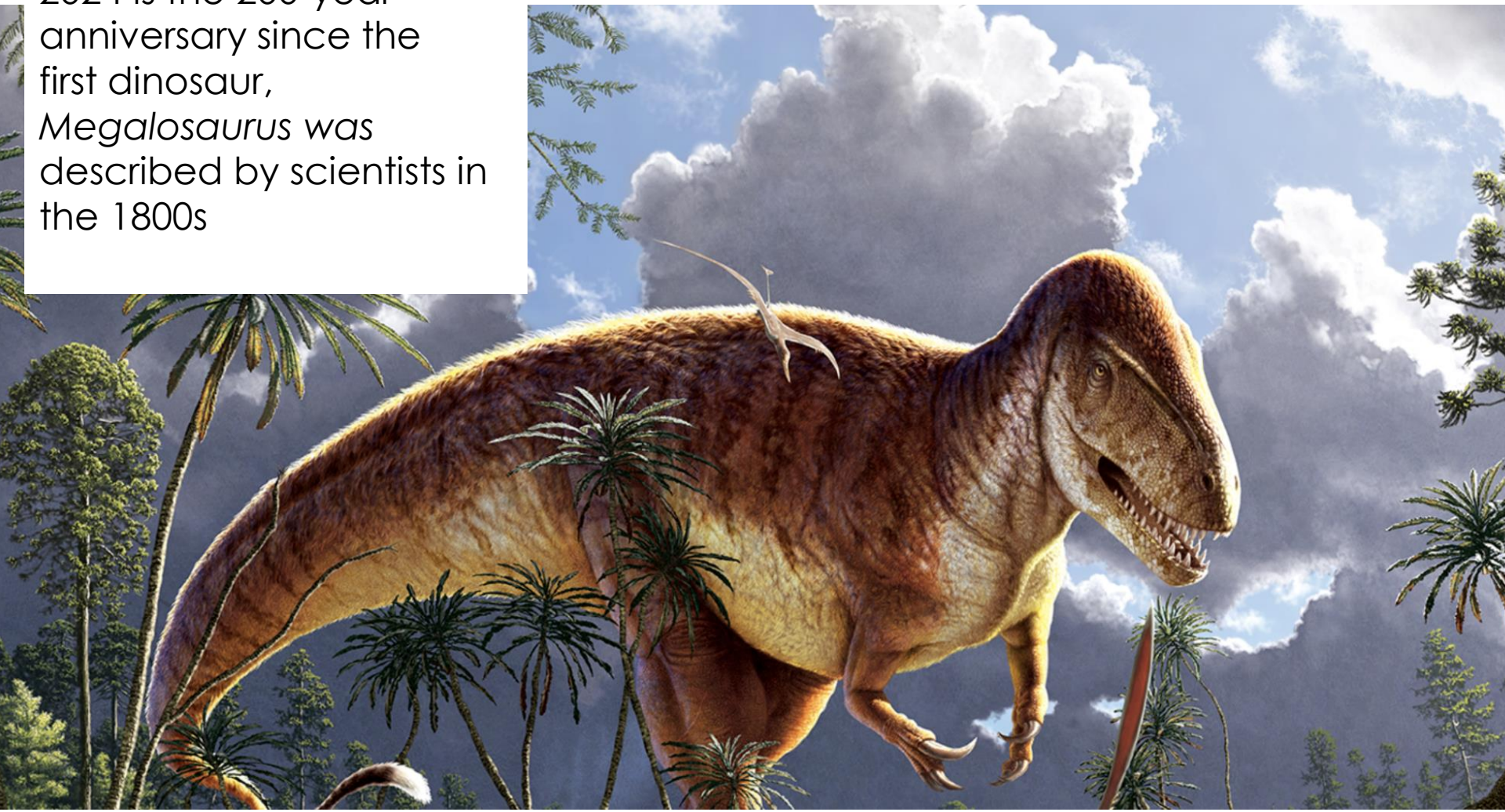


Image credit: Julius T. Csotonyi

Long legacy of dinosaur tracks in the UK

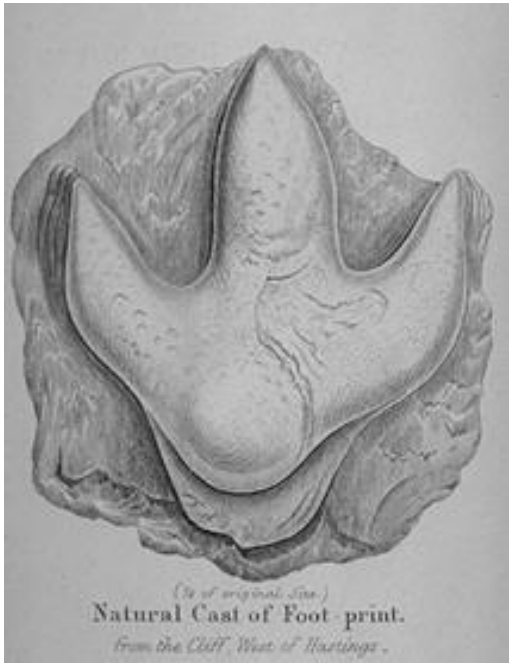


Image credit: Beckles (1854)

Iguanodons

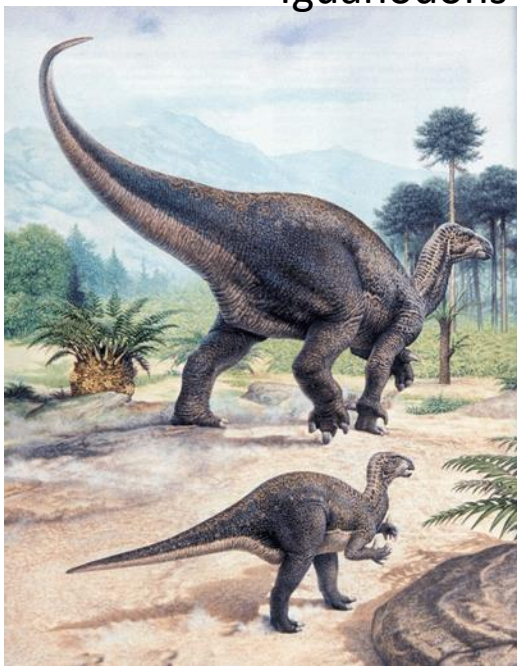
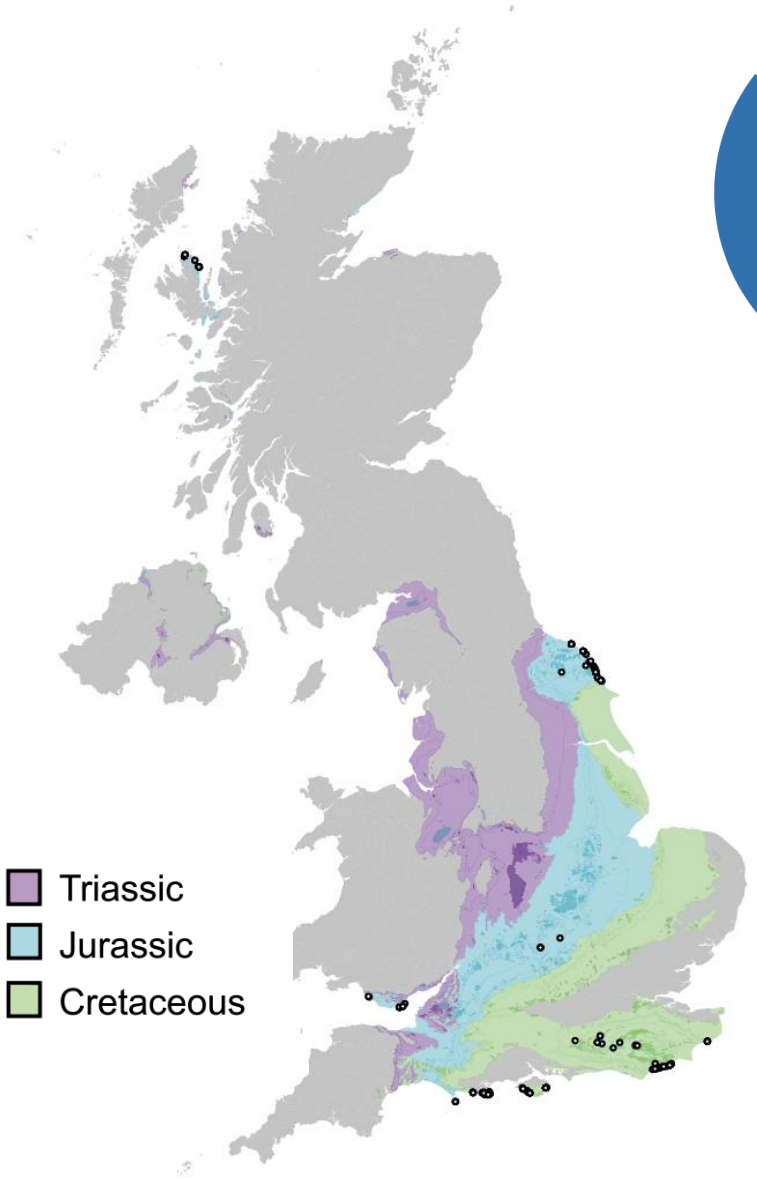
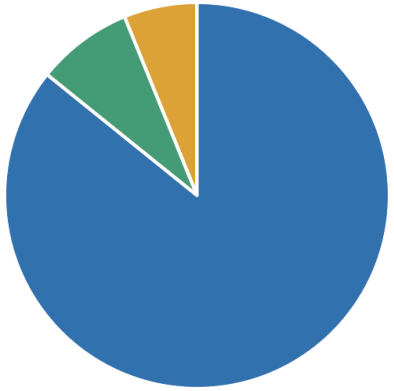


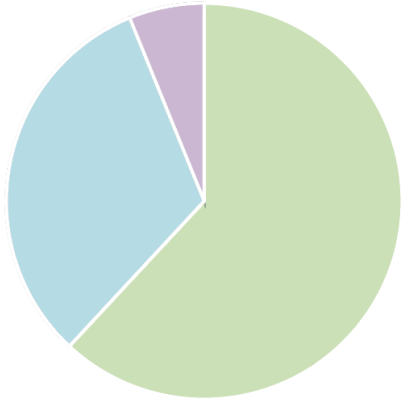
Image credit: John Sibbick

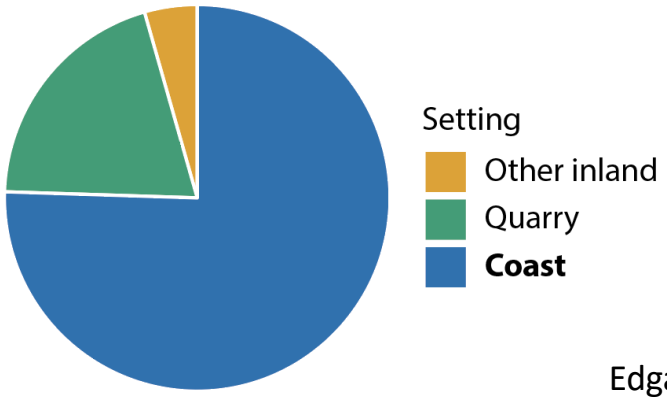
[1] What is the distribution of UK tracks; what do tracks add to our understanding of the body fossil record?
[2] How to measure the value of tracks?
[3] A conservation case study (time dependent)

Hundreds of UK tracks occurrences reported





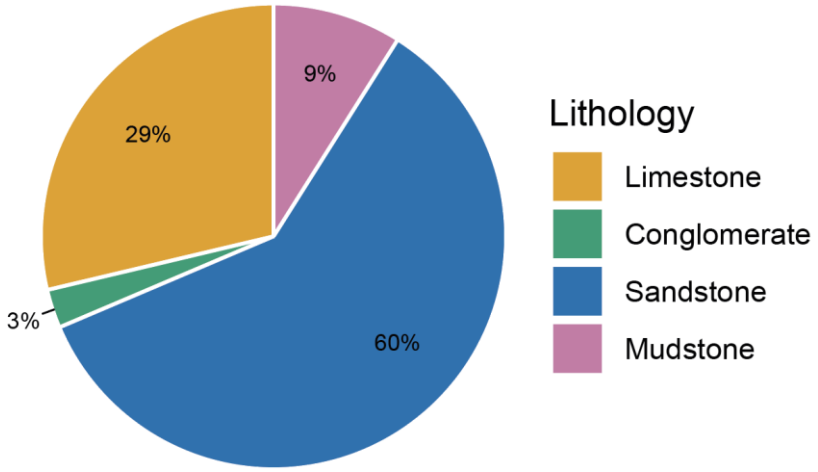


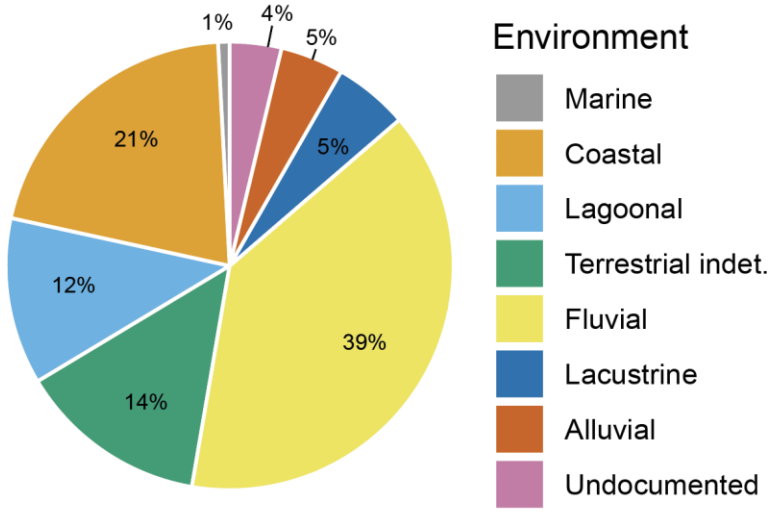


Edgar *et al*. (2023b)

What rocks do we find tracks in? in what depositional environments?

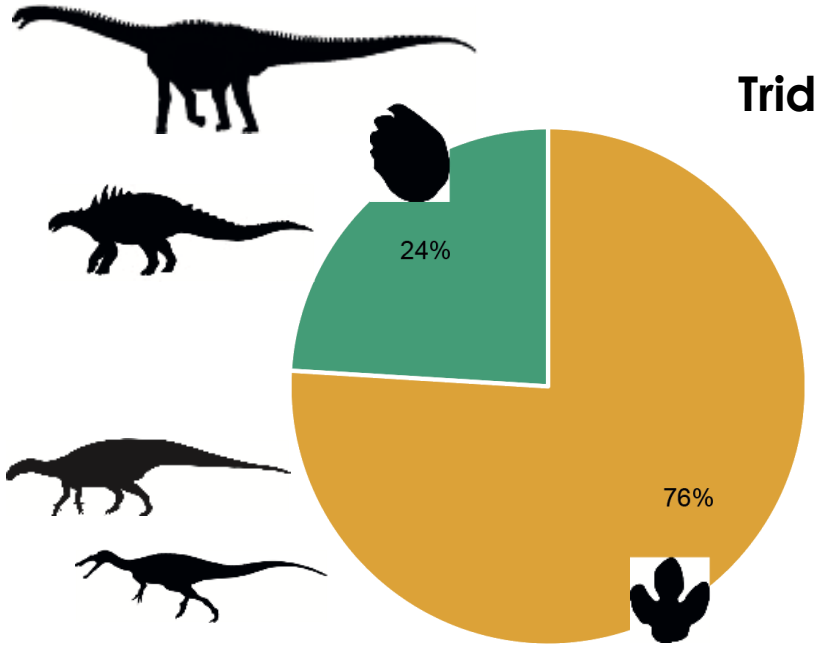
Edgar *et al*. (2023b)





Tracks commonly found in Cretaceous, fluvial sandstones exposed on the coast

What type of tracks are most common?



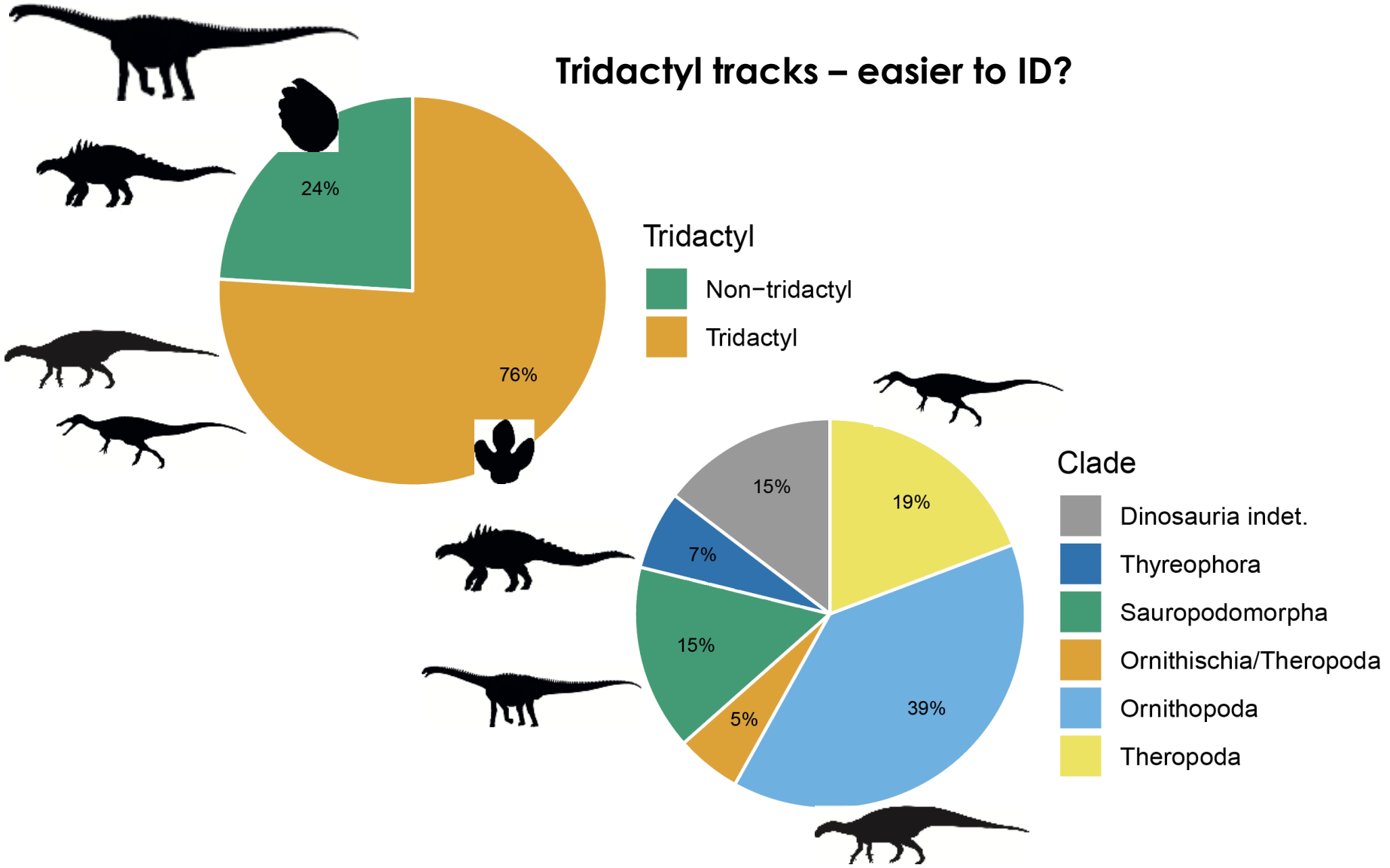
Tridactyl tracks – easier to ID?

Image credit: Marie Woods

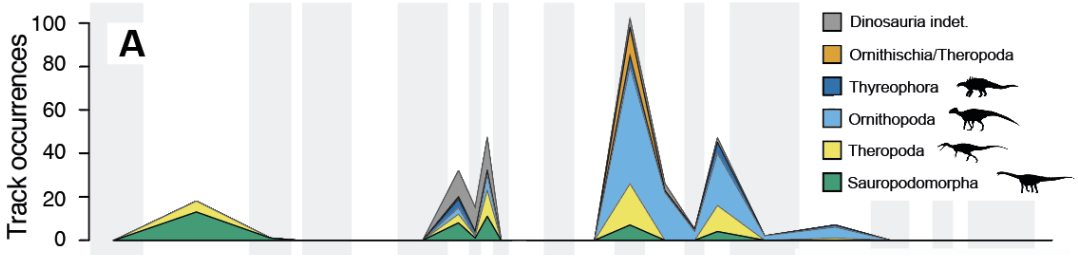
Image credit: The National Centre for Scientific Research

Edgar *et al*. (2023b)

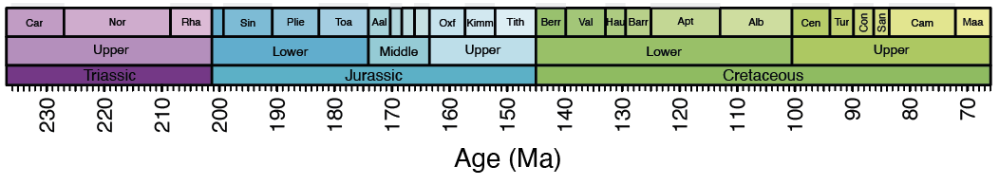
What type of tracks are most common?



Dinosaur tracks in the UK through time

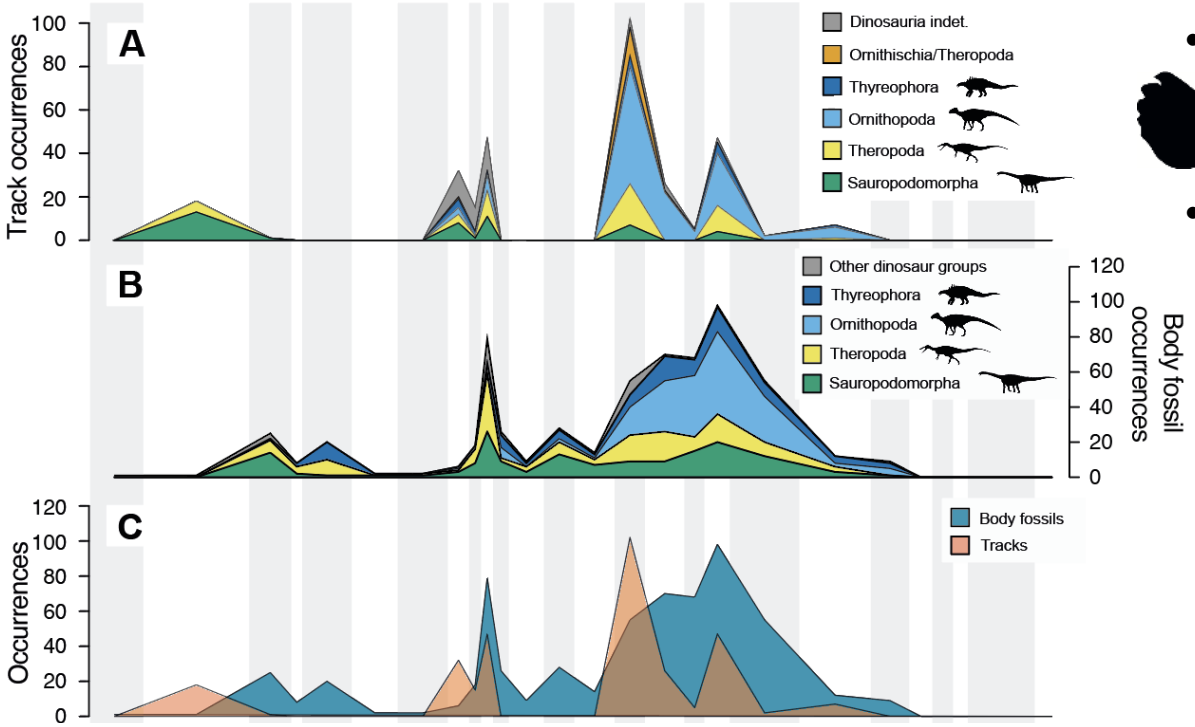


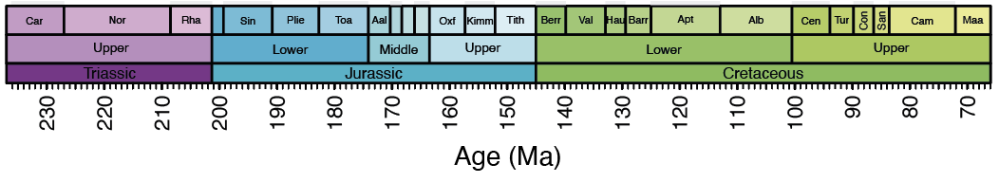
- Dis-continuous record
- Switch from sauropods to ornithopods through time
- Thyreophorans rare



Edgar *et al*. (2023b)

Dinosaur tracks & body fossils in the UK



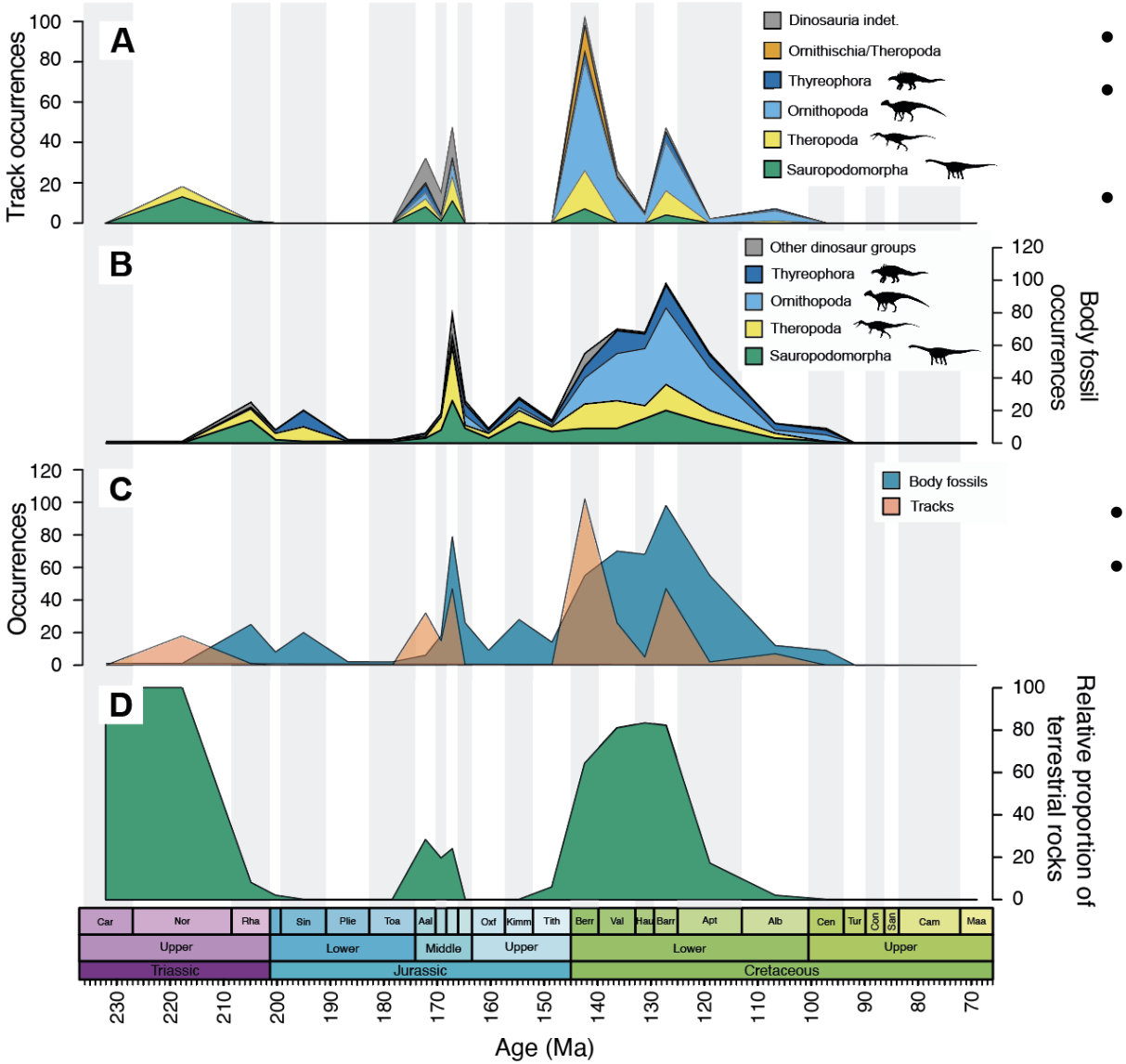


- Dis-continuous record
  Switch from sauropods to ornithopods through time
- Thyreophorans rare
  - More consistently present

- Similar patterns overall
- Higher occurrences in the Cretaceous

Edgar *et al*. (2023b)

Dinosaur tracks & body fossils in the UK

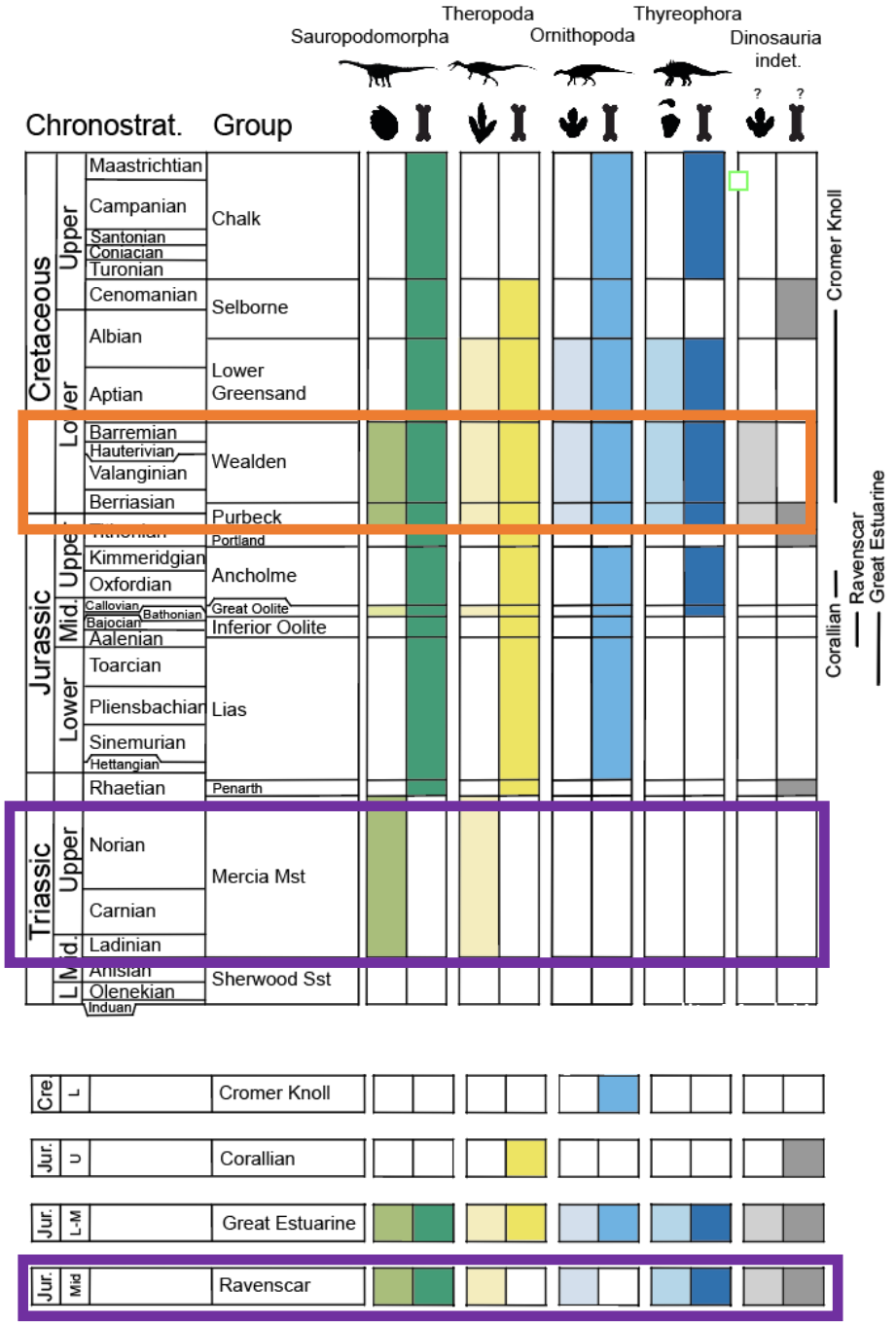


- Dis-continuous record
- Switch from sauropods to ornithopods through time
- Thyreophorans rare
  - More consistently present
- Similar patterns overall
- Higher occurrences in the Cretaceous
  - Correlation of track occurrences with terrestrial rock outcrop area

Edgar *et al*. (2023b)

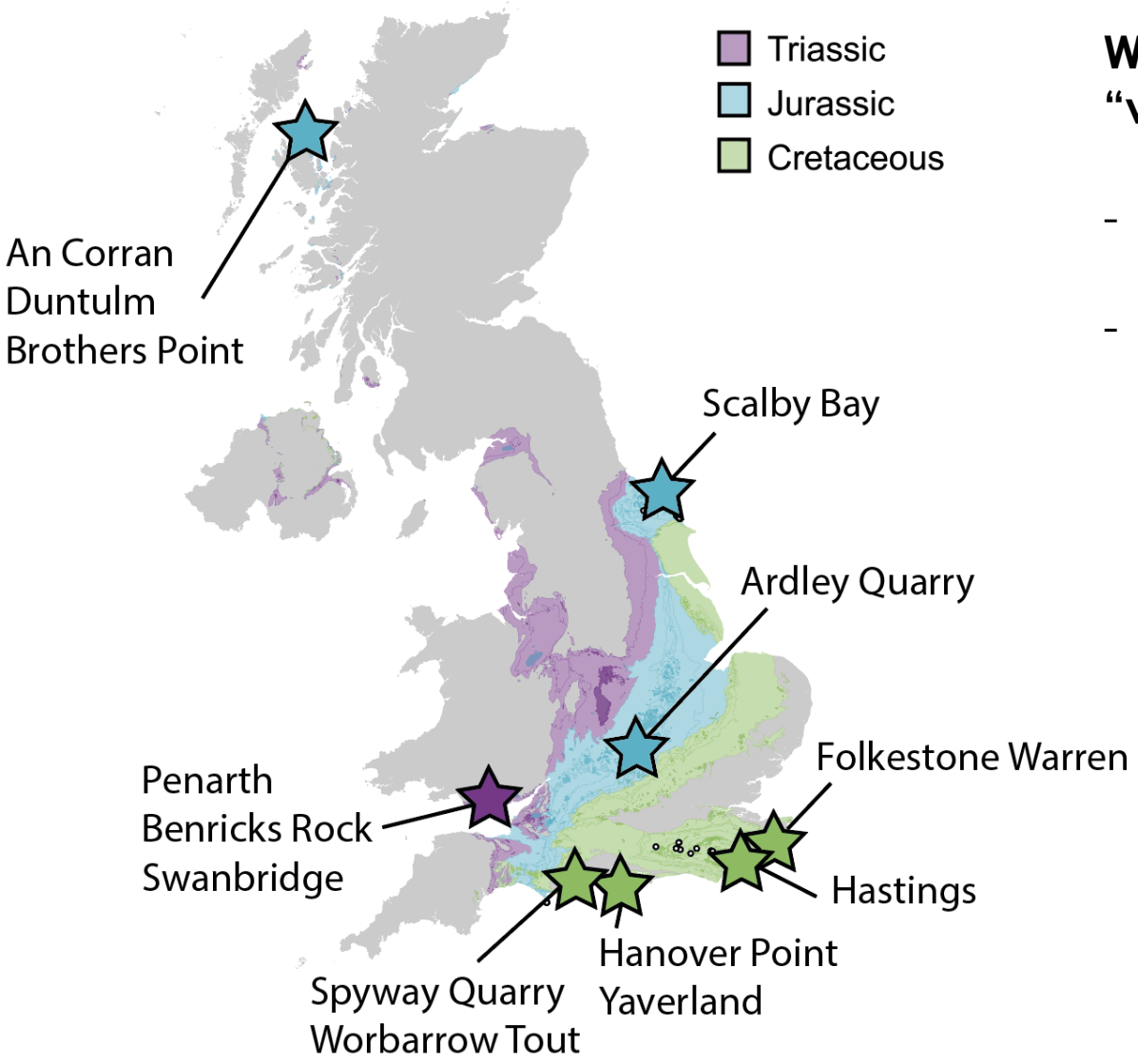
Summary of track & body fossil distributions by lithostratigraphy

- Wealden/Purbeck Groups best represented
- Tracks only evidence we have for some groups/time intervals/areas
- Importance of tracks changes through time with new discoveries



Edgar et al. (2023b)

14 UK dinosaur track sites *in-situ* today



What is the relative "value" of UK track sites?

- State of knowledge
- Priorities & potential for protection, communication & documentation

How to determine the 'value' of sites?

Scheme of Lockley (2010)

SCIENTIFIC VALUE CATEGORIES

1. Size of area
2 & 3. No. of tracks & trackways
4. No. of holotypes
5. No. of track types
6. No of track levels
7. Preservation
8. Historical value
9. No. of scientific publications

CULTURAL VALUE CATEGORIES

10. Educational value
11. Access to site
12. Visitor numbers
13. Management
14. Legal & physical protections
15. Other geological/natural features of interest at site
16. Nearby sites of geological interest

EXAMPLE: Scores for category 1: size of area

Score=	**1**	**2**	**3**	**4**	**5**
Size of area=	<250 m^2	250-999 m^2	1-5 km^2	5-20 km^2	>20 km^2

Results: summary & scientific value

	Scientific value	Cultural value	TOTAL COMBINED SCORE
Bendrick Rock, S. Wales	**31**	13	**44**
Hanover Point, IoW	21		
Hastings, Kent	24		
Brothers Point, Skye	21		
Yaverland, UoW	20		
Duntulm, Skye	17	18	**35**
Ardley Quarry, Oxfordshire	24	9	**33**
Spyway Quarry, Dorset	12	**21**	**33**
An Corran, Skye	13	17	**30**
Folkestone, Kent	15	13	**28**
Worbarrow Tout, Dorset	14		
Scalby Bay, N. Yorkshire	11		
Penarth, S. Wales	9		
Swanbridge, S. Wales	11		
TOTAL POSSIBLE SCORE	**45**	**30**	**75**

High scientific value: larger sites with higher no of types/tracks etc. & stratigraphic levels

Low scientific value: smaller sites with lower no of types/tracks etc. & stratigraphic levels

Results: cultural value

	Scientific value	Cultural value	TOTAL COMBINED SCORE
Bendrick Rock, S. Wales	**31**	13	
Hanover Point, IoW	21	**21**	
Hastings, Kent	24	14	
Brothers Point, Skye	21	15	**36**
Yaverland, UoW	20	16	**36**
Duntulm, Skye	17	18	**35**
Ardley Quarry, Oxfordshire	24	9	**33**
Spyway Quarry, Dorset	12	**21**	**33**
An Corran, Skye	13	17	**30**
Folkestone, Kent	15	13	**28**
Worbarrow Tout, Dorset	14	13	**28**
Scalby Bay, N. Yorkshire	11	14	
Penarth, S. Wales	9	11	
Swanbridge, S. Wales	11	5	
TOTAL POSSIBLE SCORE	**45**	**30**	**75**

Higher cultural value: better developed, easier to access/find

Lower cultural value: more poorly developed, harder to access/find

Results

	Scientific value	Cultural value	TOTAL COMBINED SCORE
Bendrick Rock, S. Wales	**31**	13	**44**
Hanover Point, IoW	21	**21**	**42**
Hastings, Kent	24	14	**38**
Brothers Point, Skye	21	15	**36**
Yaverland, UoW	20	16	**36**
Duntulm, Skye	17	18	**35**
Ardley Quarry, Oxfordshire	24	9	**33**
Spyway Quarry, Dorset	12	**21**	**33**
An Corran, Skye	13	17	**30**
Folkestone, Kent	15	13	**28**
Worbarrow Tout, Dorset	14	13	
Scalby Bay, N. Yorkshire	11	14	
Penarth, S. Wales	9	11	
Swanbridge, S. Wales	11	5	
TOTAL POSSIBLE SCORE	**45**	**30**	**75**

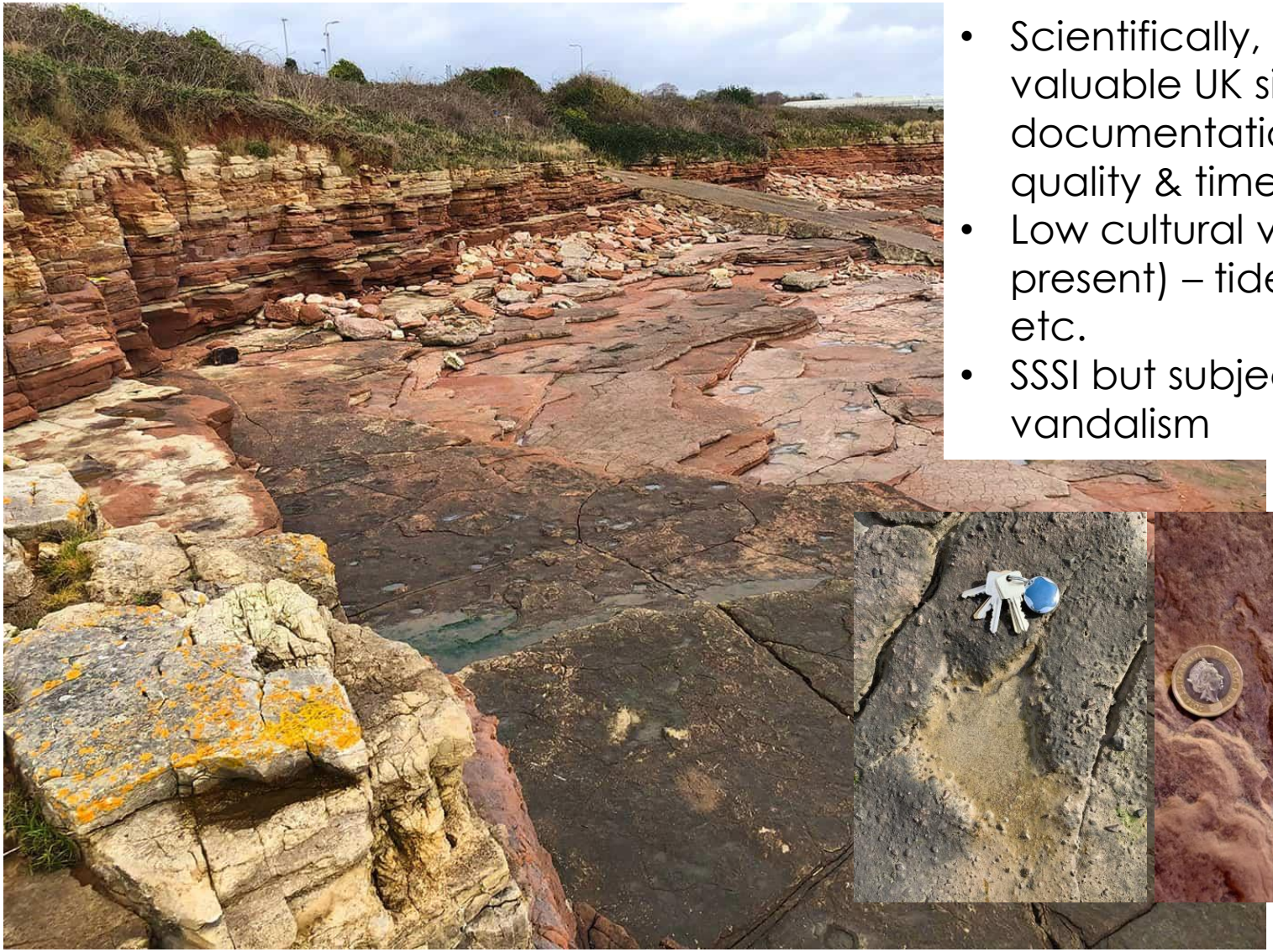
No significant relationship between scientific & cultural value

Top scoring site= Bendrick Rock, S. Wales

~220 Myrs ago

Image credit: Mark Witton

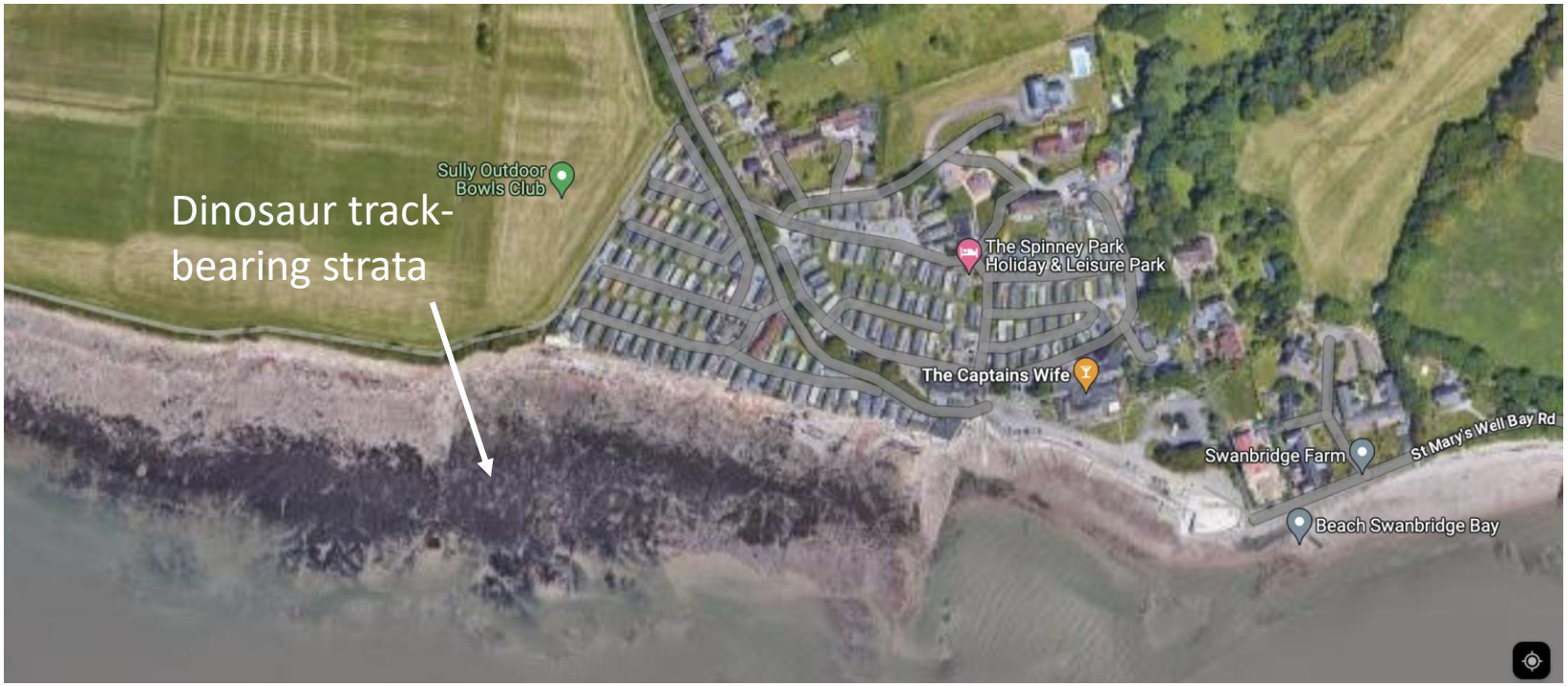
Bendrick Rock in S. Wales, now



- Scientifically, most valuable UK site – documentation of variable quality & time
- Low cultural value (at present) – tides, resources etc.
- SSSI but subject to theft & vandalism

Image credits: www.barry.cymru/history/triassic-barry/ & Wales Online

Lowest scoring site = Swanbridge, S. Wales



Google maps

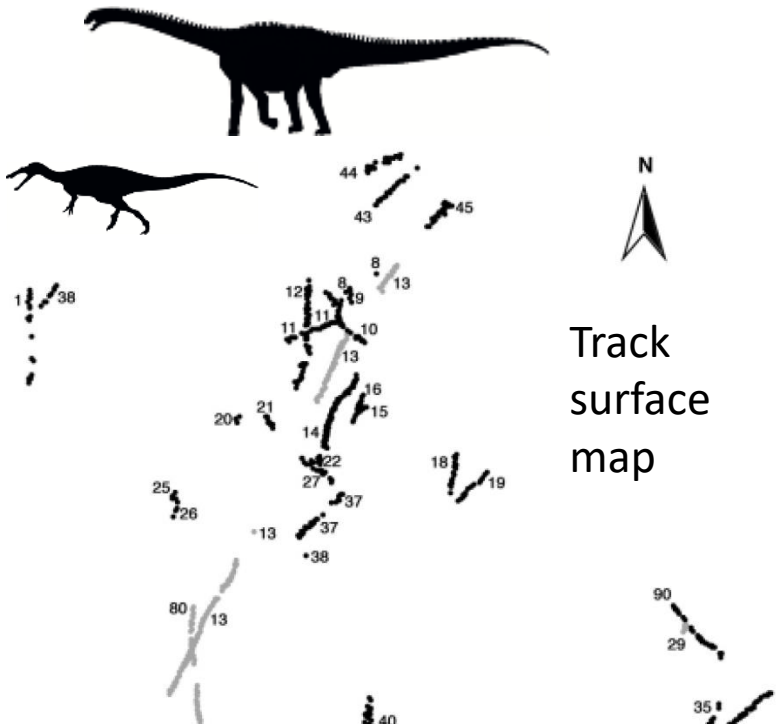
- Low scientific (11) & cultural (5) value
- Limited documentation from 1990's – no images, location, horizon, low abundance & repetition etc
- Not a high priority for development/protection

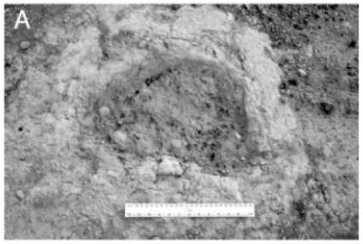
Results

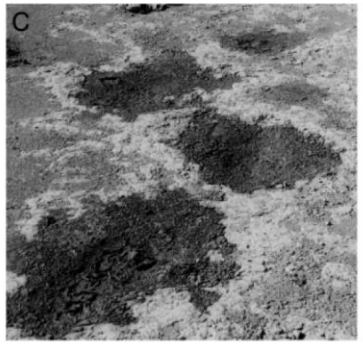
	Scientific value	Cultural value	TOTAL COMBINED SCORE
Bendrick Rock, S. Wales	**31**	13	**44**
Hanover Point, IoW	21	**21**	**42**
Hastings, Kent	24	14	**38**
Brothers Point, Skye	21	15	**36**
Yaverland, UoW	20	16	**36**
Duntulm, Skye	17	18	**35**
Ardley Quarry, Oxfordshire	24	9	**33**
Spyway Quarry, Dorset	12	**21**	**33**
An Corran, Skye	13	17	**30**
Folkestone, Kent	15	13	**28**
Worbarrow Tout, Dorset	14	13	
Scalby Bay, N. Yorkshire	11	14	
Penarth, S. Wales	9	11	
Swanbridge, S. Wales	11	5	
TOTAL POSSIBLE SCORE	**45**	**30**	**75**

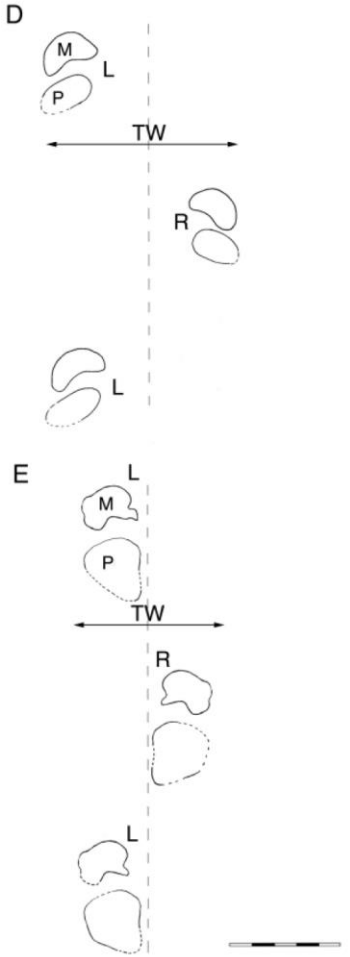
No significant relationship between scientific & cultural value

A quandry: Ardley Quarry, Oxfordshire







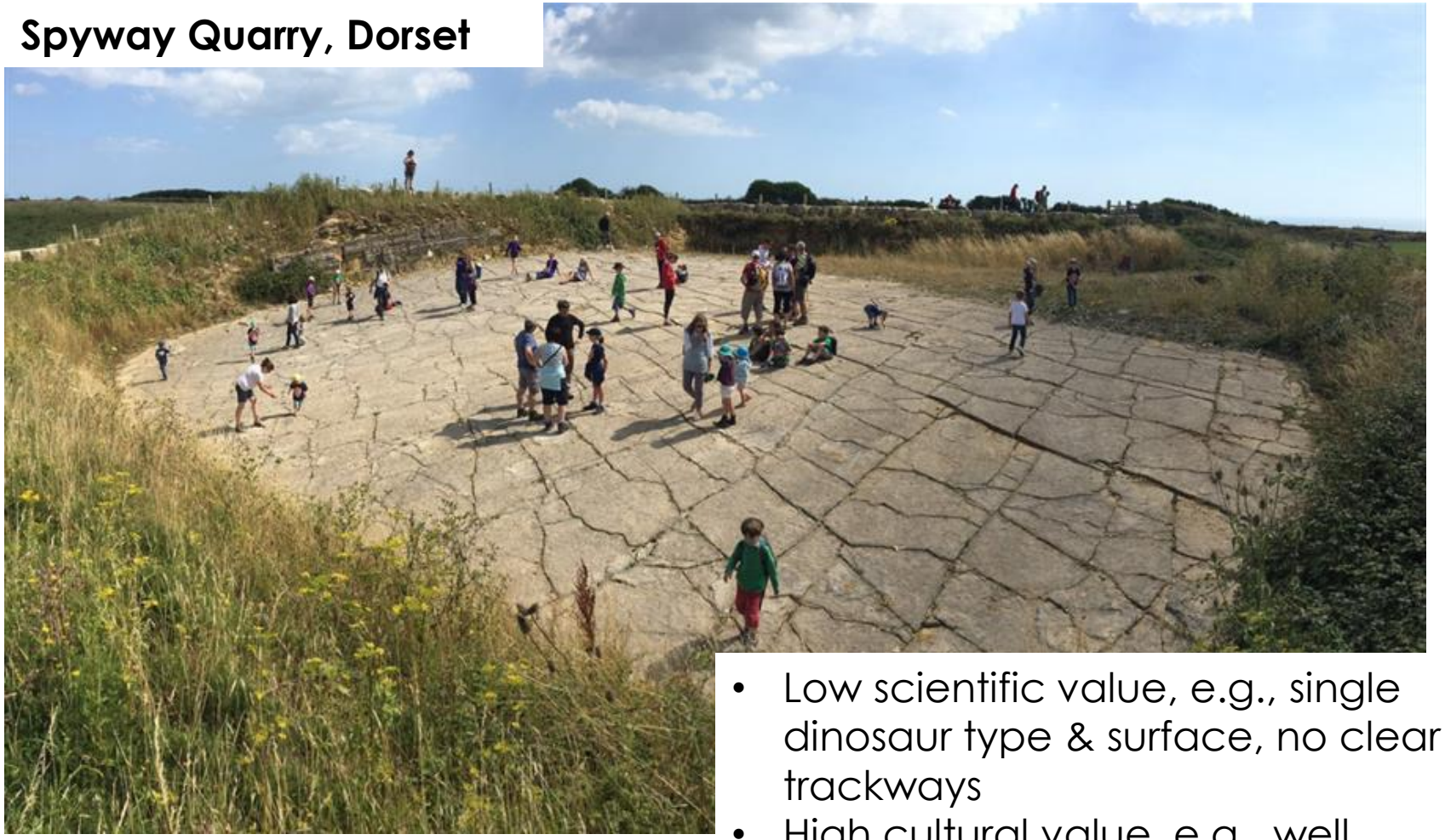


- Largest UK site
- High scientific value (mid-Jurassic), e.g., first change in dinosaur gait; titanosaurs & non-titanosaurs overlap in range; multi-species herds
- Only site a SSSI solely based on tracks
- Access issues
- Competing interests

Day *et al*. (2004)

One of the most accessible UK sites

Spyway Quarry, Dorset

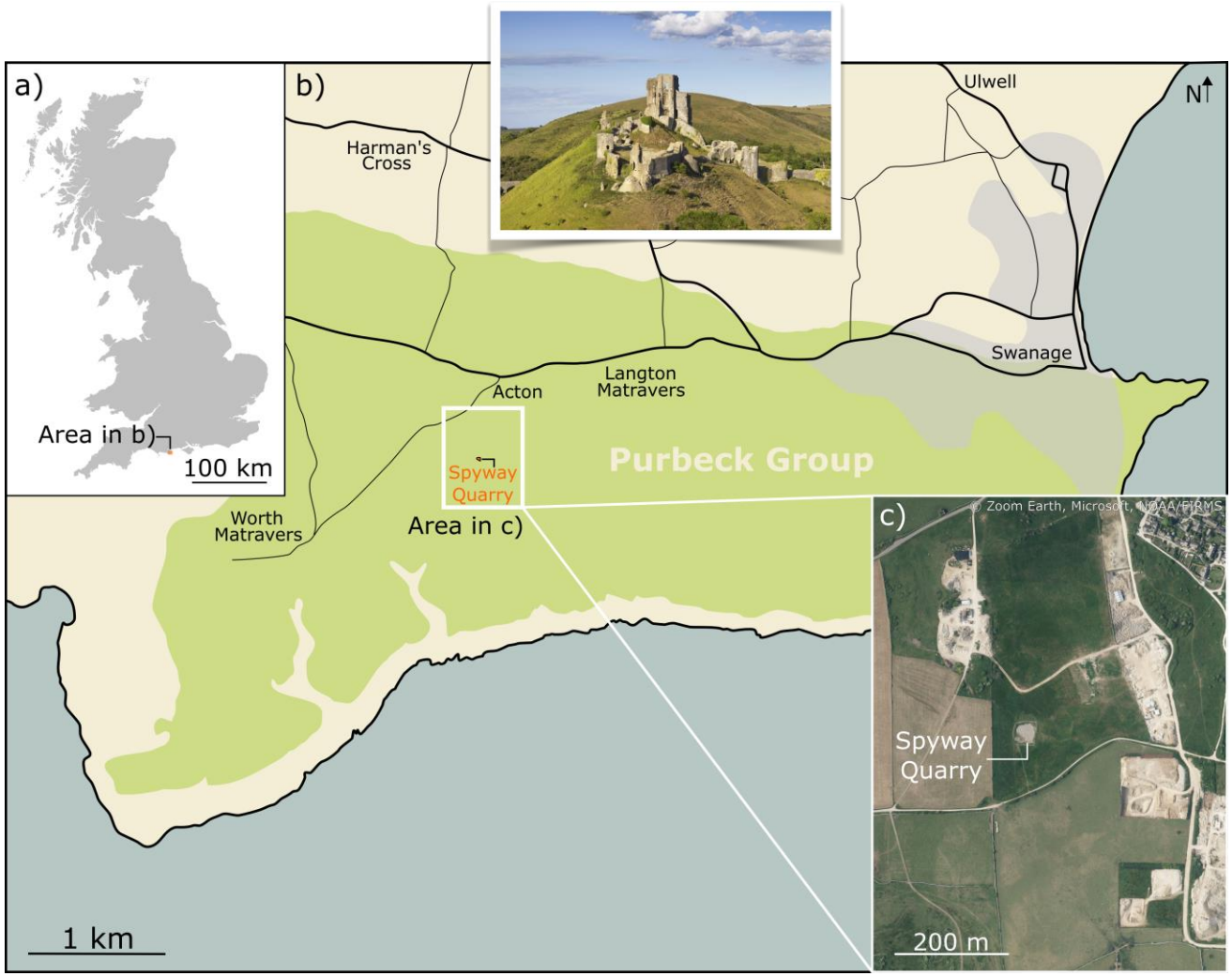


- Low scientific value, e.g., single dinosaur type & surface, no clear trackways
- High cultural value, e.g., well advertised, accessible & visited with some protections

Summary

- Put together an overview of potential for communicating sites to increase cultural value.
- Identified gaps in scientific documentation of sites and the need standard community protocols
- Assessing value is difficult -> nuance & expert knowledge needed; **priorities**

Geoconservation Case Study: Spyway Quarry, Dorset



Edgar *et al*. (2023a)

History of the site

https://sketchfab.com/d.powlesland/collections/dinosaur-footprints

2016

2014

2013

Alan Holiday

National Trust

Keates' Quarry dinosaur footprint site, Intermarine Member, Purbeck Limestone Group (Berriasian), U.K.

J.L. Wright

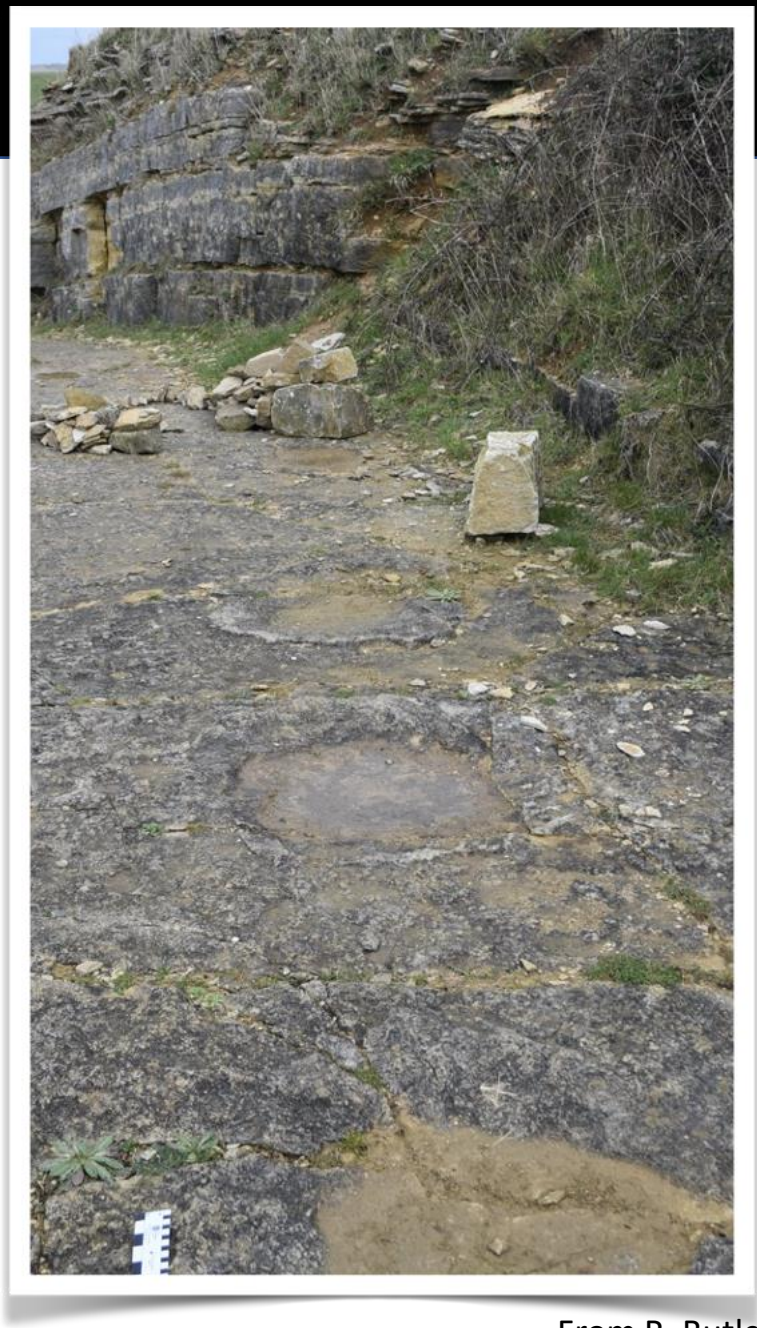
1998

1997

http://www.stone.uk.com/home.html

The site today

Tracks at the site



From R. Butler

Likely trackmakers

Image Credit: Mark Witton

What we did & why

Questions: *How has the site changed since the site was exposed to the public & the elements? Why? Any actions needed?*

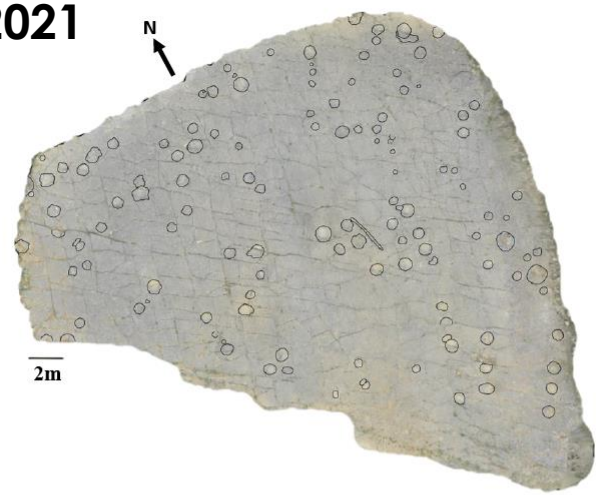
High-resolution 3D models of site

Dinosaur Prints Purbeck LoRes
3D Model

https://sketchfab.com/d.powlesland/collections/dinosaur-footprints

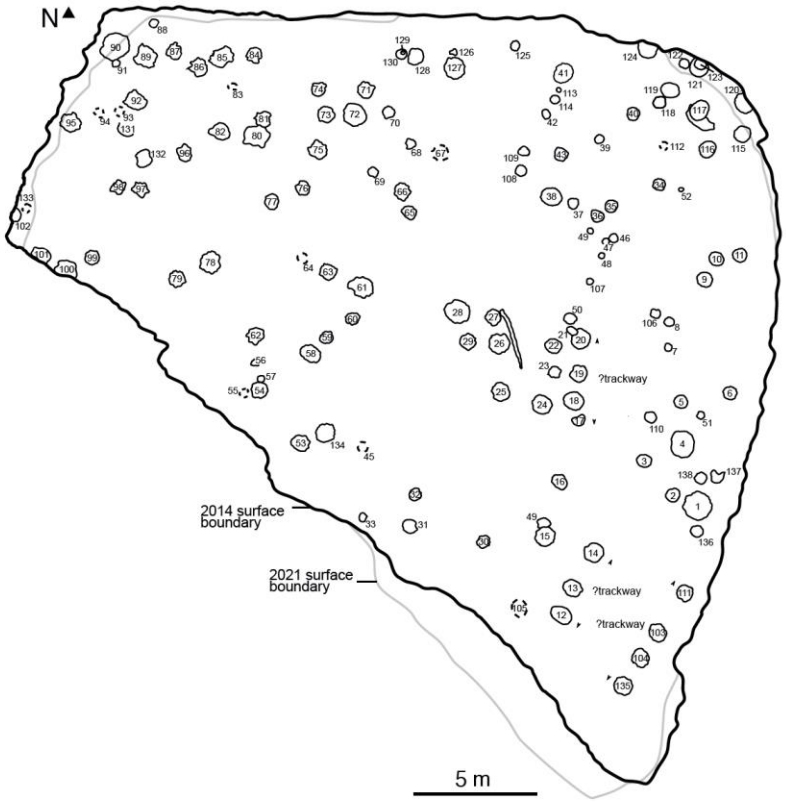
Mapping the site

2021



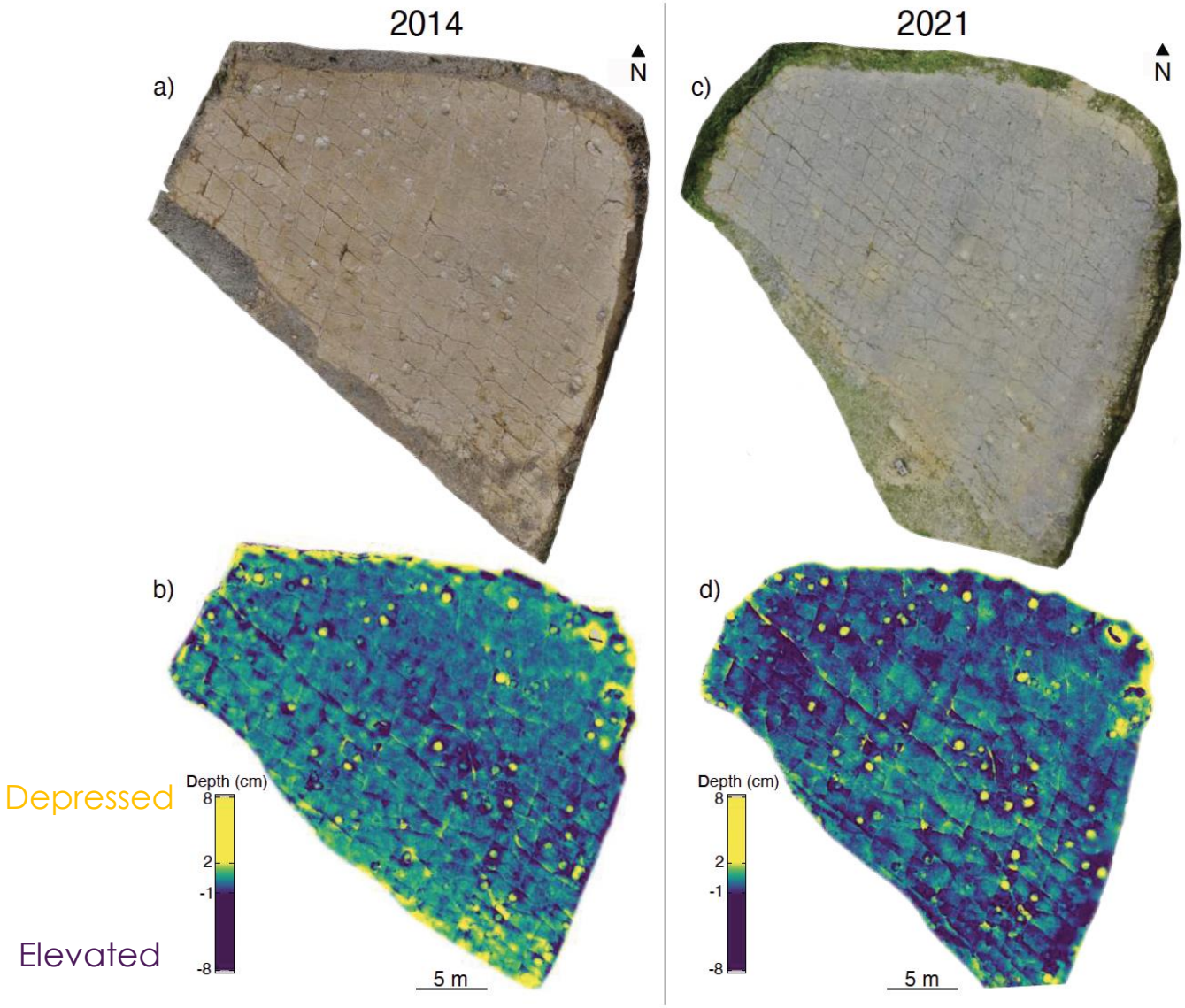
2014

Schematic site map



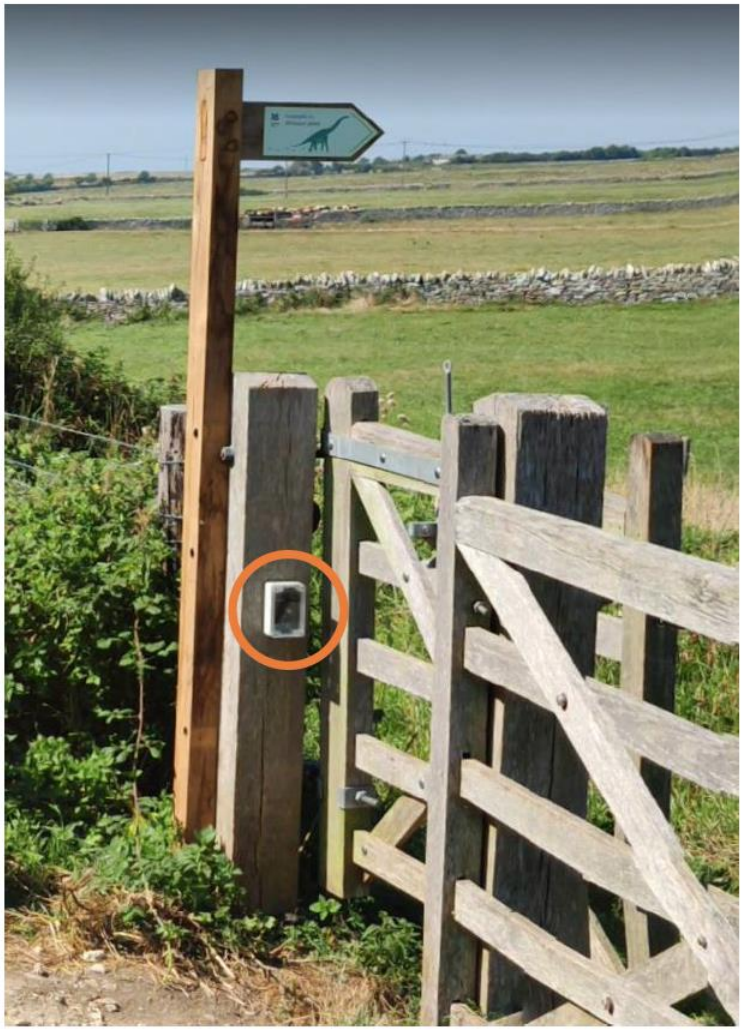
Edgar *et al*. (2023a)

Height maps from photogrammetric models



Edgar *et al*. (2023a)

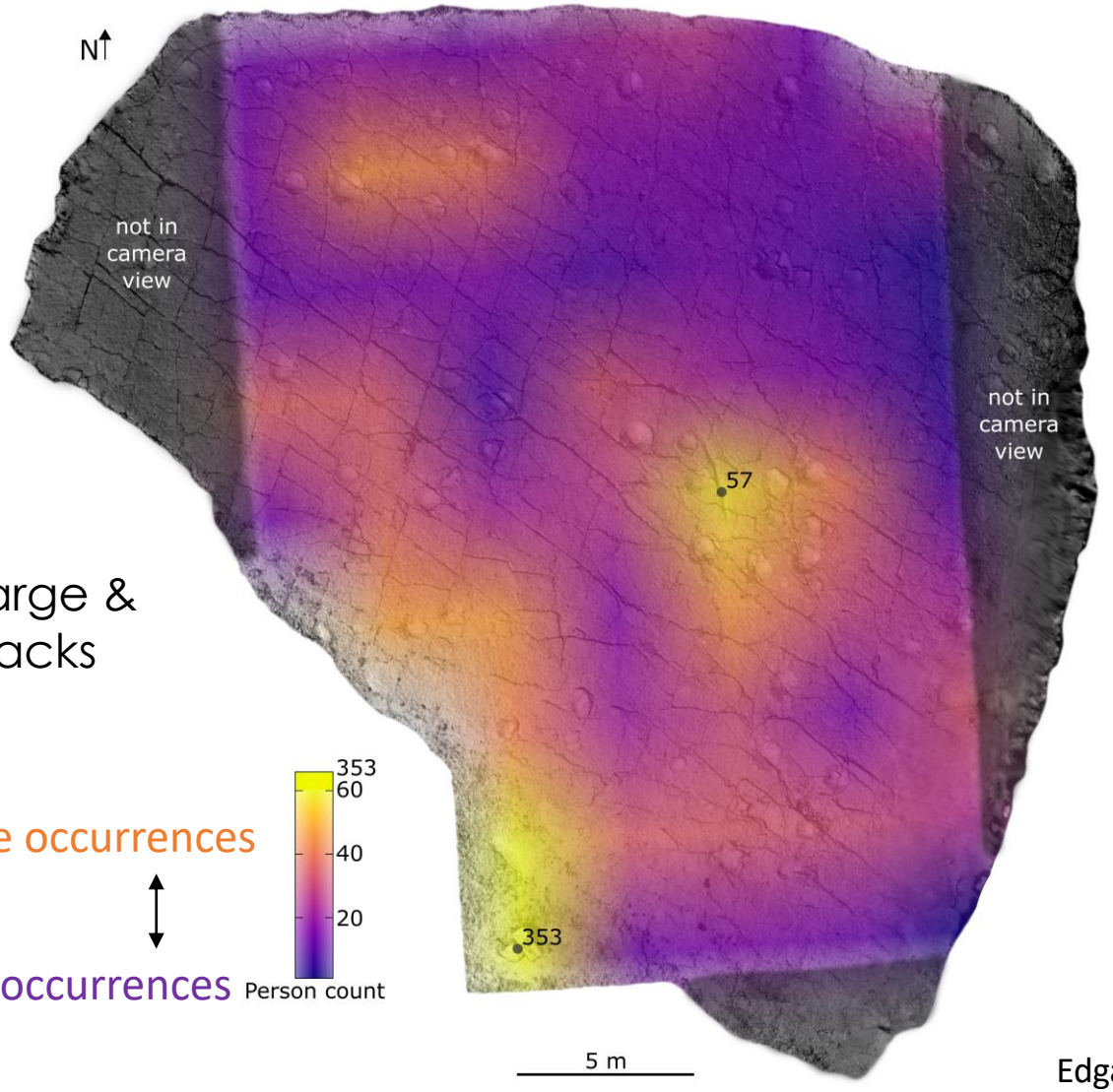
Visitor numbers



- ~10 k visitors per yr
- Weekends & holidays most popular
- Google analytics ~20 min visit

Edgar *et al*. (2023a)

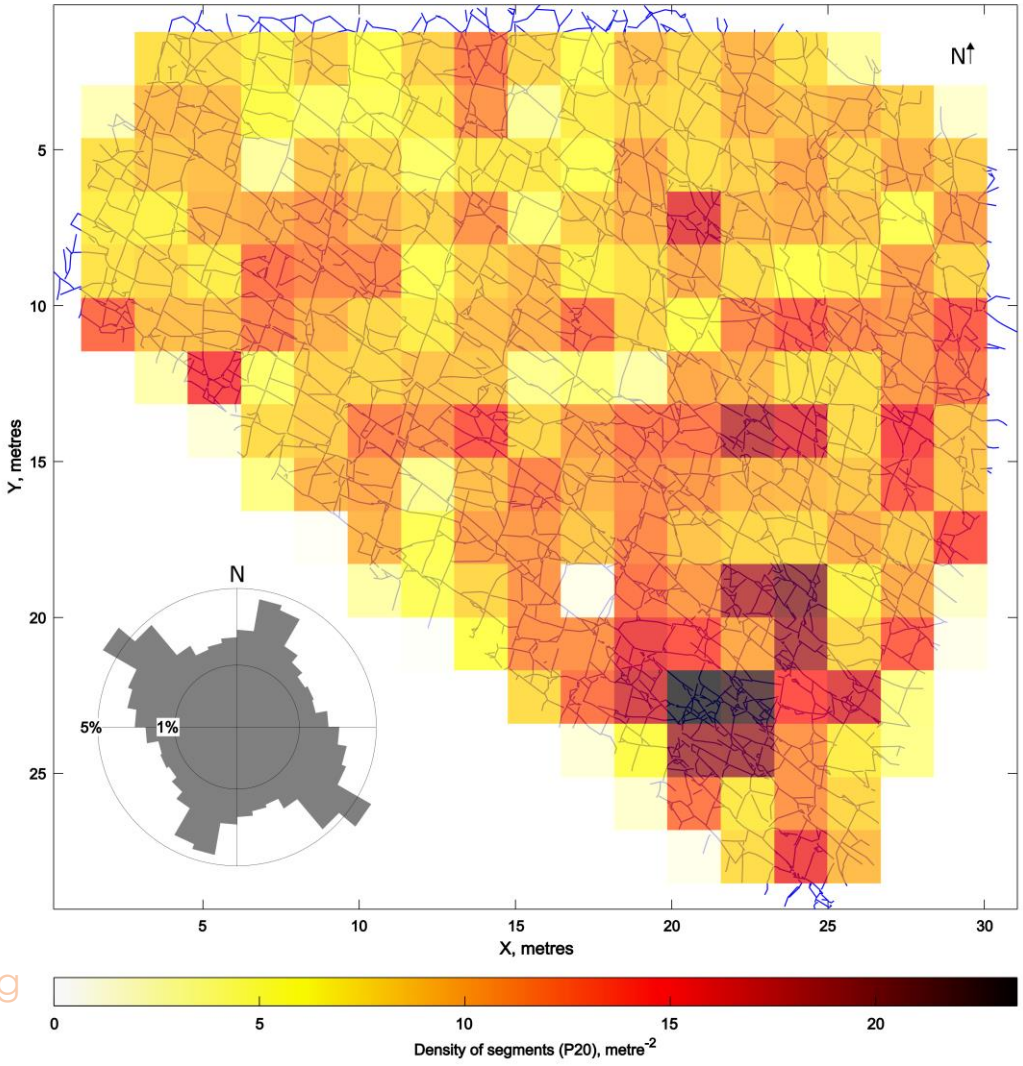
Where do people go on the surface?



Tendency to go to large & obvious clusters of tracks

Edgar *et al*. (2023a)

Fracture density & distribution on the surface



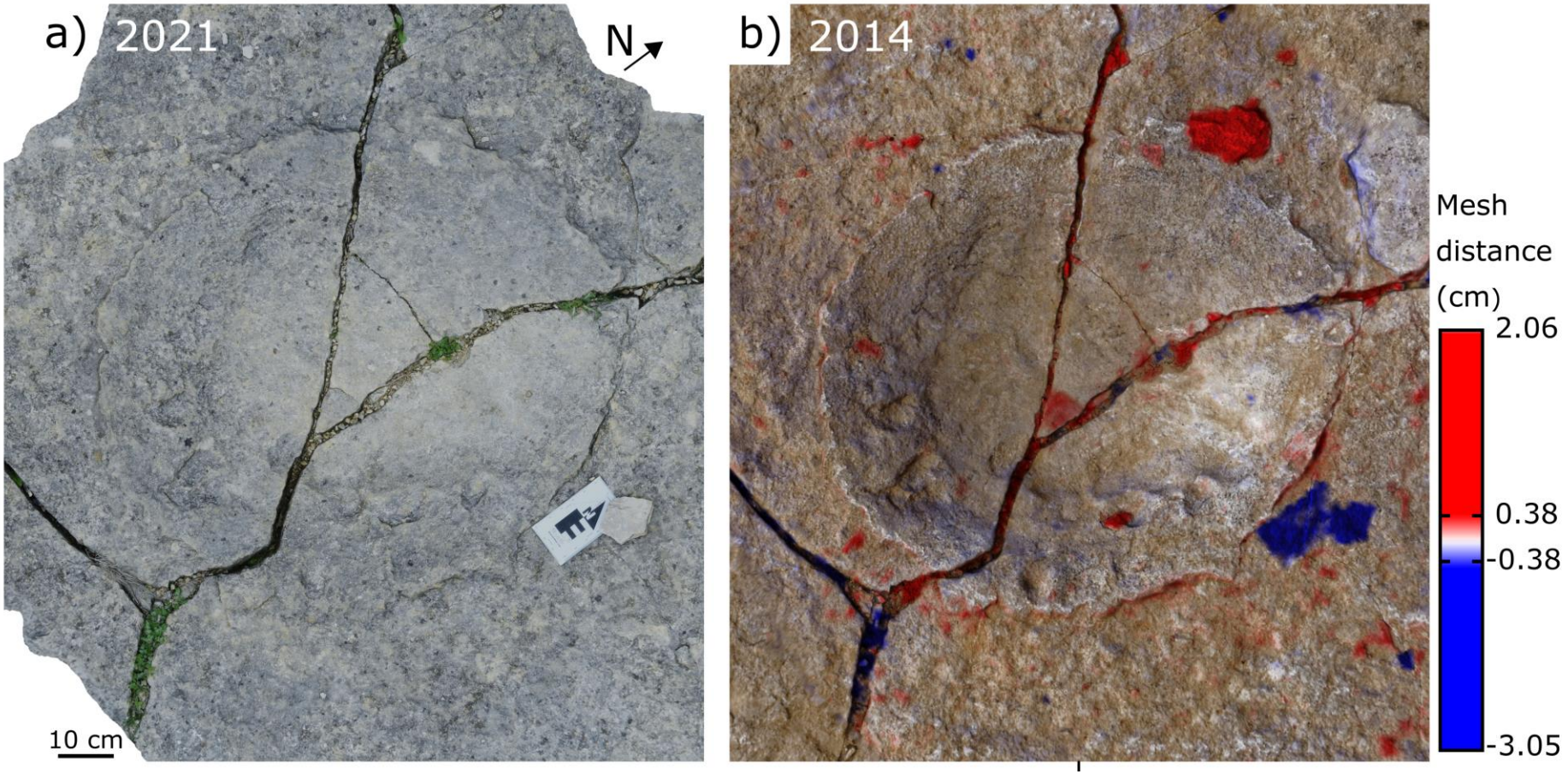
Large perpendicular fractures running NNE-SSW and SE-NW

Less intense fracturing

More intense fracturing

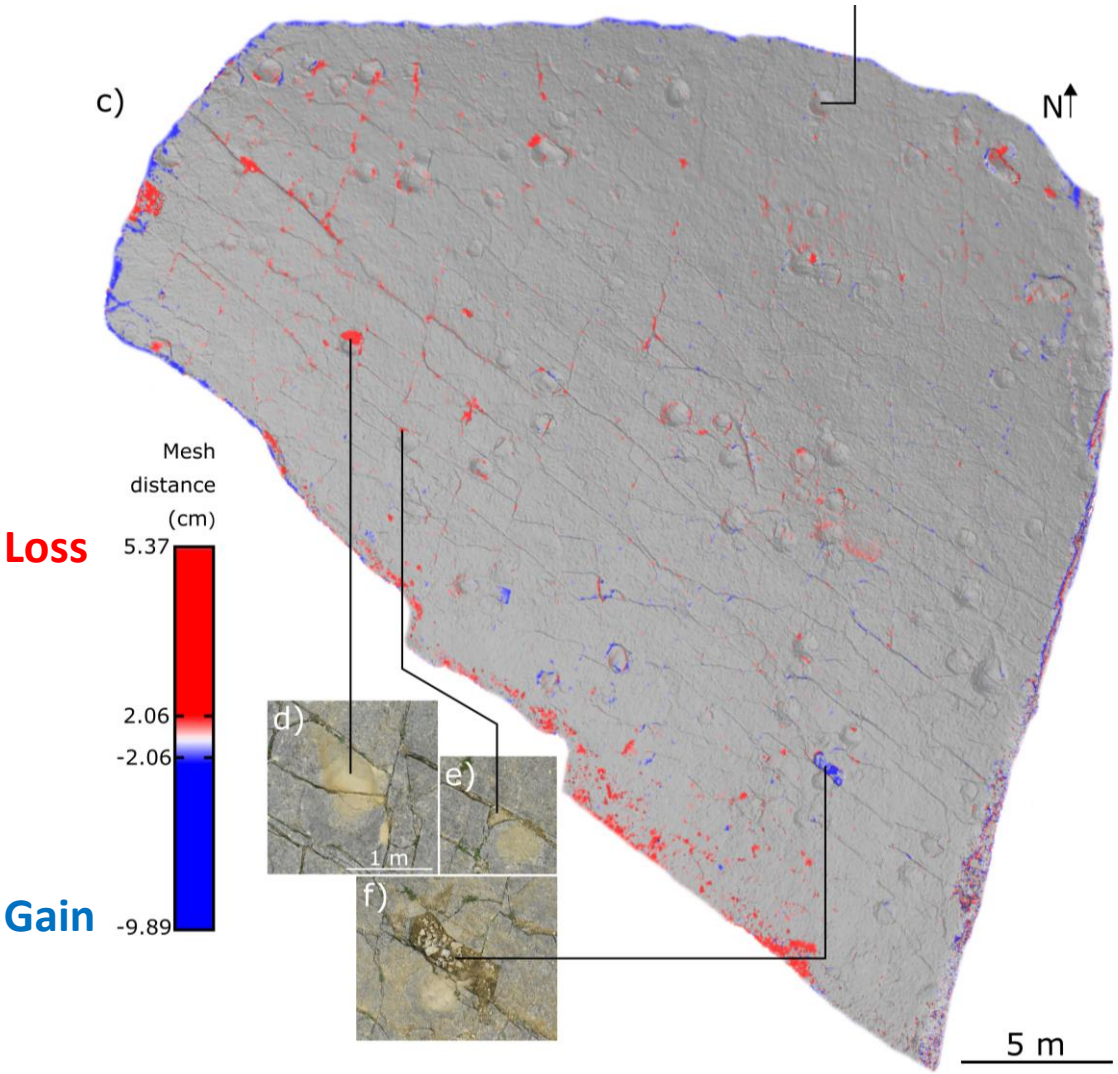
Edgar *et al*. (2023a)

Changes in tracks through time



Edgar *et al*. (2023a)

Changes in track surface through time



- Tracks less distinct & suffered damage
- Some are no longer accessible or identifiable

Edgar *et al*. (2023a)

Defoliation of tracks

- Likely combination of factors BUT natural processes v. important (fractures/exposure/vegetation)

Spyway Quarry summary

- Tracks less distinct & damaged over time
- Most damage relates to fracturing/flaking of the surface caused by natural joints and weathering
- Covering site is not affordable or desirable
- Future - balance management of these impacts with desire to allow public access
- 3D models are a powerful tool for preserving & communicating sites & should be a key part of site management plans

In-situ dinosaur tracks are a valuable component of our geoheritage yielding both scientific and cultural value but they are often a transient resource – appropriate documentation and management required.

Thanks for listening. Any questions?