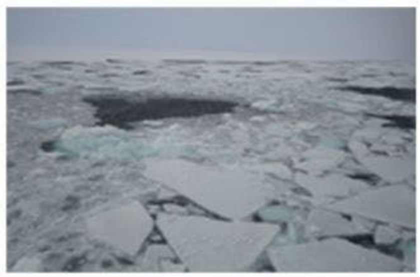



CHARTER


SYSTEMATIC MAP

CHARTER Deliverable D4.1

Grant Agreement Number: 869471
Project Acronym: CHARTER
Project title: Drivers and Feedbacks of Changes in Arctic Terrestrial Biodiversity
Starting Date: 01/08/2020
Project Duration: 54 months
Project Officer: Alberto Zocchi
Project Coordinator: Bruce Forbes / LAY
Leading Author: Dr Marc Macias Fauria / UOXF
Contributing partners: AU, UNILIV, UH, NTNU, UmU

Co-financed by the Connecting Europe Facility of the European Union

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 869471

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CHARTER Deliverable 4.1

Version 2 (revised after the 36-month review)

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Project Officer: Alberto Zocchi
Project Coordinator: Bruce Forbes / LAY
Authors: Marc Macias-Fauria and Andrew Martin (UOXF) and the WP4 team (UOXF, AU, UNILIV, UH, NTNU, UmU)
Due Submission Date: 31/01/2023 (originally, submission was planned for CHARTER month 12, but it was agreed that D4.1 will be submitted together with the D4.2, which was planned to be submitted on month 24. One additional postponement was agreed for both of these deliverables, until month 30).
Actual Submission Date: 31/01/2023

Revised version submitted: 14/12/2023

Status	
Draft	
Final	x

Type		
R	Document, report	x
DEM	Demonstrator, pilot, prototype	
DEC	Websites, patent fillings, videos, etc.	
OTHER		

Dissemination level		
PU	Public	x
CO	Confidential, only for members of the consortium (incl. the Commission services)	

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Revision history

Date(s)	Lead author(s)	Comments
30/07/2022	Marc Macias-Fauria Andrew C. Martin	Draft prepared in line with previous (now superseded) submission date
15/01/2023	Marc Macias-Fauria Andrew C. Martin	Draft updated to include progress to date
31/01/2023	Marc Macias-Fauria Andrew C. Martin	Final version, submitted
14/12/2023	Marc Macias-Fauria	Final version (v2), revised according the comments given during the 36-month review, submitted

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1 Introduction

WP4 is entitled ***Biodiversity Changes at Centennial Timescales*** and is led by the University of Oxford (UOXF). The objective of this report is to present the outputs of Work Package 4 (WP4) Deliverable 4.1 until January 2023 (= month 30) and to assess the progress made. Outputs (software, publications etc.) are underlined throughout the report, and listed again at the end. All software outputs are available in the CHARTER *Zenodo* community.

D4.1 ("Systematic Map") constitutes the first part of WP4's Objective 4.1 ("Determine the variability of key biodiversity and ecosystem state variables across the terrestrial Arctic ecosystems during the Holocene"; **Figure 1**). This Objective starts with a systematic mapping exercise that identifies all possible biological data from the Holocene (last ~11.400 years; T4.1, **D4.1; presented herein**). From this, a Pan-Arctic Palaeo-ecological database (T4.2, D4.2) is built, which is the basis for extracting Key Biodiversity/Ecosystem state variables (T4.6; D4.4) and, by analysing these over the last millennia, their temporal dynamics (T4.7; D4.5). Objective 4.2 ("Study the relationships between these variables and changes in climate, cryospheric processes, and human agency") requires first to build a dataset on Climate and the Cryosphere which spans the Holocene (T4.3, D4.3), so that the biodiversity/ecosystem state variables can be compared against coeval changes in the environment (T4.8; D4.6). Both Objectives 4.1 and 4.2 can be informed by newly collected – and existing but not yet published – palaeo-ecological data from CHARTER Focal Sites (Fennoscandia). These represent centennial and multi-centennial dendrochronological material and millennial palaeo-ecological information obtained from two newly collected peat cores (T4.4; T4.5; D4.7). Finally, Objective 4.3 ("Analyse the temporal stability of these responses, and whether they are in agreement with the more recent observational record (WPs1&2) and state-of-the-art process-understanding of the Arctic System (WP5)") represents the last stage of WP4, and consists of comparing the long-term relationships and dynamics obtained from this work package with those obtained from the observational record (WP2; D4.8) and those embedded and obtained in the modelling work package (WP5, D4.9).

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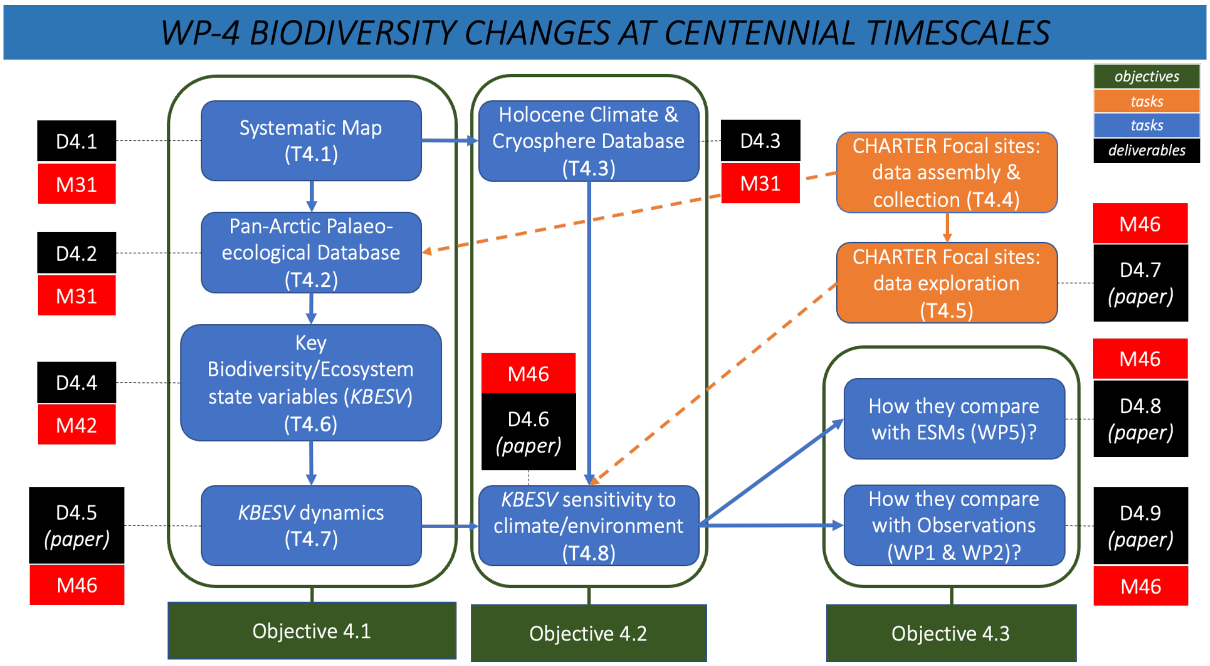

Figure 1. Relationships between the different components of Work Package 4 (WP4). **Blue** (existing data) or **orange** (production of new data) boxes represent *Tasks* within WP4; **black** boxes are the *Deliverables* linked to each task; **red** boxes are *Project Month* in which the *Deliverables* are planned; large boxes outlined in **green** with a green label are the *Objectives* linked to each task. Arrows connecting tasks represent the workflow of the project (see *text*).

2 Progress Report

The initial phase of WP4 was to identify relevant published and unpublished sources that contain evidence of changes within Holocene biodiversity indicators and combine these with the unpublished material available within the CHARTER consortium. The deliverable was defined as a systematic map. CHARTER uses the resultant evidence base of D4.1 to: (a) synthesise the evidence into new data products of core biodiversity variables that can be used in quantitative analyses; and (b) combine the data products with a Holocene cryosphere database (Deliverable D4.3) to address later CHARTER research questions / deliverables in years 3 – 5.

To ensure that the systematic map produced for this deliverable contained as few biases and uncertainties as possible, we chose to progress a systematic map using the 'gold standard' method following best practice as set out by the *Collaboration for Environmental Evidence* (Pullin and Stewart 2006). To achieve this, we published a peer-reviewed systematic map protocol in the journal *Environmental Evidence* in April 2022: link to publication (Martin et al., 2022). Although an original date of delivery for D4.1 was Month

12, it was agreed that this could be delayed so that reporting could occur alongside D4.2 (a pan-Arctic biodiversity database), as the protocol to build the systematic map has been designed so that it enables the build-up of the database that constitutes D4.3.

Systematic map protocol. Key stages completed in the development of the map protocol were identification of draft research question and scope, and integral definitions; design of a draft search strategy; creation of a *test list* to measure the performance of the search strategy; and design of a public consultation following best practices on stakeholder engagement in environmental systematic reviews (Haddaway et al 2017). A draft protocol was completed in early 2021 and stakeholder engagement was subsequently to refine the scope, selection criteria, and research question for the systematic map, and identify initial sources of grey literature. Engagement activities were undertaken over a six-month period in Russian, English, Swedish, and Finnish primarily using a multi-lingual online consultation (all above languages), distributed flyers (Russian and English), and direct contact, as detailed in the protocol. All translations were conducted by CHARTER researchers. To conduct the online consultation, we developed a custom tool – *cottongrass* - for creating and hosting multi-lingual online consultations (doi: 10.5281/zenodo.7586487). The tool's features include allowing one or many consultations to be hosted; having questions structured into sections; supporting various question types (free text, options etc.); supporting conditional questions that only appear if certain values are set; automatically detecting the user's language and allowing on-the-fly change of language at any time; and working as a static website. Following the stakeholder engagement process, a revised protocol including suggested changes was submitted to *Environmental Evidence* and published April 2022.

An important sub-task that was completed within the development of the protocol was the design and coding of a graph database architecture that works online and that allows a swift build-up of the database while minimising person errors when compared to spreadsheets. This included the development of a data coding application, which is compiled for multiple platforms. The code for this software has been released open source, and in a later release should be usable as a generalised tool for most systematic mapping projects. Please refer to the published paper for details on the method WP4 is employing.

Important collaborations were established with DIMA (*Developing Innovative Multiproxy Analyses—in Siberia and the Russian Far East*) and the Neotoma palaeoecology database. Andrew Martin presented at a DIMA meeting of British and Russian researchers in late 2021. However, all Russian links have had to be put on hold, which poses a limitation to our systematic map going forward.

Systematic map. We conducted searches for literature relevant to the final research question "*What is the evidence for variability in biodiversity measures of Arctic biota over the long-term (i.e., Holocene)*?". Search strings were applied to 13 multi-lingual

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bibliographic databases. Bibliographic searches and deduplication of sources resulted in 56,964 sources identified to be screened. Due to the wide scope and definition of the research question, title-abstract screening has been the most time-consuming task in this protocol. Andrew Martin has led a screening team with substantial input from Mari Kuoppamaa (UNILIV) and Marina Morlock (UmU), and smaller time commitments from Angela Prendin (AU), Richard Bradshaw (UNILIV), Stefaniya Kamenova (NTNU), Jakob Assmann (AU) and Niina Kuosmanen (UH).

Resources were reallocated to advance full-text screening and data coding in parallel, as the 'long tail' of publications was being entered in title-abstract screening after 22,000 sources. We are using *Colandr* for screening, which includes machine learning text analysis to 'bring forward' more relevant material as it becomes trained on previously included material (Cheng et al 2018). Currently, 25,458 sources have been screened, with an overall inclusion rate of 13.2% (*n*=2,977). The inclusion rate has dropped substantially and is now less than 4%. Assuming the rate continues to decline – which is a safe assumption given *Colandr*'s algorithm – we have likely captured more than 70% of relevant sources from our searches. Clustering analysis using machine learning text analysis of the titles and abstracts of the 2,977 included sources indicated that the largest groupings by content were: archaeological (*n*=485), multi-proxy palaeolimnology / lake-based records (*n*=337), geographical (*n*=299), and dendrochronological (*n*=259) sources.

Data coding has been conducted for many records and continues following the protocol towards publication of a peer-reviewed paper in *Environmental Evidence*. As data coding is being conducted using custom-made tools, there are no further data processing steps required before preparation of the manuscript. On top of the metadata produced from individual publication records, some datasets have been included and merged in the current effort, such as Neotoma and the International Tree-Ring Data Bank (ITRDB).

3 Summary of Outputs

Title	**License**	**Location**
Systematic map protocol	Creative Commons Attribution 4.0 International	https://doi.org/10.1186/s13750-022-00267-x
cottongrass: a multi-lingual framework for making web consultations	Mozilla Public License 2.0	https://doi.org/10.5281/zenodo.7586487
Graph Database and Data Coding Software for Palaeoecological Systematic Mapping Data	MIT License	https://doi.org/10.5281/zenodo.6358593

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