

## Authors' Response to Reviews

Dear editors,

We appreciate the two reviewers' thoughtful comments and detailed assessment of the archive. We have provided our detailed responses to the both reviewers' questions in red, as well as the revised manuscript with associated tracked changes, below.

*Warwick Vincent*

I could not find the supplementary material (Table S1) that is referred to.

**Thank you for bringing this to our attention, we have uploaded the supplementary material (Table S1) with the revised manuscript.**

Concerning data quality: the data set is accessible via the given identifier, and is complete as a first collection that can now be updated. The data quality is variable – some images are only poorly resolved and have many imperfections (e.g. dust on the slide lens or scanner, poor color rendition), and the metadata are not always complete because the exact date is unknown. The authors might note this by saying that the quality and resolution are variable, but an inclusive approach was taken to maximize the scope of the database.

**We agree that it is important to note the variable quality of the data and metadata and have added an explanation to the revised manuscript as suggested.**

Further points: The images are taken by many people and "copyright for each item remains with the respective contributor" – in that case, how would permission be obtained to reproduce any of these materials, for example in another publication?

**Unless otherwise stated, copyright for each item in the database remains with the respective contributor. If a reader wanted to gain permission to use the material in another venue, they would need to contact us or the copyright holder directly. We agree that this is important to note in the manuscript, and have added it to the revised version.**

Please give the four bounding coordinates for the geographical area covered in this database.

**The bounding coordinates are as follows (decimal degrees): North (-77.504), South (-77.642), East (164.319), West (161.111). These have been included in the revised manuscript.**

Please explain the criteria used for selecting the publications for inclusion. They seem incomplete; for example I searched on 'Onyx River' and could only find two publications among

many: 'Spatially discontinuous strain in the "semi-rigid" zone of an ice cliff. 1973. 'Principal cation concentrations for a length profile of the Onyx River, Wright Valley. 1973'. It would be useful to include the reports from the Japanese Teams in the 1970s and 1980s (Tetsuya Torii et al., as shown in Fig 1!); these include the classic paper by Yuki Yusa on the solar modeling of Lake Vanda, which is always hard to track down.

Currently, the publications included in the archive are from the three-volume bibliography of Dry Valleys publications referenced in the first paragraph of section 2.1. Together, these three volumes cover published works from 1907 through 1994. We have identified hundreds of additional publications through a Web of Science query covering the entire written record, and plan to add their references to the database in the future. Regarding publications such as those produced by the Japanese research team: these are indeed included in the archive, and the reviewers' comment brought to our attention that the backend of the database had not been configured to index the 'Bibliographic Citation' field, which is why the search was not returning all of the results. We have since adjusted the search configuration, and publications such as those by Yuki Yusa now appear in the search results (e.g., type "Yusa" in the Search bar). The dearth of results when searching for publications on the Onyx River likely reflects the term "Onyx" being seldom used in the title or abstract of earlier Dry Valleys publications. This will change once we include the additional publications identified through the Web of Science.

Line 29 (and twice later) states: "the raw data are available at the Environmental Data Initiative <https://doi.org/10.6073/pasta/6744cb28a544fda827805db123d36557>" But these are not the raw data – they are metadata (CSV files describing each data item). It seems that the actual data are the photographs, the maps, audio clips etc.

It is correct that the Environmental Data Initiative only holds the metadata. It may be possible to upload the raw data as well in the future, but the reviewer is correct in stating that presently, the raw data are the photographs, maps, etc. available in the digital archive. We thank the reviewer for bringing this to our attention and will clarify this text in the final version of the manuscript.

ESSD Editors may need to comment: this article will have a doi, the collection of meta-data has a doi, but the data itself (the images, maps etc) are in a relational database that does not have a doi assigned - is that OK?

We defer to the editors for this question.

Story Maps: First Western Journey, 1911 Follow the route of the first expedition into the Dry Valleys in 1911. Maybe this should be 'first exploration' because the first expedition visit was in December 1903, led by Scott, who wonderfully proclaimed at that time: "It is certainly a valley of the dead."

We have amended the text on the story maps page to: "Follow the route of the 1911 expedition into the Dry Valleys, which was the first to spend significant time exploring the region."

*Anonymous Referee #2*

This is just a comment to the authors - I wonder whether the web-browser interface might also be able to house historic US human movement data- similar to a programme of work you probably know called the Antarctic Data Analysis project, run out of Manaaki Whenua - Landcare Research NZ,(<https://www.landcareresearch.co.nz/science/soils-and-landscapes/terrestrial-data-analysis-ross-sea-region/data-analysis/human-movement>) whereby human movement data (camp and sampling locations) were accessed from Antarctica New Zealand, annual data inputting into a database, and forms a layer in this management tool. Once the tool is up and running, data will be displayed and searchable, to build up a picture of historical human movement (by the NZ programme). It is a combination of these historic photos, maps, oral interviews, publications etc, and data, such as the human movement data, that will be very useful for environmental managers and decision makers as visitor (science and tourist) and environmental pressures increase in the coming years.

We appreciate the comparisons to the Antarctic Data Analysis project from New Zealand, and we think adding annual data on human movement is an excellent suggestion. We have considered this for the archive, but relocating historical movable field camps is very time consuming and we did not have the resources to do so in this project. Moreover, while data on 'modern' (i.e., past 10-20 years) movable camps may exist in some compiled format, the United States National Science Foundation data policy has prevented us from being allowed to access such data. Still, our digital archive provides a platform to build from, and we hope that in the future we can include such data in a similar way as you describe for Antarctica New Zealand.

I liked the story maps. More of these would be great! I am sure the NZ Antarctic Programme has many many photos of the decommissioning of the Vanda Station (<https://adam.antarcticanz.govt.nz/nodes/view/37814>). It could be great to have all these resources combined and available on one site - but I know this is not possible, but perhaps adding links to other sites with reputable information would be useful.

Thank you for the suggestions regarding the Story Maps. We are glad you found them effective and will add additional links and resources as future time and funding permits.

# A digital archive of human activity in the McMurdo Dry Valleys, Antarctica

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15 **Abstract.** Over the last half century, the McMurdo Dry Valleys (MDV) of East Antarctica have become a globally important site for scientific research and environmental monitoring. Historical data can make important contributions to current research activities and environmental management in Antarctica, but tend to be widely scattered and difficult to access. We address this need in the MDV by compiling over 5,000 historical photographs, sketches, maps, oral interviews, publications, and other archival resources into an online digital archive. The data have been digitized and georeferenced using a standardized metadata structure, which enables 20 intuitive searches and data discovery via an online interface. The ultimate aim of the archive is to create as comprehensive as possible a record of human activity in the MDV to support ongoing research, management, and conservation efforts. This is a valuable tool for scientists seeking to understand the dynamics of change in lakes, glaciers, and other physical systems, as well as humanistic inquiry into the history of the Southern Continent. In 25 addition to providing benchmarks for understanding change over time, the data can help target field sampling for studies working under the assumption of a pristine landscape by enabling researchers to identify the date and extent of past human activities. The full database is accessible via a web browser-based interface hosted by the McMurdo Long Term Ecological Research site: <http://mcmurdohistory.lternet.edu/>. ~~T-and-the complete raw metadata data for all resources in the database areis also~~ available at the Environmental Data Initiative: 30 <https://doi.org/10.6073/pasta/6744cb28a544fda827805db123d36557> (Howkins et al., 2019).

**Keywords.** digital history; environmental history; history of science; human footprint; human impact; long-term ecological research; LTER

## 1 Introduction

Antarctica's McMurdo Dry Valleys (MDV) comprise the largest ice-free area in the Southern Continent and are among the coldest, driest places on Earth. Since their discovery in 1903, relatively few people have visited the MDV, and the vast majority of these visitors have been involved in scientific activity. Historical perspectives can make valuable contributions to current scientific research in Antarctica, including the MDV (Howkins, 2016a, 2016b). As a result of the international and often decentralized nature of Antarctic research, historical data are widely scattered and frequently difficult to access. Photographs and field notebooks, for example, often remain with individual researchers. Universities, libraries, archives, and national Antarctic programs have different collection policies and metadata standards, and historical data have only occasionally been digitized and made available online. More broadly, the future-oriented nature of much scientific research in Antarctica means that preservation of the historical record has often been a low priority.

The aim of this project was to collect historical data related to the MDV, digitize it, and make it easily available to researchers working in the region through an online archive. The dispersed and varied nature of historical documents related to the MDV has necessitated an eclectic approach to data collection. We have concentrated our efforts on data from the United States and New Zealand, the two countries with the most significant scientific programs in the MDV. We have also collected data from other countries with historical interests in the region.

## 50 2 Data

### 2.1 Data collection

Using bibliographies of MDV publications (including grey literature) (Antarctic Division, D.S.I.R., 1985; Mead, 1978; New Zealand Antarctic Programme, 1995), recommendations from other researchers, and outreach to "Old Antarctic Explorer" organizations, we compiled a list of individuals who have worked in the MDV. We then contacted these individuals with requests for historical photographs and documents related to the MDV (Fig. 1). When we received interested replies, we collected the data using one of the following approaches. If data (especially photographs) were already available in digital format, we arranged for files to be sent to us electronically. When data were not available digitally, we either arranged for the contributors to digitize their documents locally through commercial scanning services, or we visited the researchers in person with a scanner (either a slide scanner or a flatbed scanner depending on the nature of the data). The in-person visits also facilitated oral history interviews with researchers, which we recorded, transcribed, and included in the archive (Fig. 2).

In addition to individuals, we also worked with universities, libraries, archives, and national Antarctic programs. Sometimes data were already easily accessible online, such as the Antarctica New Zealand's digital photograph collection (Antarctica New Zealand, 2017). More often, however, data were only available in non-digital

formats, in which case we followed a digitization process similar to our work with the individual researchers. The resolution and provenance of the photographs and other data are variable, but an inclusive approach was taken to maximize the scope of the database. The full database is accessible via a web browser-based interface hosted by the McMurdo Long Term Ecological Research site: <http://mcmurdochistory.lternet.edu/>, and ~~the raw data are available~~ ~~the complete metadata for all resources in the database is also available~~ at the Environmental Data Initiative: <https://doi.org/10.6073/pasta/6744cb28a544fda827805db123d36557> (Howkins et al., 2019).

## 2.2 Metadata structure

All data in the archive are organized according to the Dublin Core (DC), an international metadata element set intended to facilitate the discovery of electronic assets (Weibel, 1997; Weibel et al., 1998). The DC is designed to be simple and flexible, and we have tailored its core fields for the specific purposes of the archive. This provides a consistent metadata structure among the various types of resources while maintaining interoperability with other DC databases. The full list of fields and the associated definitions for each type of resource is available in the supplementary material (Table S1).

## 2.3 Georeferencing

Although the DC metadata schema includes a "coverage" field for storing geospatial information, the MDV archival data cover a wide range of spatial scales with highly variable locational certainty. We therefore chose to assign each resource a geographic "place;" these range from the scale of individual huts to entire valleys. The majority of these places are associated with a set of existing geospatial vector layers acquired from the MDV Long Term Ecological Research site (Gardner, 2016) which we augmented to include additional features. The layer list includes:

- Camps, Stations, and Huts
- Glaciers
- Lakes and Ponds
- Streams (monitored)
- Streams (not monitored)
- Stream Gauges
- Meteorological Stations
- Dry Valleys Drilling Project sites
- Miscellaneous Human Features
- Miscellaneous Natural Features

We decided that places such as valleys or mountain ranges were too general to assign a specific geospatial layer.  
100 However, these were still assigned a searchable term in the relational database—and may be assigned a geospatial location as additional layers become available. The general bounding coordinates (decimal degrees) for the MDV and the data in the archive are: North (-77.504), South (-77.642), East (164.319), West (161.111).

### 3 Online interface

105 We developed a web-based interface to facilitate discovery, visualization, and dissemination of the data (Fig. 3). This comprises a relational database built using Drupal, a free and open source content-management system (Buytaert, 2016). The interface provides the ability to quickly filter the database using custom searches or the DC metadata elements (e.g., date range, places, people). Clicking a photograph or other resource shows a larger version as well as the full list of DC metadata elements, which link to related resources. The user can also submit  
110 an edit to the metadata, which is intended to engage the Antarctic community and fill information gaps. We also used the geospatial vector layers as the basis for an interactive web app, which supports geospatial queries and basic geographic information system functionality.

### 4 Data availability

115 The historical archive is a "living" dataset which we expect to grow as future contributions are collected and digitized. At the time of this writing the database comprises more than 5,000 archival resources. These include photographs, sketches, interviews (recordings and associated transcripts), maps, sketches, bibliographic citations, and other archival data (e.g. documents) (Fig. 4). All The data in the archive are accessible through a user-friendly Drupal website—~~is~~ maintained by the McMurdo Dry Valleys Long Term Ecological Research (LTER)  
120 project: and available at <http://mcmurdochhistory.lternet.edu>.—The complete raw metadata for all resources in the database ~~are~~ ~~is~~ also available at the Environmental Data Initiative: <https://doi.org/10.6073/pasta/6744cb28a544fda827805db123d36557> (Howkins et al., 2019). New Future  
contributions will be uploaded and cataloged according to the existing structure via a semi-automated system.  
125 Unless otherwise stated, copyright for each item in the database remains with the respective contributor. For permission to use the material in another venue, the corresponding author or the copyright holder must be contacted directly. Individuals or organizations seeking to make a contribution to the archive are encouraged to contact the corresponding author for information.

### Conclusions

130 Access to a geospatially referenced, historic account of human activity will be a useful resource to guide current research and environmental management in the MDV. Researchers can use these data to target investigations of the long-term environmental legacy of human activity. Scientists interested in sampling pristine landscapes can

search the archive to avoid previously inhabited or impacted areas. The data can also provide benchmarks and insights into function and changes in natural systems (e.g., glacier movement, lake level rise). As research, tourism, and climate change continue to shape the Southern continent, our database and approach may also serve as a template for other regions seeking to better understand their own human-environmental histories.

**Author contributions.** AH and AGF conceived the project. AH, SMC, and PG devised the metadata schema and overarching structure of the database. AH and SMC led the design of the web map and Drupal interface, with assistance from PG, MB, and AGF. MB and AGF led the slide scanning efforts. AH and PG led archival visits and oral history interviews, with assistance from AGF and SMC. All authors collected and digitized data for the archive. AH and SC led the writing of the manuscript and SC designed the figures. All authors provided comments and edits for subsequent drafts.

145 **Competing interests.** The authors declare that they have no conflicts of interest.

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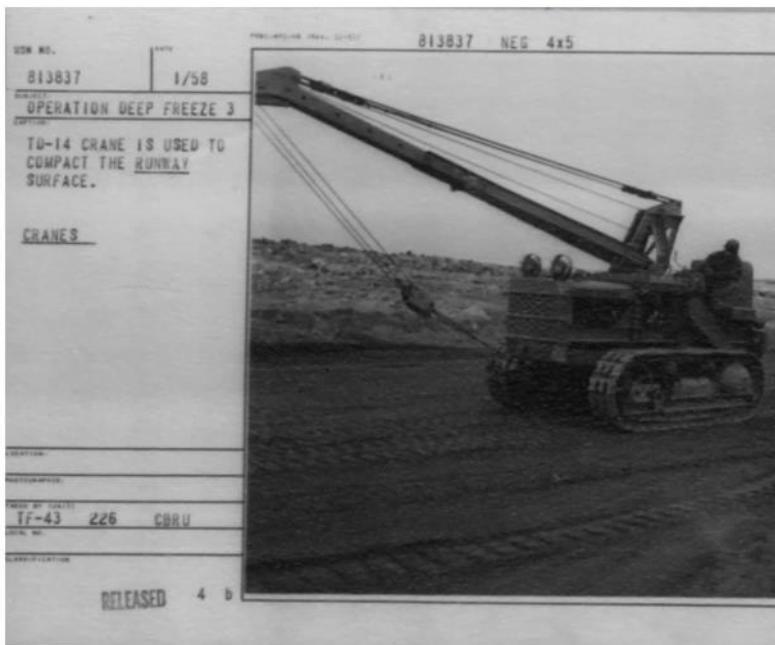
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Figure 1: Examples of photographs from the archive showing human activity in the MDV. Unless otherwise stated, copyright for each item remains with the respective contributor. Detailed metadata for each item is available on the archive website (<http://mcmurdohistory.lternet.edu>) and the Environmental Data Initiative (Howkins et al., 2019)

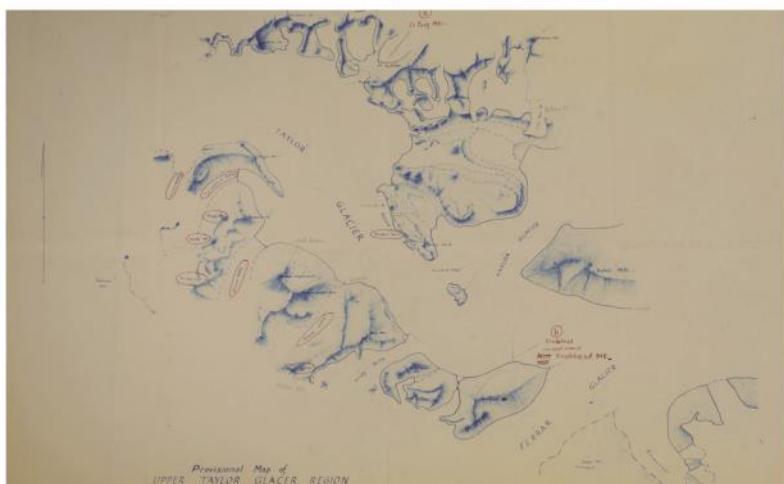
Griffith Taylor Papers, National Library of Australia

MS 1003 T.G. Taylor Series 2, Box 3, 60, "Geological Journey  
British Antarctic Expedition, 1910-13.

Two reports are included in this bound volume. Not to be quoted:

I. A typewritten copy of my first Western Journey, made from t  
hand over later. It is illustrated with rough sketches, and the co  
1912. The map at the end is the first rough draft of our explorations.  
Seaman Evans were other members of this geological party – o  
geologist.

II. A pen-carbon copy of my long geological report – actually v  
night in 1911. It is illustrated by sketches. This was handed to the  
original may be among the Scott relics. (In the second summa  
the glaciers to the north of the Taylor Glacier. These reports are  
Taylor, 21 Jan 1954.



Content	Title	Place	Season	Field
	Warren Hamilton Interview	Taylor Valley	2016	Geology
	Ian Hawes Interview	Lake Vanda	2014	Limnology
	Berry Lyons Interview	Taylor Valley	2014	Geochemistry
	Bruce Parker Interview	Lake Bonney	2014	Biology
	Bill Green Interview	Wright Valley	2014	Limnology

185 **Figure 2: Examples of non-photograph data available in the archive. Unless otherwise stated, copyright for each item remains with the respective contributor. Detailed metadata for each item is available on the archive website (<http://mcmurdohistory.lternet.edu>) and the Environmental Data Initiative (Howkins et al., 2019)**

**Content Type**

- Photographs (3173)
- Publications (799)
- Sketches (37)
- Maps (2)

[List View](#) [Grid View](#)

**Date Range**

1902 1994

Lake Hoare Camp

Soil at Lake Vida

Helicopter on Hughes Glacier

Ice drilling a Taylor Valley glacier

**Place**

- Unknown Place (1459) +
- Valleys (529) +
- Glaciers (394) +
- Camps, Stations, and Huts (379) +
- Lakes and Ponds (353) +
- Shores (239) +
- General Antarctic (144) +
- Mountains (137) +
- Stream Gauges (118) +

Instruments in Taylor Valley

Instruments near Lake Hoare

Stake installation terminus Howard Glacier

Snow pit Howard Glacier

190 **Figure 3:** Browser-based interface for searching the archive. The right-hand window refreshes as the left-hand filters are applied. Clicking on a photo or other piece of content opens a new window showing a larger image and the associated metadata.

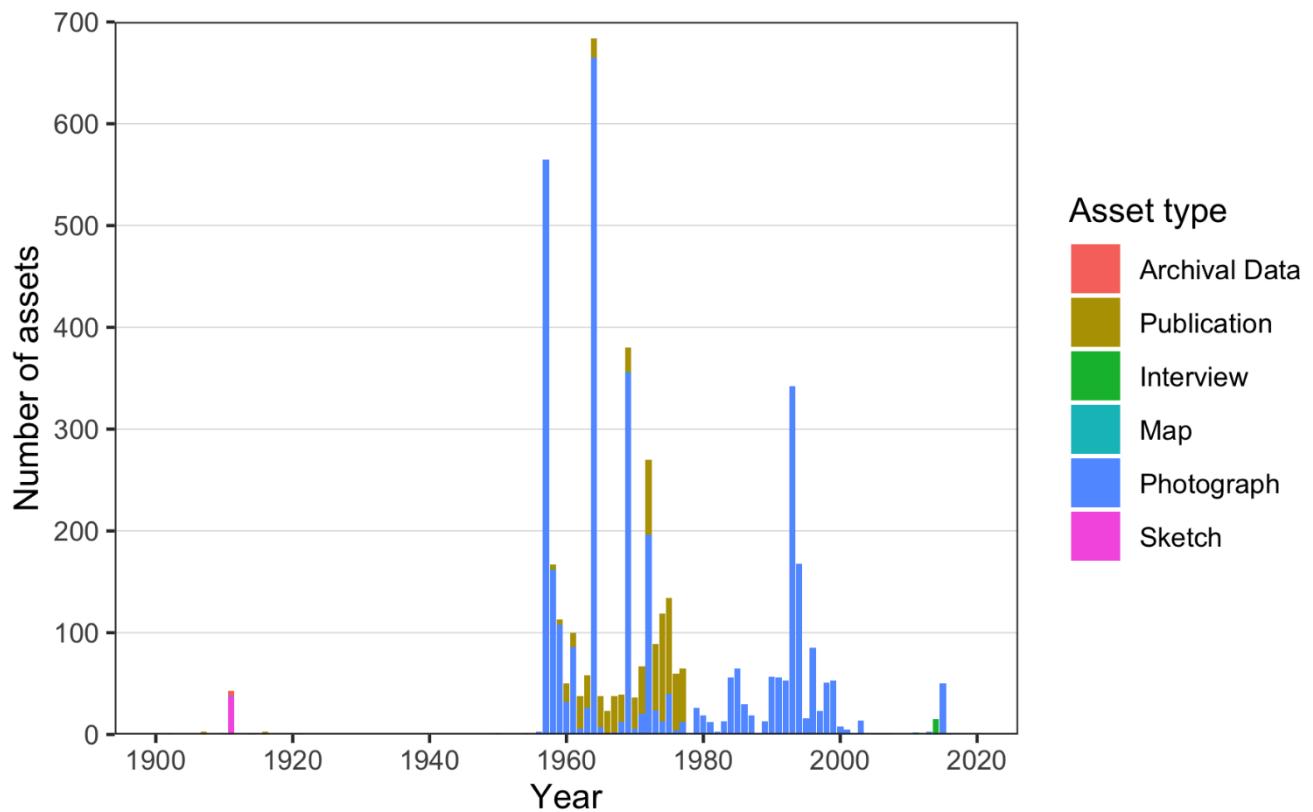


Figure 4: Number of assets in the archive over time, based on their year of creation. Bars are colored by type of asset. Approximately 25% of the assets (1489 of 5943 total assets) were contributed without information on when they were created (i.e., “unknown season”). These assets are available in the archive but are not shown by this figure. This figure represents a snapshot at the time of writing and will be updated on the website with future additions to the archive.

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