UNIVERSITY OF BIRMINGHAM

ELECTROACOUSTIC MUSIC COMPOSITION, GUIDED BY THE INHERENT METHODOLOGIES AND APPROACHES OF WILDLIFE SOUND RECORDING

PORTFOLIO OF COMPOSITIONS

by

Mark George Thomas Ferguson

A thesis submitted to the University of Birmingham for the degree of
DOCTOR OF PHILOSOPHY

Department of Music
School of Languages, Cultures, Art History and Music
College of Arts and Law
University of Birmingham

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ABSTRACT

This commentary accompanies a portfolio of eleven fixed-media electroacoustic works, realised during full-time doctoral research at the university of Birmingham between October 2018 and October 2021. All works in the portfolio were composed using my own wildlife source recordings exclusively.

An analytical discussion of the portfolio—the main body of the commentary—is set within a wider discourse, encompassing: research background and context; approaches to wildlife sound cataloguing and source selection; practical and theoretical methodologies; emergence of methodological symbiosis between field and studio practices; notes on listening space, work diversity and genre; and additional research interests. The commentary closes with some thoughts on future research.

The main appendices to the commentary include: selected pre-doctoral works and wildlife recordings; technical/programme notes; source recordings by composition; Csound code; wildlife sound cataloguing materials; full-resolution plates; tabular piece overviews; and supplementary materials. These appendices are referenced throughout the discussion, with a view to providing as much context as possible on my working practice.

Keywords: wildlife sound recording, field recording, phonography, fixed-media electroacoustic composition, studio, methodologies, approaches, music, sonic arts, cataloguing, conservation, species, nature, natural phenomena.

To my daughter, Anna, who arrived in the middle of it all and put it into perspective.

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November 2021

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Cassiano’s Blackbird (2019)			Stereo	10' 04"
The Sunlit Thawing (2019)			Stereo	04' 06"
Mud Roots (2019)			Stereo	07' 08"
Machair Impressions (2019–2020)			Stereo	10' 05"
Habitats (2020)				
	I	Oak Trunk	Binaural/stereo	02' 47"
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Total portfolio duration:				88' 16"

Notes:

- All multichannel works have been submitted with an accompanying stereo mixdown.
- All pieces have been realised as fixed-media compositions, for presentation over static loudspeaker configurations.

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Note:
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Note:

Full technical and programme notes for all pieces can be found in Appendix 2.

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Digital materials submitted for the thesis include the portfolio of compositions, a PDF version of this commentary, and full commentary appendices. These materials have been uploaded to a Google Drive folder, accessible via the following link:

https://drive.google.com/drive/folders/1DoQPRXeq6O5bkNvRxzJ6SbtyjcE4BnER?usp=sharing

All materials have been organised into three main directories: 01_PORTFOLIO, 02_COMMENTARY and 03_APPENDICES. These directories contain additional subdirectories and files, organised as shown in the list below. (For clarity, all directories and subdirectories in the list are shown in **bold typeface**.)

Important Note:
The ordering of materials may change slightly when viewed within Google Drive (and when downloaded onto different computer systems), based on how the listing of directories and files is prioritised by software. Since an alphabetical and numerical system has been used, these changes will likely be negligible.

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GLOSSARY

The following glossary summarises some of the key technical/theoretical terms and abbreviations used throughout the commentary. Although it provides a useful overview, the glossary is necessarily restricted in scope and the reader may need to refer to additional resources to gain a fuller understanding of unfamiliar definitions.

_____

A

AB
A stereo microphone configuration in which two omnidirectional microphones are spaced apart, typically at a distance of between 17 and 70cm.

Ambisonic / ambisonics
A full-sphere audio format, capable of recording and representing a theoretical, three-dimensional sound field.

Anthropocene
The proposed, current geological age, characterised by the dominance of human activity and our overwhelming influence on (and transformation of) the environment.

Azimuth
In spatial hearing, the horizontal plane (where elevation = 0˚). See also: *Elevation*.

B

Baffle
An absorptive object placed between microphones, in order to enhance the acoustical separation between microphone capsules.

Binaural (recording methodology)
A means of capturing audio three-dimensionally, using a pair of microphones placed in, or close to, the recordist's ears. The ears of an artificial head or baffle may also be used.

Bioacoustics
The scientific study, recording and analysis of animal sounds, covering such areas as sonic communication, production mechanisms and transmission (Bioacoustics 2021).

C

Cardioid microphone
A microphone which is most sensitive to sounds originating on-axis (i.e. in front of the recording position), attenuating sounds originating from the sides and especially the rear.

Centre frequency
The frequency lying at the mid point between the upper and lower cutoff frequencies of a bandpass or bandreject audio filter.

Clipping
In digital audio, clipping occurs when a signal has exceeded the maximum possible range of amplitude representation in a given audio system. The upper/lower portions of the signal are ‘clipped’ (or flattened) at the points where this range is exceeded.

Closed canopy (woodland)
A mature woodland with dense upper tree branches and leaves, shading a considerable portion of the woodland floor.

Close miking
A recording methodology in which a microphone is placed very close to the recorded subject.

Composed space
The space composed into a piece (Smalley 1997: 122). Compare with: *Diffused space*, *Listening space, Recorded space.*

Contact microphone
A microphone (commonly consisting of a piezo element glued to a thin metal disc), which may be placed directly onto surfaces in order to transduce internal structural vibrations.

Coppice
A portion of woodland which is cut to ground level periodically. Coppicing significantly extends tree age, providing a source of wood for timber, charcoal, and other commercial uses.

Corvid
An avian species belonging to the crow family, *Corvidae*.

COVID-19
A respiratory disease caused by the SARS-CoV-2 virus, first identified in Wuhan, China in December 2019. Following its identification, the disease rapidly spread around the world, causing a global pandemic.

Cross-synthesis
A synthesis technique in which the spectral characteristics of one audio signal are

applied to another, to produce a fusion or ‘hybrid’ signal possessing the characteristics of both.

Csound
An audio programming language written in C, used for sound synthesis, processing, editing and other audio applications.

D

DAW
An abbreviation and acronym for Digital Audio Workstation: a graphical software application for recording, manipulating and outputting sound.

Detritivore
An organism which feeds on dead/rotting organic material such as wood, leaves, etc.

Diffused space
Multi-loudspeaker concert space, in which composed stereo or multichannel space is augmented, redistributed or otherwise altered during performance using a specialised audio system (Smalley 1997: 122). Compare with: *Composed space, Listening space, Recorded space*.

(Sound) Diffusion
The practice and process of projecting a fixed-media work via a multi-loudspeaker system, typically in a live concert setting, with sound levels controlled by the composer/performer using a series of faders on a diffusion desk.

Diffusion desk
A specially adapted audio controller used for sound diffusion, on which groups of (or individual) faders can be used to project a work in real time through volume level manipulation by a composer/performer.

DIN
A stereo microphone configuration in which two cardioid microphones are spaced apart at 20cm and angled at 90˚.

E

Elevation
In spatial hearing, an angle relative to the azimuth plane. Positive values are above the azimuth plane and negative below. The normal range of values is +/- 90˚. See also: *Azimuth*.

Encode / encoding
Refers to the placement of a sound or sounds within an ambisonic sound field.

F

Fixed-media
Describes an electroacoustic work that is composed specifically for (and played back directly from) a physical storage medium such as tape, CD, computer hard drive, etc., typically through loudspeakers in a concert setting.

G

Granular synthesis / granulation
A type of audio synthesis in which a sound is broken into small components or ‘grains’, typically between 1 to 50ms in duration. The grains may be reassembled and redistributed in a variety of ways, with their individual parameters manipulated to create a range of sounds and textures.

GRM Tools
An audio processing suite developed by ina-GRM, containing a range of specialised plug-ins to transform and manipulate sound.

I

IEM Plug-in Suite
A suite of DAW-based tools developed by IEM for various forms of ambisonics processing.

Input gain (recorder)
The amount of amplification applied to a microphone signal, typically expressed in dB.

L

Listening space
The physical space in which composed space is heard (Smalley 1997: 122).
Compare with: *Composed space, Diffused space, Recorded space.*

M

Mid-side
A coincident stereo microphone configuration in which a cardioid and figure-eight microphone are used to provide stereo width flexibility, either during or after a recording. The configuration requires transcoding in order to correctly render the complete, stereo signal.

O

Omnidirectional microphone
A microphone which (theoretically) captures sounds from all directions equally.

Opcode (Csound)
A unit generator in Csound, specified as a unique piece of text in Csound code and used to process signals and generate output (Canonical Csound Reference Manual 2021a).

ORTF
A stereo microphone configuration in which two cardioid microphones are spaced apart at 17cm and angled at 110˚.

P

Pro Tools
A DAW produced by Avid Technology.

R

Reaper
A DAW produced by Cockos Inc.

Reason
A DAW produced by Reason Studios.

Recorded space
The spatial information captured and rendered naturally as part of an unprocessed audio recording.

Riparian
Referring to land in close proximity to rivers and streams (e.g. riverbanks).

S

SAAM (Stereo Ambient Array Microphone)
A similar configuration to the SASS (see below), developed by Wildtronics LLC and employing boundary-mounted microphones separated by a specially contoured, acoustic baffle.

SASS (Stereo Ambient Sampling System)
A quasi-binaural recording configuration produced by Crown, using two, boundary-mounted microphones separated by a specially contoured baffle.

Shelving (EQ)
A filtering technique used to reduce or increase a signal equally, above or below a specified cutoff frequency.

Source bonding
A term invented by Denis Smalley, referring to ‘the intrinsic-to-extrinsic link, from inside the work to the sounding world outside’, and describing the ‘natural tendency

to relate sounds to supposed sources and causes, and relate sounds to each other because they appear to have shared or associated origins' (1997: 110).

Spatial simultaneity
Referring to listener perception of two, simultaneously occurring composed spaces (Smalley 1997: 124).

Spectromorphology
A set of concepts and terminologies developed by Denis Smalley, used to describe and analyse the listening experience. According to Smalley, 'the two parts of the term refer to the interaction between sound spectra (*spectro*-) and the ways they change and are shaped through time (-*morphology*)' (Smalley 1997: 107).

Stem / stemming
In audio practice, stemming typically refers to the grouping of separate audio tracks (or groups of tracks), often with similar characteristics, into sub-mixes. During stereo diffusion, stems may be routed to groups of loudspeakers to achieve composer-specific effects: for example, a stem of consisting of high-frequency sources may be routed to ceiling-based loudspeakers, in order to reinforce the characteristics of a light, 'airy' texture.

V

Vocabulary (recording)
In wildlife sound recording practice, vocabulary recording refers to the capture and documentation of a species' vocal repertoire as fully as possible, often with an emphasis on conveying unique behaviours and shedding new light on communication habits. The term 'vocabulary' may also be used more generally, when referring to the range of vocalisations used by a particular species.

W

Windshield
A protective structure (e.g. a material-lined basket, fur covering) placed around a microphone configuration, in order to prevent unwanted wind noise from interfering with a recording.

X

XY
A stereo microphone configuration in which two cardioid microphones are positioned coincidentally, angled at 90˚. Wider or narrower angles may be used depending on the source and desired reproduction width.

[MISC]

32-bit float recording
A digital recording technique capable of representing a dynamic range of 1528dB,

theoretically removing the possibility of digital clipping and the need for input gain adjustment on a recording device.

1. INTRODUCTION

1.1 Preface

This commentary accompanies a portfolio of eleven fixed-media electroacoustic works, composed during full-time doctoral research at the University of Birmingham between October 2018 and October 2021.

The development of the portfolio was underpinned by two distinct crafts: wildlife sound recording (which provided all source material for the pieces), and fixed-media electroacoustic composition. Both crafts were focal points of my artistic output prior to the commencement of doctoral study (see Appendix 1 for work/recording examples), and my research proposal therefore grew quite naturally from the latent idea of exploring, through supervised practice, how the inherent methodologies and approaches of wildlife sound recording guided creative work in the studio.

It was assumed from an early stage that this one-way workflow between practices—with the methodologies and approaches of wildlife sound recording informing a separate, subsequent compositional process—would remain unchanged for the duration of study; in some cases, however, a two-way ‘methodological symbiosis’ emerged, with one craft informing the other at various levels and to varying degrees. A number of additional research interests also grew alongside, and emerged out of,

my work, and had a much greater influence on the development of the portfolio than expected.

In considering the layout of this commentary, then, it seemed appropriate to set the main body of the discussion—a written analysis of the portfolio—within a wider discourse, encompassing: research background and context; approaches to wildlife sound cataloguing and source selection; practical and theoretical methodologies; emergence of methodological symbiosis between field and studio practices; notes on listening space, work diversity and genre; and additional research interests. Whilst there is never an ideal way for a practitioner to write-up a complex body of creative work, it is hoped that this hybrid approach provides, at the very least, a useful indication of the scope and impact of my research, and offers as much insight as possible into my creative practice.

The commentary begins with a summary of the research background and wider context to the thesis (Section 1.2). After briefly discussing the derived thesis topic (1.3), the following sections explore my approach to wildlife sound cataloguing and source selection (1.4), and provide an overview of the practical and theoretical methodologies running through my work (1.5).

The main body of the commentary (2) charts the portfolio's development over the course of my studies, discussing the various thematic, aesthetic and methodological concerns of each piece in detail.

After presenting my main conclusions from the portfolio (3) and discussing two additional research interests connected to the thesis (4), the commentary closes with some thoughts on future research (5).

1.2 Research Background and Context

This section lays a contextual foundation for the commentary by providing a highly condensed overview of recording, composition and sound art practices of particular relevance to the research focus of the thesis.[1] A brief summary of the wider context to the thesis is also provided.

1.2.1 Wildlife Sound Recording

Wildlife sound recording can be regarded as a specialised form of field recording (Ratcliff 2016: 20), emphasising the pursuit and documentation of sounds produced by undomesticated, non-human species and naturally occurring environmental phenomena.

1 Most of the content in the section has been derived from a detailed literature and discography review, undertaken prior to the commencement of doctoral research in 2018 and updated on an annual basis to reflect research developments during the study period. Whilst each area is discussed separately, it is important to note that crossovers and collaborations frequently occur between practitioners, blurring the boundaries between established sonic fields through a diversity of media, methodologies and approaches to dissemination.

The inherent methodologies and approaches of the craft are perhaps best exemplified by the output of the Wildlife Sound Recording Society (WSRS).[2] Historical and current members of this society have written and spoken extensively about equipment use, fieldcraft, sound cataloguing and many other issues pertinent to wildlife sound capture, all of which are deeply interwoven with my own research (e.g. Fisher 1977; Margoschis 1977; Elliott 2014; Watson 2016; Pratley 2018; Boughton and Shepard 2020). Various members have also composed works using recordings of undomesticated species and environmental phenomena as primary (or in many cases, exclusive) source materials (e.g. Watson 2013, 2017; Kennedy 2017; Taylor 2017, 2018).

In addition, WSRS practitioners have made substantial contributions to the internationally significant Wildlife and Environmental Sounds Collection held by the British Library (Ranft 1997: 316; Tipp 2016; British Library 2021a, 2021b), and, directly and indirectly, to the scientific discipline of bioacoustics (Sellar 2013; Ranft 2015: 199).

1.2.2 Field Recording

Field recording refers to any recording activity happening outside the studio, in the wider world (Virostek 2013: 30; Benson and Montgomery 2018: 5). It encompasses a vast range of subjects, environments, behaviours and recording situations: from prearranged sound effect capture in tightly controlled outdoor environments, to

2 Of which I am currently a member. The UK-based society was formed in 1968, has a current, global membership of approximately 320, and is believed to be the oldest sound recording society in the world (Wildlife Sound Recording Society 2021).

spontaneous documentation of folksong and stealth recordings of civil unrest (Virostek 2013: 35–38).

Field recordists may be involved in a diversity of commercial and non-commercial activities, including: site-specific and multidisciplinary arts projects (e.g. French 2021; Gruska 2021; Meireles 2021); recording and editing for online sound effects libraries (e.g. Airborne Sound 2021; Free to Use Sounds 2021; Mindful Audio 2021); video game development (e.g. Lipka 2017; Jojo 2018; Wu 2021); and sonic documentation and preservation (e.g. Hempton and Grossmann 2009; Cusack 2011; Krause 2015; London Sound Survey 2021).

Much of this work is methodologically relevant to my own research, and many wildlife recordists have adapted a range of techniques and approaches found within the wider, parent craft of field recording for their own specialised recording requirements (see Section 1.5.1).

1.2.3 Electroacoustic Composition

Two forms of electroacoustic composition are especially relevant for my own research.

The first—acousmatic—can be regarded as both an approach to listening, and to the treatment and presentation of sonic materials (Dhomont 1995; Adkins, Scott and Tremblay 2016: 106). From a creative standpoint, it is arguably most concerned with

the detailed exploration, transformation and arrangement of sounds for projection over static (often concert-based) loudspeaker configurations, emphasising the development of inherent sonic qualities over causal identities (Dhomont 1995).[3]

Acousmatic composers may choose to explore an infinite number of sonic materials captured or generated within or beyond the studio.[4] This includes field recordings of species and naturally occurring phenomena, and a number of artists working within what could be regarded as the acousmatic milieu have utilised such materials in their work (e.g. Stollery 2005a, 2005b; Barrett 2007; Berezan 2007; Mahtani 2016, 2018).

The second relevant practice—soundscape composition—is characterised by an exploration of recognisable environmental sounds and contexts (Truax 2021), with roots in acoustic ecology: an area of research concerned with the state of our sonic environment and the interrelationship between sound, nature and society (Westerkamp 2002: 52; World Forum for Acoustic Ecology 2021).

Soundscape composers may attempt to convey environmental sounds and contexts as accurately as possible, or transform them to varying degrees using studio-based electroacoustic techniques, moving beyond the literal presentation of field-recorded

3 This is the definition of acousmatic composition with which I identify and engage as an artist, and which has had the greatest bearing on my own research to date. It is important to note, however, that the term ‘acousmatic’ has many different, often controversial meanings for listeners and practitioners, and is constantly evolving against a wider backdrop of contemporary sonic arts practice. With this in mind, Adkins, Scott and Tremblay (2016: 106) have recently proposed the notion of the ‘post-acousmatic’, in considering the diverse work of contemporary practitioners ‘who are indebted to the Schaeffarian heritage, but pursue alternative trajectories from the established canonical discourse of acousmatic music.’

4 Some practitioners would argue that all source materials, to be strictly compatible with an acousmatic approach, should be recorded rather than generated synthetically.

sounds (Truax 2012: 196). Although a range of environmental sources may be exploited in soundscape composition, many practitioners have a particular interest in sounds from the natural world, and have utilised recordings of species and habitats extensively in their compositions and associated output (e.g. Westerkamp 1987, 1989; Martin 2012, 2019; Truax 2014).

Theoretical frameworks relating to soundscape composition, such as Barry Truax's concept of acoustic communication (2001; 2012: 193–194), are also relevant to the research focus of the thesis: especially with regard to the compositional (re)presentation of wildlife/habitat sounds, and methodologies for incorporating documentary materials into fixed-media electroacoustic works. In explaining the basic model of acoustic communication, Truax argues that it is grounded in the understanding that 'information and meaning arise through listening from both the inner structure and patterns of sound itself and also the listener's knowledge of context', and that 'sound…is capable of creating relationships between listeners and their environment in a dynamic process of embodied cognition' (2012: 194).

In terms of my own practice, Truax's ideas are strongly bound-up with notions of place and representation of landscape captured through the methodologies of wildlife sound recording, with soundscape composition and its underpinning studio methodologies working in parallel to preserve, enhance and draw out environmental contexts documented in the field (Truax 2001: 237; Westerkamp 2002: 52; Akiyama 2010: 55).

1.2.4 Environmental Sound Art

Within the incredibly broad and diverse practice of sound art, a growing number of artists are engaging with projects exploring wildlife conservation and environmental issues relevant to my own research (see also Sections 1.2.5 and 4.1). Many of these practitioners are fundamentally concerned with preservation and awareness-raising (Bianchi and Manzo 2016: ix–xvi) around issues such as habitat degradation, biodiversity loss and climate change; indeed, a substantial portion of their output could perhaps be described more accurately as ecological sound art (Gilmurray 2017).

Themes explored within this sphere include: melting glacial ice (e.g. Leonard 2013); sonification and visualisation of scientific weather data (e.g. Polli 2005); site-specific, species-based soundscape composition (e.g. Monacchi 2004); amplification of indigenous and invasive species (e.g. Dunn 2006); audification of seismic vibrations (e.g. Bullitt 2006); and performative interactions in remote natural environments (e.g. Burtner 2011; Rothenberg 2016).

1.2.5 Wider Context

The development of the portfolio between 2018 and 2021 took place against a wider backdrop of increased environmental awareness, activism and protest, which continues to grow at the time of writing.

Global environmental threats such as widespread deforestation (Nunez 2019), species extinction (IUCN 2021), oceanic plastic pollution (Eriksen et al. 2014) and climate change (UN 2021) have contributed to an increasing awareness of environmental crisis and impending ecological catastrophe, with prominent activists such as Greta Thunberg (2019, 2021) and international protest movements such as Extinction Rebellion (2021) calling for immediate action to halt humanity's detrimental impact on the natural world.

The outbreak of COVID-19 in late 2019 and the ensuing pandemic from early 2020 onwards threw our relationship with wildlife into even sharper focus, raising challenging questions about unsustainable habitat destruction, illegal species trafficking, and widespread misconceptions about bats and other animal groups hosting zoonotic diseases (Bat Conservation Trust 2020; Briggs 2020; Gibb et al. 2020).

Given the wildlife-orientated focus of the thesis and my long-running interest in environmental issues and wildlife conservation, this wider context naturally had a bearing on source recording and selection, exploration of compositional themes, public engagement and other elements of the portfolio as it evolved (see Section 4.1).

1.3 Derived Thesis Topic

Whilst my research overview (Section 1.2) highlighted a number of electroacoustic composers utilising wildlife source materials in their work, it also suggested that there were opportunities for further exploration of wildlife sounds in a fixed-media context.

This was particularly apparent with regard to highly detailed, isolated source recordings of individual fauna and flora, whose inherent spectromorphological characteristics and behaviours hinted at exciting possibilities for processing and manipulation using audio programming languages such as Csound. When laying groundwork for the portfolio and with the wider context of my field-based practice in mind, I also became interested in the notion of exploring how the various methodologies behind wildlife sound recording could inform source selection, processing techniques, spectromorphological shaping, spatial articulation and other compositional elements.

In an attempt to group these interrelated research concerns under a single topic, I decided to focus on the composition of fixed-media electroacoustic works, using my own wildlife recordings as source materials and exploring how the inherent, field-based methodologies and approaches of the wildlife sound recording craft guided studio-based composition.

This became the derived research topic of the thesis, underpinning the portfolio's development and remaining unchanged for the duration of study.

1.4 Working Basis: Cataloguing and Source Selection

The process of cataloguing recordings and their accompanying metadata (time, date, species, behaviour, weather conditions, etc.) is arguably an integral part of wildlife sound recording, and numerous practitioners have highlighted the benefits of maintaining good working practice in this area (Fisher 1977: 162–163; Margoschis 1977: 97–101; Simms 1979: 107; Elliott 2014: 37:57; Boughton and Shepard 2020: 150–158).[5]

In the months leading up to my research, approximately 180 of my own wildlife recordings had been catalogued, with spoken field notes and associated metadata for each recording transcribed onto tabular documentation sheets (see Appendix 5a for examples). Whilst these sheets formed a useful foundation for composition in terms of basic source organisation and selection, little thought had been given to the latent creative potential of the contextual metadata they held (especially behavioural), or to the design of a more functional, unified database that would better facilitate comparative decision-making in the studio.

5 I am referring here to contextualising metadata, typically noted in the field (or shortly after) and providing as much information as possible on the associated recording. This information is often spoken directly into the recordist's microphone(s) following a successful take, then transcribed into written format and stored alongside, or embedded within, the fully edited sound file.

Having derived a research focus fundamentally concerned with the relationship between field- and studio-based practices, I became acutely aware of the need for a better system, capable of functioning as an effective bridge or 'mediator' between crafts. From late 2018 to the end of 2019, I therefore embarked on a detailed revision of my own cataloguing system, unifying hundreds of documentation sheets into a single, spreadsheet-based design (see Appendices 5b, 5c for the full catalogue and accompanying guidance notes).[6]

This revision was informed throughout by various historical and current models, (notably Fisher 1977: 162–163; Margoschis 1977: 98; Rasmussen 1980: 30; Krause 2002: 103–109; British Library 2018; FNJV 2018; Niven Library 2018; Tierstimmenarchiv 2018; eBird 2021), with my own, creatively orientated design elements incorporated as follows:

i. Numbered metadata fields, specifically tailored to allow clear cross-referencing and comparison between a range of sonic characteristics and behaviours. These have additionally been grouped under four 'parent' metadata categories, to allow broad, block-based comparisons between related elements of the catalogue.

6 In early 2022, I intend to submit my fully catalogued library of wildlife sounds (i.e. all recordings made between December 2014 and April 2020) to the British Library's Wildlife and Environmental Sounds Collection, along with my doctoral thesis. To the best of my knowledge, this will be the first submission of its kind to the collection where catalogued recordings are contextualised, in detail, by a doctoral research project exploring their use in creative sonic practice.

ii. A bespoke, descriptive abbreviation system for digital filenames, to facilitate clear overviewing of species characteristics and behaviours without reference to the main catalogue. This has proven especially useful when processing large numbers of files using audio programming languages such as Csound.
iii. A Main Area of Interest (MAOI) metadata field, indicating either sonic or behavioural content as a focal point of the recording.
iv. A subjective quality rating for each recording, ranging from 1 (poor) to 6 (outstanding; rare species).
v. Unlimited space, via embedded spreadsheet comments, for additional contextualising remarks and field note transcriptions.

In succinctly conveying various field methodologies, impressions, memories and other contextualising information via organised sets of metadata, my bespoke cataloguing system has served as a valuable working basis for the portfolio, informing spectromorphological shaping, narrative development, spatial articulation and other creative elements at various stages of the compositional process (especially during initial source processing). Far from becoming a prescriptive aspect of my creative practice, it has instead facilitated the intuitive selection of relevant sources, behaviours and spectral features for processing and further exploration, transplanting location experiences, observations, memories, and gestural/textural/spatial impressions from field to studio. In short, it has functioned as the craft mediator I envisaged.

Exactly *how* this has happened represents a fascinating research area in its own right, and there are a number of additional research questions connected to my wildlife sound cataloguing practice which may become main or secondary foci in future academic projects (see Section 4.2).

1.5 Methodological Overview

The following sections discuss the practical and theoretical methodologies underpinning my research, including: technical and fieldcraft-based recording methodologies; the techniques and technologies of studio practice; and theoretically orientated considerations relating to interpretations of wildlife/nature, and recordist effacement.

1.5.1 Recording Practice

Four technical wildlife sound recording methodologies have proven crucial for effective source capture during my research, and for the growth of my wildlife sound library in general:

i. *Handheld/tripod-mounted parabolic reflector recording.*

This methodology exploits the unique properties of a parabola-shaped dish (typically constructed from lightweight plastic or carbon fibre), which reflects incoming, on-axis

sound waves to a focal point occupied by a cardioid or omnidirectional microphone.[7] The incredibly high directivity of reflector recording at mid and high frequencies allows sound capture at distances of up to 100 metres or more in the field:[8] especially useful for recording wary or dangerous species, or in situations where habitat disturbance must be kept to an absolute minimum.

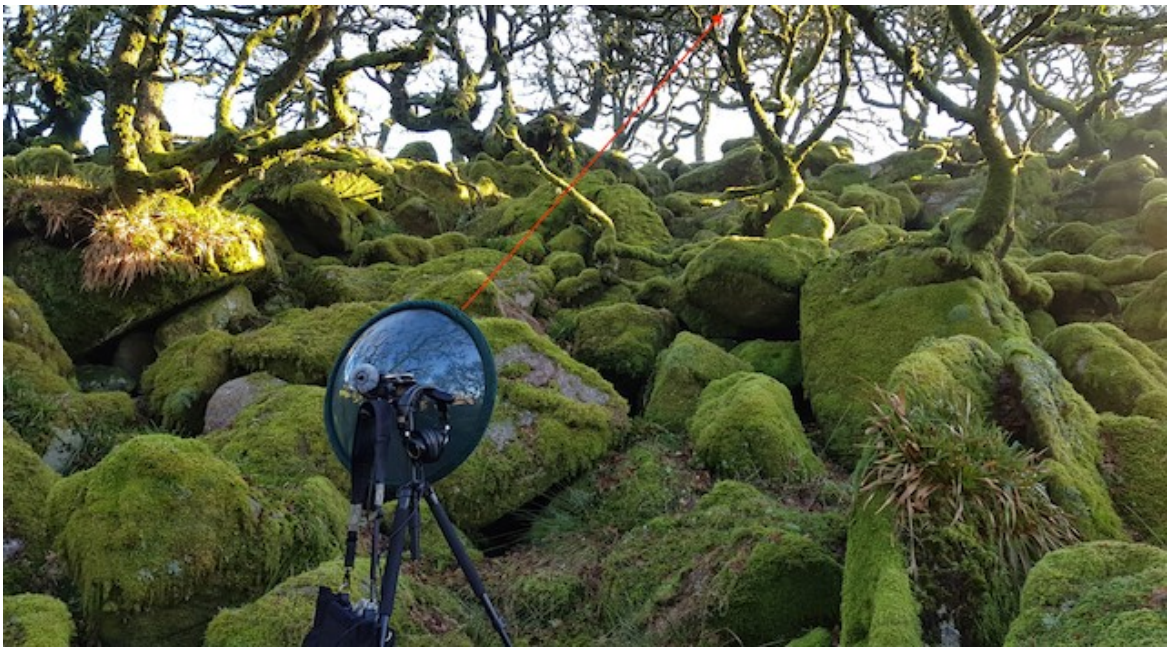


Plate 1
A tripod-mounted parabolic reflector configuration, used to record common chaffinches and mistle thrushes in Dartmoor National Park, Devon. The enclosed, moss-covered position amongst ancient woodland rocks was chosen to combat strong winds from the surrounding moorland. In the absence of additional camouflage for this setup, the natural curvature of the rocks was exploited in an attempt to break up the profile of the reflector. (Photo taken prior to recording. Red arrow shows actual reflector angle when in use.)

7 Although a single microphone is normally used, stereo recording is possible with a parabolic reflector, using two microphones placed either side of an internally mounted flat disc or other boundary (Strandberg n.d.). Stereo recordings can also be made using an internally mounted mid-side configuration, or externally, by clipping miniature omnidirectional microphones onto the left and right edges of the reflector (usually as a complement to an internally mounted, mono microphone).

8 Effective recording distance will vary based on the frequency content of the sound emitter, habitat, weather conditions, microphone type, and other factors.

ii. *Static microphone placements.*

Typically tripod-mounted or attached to suitable structures in the field, this methodology broadly encompasses: mono, stereo, surround or ambisonic microphone configurations housed in protective baskets; various binaural or quasi-binaural configurations (e.g. SASS/SAAM arrays) employing dummy heads and natural/artificial baffles; and miniature microphones, placed at or near nest sites, inside flowers, amongst foliage, etc. Static placements may be fully monitored from a distant hide or other concealed position, left entirely unattended for subsequent collection, or intermittently monitored.

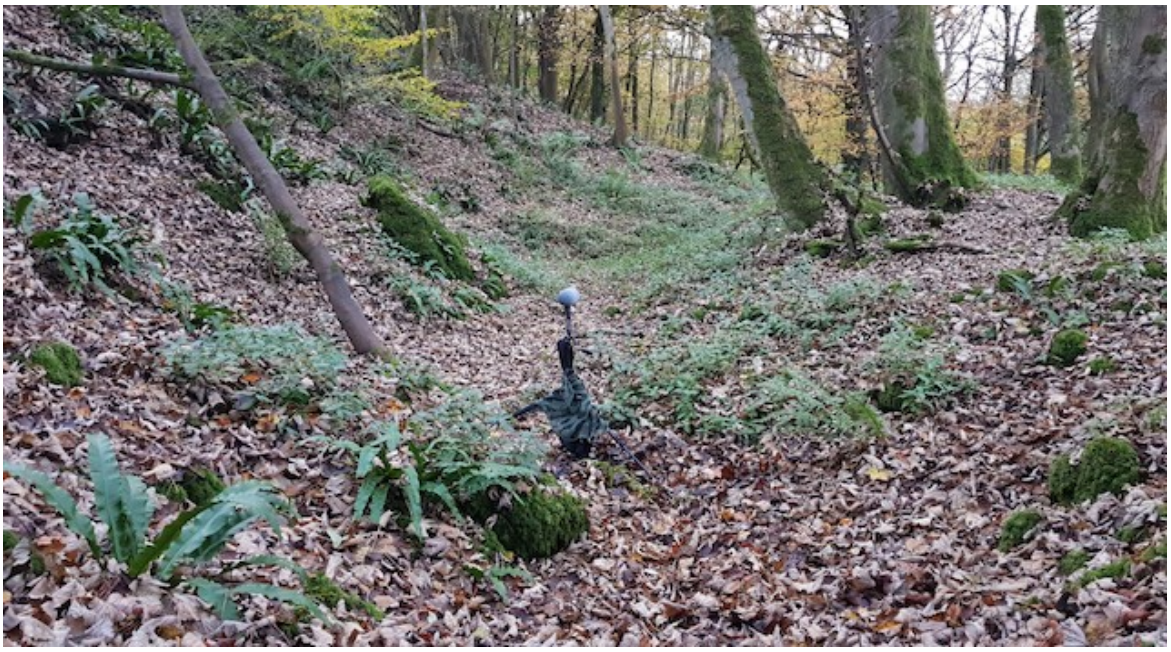


Plate 2
A tripod-mounted static placement in deciduous woodland, rigged in preparation for tawny owl recording throughout the night. A natural recess in the woodland floor was chosen for the placement to attenuate background noise from a nearby river and distant farming activity. The basket windshield housed two omnidirectional microphones for AB stereo recording, both of which were connected to a

portable recorder slung around the tripod centre; a scrim net was then wrapped around the recorder to help conceal LED lights and screen glare in the darkness.

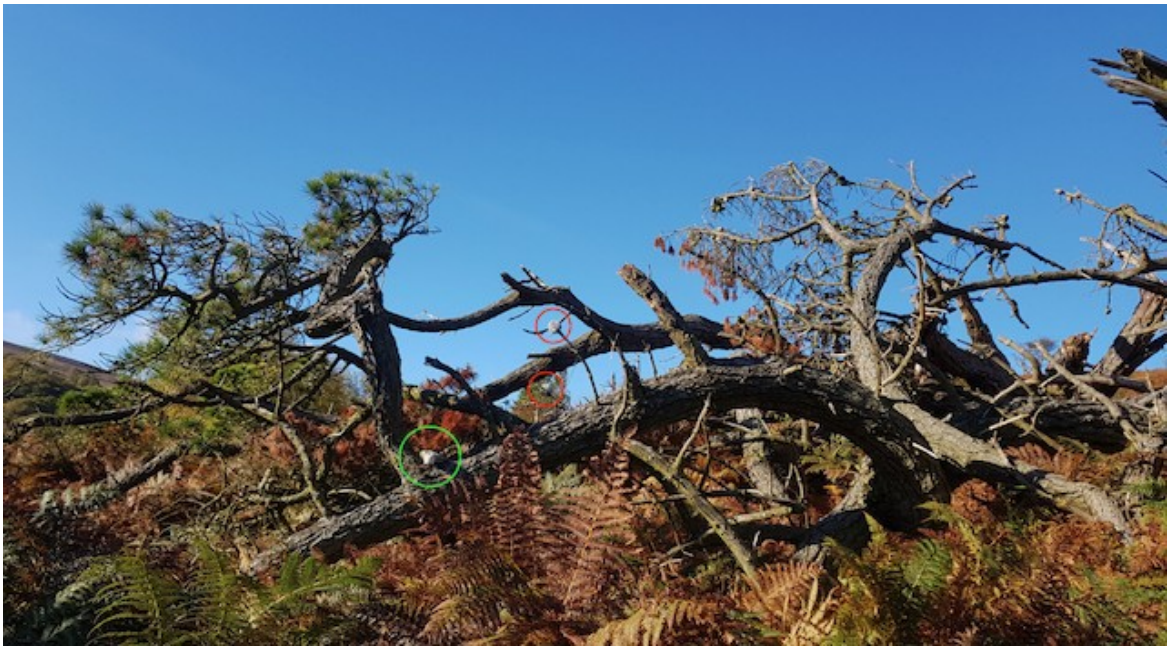


Plate 3
Another example of a static placement, this time using miniature omnidirectional microphones to record avian species foraging along a fallen conifer tree in Exmoor National Park, Somerset. The mics (red circles) were placed on the ends of small branches to roughly mimic cones, and the recorder (green circle) was placed inside a camouflage-patterned sock before being securely wedged in a nearby branch fork.

iii. *Piezo-based contact microphone recording.*

Used to capture the internal structural vibrations of trees, plant stems, roots and other floral structures excited by the action of wind or water. This methodology may also be used to amplify faunal activity within and around a solid object (e.g. woodpecker drums recorded through tree branches, or wood-boring beetle vocalisations recorded through wooden house beams).

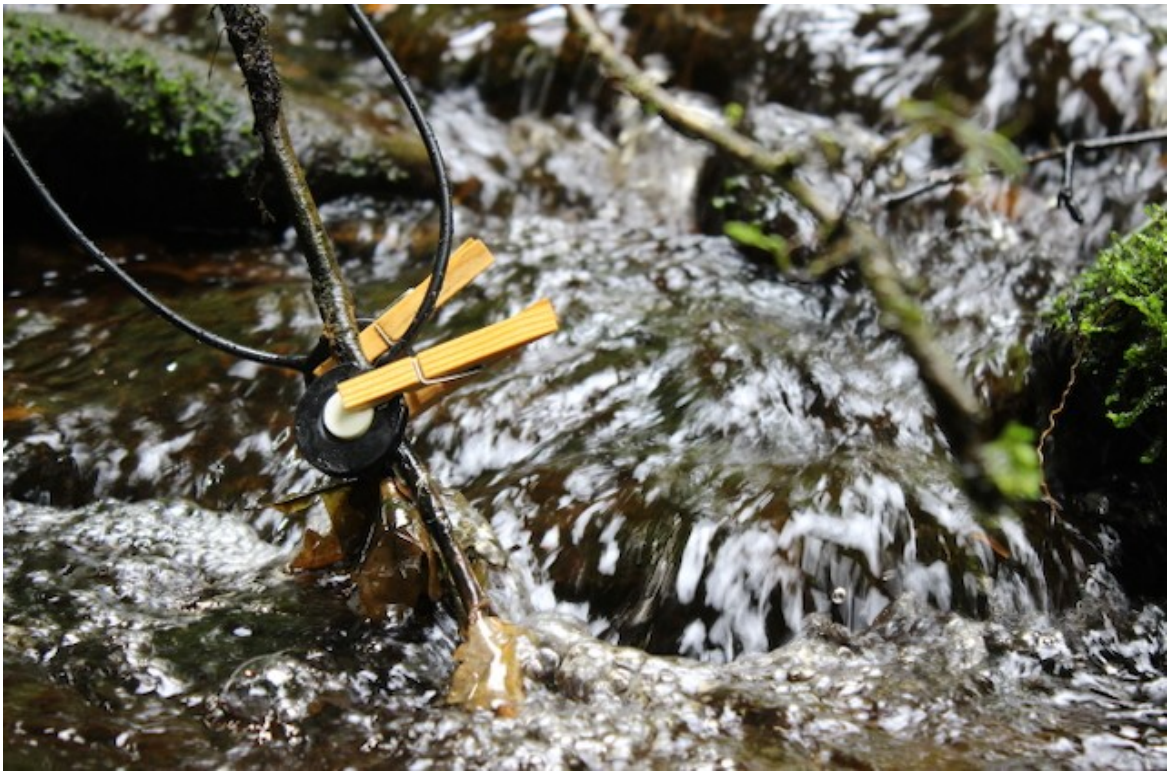


Plate 4
Two contact microphones were used to record internal vibrations from this branch, the lower portion of which had become partially submerged in a mountain stream. Since this portion of the stream was inaccessible, both microphones had to be positioned by shimmying across a nearby tree trunk (lying across the stream), and reaching downwards to secure them with clothes pegs. This recording methodology could be regarded as a quasi-hydrophonic variant of contact mic recording, with the branch structure acting as a kind of natural, hydrophonic projection into the water.

iv. *Hydrophone recording*.

Typically employed to record a range of aquatic species and phenomena in water courses and bodies, as well as sounds propagating within viscous or quasi-viscous substances such as mud, sand, faeces, etc.

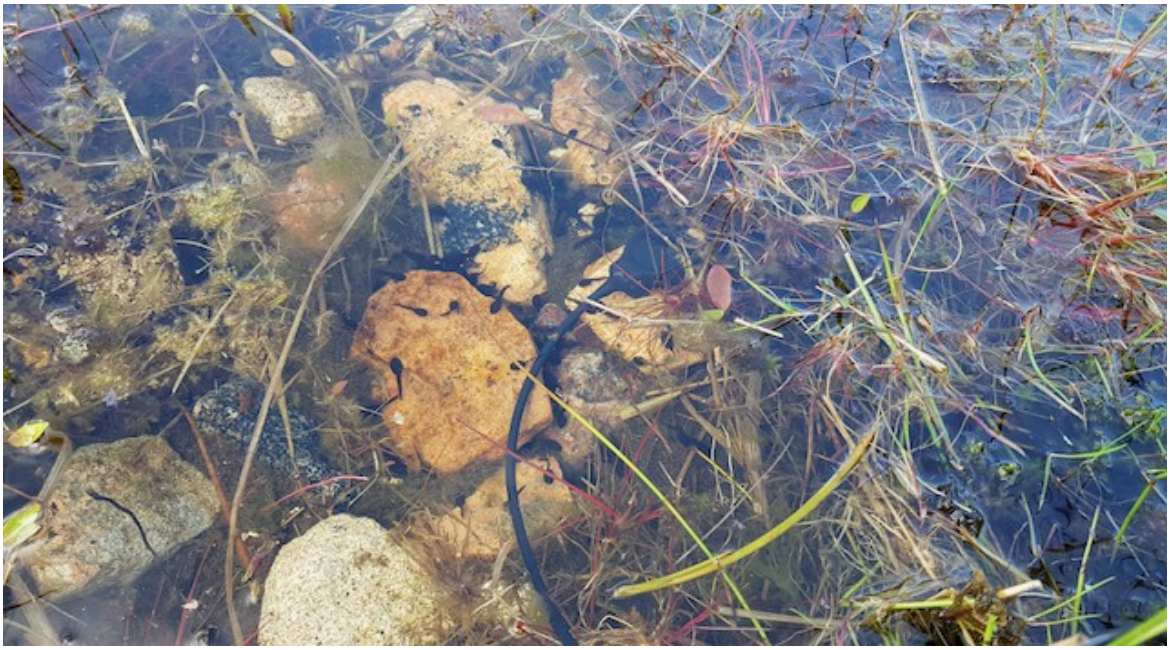


Plate 5
For this hydrophonic recording, the casing of the underwater microphone itself was used to amplify the frictional body movements of tadpoles in a small stream. Because of the delicate nature of these sounds and the amount of amplification required to capture them, considerable thought was given to minimising cable-borne vibrations from wind-blown, moorland vegetation beside the water. The microphone also had to be positioned in a portion of the stream which would simultaneously allow tadpole investigation whilst attenuating upstream current noise as much as possible.

Whilst these methodologies have been fundamental to source gathering for the portfolio and my own recording practice in general, it is important to note that a multitude of variants and sub-variants are regularly utilised by wildlife sound recordists. Many of these are drawn from the wider, parent discipline of field recording, and are often customised around the very specific requirements of the practitioner.

In addition (and as the annotations for Plates 1–5 clearly illustrate), a substantial body of practical approaches lie *behind* each technical methodology: what Boughton

and Shepard describe as ‘the collection of tools, techniques, skills and insights required to work effectively as a wildlife sound recordist’ (2020: 139). These elements constitute what is known as recording fieldcraft: the ability to effectively conceal self and equipment; knowledge of landscape, weather patterns, species behaviour and vocalisation frequencies; awareness of traffic patterns and other human activity when determining optimal time periods for microphone deployment; and so on.

As I have discovered throughout my research, a thorough understanding of fieldcraft methodologies is as essential for effective wildlife sound capture as technical know-how, and must ultimately be developed through practice over considerable periods of time.[9]

1.5.2 Compositional Practice

The practical foundations for electroacoustic composition (especially those relating to studio-based source processing and arrangement)[10] were laid well before doctoral research, during full-time MusM studies at the University of Manchester from 2012 to 2013.[11]

For works such as *Invader* and *Mancunian Canvas* (2012, 2013; see Appendix 1b), GRM Tools–based processors (e.g. Shuffling, Reson and SpaceGrain) were used for

9 See Ratcliff (2016: 21–22) for a useful illustration of technical/fieldcraft methodological interdependence, when discussing approaches to recording the European badger, *Meles meles*.

10 For a diagrammatic overview of where processing and arrangement are situated within the overall creative process for the thesis, see Appendix 8a.

11 Undertaken in the NOVARS Research Centre Studios at the Martin Harris Centre for Music and Drama, under the supervision of Profs. David Berezan and Ricardo Climent.

initial, spectromorphological transformation of urban field recordings made around London and Manchester. The outputs from these processors were then typically fed into several, custom-coded Csound instruments,[12] designed to apply varying degrees of quasi-random modulation to panning, amplitude envelope, filter cutoff frequency and other opcode parameter values. Following editing, arrangement, mixing and mastering of all sonic material in Pro Tools, the completed works were projected over stereo loudspeaker setups as-composed, or diffused over multichannel loudspeaker configurations performatively using a customised mixer or diffusion desk.

These methodologies were greatly expanded during doctoral research, with Csound emerging as a fundamental tool within a processing/re-processing workflow between GRM Tools, Reason and Reaper. Building on earlier frameworks developed at Manchester, a suite of 15 Csound instruments was specifically created for the purposes of wildlife source processing (see Appendix 4a); many of the instruments in this suite expanded on earlier modulation designs, notably through the addition of nested, control-rate modulation blocks for random manipulation of granular synthesis, amplitude modulation, bandpass filtering, panning and other opcode parameters (Ferguson 2019e, 2019f).

12 Within the Csound audio programming language, instruments are essentially blocks of code within a Csound file, which invoke signal processing subroutines that lead to an audio output (Canonical Csound Reference Manual, 2021b). These instruments reside within a delimited orchestra segment, and are instantiated (played) by various statements in a separately delimited score segment. Throughout this discussion, the term ‘instrument’ is used when referring specifically to the signal processing block of code contained within an orchestra segment in a Csound file: in other words, the portion of code used to directly process sound. For clarity, all Csound files in Appendix 4a have filenames corresponding to the signal-processing instruments referred to in the commentary.

Degrees and approaches to processing with these Csound instruments varied as the portfolio progressed, and were often based on how recording practice was guiding studio-based decision-making at the time of composition. Source materials for early works such as *Deadwood* (see Section 2.1.1) and *Shorelines* (see Section 2.1.2), for example, were intensively processed to create complex 'secondary' source materials with high degrees of intrinsic detail; these secondary sources were then continually reprocessed to forge a range of extrinsic connections—through the inherent power of source bonding—to imagined species, phenomena and habitats (Smalley 1997: 110; Ferguson 2019e: 5). Subsequent works such as *The Sunlit Thawing* (see Section 2.2.2) employed processing as a primarily emotive tool, to articulate a personal response to place; others, such as the *Habitats* suite (see Section 2.4.2), utilised processing as transparently as possible, exploring the interplay between reality and representation, and deliberately blurring the boundaries between recorded and composed experience.

Rather than primarily facilitating the arrangement of processed sources (as was the case during master's study), DAW software became deeply intertwined with my processing/re-processing workflow as the portfolio developed. In many cases, entire sections of arranged material within Reaper were rendered to file and repeatedly fed through Csound, Reason and GRM Tools processors; these processed sections were then re-imported into the same Reaper session (their newly transformed spectromorphologies and behaviours used to guide further envelope shaping, EQ adjustments, etc.) before being rendered out again, re-processed, and so on.

Much greater attention was also paid to the eventual projection/performance space of each work, which often had a profound bearing on the shaping of composed spaces during processing and arrangement. Perhaps the most notable example in this regard is *Mud Roots* (see Section 2.3.1), which used the performative capabilities of the BEAST loudspeaker diffusion system at the University of Birmingham as a theoretical basis for composition.

1.5.3 Concepts of Wildlife and Nature

As a sound recordist and composer working with wildlife sounds, my research has proceeded under the assumption that I have a reasonable understanding of what 'wildlife' means: what it represents to me, and what others presumably understand by this representation when I talk or write about my practice.

Whilst the concept of wildlife has arguably played an essential role as a descriptor for my work—especially for the purposes of public engagement—I am cognisant of its problems: not least its tendency to evoke unrealistic notions of species and environmental phenomena existing somewhere beyond our own day-to-day environment, entirely unaffected, influenced or controlled by human activity. The term also tends to evoke the kinds of publicity-friendly, 'camera-worthy' fauna featured in highly polished TV documentaries (e.g. Bengal tigers, African bush elephants, lions, polar bears and emperor penguins), sidelining less visually and audibly engaging species which play a crucial role in sustaining our ecosystems.

‘Nature’ is an even more problematic concept, since it comes bundled with a multitude of contextually dependent meanings and sub-meanings, each of which may represent different things to the individual based on experiences, memories, and cultural background(s); it is ‘both a material object and a socially constructed metaphor that is infinitely interpretable and ideologically malleable based on one’s values and biases’ (DeLuca 2018: 71).[13]

Considering these concepts as they relate to my own work, I should, above all else, point out that I do not subscribe to idealised notions of wildlife or nature: to the notion of pristine, unspoilt wildernesses which ‘[build] upon romanticised myths of the frontier’ and an unrealistic return to ‘simpler, more primitive living’ (ibid: 72). Such idealisations place other species erroneously *apart* from our own, within an artificially constructed, objectified purity, somewhere beyond our immediate environment to be consumed and enjoyed at will. My own recording practice—much of which now takes place in-and-around villages, towns and densely populated urban environments—has consistently exposed this fantasy; in reality, we are embedded *within* nature as animals, and, like other species, are actively transforming it to our own ends (the only difference being the scale of transformation on the part of *Homo sapiens sapiens*, brought about through the use of advanced technologies and machinery).

The notion of anthropogenically unaffected wildlife within a pure natural world existing

13 For the purposes of this discussion, ‘nature’ also encompasses phrases such as ‘the natural world’, ‘the natural environment’, etc., which are, to all intents and purposes, built on individual concepts of nature.

somewhere beyond our town and city limits, then, is arguably nothing more than a constructed experience which, as Katherine Hayles argues, could appropriately be regarded as simulation:

> When ‘nature’ becomes an object for *visual* consumption, to be appreciated by the connoisseur’s eye sweeping over an expanse of landscape, there is a good chance it has already left the realm of firsthand experience and entered the category of constructed experience that we can appropriately call simulation. Ironically, then, many of the experiences that contemporary Americans most readily identify with nature—mountain views seen from conveniently located lookouts, graded trails traversed along gurgling streams, great national parks like Yosemite visited with reservations made months in advance—could equally well be considered simulation. (1995: 411, cited in DeLuca 2018: 77)

Although my own fieldwork continues to ground me in the apparent realities of nature (where humanity’s transformations of, and presence within, the environment are all too evident and fully acknowledged), it could of course be argued that through the act of transforming and (re)presenting species and environmental phenomena artistically via my research, I have been constructing a set of idealised snapshots of nature for the listener: a set of compositionally simulated objects and experiences far removed from the realities of the field. This raises a multitude of embedded questions concerning the romanticisation of the natural world (Michael 2011: 206; Parmar 2012: 204), the ethics of artistic representation (Andean 2014), and practitioner self-reflexivity in the field (Anderson and Rennie 2016), all of which are well beyond the scope of this commentary.

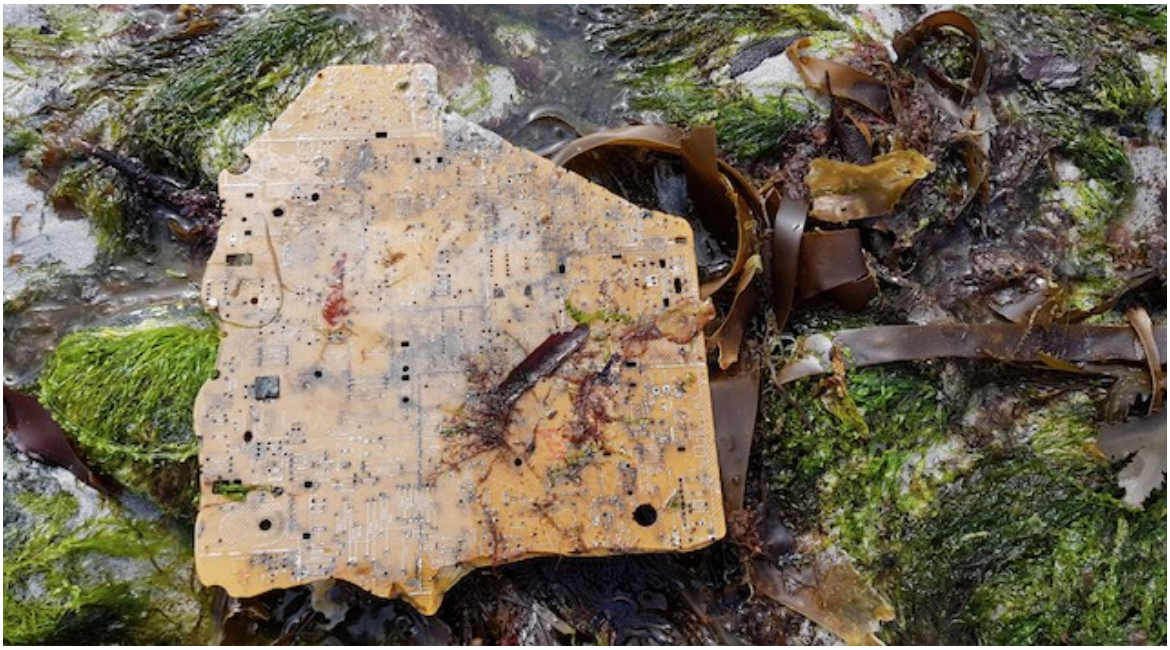


Plate 6
A printed circuit board fragment, washed up on the beach between Askernish and Daliburgh, on the coast of South Uist, Scotland: an area visited frequently during fieldwork for *Machair Impressions* (see Section 2.4.1). Such marine waste was profuse here, with new items washing up on a daily basis; none of it was represented in the finished piece or mentioned in my programme notes. Am I guilty of purveying an unrealistic interpretation of nature because of such omissions? To what extent can we truly represent a 'realistic' nature as artists?

Given humanity's overwhelming transformation of the environment, we might also question whether terms such as 'wildlife' or 'nature' are even applicable in the twenty-first century, and whether they should be substituted with something less suggestive of the unaffected or pristine. The philosopher Timothy Morton has, for example, argued for the substitution of 'nature' with 'ecology', since it apparently has 'the advantage of being defined in a manner not overly constrained by centuries of aesthetics and politics' (2007: 204, cited in Parmar 2012: 204).

Directing attention back towards my own practice, another (in my opinion more

useful) approach may be to view environmental sound art of all kinds through a different lens: one that promotes a rehearing of the natural world and takes account of human influences, intentions and effects. Mark Peter Wright (2017: 1) has convincingly proposed such a shift, suggesting a move towards what he calls a 'post-natural sound arts':

> In a time where human impact is radically altering the sedimentary signature of the earth, a Post-Natural approach asks if it plausible to claim 'non-impact' anymore? Has the long-empathetic notion of non-invasive environmental recording become a redundant ideal that is as illusionary as so-called Nature itself? Can the recording of species and phenomena continue to be deemed inconsequential? How is technological agency performed and part of an ecological approach? Whom do 'we' speak for in the sounding of environments? What is the impact of such questioning in the field and how do aesthetic modes of documentation and production respond? (ibid.)

He also argues:

> In the context of anthropogenic change and the long-term debates around what constitutes Nature, sound recordists must recognise they are bound into new ecological relationships with themselves and their technologies of capture. Both must be brought into heard and unheard earshot in order to destabilise and reactivate essentialised legacies of silence and the pristine. (ibid: 6).

Whilst these and other questions associated with concepts of 'wildlife' and 'nature' have ultimately remained well beyond the scope of the thesis, it has been enlightening to critically engage with them and consider how they might shape future

creative work. Fully acknowledging the problems with each term and the ongoing debate regarding their use, I have provisionally concluded—at least with regard to creative sonic practice—that attempting to establish exactly what wildlife and nature are will, in the long run, prove futile; instead, we might more beneficially ask what these concepts mean for the artist. This is in line with DeLuca's previously cited postulation of a nature that is infinitely interpretable and ideologically malleable based on one's values and biases (2018: 71). If we can at least agree on this, it follows that we should place responsibility on the artist's shoulders to describe what nature and/or wildlife mean(s) to them as a practitioner; perhaps then we can begin to interpret what (and how) they are attempting to explore through their practice with greater sensitivity, and build critiques rooted in an understanding of craft and intention as opposed to terminology.

For me, the craft of wildlife sound recording primarily involves recording undomesticated, non-human species and naturally occurring environmental phenomena such as rivers, streams, wind and waterfalls, with a particular focus on capturing and conveying animal behaviour. Other practitioners may have a special interest in recording captive species in zoos or domestic holding pens, and regard these sounds as representative of 'wildlife'. Whatever/however wildlife sound practitioners attempt to record and whatever wildlife may mean to them, a firm focus on documenting species behaviour and communicative vocabulary will presumably remain a defining element of their craft within an ever evolving, ultimately undefinable 'nature'. The output of some of wildlife sound recording's most prominent figures (e.g.

Ludwig Koch, Peter Paul Kellogg, Chris Watson), and the ongoing archival contributions of Wildlife Sound Recording Society members, strongly reinforces this assumption.

Over the course of the portfolio's formation, I have gradually reheard my creative exploration and (re)presentation of wildlife sounds as an unavoidable by-product of a post-natural world, where I am bound into an ecological relationship with advanced recording and processing technologies as much as with the species and phenomena I am pursuing (Wright 2017: 6). This development demonstrates that my own perceptions and concepts of wildlife and nature continue to evolve alongside my practice, opening up new avenues of investigation within the creative sonic arts: avenues which may shed more light on what it means to work creatively with wildlife sound as my research progresses.

1.5.4 Recordist Presence and Narrative

Throughout the portfolio, I have chosen not to draw attention to my own presence as a recordist; indeed, all source recordings used as a basis for composition (see Appendix 3) have been edited so that they are free from spoken field notes, handling noise, and other overt indicators of practitioner agency.

Viewed in the context of recent, discursive trends around embodiment (e.g. Carlyle and Lane 2013; Findlay-Walsh 2019), first-person approaches (Findlay-Walsh 2019) and self-reflexive narrative (Anderson and Rennie 2016) in field recording, this could

easily be interpreted as a clinical attempt to erase my own 'story' from the portfolio, and accumulate a set of objective, highly polished species snapshots for use purely as 'compositional departure points' (Anderson and Rennie 2016: 222).

The first point to make here is that whilst I have not drawn attention to my own presence as a recordist, I *have* attempted to draw attention to the inherent narratives and embodied presences of other, non-human species and environmental phenomena, foregrounding, where possible, the recorded and (re)composed perspectives of those subjects. A natural influence from the wildlife sound recording craft (which tends to emphasise the exploration and documentation of animal vocabulary and behaviour), this species-centred approach also stems from my own interests in wildlife conservation (discussed in Section 4.1), and the broader conviction that we, as human beings, should focus much more on listening to the sounds and behaviours of other species in order to better understand the world around us.[14]

Secondly, although my own narrative is not overtly detectable through direct sonic indicators such as voice, body movements or recording equipment manipulation, it has not been excluded; in fact, the species narratives and embodied presences I have attempted to foreground in the studio have themselves been informed by self-reflexive, narrative elements present within catalogued metadata (see Sections 1.4 and 4.2): experiences, memories, behavioural descriptions, weather observations

14 This thinking aligns with aspects of anti-anthropocentrism promoted by Tim Morton and other members of the Object-Oriented Ontology philosophical movement (see e.g. Morton 2016).

and so on, all of which have been distilled from spoken field notes made before and after encounters with recorded subjects. Throughout my research, I have often referred to this metadata to inform the processing and arrangement of existing species behaviours, and guide the composition of new, imaginary behaviours and interactions.

Reheard from this perspective, it could be argued that the portfolio is infused with the inaudible or ‘indirect’ self-reflexive narratives conveyed through my wildlife sound catalogue: a catalogue which has, to paraphrase my own words, functioned as a mediator between recording and electroacoustic composition crafts, and facilitated the intuitive selection of sources, behaviours and spectral features by transplanting location experiences, observations, memories, and gestural/textural/spatial impressions from field to studio (Section 1.4: 12–13).

As a practitioner, this realisation has prompted a reevaluation of Isobel Anderson and Tullis Rennie’s seminal work on self-reflexive field recording (2016), and has raised important questions concerning what it means to engage in self-reflexive narrative. Two of the most relevant for my own work are:

- How can we develop strategies for detecting inaudible/indirect self-reflexive narratives in field recording?
- To what extent do overt self-reflexive narratives in wildlife sound recording draw focus away from the inherent narratives and embodied presences of other species, particularly those that are endangered or near-extinct?

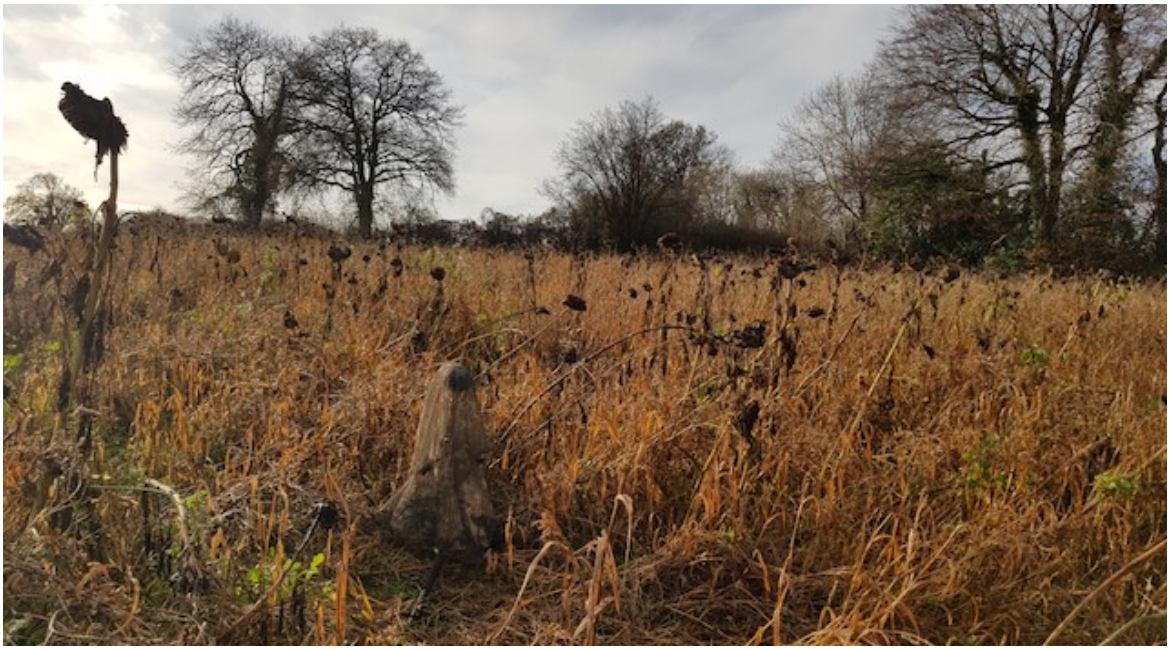


Plate 7
To capture the feeding activity of common linnets (*Linaria cannabina*) on the edge of this rotting maize plantation, I left a partially camouflaged AB stereo configuration unattended from sunrise to sunset, so that the flock could return to the area and vocalise undisturbed. As a recordist, I prefer to let non-human species narratives unfold without overt self-reflexivity, typically verbalising my own field notes and observations into the microphone after the recording; these spoken words are then written-up, catalogued, and used to guide creative work in the studio.

In considering how I might approach compositional storytelling in the future, I see great potential in teasing apart the two primary narrative elements explored during my doctoral research: the inherent, non-human species narratives captured directly through wildlife source recordings, and the inaudible/indirect self-reflexive narratives conveyed through catalogued sounds via studio-based composition. Key questions of interest here include:

- How can the tensions between self-reflexive and non-human species narratives be explored compositionally?
- What can we learn from other species' narratives when attempting to compose our own stories, and how can these non-human narratives be combined and contrasted with our own via studio-based processing?

2. MAIN DISCUSSION: PORTFOLIO DEVELOPMENT

The following section of the commentary charts the evolution of the portfolio over the course of my research, exploring the various thematic, aesthetic and methodological concerns of each piece in detail.

All timeline references are given in minute and second (MM:SS) format; for example, an event occurring at one minute, twenty-seven seconds in a particular piece would be specified as 01:27.

2.1 Embarkation

2.1.1 Deadwood (2018–2019)

Inspiration for my first portfolio work—*Deadwood*—was largely drawn from a single, contact microphone recording of a rotten branch, made along the banks of the River Severn (UK) in mid 2017 (Appendix 3a: rec. 0107-2017).[15]

The piece is a compositional re-exploration of the branch object, taking the listener on an imaginary, octophonic journey through its internal and surface sound worlds. It

15 The original, stereo recording of two separate branches was made along flood defences near Fretherne, Gloucestershire, on the southern edge of the Arlingham peninsula (see Plate 8: 37). The water level of the Severn around the peninsula is strongly influenced by the tidal effects of the Severn Estuary: flooding is frequent, and at low tide, a series of expansive mudflats are revealed, providing excellent foraging opportunities for a variety of avian species.

is also a broader, compositional reflection on my field experiences during the recording: a series of complex interactions between the intimate, internal vibrations and resonances of dead wood (revealed directly through contact microphones), and the surrounding, external habitat of the river (audible outside/beyond my headphones, and characterised by an evolving sonic fabric of reeds, wind, and tidal flow over dense mud).

Deadwood's spatially led structure reflects and builds upon this dynamic listening experience, re-articulating the tension and interplay between internal and external environments perceived during headphone monitoring. Subtle environmental hints (e.g. muted, external shore sounds from 00:32 to 01:07; muffled carrion crow call at 04:41) are contrasted with overt and sometimes forceful transitions, which simultaneously function as structural markers and points of release (e.g. breaking through wood and moving towards water from 03:42 to 03:45; emergence amongst wind-blown shore reeds from 04:57). Much of the work is therefore built around potential and the build-up of latent energy, playing on a pervading sense of tension through glimpses and hints of external forces and phenomena, which could, at any time, lift the listener out of the proximate space of the wood.

As part of my compositional re-exploration of the branch, I have also attempted to convey the various morphologies, behaviours and life processes of invertebrates known to inhabit locations in-and-around the River Severn (National Biodiversity Network 2021). The programme notes for the work detail these elements explicitly:

Decomposition processes.

Common woodlouse, brown centipede and white-legged snake millipede. Larvae of deathwatch, stag, lesser stag and red-headed cardinal beetles.

Invertebrate palps, mandibles, antennae, body segments, wings, elytra, and mucous membranes.

Larval stages, egg casing friction and arthropod communications.

Figure 1
Extract from *Deadwood* programme notes (taken from Appendix 2a).

Since most of these sounds are either incredibly difficult or impossible to record in the field,[16] they were brought to life compositionally using three Csound instruments: a gesture generator (Appendix 4a: Instrument 5), sample glitcher (ibid: Instrument 9) and octophonic panner (ibid: Instrument 15). These instruments were repeatedly applied to AB stereo source recordings of reeds, wind and lapping water made along various stretches of the Severn, in order to generate abstract textures and microgestures. With continued re-processing and additional spectromorphological shaping using GRM Tools and Reason, these abstract sonic materials gradually took on organic characteristics, strongly source bonded to a microscopic sound world inhabited by woodlice, centipedes, beetles and other invertebrates (Ferguson 2019e: 2–3).

16 Centipedes, beetles, beetle larvae and similar organisms can be recorded directly in the field, but proved difficult to locate during the composition of *Deadwood*. Where appropriate, they may be captured and recorded under controlled, indoor conditions (see e.g. Chris Watson, via French 2012); for a variety of reasons, however, this is not an approach I advocate as a wildlife sound recordist.

The internal branch space central to *Deadwood* is inhabited, then, by creatures forged from the raw materials of their surroundings; by organisms born out of their own, real-world riparian habitat through studio-based processing. Their world is one of minute, intricate gestures and morphological interactions—at times delicate and playfully iterative—which occasionally coalesce into spectrally dense, quasi-tactile textures suggestive of microscopic biological processes (e.g. 04:23 to 04:31). Throughout the piece, their interactions are fundamentally bound by the ever-present tidal forces acting on the River Severn, to which they respond and adapt before finally being consumed (06:30 to END).

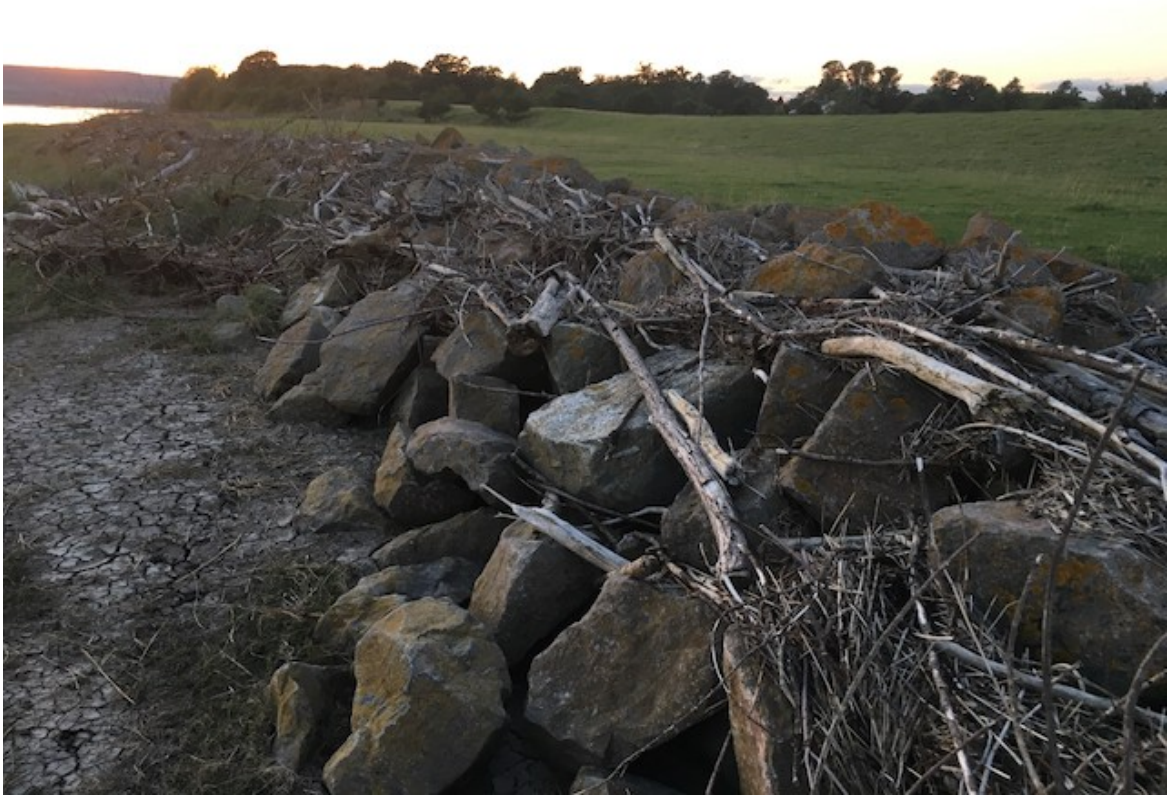


Plate 8 (previous page)
The location of the branch source recording made for *Deadwood*. Two contact microphones were used to record internal vibrations from separate branches; the most suitable channel was then isolated and rendered to mono for processing.

2.1.2 Shorelines (2018–2019)

My second portfolio work—*Shorelines*—builds on the aesthetic and methodological foundations laid by *Deadwood*, elaborating on themes of tides, water bodies, sedimentation, submersion, and composed species behaviour.

A series of reflections on Talisker Bay Beach, Isle of Skye (Scotland), the work is essentially a re-imagining of the Talisker Bay shoreline and the various species, phenomena and environmental processes encountered in the area during a short field recording trip undertaken in late 2018. It is also a reflection on my own ancestral points or 'lines' of connection between Northern Ireland and western Scotland,[17] as well as the vast volcanic and tectonic forces which have shaped both landscapes over millions of years.

17 Revealed in significant detail in mid 2018, through privately funded, ancestral DNA analysis. Based on the latest analytical models, my recent ancestral DNA weighting for both Northern Ireland and the west of Scotland (covering roughly the last 1500 years) amounts to approximately 60%, with an additional 11% coming from other Scottish regions and islands.

Plate 9
Source recording for *Shorelines* on Talisker Bay Beach, Isle of Skye, using an AB stereo configuration housed in a protective basket windshield (left foreground).

All open-air source material for *Shorelines* was derived from a single, AB stereo recording of breaking waves along Talisker Bay Beach (location shown in Plate 9 above; see also Appendix 3b: rec. 0195-2018). The remaining sounds for the work were derived almost entirely from a handful of hydrophonic and XY/AB stereo source recordings, made in various locations throughout Northern Ireland and used as processing inputs for the generation of complex, water-based textures, gestures and imaginary species behaviours.[18]

18 One source in particular—a subterranean, hydrophonic recording of breaking waves and sand grains, made at Cushendun Bay on the Northern Irish coast (Appendix 3b: rec. 0010-2015)—had a profound impact on spectromorphological shaping and the overall sonic palette of the piece, informing numerous textural and microgestural explorations within Csound, and focusing much processing attention around the mid and high regions of the frequency spectrum.

Csound was used for the majority of this processing, with particular emphasis placed on granular synthesis (Appendix 4a: Instrument 3) and random bandpass filtering (ibid: Instrument 4) to create gesturally enveloped, aquatic textures suggestive of particulate sand, sediment clouds, bubbling, swirling currents, and so on (Ferguson 2019e: 3–4). An octophonic panner (ibid: Instrument 15) was additionally used to spatially enhance these secondary sources and create a sense of envelopment within their complex internal behaviours (e.g. swirling underwater material from 02:15 to 02:28).

Following the same re-processing methodology as *Deadwood*, many of these sounds were additionally manipulated in GRM Tools and Reason, in order to generate materials strongly source bonded to imaginary species and their various behaviours: in this case, jellyfish propulsion mechanisms and the intricate feeding processes of limpets, crabs and snapping shrimp.[19] These species occupy composed spaces such as rock pools (e.g. juvenile crabs from 02:57 to 03:25), channelled currents (e.g. jellyfish propulsion from 03:45 to 03:58) and vast ocean floors (e.g. snapping shrimp from 04:03 to 04:42), and are periodically lifted, swept, buffeted and jostled by the powerful forces of enveloping water (e.g. snapping shrimp lifted and carried by strong current from 07:58 to 08:21).

19 Snapping shrimp were successfully recorded during the same trip to the Isle of Skye, around Neist Point on the westerly tip of the island. Although unsuitable for the studio-based manipulations I was exploring at the time, the sonic characteristics of these recordings undoubtedly had a substantial influence on source bonding when processing other, more abstract materials for *Shorelines*.

In contrast to the clearly delimited spatial range of *Deadwood*, the composed spatial range within *Shorelines* is truly vast. At the very beginning of the piece, the listener is confronted with a powerful, low-frequency tectonic shift, instantly defining a quasi-infinite space that is unlocalisable, deeply reverberant and threatening.[20] These powerful geological shifts recur throughout in various forms, underpinning transitional portions and build-ups (e.g. 04:41 to 04:45), adding weight and body to gestural climaxes (e.g. at 02:34), and occasionally revealing themselves through the sudden disappearance of existing material (e.g. at 02:28). In stark contrast to this geological vastness, the listener must also traverse the confined, resonant spaces of gastropod shells (05:11 to 06:10), the intricate behaviours of marine organisms, and the microscopic impacts of sand particles and sediment (e.g. 01:55 to 02:20).

The spatial regions between these proximate and quasi-infinite extremes are occupied by a multitude of dynamic, swirling currents, pools and water channels, distributed octophonically and twice broken by the open-air, panoramic space (Smalley 2007: 55–56) of Talisker Bay Beach (at 04:45 and 06:11). These open-air interludes serve as brief reminders of the work's recorded genesis, and continuation of sonic life above water.

A number of performative diffusion strategies were exploited to further enhance the composed spaces of *Shorelines* during the work's premiere.[21] Low-frequency tectonic

20 This composed, spatial vastness was strongly influenced by my recording experiences with hydrophones, where audible, underwater material is often unlocalisable and distance is virtually impossible to estimate with any real degree of accuracy.

21 At the Elgar Concert Hall, University of Birmingham on May 3, 2019. The BEAST loudspeaker diffusion system was used for the performance. See Appendix 8b for a full schematic of this

shifts were reinforced using subwoofers, and tweeter trees hanging above the audience were exploited to enhance HF-rich textures (e.g. 08:14 to 08:22). Two reverb chambers were additionally exploited to enhance composed shell resonances (e.g. 05:11 to 06:10), and floor-situated loudspeakers were used to follow the gestural contours of breaking waves, drawing them through the audience's feet in a real-time, spatial augmentation of the Talisker Bay recording which inspired the piece.

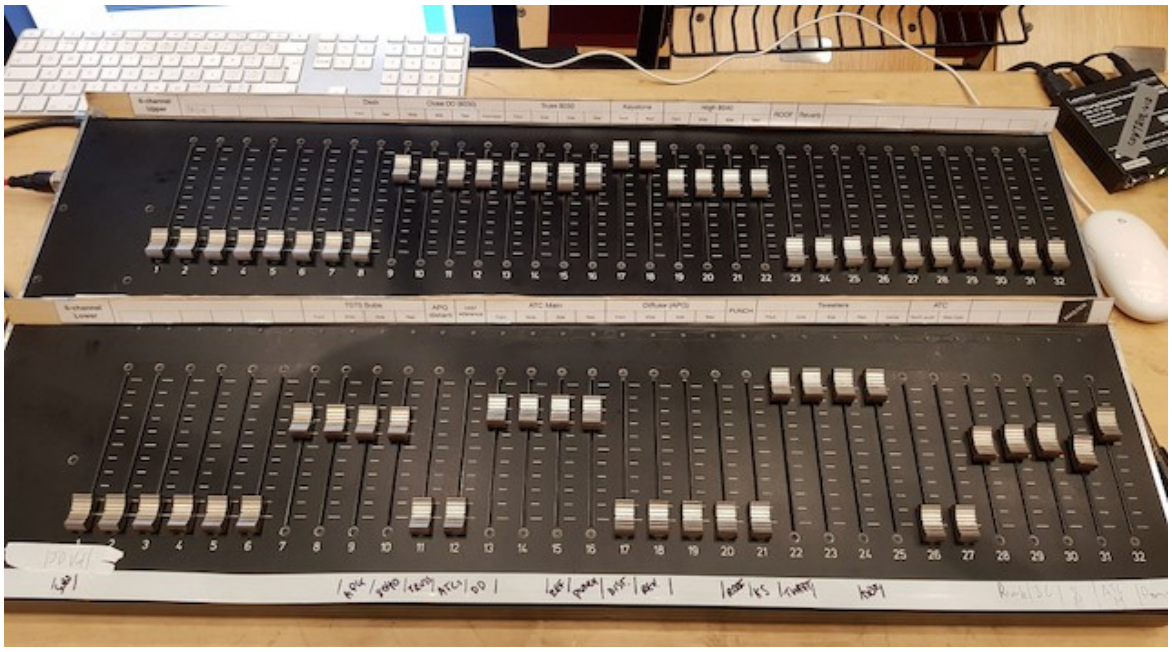


Plate 10
The BEAST diffusion desk, used to premiere *Shorelines* over the BEAST multichannel sound system in real time. Volume levels for individual (or entire groups of) loudspeakers are freely controllable via sets of faders, with overall volume controlled by a single, master fader to the bottom right corner of the unit. (Photo taken by the author, during pre-concert rehearsal.)

system, as deployed on the night of the premiere.

2.2 Aesthetic Carvings

‘Composers also have problems: how to cut an aesthetic path and discover a stability in a wide-open sound world, how to develop appropriate sound-making methods, how to select technologies and software.’ (Smalley 1997: 107)

Following the composition of *Shorelines*, I spent several days considering the development of the portfolio, using feedback from student colleagues and supervisors as a basis for critical reflection on my artistic practice.

A key realisation at this early stage of my research was that I had begun to settle on a compositional aesthetic fundamentally reliant on juxtaposing and interweaving highly detailed, intensively processed materials (source bonded to imaginary species and their associated behaviours) with unprocessed recordings of natural environments and phenomena (which served primarily as structural indicators and real-world points of reference).[22]

Although positively received, a recurring critique of this approach centred around questions of compatibility: namely, whether intensively processed and unprocessed sources complemented each other as effectively as I thought, when juxtaposed and combined within the same sonic fabric.[23] Following on from this and in the same vein

22 For the purposes of this discussion, an ‘unprocessed’ recording is a recording which has been selectively edited from an original field take, with terminal volume fades and minimal highpass filtering applied (to an upper limit of 200Hz, fourth-order steepness). No additional sonic transformations will have been used. Whilst, for me, processing technically starts at the very root of the audio chain during microphone selection, a distinction must be made at this point between basic editing/filtering practice for field recordings, and more extensive, studio-based transformations of recorded sounds using granular synthesis, reverb, distortion, etc.

23 I am especially grateful to my lead supervisor, Scott Wilson, for critical feedback in this regard.

of critique, a number of listeners had also suggested that processed and unprocessed sonic materials could perhaps be isolated completely, and developed apart from each other in entirely separate, contrasting works.

With this feedback in mind, over the following months (April to August 2019) I decided to carve out the juxtaposed processed/unprocessed aesthetic bases of *Deadwood* and *Shorelines* and apply them as separate, piece-level compositional strategies in their own right, using them alongside the ever-present, guiding influence of recording methodologies to inform source selection, processing, arrangement and overall thematic development in the studio. As a result of this approach, two contrasting works emerged: one entirely rooted in a recognisable, mimetic sound world; the other heavily weighted towards the farthest extremes of abstraction (Emmerson 1986: 17–20).

As discussed in Section 2.3, these ‘aesthetic carvings’ ended up guiding my compositional palette towards a settling point in the portfolio, as I moved towards the end of my first year of study.

2.2.1 Cassiano’s Blackbird (2019)

Cassiano’s Blackbird was commissioned by the Barber Institute of Fine Arts at the University of Birmingham, to accompany a curated exhibition of Cassiano dal Pozzo’s Paper Museum: an extensive, 17th-century collection of drawings, watercolours and

prints, incorporating depictions of various zoological, botanical and geological subjects (Barber Institute of Fine Arts 2019c).[24]

Reflecting the Italian patron Cassiano dal Pozzo's particular interest in ornithology, the collection features numerous, highly detailed avian illustrations, including a striking drawing of a leucistic[25] common blackbird (*Turdus merula*) by Vincenzo Leonardi. This drawing was serendipitously curated for the exhibition at the Barber, and viewing it during my initial consultation with exhibition organisers prompted the concept of a species-based response to the dal Pozzo collection, via an exploration of my own blackbird recordings.

24 The commission brief was for approximately 20 minutes of fixed-media electroacoustic material, suitable for and/or responding directly to the Cassiano dal Pozzo Paper Museum exhibition (on temporary display at the Barber). All commissioned material was played on the evening of June 25, 2019 during the 'A Night at the Paper Museum' event: part of the multidisciplinary *Barber Lates: Nocturnes* series, which showcased the Institute's collections and exhibitions alongside current academic research at the University of Birmingham. In order to fulfil the commission duration requirement, *Shorelines* (see Section 2.1.2) was also played at the event; unlike *Cassiano's Blackbird*, however, this piece was not a direct response to the dal Pozzo exhibition, and served instead as a sonic complement to seascape paintings by Gustave Courbet and other artists on display in a separate portion of the Barber (Barber Institute of Fine Arts 2019b).

25 Leucism is a genetic condition in which normally dark-coloured animal plumage, skin or fur appears white, due to a lack of pigmentation.

Plate 11
Vincenzo Leonardi's leucistic common blackbird drawing, which formed the basis for my response to the Paper Museum collection. Royal Collection Trust / © Her Majesty Queen Elizabeth II 2021.

Apart from aligning strongly with my research objective of using unprocessed materials exclusively in a piece (see Section 2.2: 43–44), I realised that a relatively pure compositional aesthetic focusing on individual species recordings would neatly complement the depictive style of the dal Pozzo collection, whose formation had been underpinned by the meticulous study and representation of individual, real-world subjects (Royal Collection Trust 2021). An additional benefit was the prevalence of common blackbird vocalisations over the spring period of the

commission, which would provide numerous opportunities to focus on the species' behaviour and vocabulary in detail.

Having settled on a thematic starting point, I began my initial arrangement of recorded sources, at all times bearing in mind the key, site-specific challenges of the commission: the potential modulatory effects of visitor pacing and positioning around the exhibition; the inherent difficulties of layering habitat sounds convincingly around individual species vocalisations; and ensuring the effective, balanced propagation of sonic materials within the reverberant acoustic of the Barber.[26] Additional challenges arose as the commission deadline approached, including limited loudspeaker availability and rigging/de-rigging manpower, limited time of access around the planned event, and staff concerns regarding loudspeaker proximity to valuable artworks.

Collectively, these challenges ended up restricting the delivery of the work to a single, stereo placement, positioned in one corner of the Barber's Green Gallery opposite the Cassiano dal Pozzo exhibition space.[27] Having initially envisaged a multichannel work in which blackbird vocalisations emanated from a series of loudspeakers placed strategically around the Barber, I now faced a situation in which the piece could

26 Although the majority of gallery paintings in the Barber are mounted in front of fabric-lined wall panels (which provide some acoustic absorption), most of the main gallery surfaces are flat and smooth, including the floor, upper/lower wall sections and ceiling recesses. During early arrangement of *Cassiano's Blackbird*, I made a number of visits to the galleries in order to get a sense of their overall acoustic quality, using hand claps and finger clicks to assess reverberation levels.

27 The Barber Institute consists of four main galleries named for the colours red, green, blue and beige, joined together at each end in a square formation. The Lady Barber Gallery—an additional, smaller display area—facilitates temporary exhibitions such as the dal Pozzo Paper Museum (Barber Institute of Fine Arts 2019a).

potentially lose definition, becoming smothered by the wider acoustic of the building and the overall bustle of the event.

The main solution to this problem was directly informed by my field experiences with parabolic reflector recording (see Section 1.5.1: 14–15): a methodology whose greatest strength lies in the ability to isolate sources, with pinpoint accuracy and over substantial distances, from their surrounding habitat. In what became the driving force behind the piece's composition, three mono, parabolic blackbird recordings (Appendix 3c: recs. 0096-2017, 0207-2019, 0234-2019) were used as primary compositional sources, providing much-needed spatial clarity and definition for the species' vocalisations in the reverberant gallery space.

As a complement to this solution and in order to turn the inherent restrictions of stereo projection to my advantage, both loudspeakers were angled towards the centre of a small wooden bench in the centre of the gallery. This roughly corresponded to a studio monitoring situation, and encouraged seated listening within a pre-determined acoustic sweet spot, preserving much of the composed stereo image.

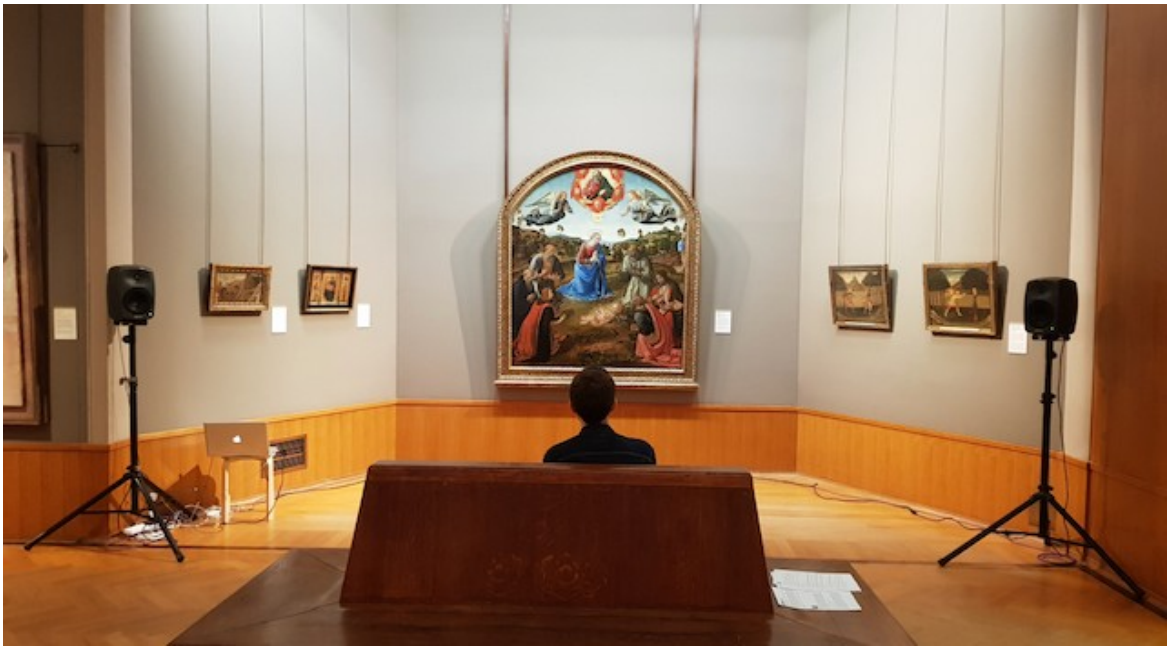


Plate 12
A visitor listens to *Cassiano's Blackbird* in the Green Gallery. The angled loudspeaker positioning encouraged active listening within the pre-determined acoustic sweet spot at the bench. This was well received by visitors, many of whom had walked and stood for extended periods around the nearby Paper Museum exhibition. Image used by permission of the Barber Institute of Fine Arts, Birmingham.

Cassiano's Blackbird unfolds as a crossfaded montage of common blackbird vocabulary, layered with recordings of an English dawn chorus, windswept grass tussocks, upland streams, and ancient woodland streamlets: habitat sounds complementary to, and representative of, my own experiences observing and recording *Turdus merula* in the wild.

The piece begins with a gradual fade into the barest traces of distant blackbird song, just audible against the surrounding dawn chorus and a nearby meadow stream (00:00 onwards). These habitat sounds are subsequently layered with a parabolic recording of the species' well-known, iterative alarm call variant (01:03 to 02:00), as a

swelling stream (01:38 to 02:47) carries us into a fresh soundscape of exposed, upland grass tussocks (02:34 to 05:43). After an appearance of the blackbird's lesser-known 'trilled' call variant (03:58 to 05:02), the dawn chorus and stream soundscape slowly resurfaces (05:08 onwards), with blackbird song briefly foregrounded (05:52 to 06:21); this is followed by a very gradual transition into the gentle trickling and bubbling of an ancient woodland streamlet (07:12 onwards).

Following a prominent blackbird reappearance (08:18 to 09:25), the streamlet slowly fades away (09:36 to END), leaving the barest vestiges of blackbird song in the distance.

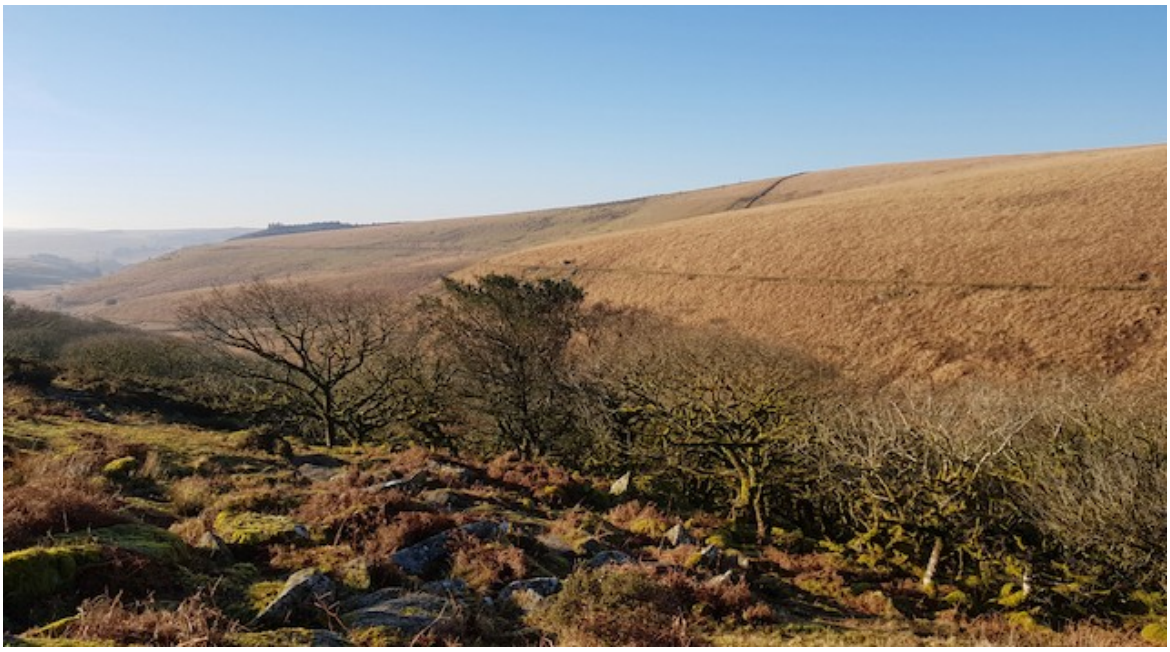


Plate 13
The common blackbird's 'trilled' call variant—a key source for *Cassiano's Blackbird*—was recorded on a raised portion of moorland in Dartmoor National Park shortly before the commission, using a parabolic reflector (see Appendix 3c: rec. 0207-2019). In this case, the dry acoustic of the surrounding moorland further enhanced the definition of the blackbird's vocalisations: a useful, additional benefit when composing for the Barber's reverberant Green Gallery.

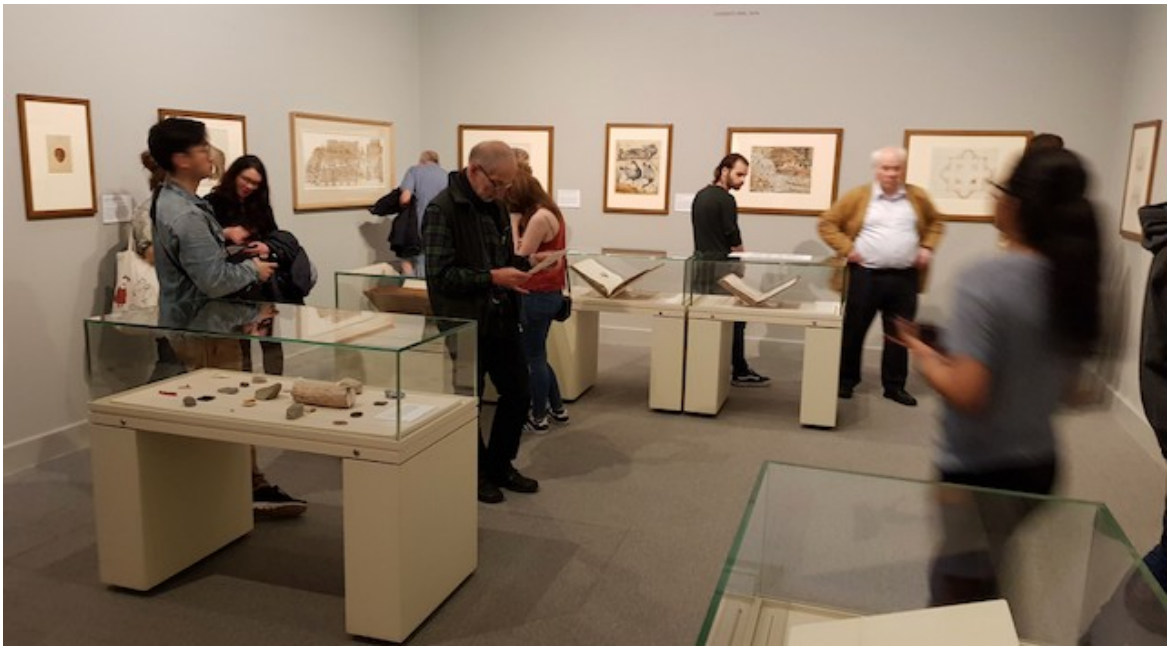


Plate 14
Visitors explore the Paper Museum exhibition in the Lady Barber Gallery. Loudspeaker placement in this relatively small and busy space was understandably ruled out at an early stage, due to health and safety concerns. Image used by permission of the Barber Institute of Fine Arts and The Royal Collection Trust.

2.2.2 The Sunlit Thawing (2019)

In stark contrast to *Cassiano's Blackbird*, *The Sunlit Thawing* employs extreme transformational processes such as cross-synthesis, granular synthesis and digital distortion to articulate a deeply personal, abstract response to place.[28]

The concept for the work grew out of a recording made in Drumnaph Wood: an ancient forest remnant on the eastern edge of Northern Ireland's Sperrin Mountains,

28 As distinct from the wider concept of 'space'. Acknowledging the debate around the meaning and application of both terms (as noted in Schroeder 2016: 250), my concept of place broadly aligns with Robert Sack's, who notes that '[it] differs from space in terms of familiarity and time… requires human agency, is something that may take time to know, and a home especially so' (Sack 1997: 16, cited in Schroeder 2016: 250).

whose secluded woodland paths are punctuated by the gentle creaks of centuries-old hazel coppice (Woodland Trust 2021).[29] During favourable wind conditions in April 2019, I managed to capture these delicate creaking sounds using two miniature omnidirectional microphones attached directly to a single tree, close to a point of friction between two coppiced stems (see Appendix 3d: rec. 0233-2019).

Plate 15
The central portion of Drumnaph Wood, showing overhanging coppiced hazel trees in early spring. A number of pathways have been laid through the Wood to prevent damage by trampling.

29 Drumnaph Wood consists largely of closed canopy hazel, holly and ash, and is encompassed by the wider Drumnaph Nature Reserve: a patchwork habitat incorporating mixed scrub, open grassland, bogland and rush meadow (Woodland Trust 2021). The reserve is jointly managed by the Woodland Trust and Carntogher Community Association.

Plate 16
Two microphones were placed on either side of a coppiced hazel stem, in order to record the internal sounds of the creaking tree and woodland soundscape simultaneously. Whilst this is technically a stereo boundary mounting approach for omnidirectional microphones, it also serves as a hybrid binaural/contact microphone recording methodology, with the tree serving as a natural head. Both microphone cables were carefully wrapped around the lower, moss-covered portion of the tree to decouple unwanted cable-borne vibrations from surrounding vegetation.

In simultaneously revealing the rhythmic, structural sounds of the tree alongside the wider soundscape of Drumnaph, this hybrid binaural/contact microphone recording methodology focused much of my early compositional thinking around notions of temporality, and the idea of isolating and developing the tree's creaks into a rhythmically themed work. Over the following weeks, these thoughts grew into a much broader, abstract meditation on concepts of ancientness, the vast, unrecordable rhythms of geological epochs (through which sounding species have evolved), and the potential for trees to convey complex temporal and ecological

information to the listener.[30] Intimately linked with all of this was the emotional and personal significance of recording within the ancient landscape of Drumnaph: an experience which provoked deeply embedded memories of the nearby Sperrin Mountains and surrounding topography of my mid-Ulster homeland.

Reflecting on these abstract temporal and emotional themes in the studio, I settled on the idea of overlaying the unprocessed hazel recording with abstract sonic content, using intensively processed sounds to articulate a powerful, emotional response to the Drumnaph landscape. An imaginary melting of hoar frost on the surface of the recorded hazel emerged as a thematic vehicle for this response, encapsulated by a brief poem written during the early stages of composition.[31]

> When I found it, the sun fell across it; flaked bark and moss,
> rimed crisp on the winter's edge.
>
> It burnt across the wood, as it had done for centuries. That ancient hazel tree
> warmed,
> as I stood in silence.

30 For example: root integrity, water movement within the tree's structure, changes in humidity, and soil degradation (Ferguson 2018; Metcalf 2021). With regard to recording ancient trees, I am very interested in how this could reveal more about human interactions within historical ecosystems, and re-inform our assumptions about the role and importance of trees in ancient societies within the discipline of archaeoacoustics.

31 In mid 2019, I became interested in drafting poetically styled programme notes at various stages of the compositional process, in an effort to free myself from the notational, quasi-scientific style of writing used for *Deadwood* and *Shorelines*. Notable influences at the time came from selected poems by Seamus Heaney (1990)—a number of which contain references to the people and places of my mid-Ulster homeland—and Alice Oswald's long-form poem *Dart* (2002), which references locations of deep personal significance to me along the course of the River Dart, in Dartmoor National Park.

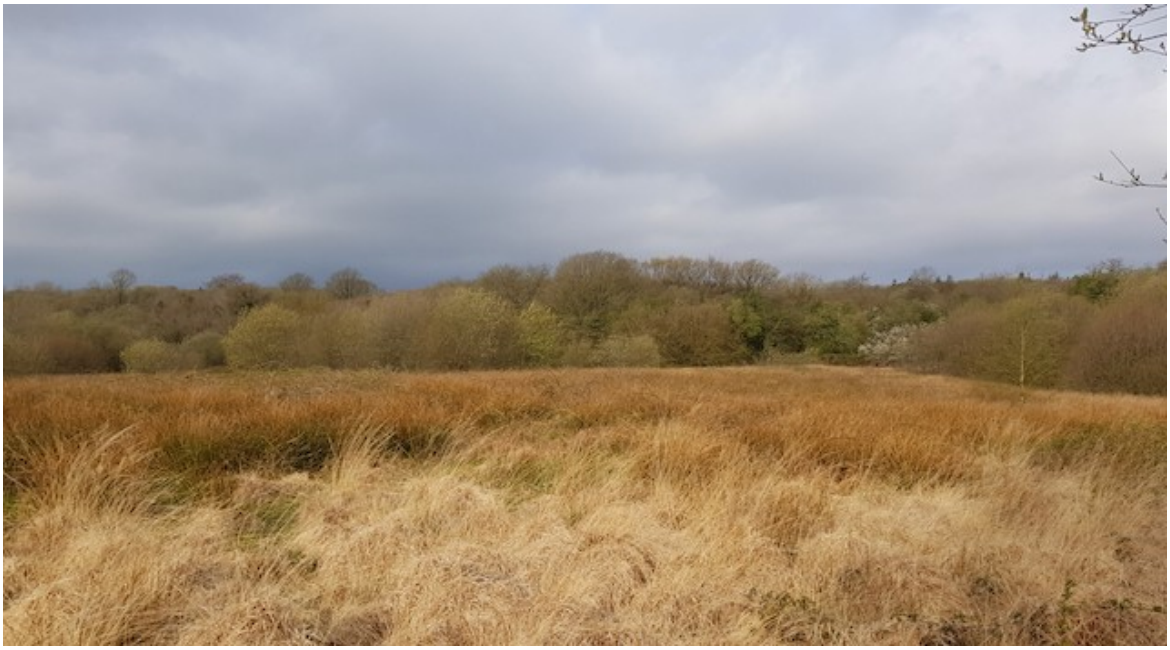
Figure 2 (previous page)
Programme notes for *The Sunlit Thawing* (taken from Appendix 2d).

A close-miked recording of a black-headed gull flock (Appendix 3d: rec. 0073-2016) served as a key source for the composition of this thawing event, providing a dense and complex sonic fabric conducive to a wide range of processing methodologies, as well as a rhythmic tension complementary to the frictional harshness of the hazel creaks. These gull sounds were slowed and processed in Csound using a bank of randomly modulated bandpass filters separated according to the golden ratio (Appendix 4a: Instrument 1),[32] then intensively processed and reprocessed using cross-synthesis (ibid: Instrument 2) and granular synthesis (ibid: Instrument 3); the resulting material was then heavily distorted in Reason using analogue distortion emulators, and finally passed through a chain of reverb and EQ plug-ins in Reaper. What emerged was a richly expressive, powerful textural layer of considerable spectral density, standing in stark juxtaposition to the real-world hazel recording which inspired it and reaching far beyond any sense of physical space into a composed sound world free of physical boundaries. In responding to themes of ancientness and articulating an emotional response to my Northern Irish homeland, this composed 'thawing' occupies its own imaginary, disembodied space around the sonic fabric of Drumnaph, drawing the listener away from the recognisable into the

32 Aside from its debated occurrence in the natural world, my interest in using the golden ratio (expressible as the irrational number 1.618033...) was inspired by John Chowning's 1977 work *Stria*, whose spectral components were determined through FM synthesis carrier-modulator relationships based on powers of the golden ratio (Chowning 1982: 4–6). To determine filter bank centre frequency values for *The Sunlit Thawing*, an arbitrary base value was entered in Csound, and a bank of 15 bandpass filters were assigned centre frequency values derived from this base number multiplied by increasing powers of 1.618.

realm of memory and personal reflection on place.

The Sunlit Thawing follows a three-part ternary (A-B-A) form: unprocessed, creaking hazel material (A) is introduced from 0:00 to 01:25; textural thawing material (B) fades in from 00:23 and is fully overlaid from 01:25 to 02:52; thawing material fades out from 02:52 onwards, and the raw hazel recording (A) returns until the work's conclusion (02:48 to END).[33] Congruent with the abstract temporal themes explored in the work, these sections are far from clear-cut; instead, we are left uncertain of where each section begins and ends as we are transported beyond temporal and spatial boundaries into my own, ultimately unknowable memories of mid-Ulster.



33 The textural thawing material (B) can be further broken down into two sections: B1, consisting of a powerful, gestural entry at 01:25 with after-effects lasting until 02:14; and B2, which builds from 02:14 towards a peak at 02:24, with after-effects lasting until 03:21.

Plate 17 (previous page)
View over a rush meadow, looking towards Drumnaph Wood. On clear days, the Sperrin Mountains are visible from various points around the wider Drumnaph Nature Reserve.

2.3 Settling Point

In facilitating the exploration of two aesthetic extremes, *Cassiano's Blackbird* and *The Sunlit Thawing* helped guide my compositional palette towards what I now regard as a settling point in the portfolio: a period of relative aesthetic consistency, where processing and arrangement methodologies became much more strongly aligned with, and complementary to, the inherent characteristics of recorded source materials.

I was particularly enamoured of the arrangement style adopted for *Cassiano's Blackbird*, where gradually crossfaded recordings where given space to grow and interact organically over the course of the piece; following a brief period of critical reflection, I decided to carry forwards and develop this montage-based approach in subsequent works.[34] By directing my focus towards the delicate spectromorphological qualities and inherent behaviours of my catalogued source recordings, *Cassiano's Blackbird* also highlighted the latent possibilities of a lighter, more considered processing methodology for future compositions, where simplified transformations such as shelving EQ, playback speed adjustment and sparingly applied granular

34 My growing preference for slow montage at the time was also heavily influenced by the work of Tom Lawrence (2011) and Chris Watson (2013, 2017).

synthesis could be used to enhance and draw out the inherent characteristics of recorded sources in a single processing pass.

This line of thinking also fed into critical reflection on methodologies for abstract material generation, which, for *The Sunlit Thawing*, had actually followed a similar (albeit much more intensive) pattern of iterative processing used to create source-bonded species sounds for *Deadwood* and *Shorelines*. In the weeks following *The Sunlit Thawing's* composition, I began experimenting with subtractive approaches to abstract material generation, moving away from cross-synthesis, distortion and other intensive processing methodologies towards 'single-process, single pass' transformations. Much of this experimentation focused on the use of individual bandpass filters (and bandpass filter banks) to draw out and develop naturally prominent frequencies from a range of floral and faunal sources.

A number of other considerations surfaced during critical reflection on both works, all of which related to my handling of space.

Firstly, there was the implicit reference to roots/rootedness in *The Sunlit Thawing*, carried literally within the tree's audible structure and abstractly through my response to place. This naturally extended into notions of the subterranean—a theme I was enthusiastic to explore further—and directed my thinking towards the various methodologies, both field and studio-based, which might be used to effectively portray underground spaces in future works.

Directly linked to this was a broader, craft-based consideration about the relationship between recorded, composed and listening space in the portfolio (Smalley 1997: 122). This relationship had proven crucial to navigate in *Cassiano's Blackbird* due to the site-specific restrictions of stereo playback, loudspeaker positioning and gallery acoustics (see Section 2.2.1: 47–48 for context), and I was curious about how it could be explored further via stereo diffusion, despite the apparent spatial benefits of moving back to multichannel composition at this stage in the portfolio.

Finally and following on from both of these points, fascinating questions remained about how spatial simultaneity (Smalley 1997: 124) could be articulated at the intersection of recorded, composed and diffused space (ibid. 122): in other words, how a sense of surface reality—an above-ground, external space—could be effectively conveyed alongside the subterranean via a combination of recording, compositional and diffusion-based methodologies.

2.3.1 Mud Roots (2019)

In preparation for my next composition and with critical reflections on *Cassiano's Blackbird* and *The Sunlit Thawing* very much in mind, I began a series of lengthy recording trips along the banks of the River Severn, revisiting locations around the villages of Fretherne and Arlingham (Gloucestershire, UK) which had proven fruitful during earlier source recording for *Deadwood* (see Section 2.1.1).

My main focus throughout this intensive recording period was on capturing sounds beneath the riverbed of the Severn at low tide, either by slingshotting a pair of weighted hydrophones directly onto exposed mudflats from a standing position on the riverbank, or shimmying along beached driftwood logs and pushing hydrophone capsules deep into the mud using a long stick.[35] Despite numerous attempts, these methodologies failed to convey a convincing sense of subterranean enclosure, or effectively amplify the fascinating surface behaviours of avian species foraging across the mudflats.

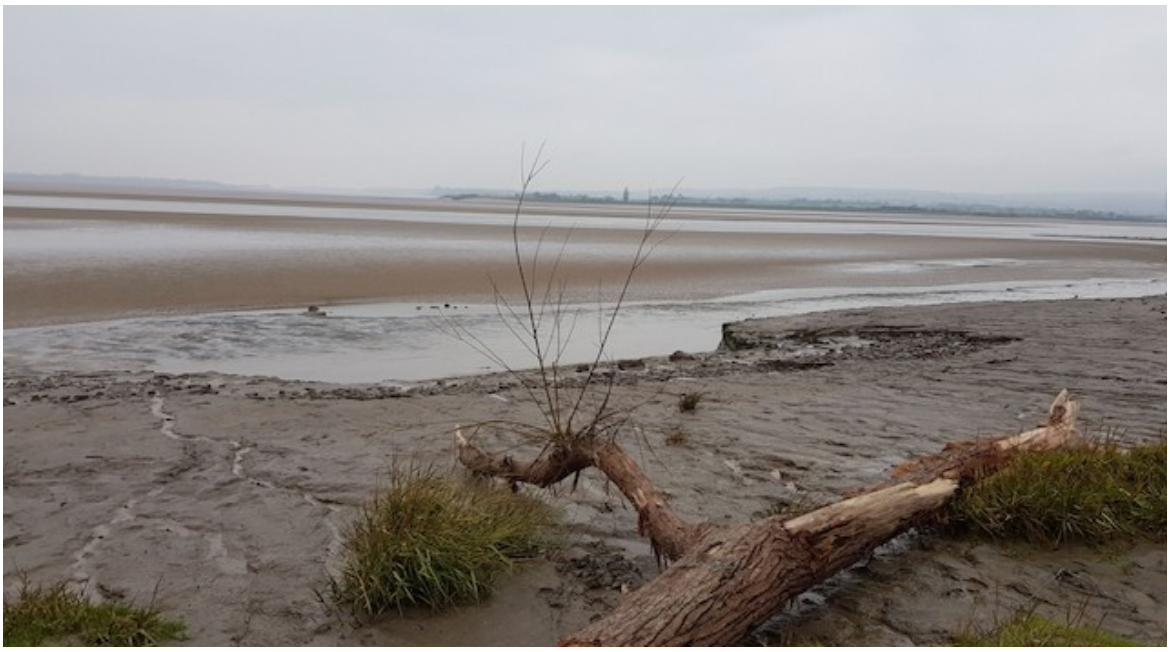


Plate 18
A beached driftwood log near Fretherne, Gloucestershire (likely part of a crack willow tree, *Salix fragilis*). By moving across such logs from the bank, it was possible to reach the mudflats safely and push hydrophones beneath the exposed riverbed using a long stick. In the end, the mud proved too dense to effectively convey the sense of subterranean enclosure I was looking for during source recording attempts for *Mud Roots*.

35 As noted in Section 2.1.1 (34, fn. 15), the water level along this stretch of the River Severn is influenced by the powerful tidal effects of the nearby Severn Estuary. Recording around the mudflats is relatively safe during low tide (the mud can even be walked on safely, along various stretches), but should never be attempted in poor weather or when tidal conditions are in doubt.

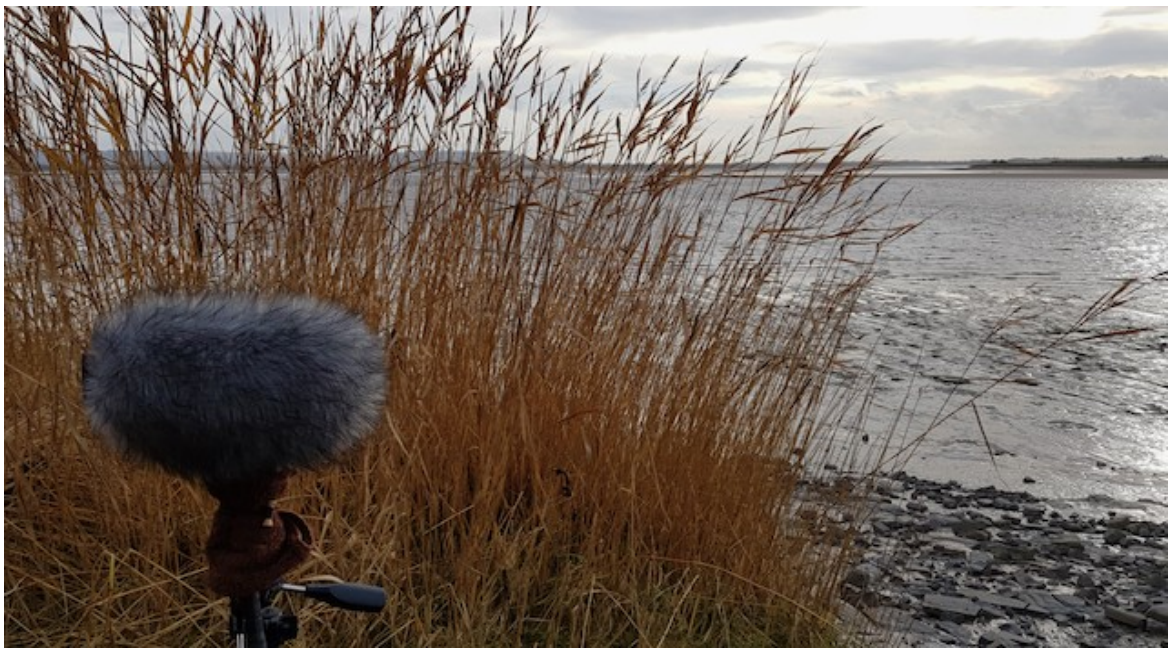
Following these failed recording attempts and taking inspiration from the methodological basis of *The Sunlit Thawing* (see Section 2.2.2: 51–53), I turned my attention towards a familiar, riparian species of the Severn: the common reed (*Phragmites australis*). This species had already been recorded during previous trips to the area, using contact microphones to capture internal knocks and gestural impacts from individual reed stalks, and external AB stereo placements to capture broadband, gesturally contoured reedbed textures. Rather than record subterranean environments directly, I became interested in exploring whether these catalogued floral sounds could be used to compose a sense of the subterranean in the studio, using thoughtfully applied spectromorphological transformations to place the listener amongst the imaginary, mud-enveloped roots of *Phragmites australis*.

Work on my fifth portfolio piece—*Mud Roots*—therefore began in earnest with a lengthy period of studio-based manipulation, employing simplified playback speed and EQ processing methodologies to draw out low-frequency reed and wind sounds as key compositional building blocks.

With the broadband (external AB stereo) reed source (Appendix 3e: rec. 0191-2018), two separate processing steps were taken. Firstly, the recording was duplicated and slowed to ten, fifty and eighty percent of its original playback speed; these three, speed-reduced versions were then processed separately through a randomly modulated bandpass filter in Csound (Appendix 4a: Instrument 4), to create a set of

slowly evolving, textural ‘surface’ layers. Secondly, narrowband frequencies were drawn out of the original recording using a bank of fifteen bandpass filters (ibid: Instrument 1), whose centre frequency values were spaced according to the golden ratio and calibrated to gradually evolve in bandwidth via cubic interpolation between a set of randomly generated control values.[36]

The internal (contact mic) reed source recording (Appendix 3e: rec. 0035-2016) was simply reduced to ten percent of its original playback speed, creating a series of low-frequency, gestural reed impacts. Portions of this material were additionally processed using golden-ratio-spaced bandpass filters to subtly tighten the very lowest spectral contours and provide further gestural definition.



36 The same processing methodology was used for abstract material generation in *The Sunlit Thawing* (see Section 2.2.2: 55, fn. 32). Once again, an arbitrary base value was set in Csound, and a bank of bandpass filters were assigned centre frequency values derived from this base number multiplied by increasing powers of the golden ratio.

Plate 19 (previous page)
Recording wind-blown common reeds using an AB stereo configuration, on the banks of the River Severn near Fretherne, Gloucestershire (Appendix 3e: rec. 0191-2018). Two omnidirectional microphones were positioned 17cm apart inside a basket windshield, with a fur windjammer applied for additional protection against strong gusts. A small towel was also wrapped around the handle portion of the windshield to prevent whistling noises.

The subterranean world of *Mud Roots* gradually reveals itself in the form of barely audible reed vibrations, accompanied by a handful of intertwined, narrowband frequencies (focused around the 490 to 500Hz region) which project through the sonic fabric as delicately pulsing, resonant 'interstices' (0:00 to 01:20).[37] From 01:20 onwards, the gestural impacts of *Phragmites australi*s travel from stem to root, into and around the composed mud space. Following this, we gradually become conscious of surface life via three, slowly crossfaded sonic elements: the barely-audible, muted song of the Eurasian reed warbler, *Acrosephalus scirpaceus* (01:50 to 02:45); internal, low-to-mid-band reed vibrations (02:30 to 03:38); and distant, broadband wind and reedbed material (03:23 to 04:13).

The reed warbler returns more prominently from 03:50 to 04:45 (closer to the surface; as if farther down an imaginary reed stem), ushering in a second, more forceful appearance of broadband wind and reedbed material (04:22 to 05:10). This material dies away shortly before the final section of the piece (05:29 to END): an understated yet powerful tidal encroachment or 'seepage' into the composed mud root space, rendered entirely out of a hydrophonic river current source (Appendix 3e: rec. 0019-2015) slowed to twenty percent of its original speed.

37 The audible pulsing or 'beating' effect is the result of constructive and destructive interference between closely spaced, quasi-sine frequencies.

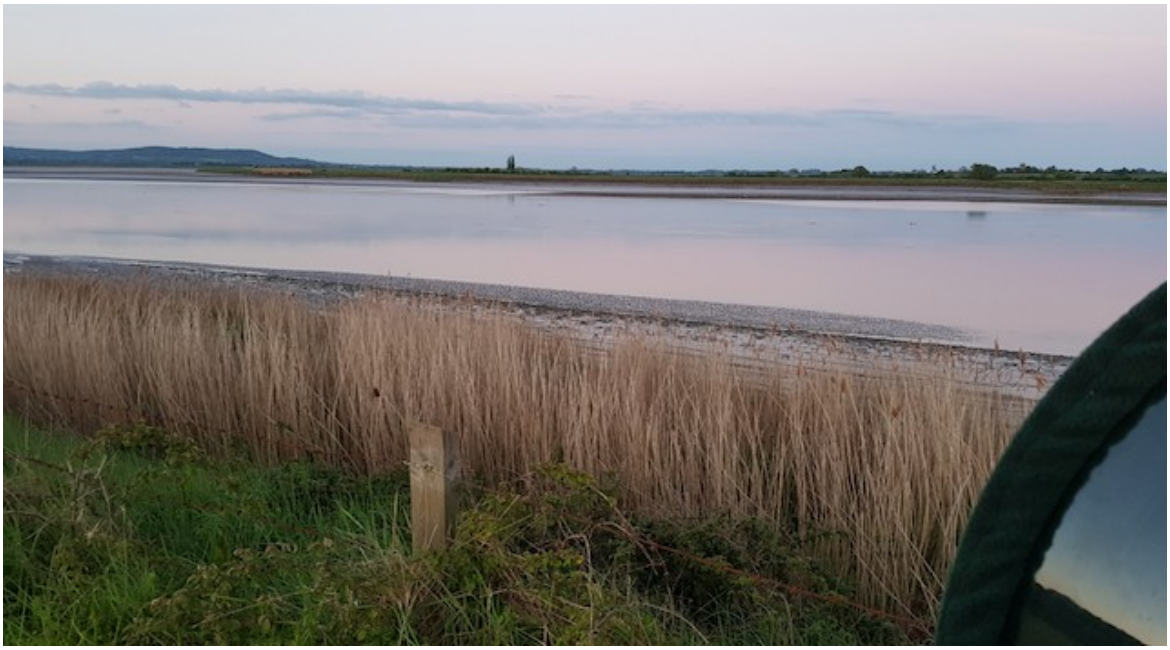


Plate 20
The Eurasian reed warbler song featured in *Mud Roots* was recorded using a parabolic reflector, angled downwards from a position behind common reeds along the banks of the River Severn. In contrast to the internal and external reed material used throughout the piece, successfully recording this species' vocalisations required relatively calm conditions, in order to achieve a favourable signal-to-noise ratio.

Whilst the piece comes across well over headphones and stereo loudspeaker configurations, the fundamental compositional elements of *Mud Roots* (slow montage; simplified, more informed approaches to source processing; articulation of subterranean environments and spatial simultaneity; exploration of the relationship between recorded, composed and listening space) were explored with large-scale, stereo diffusion over a multichannel sound system very much in mind.[38]

My (as yet unrealised) performative strategy for the piece centres around exploiting

38 Due to the global COVID-19 pandemic, the live concert premiere of this work was postponed throughout 2020 and 2021. I now intend to premiere the piece over a large-scale concert diffusion system in 2022, ideally in the Elgar Concert Hall at the University of Birmingham.

the multilayered characteristics of the BEAST loudspeaker diffusion system at the University of Birmingham, in order to enhance the work's composed spatial simultaneity. This would theoretically involve stemming composed surface materials (broadband reed and wind sounds and reed warbler vocalisations) to elevated loudspeaker groups in the University's Elgar Concert Hall (see Appendix 8b: '8030 keystone' and 'APG roof' loudspeaker groups); at the same time, reed impacts (audible from 01:20 onwards) would be routed exclusively to the system's subwoofers (see ibid: '7070 sub' loudspeaker group), enveloping the audience in the low-frequency environment of subterranean reed roots. Internal, mid-band reed vibrations (audible from 02:30 to 03:38) would then be freely diffused around these signals, using mid-level loudspeakers (see ibid: '8040 high' loudspeaker group) to form a link between these simultaneous spaces and project sonic energy downwards, from the composed riverbank surface.

In the latter stages of the work (05:29 to END), encroaching tidal water would gradually be diffused downwards, slowly channeling itself through subterranean mud past the audience's ears, around their feet, and finally outwards towards subwoofer 'roots'.

> My memory is of reeds in a slowly seeping tide; thick clay, barely a morning (or anything). A thousand-year grey air pushed through tall stems, teasing another world to mud roots before the water took them.

Figure 3
Programme notes for *Mud Roots* (taken from Appendix 2e).

2.4 Species / Habitats

2.4.1 Machair Impressions (2019–2020)

Towards the end of *Mud Roots*' composition in August 2019, I took some time away from the studio to embark on a week-long recording trip around the Outer Hebridean island of South Uist, Scotland.[39]

My main goal during this intensive recording period was to capture the flight buzz of one of the UK's rarest bumblebee species—the great yellow bumblebee, *Bombus distinguendus*—as it foraged through the wildflower-rich machair habitat of the island.[40] I was also keen to capture sonic perspectives from within the machair itself: the playful internal gestures of prominent floral species such as thistle, ragwort, knapweed, burdock and Yorkshire fog grass, and the ever-present island soundscape of wind-blown vegetation and breaking North Atlantic waves.

39 With financial assistance from the Midlands4Cities Student Development Fund.

40 Machair (roughly pronounced 'mah-hur') is a Gaelic word referring to the low-lying, grassy plains unique to the west-facing shores of Scotland and Ireland (Wildlife Trusts 2021). This rare habitat is rich in wildflowers such as red clover and knapweed, and is therefore a vital source of pollen and nectar for a variety of bumblebee and other insect species.

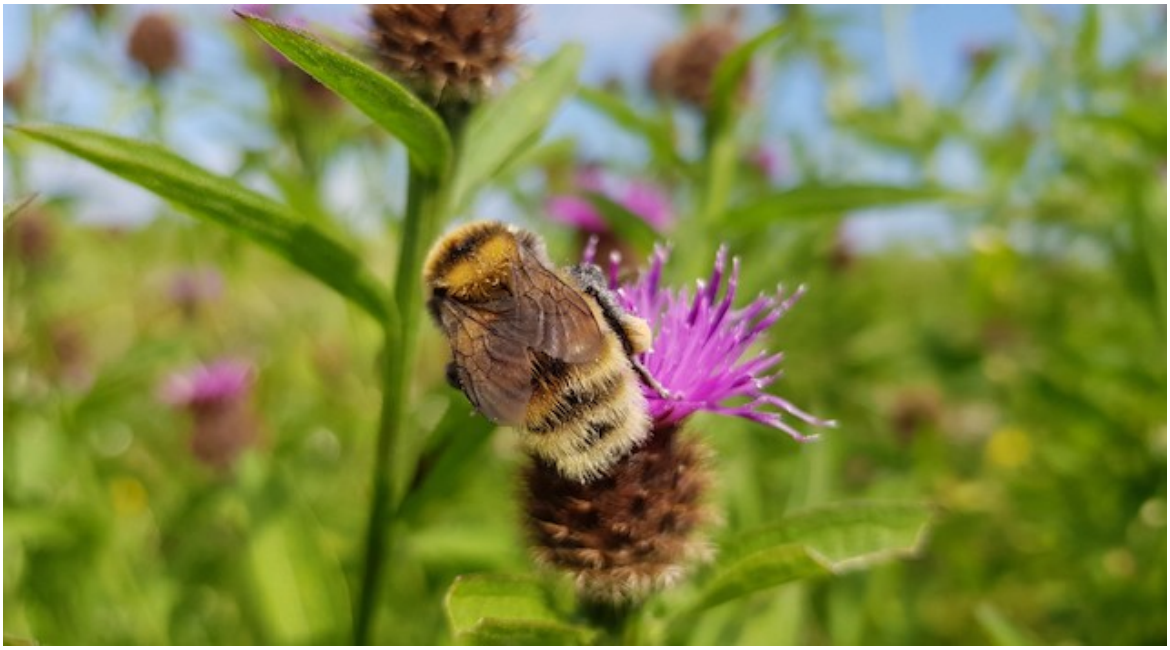


Plate 21
A great yellow bumblebee worker, *B. Distinguendus*, foraging on common knapweed on South Uist. The Hebridean Islands are one of the last remaining strongholds of this formerly widespread UK species.

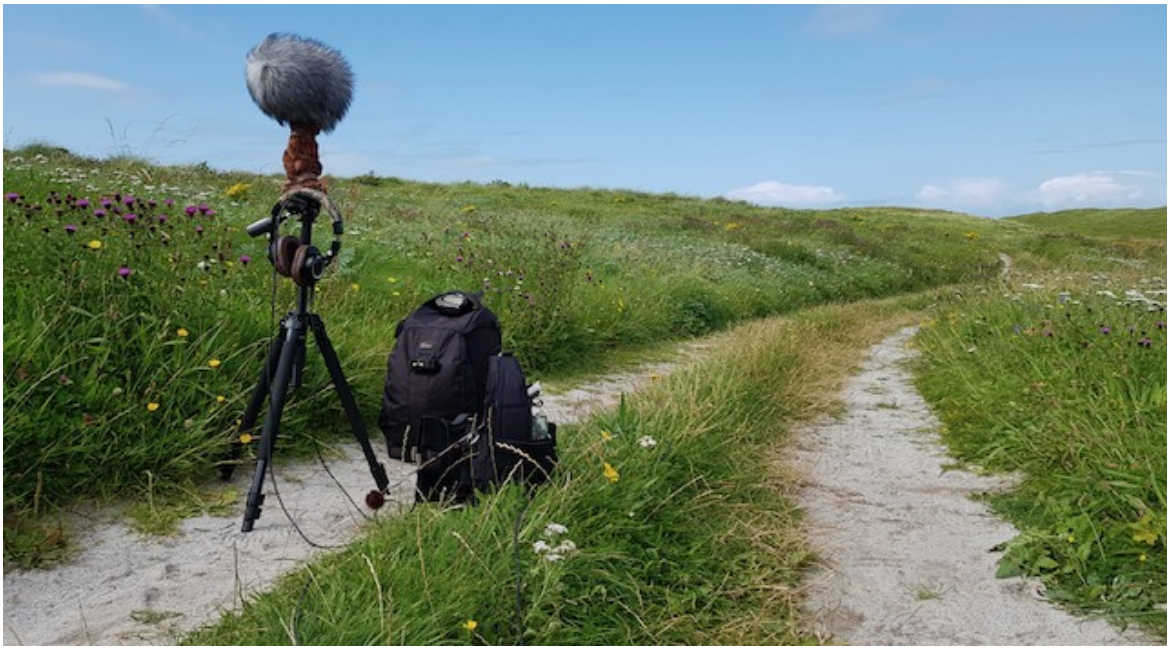


Plate 22
A typical stretch of machair vegetation, west of Askernish on South Uist. In this case, a customised lavalier microphone solution was used (unsuccessfully) to record bees at very close range as they

foraged, with an additional, tripod-mounted AB stereo configuration used for simultaneous ambient capture.

The trip was an overwhelming success, and, at the time of writing, represents one of the most significant achievements of my wildlife sound recording career.

In addition to gathering all of the aforementioned sounds, I managed to document the reproductive activity of *B. distinguendus* outside a fortuitously discovered nest, as several male bumblebees jostled competitively for a mating opportunity with an emerging queen (Appendix 3f: recs. 0284-2019 to 0289-2019). These incredibly rare behavioural recordings (an apparent world research and field recording first for the species)[41] were widely publicised by the BBC (Broadcasting House 2019), University of Birmingham (Ferguson 2019d), Bumblebee Conservation Trust (Ferguson 2019g) and AHRC (Ferguson 2019h), raising awareness of one of the UK's rarest invertebrates and its unique coastal habitat.

The weather conditions on South Uist were some of the most challenging I have ever encountered on a UK field trip, requiring numerous adjustments to recording fieldcraft and technical methodologies (described in Ferguson 2021: 36:57–40:27; see Appendix 8g, 8h). In addition to heavy rain, rustling vegetation, anthropogenic

41 The apparent uniqueness of the recordings has been corroborated by experts and practitioners from the following organisations: Wildlife Sound Recording Society, UK (Boughton 2019); Bees, Wasps & Ants Recording Society, UK (Early 2019); Xerxes Society for Invertebrate Conservation, USA (Hatfield 2019); National Insect Collection at CSIRO, Australia (Rodriguez 2019); British Library, UK (Tipp 2019); Bumblebee Conservation Trust, UK (Cox 2021). Several other archival and conservation experts confirmed the recordings' apparent uniqueness in late 2019, but I have been unable to reconnect with them to obtain citation permission for this commentary.

disturbance and the sonic masking effects of breaking Atlantic waves, one of the most problematic issues on the island was the sheer strength of prevailing southwesterly winds, which rendered most bumblebee flights throughout the machair unrecordable. Several hours would therefore be spent each day in search of sheltered portions of machair, situated in the lee of dunes and other raised portions of land; following the discovery of a promising location, most recordings would be made by hand (in a half-crouched position), painstakingly following *B. distinguendus* workers with a handheld microphone/windshield as they foraged from flower to flower. All of this would happen whilst simultaneously trying to monitor the species through headphones, and minimise trampling damage to the surrounding wildflower habitat.[42]

Unsurprisingly, around 97% of these handheld recording attempts were unsuccessful.

42 I received considerable assistance with finding suitable recording spots from South Uist locals, who offered advice on where/how to record based on their intimate knowledge of the island's landscape. I am particularly grateful in this regard to Bill Neill (Bumblebee Conservation Trust surveyor for South Uist), for his expert guidance and suggestions, and for accompanying me on an initial scouting trip along the coastal dunes of Askernish.

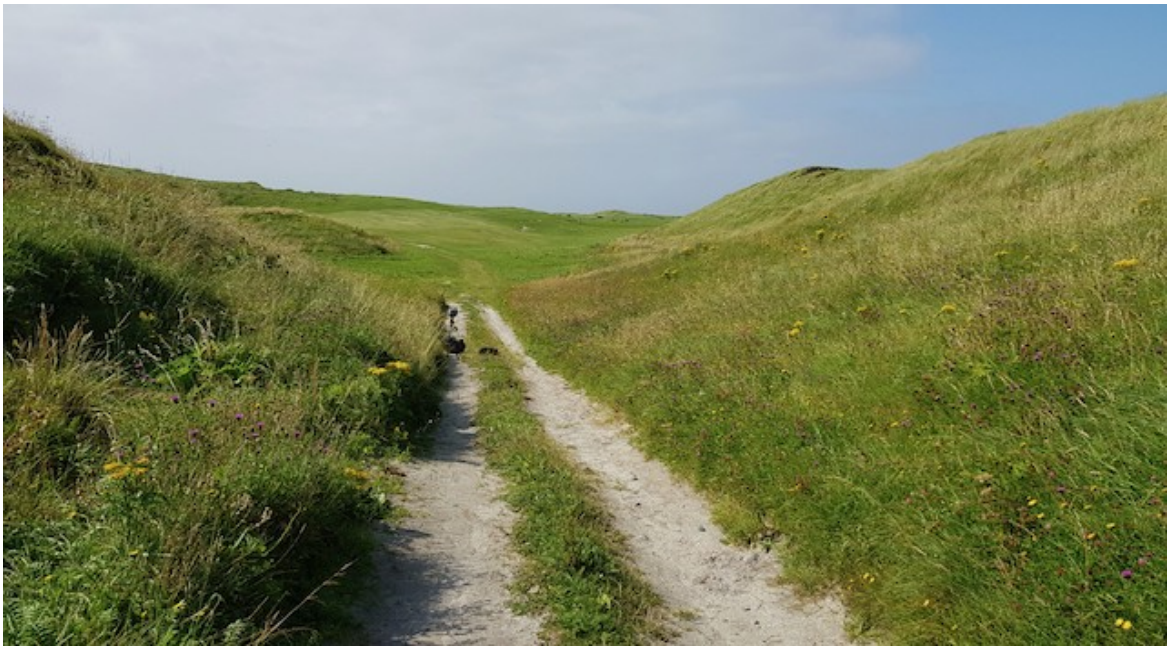


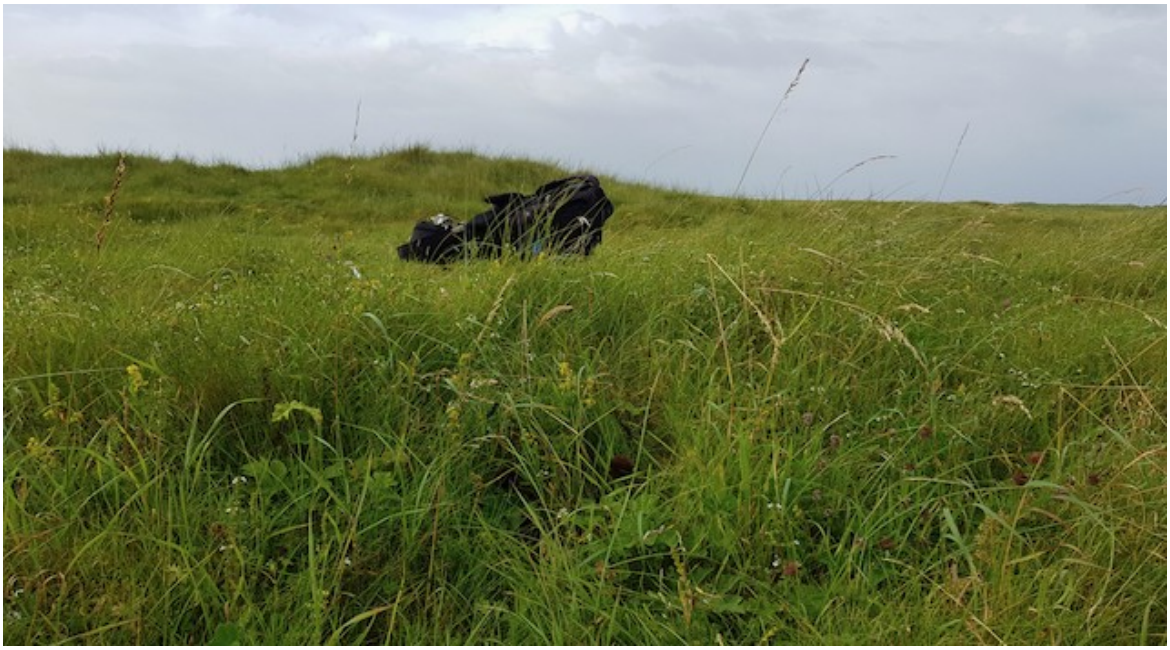
Plate 23
A stretch of machair, bisected by a track through Askernish Golf Course. This location worked well for recording, since prevailing southwesterly winds were naturally attenuated by the structure of the surrounding dunes. Despite this natural shelter, a fully protected, fur-covered basket windshield had to be used to track bees from plant to plant they foraged: a methodology which led to the first successful *B. Distinguendus* recordings of the trip.

In contrast to this handheld methodology for tracking individual bumblebees, the rare behavioural/nest recordings of *B. distinguendus* were made towards the end of the field trip using a pair of statically placed, mini omnidirectional microphones: a methodological switch made possible by the sheltered position of the nest entrance, which lay on the lee side of a grassy mound.[43] To successfully capture these sounds, a recorder was first placed several metres away, with moderate and very low input gain levels set for each microphone signal to avoid any possibility of digital clipping.[44]

43 The nest itself was likely a vacant rodent burrow. Abandoned animal burrows are a popular nesting choice for many UK bumblebee species, since they offer a good degree of protection for the establishment and maintenance of a colony.

44 Using the dual gain function of my field recorder, each microphone signal was assigned two separate input gain values; in this way, the bumblebees—whose maximum volume level could not be established beforehand—were much more likely to be recorded without input signal levels

Silicone vibration decouplers were then wound around each microphone cable (at the capsule end) to reduce impacts from buffeting grass, and both microphones were inserted into appropriately sized fur windjammers. Finally, a utility grabber was used to delicately place both microphones near the nest entrance, where male bumblebees had begun to congregate for mating.[45]



exceeding the available range for digital amplitude representation. This functionality has largely been rendered obsolete by 32-bit float recording, which removes the need for input gain adjustment and is capable of representing a dynamic range of 1528dB: well beyond what will ever be required to represent acoustical sound amplitude digitally (Sound Devices 2021).

45 See Appendix 8c for a video overview of this methodology, which also serves as an indication of typical weather conditions on South Uist. It is important to note that the recording was made with the welfare of the *B. distinguendus* as an absolute priority, and was undertaken based on extensive field experience and prior knowledge of the species' conservation requirements. Whilst no licence is required (at the time of writing) to record bumblebee nests, the general advice from conservation organisations is to minimise disturbance by not approaching them. In this case, all field observations during microphone placement indicated that the bumblebees were undisturbed by my actions; had this changed at any point, the nest would have been left alone.

Plate 24 (previous page)
It took roughly fifteen minutes to position both microphones in front of the great yellow nest entrance using a utility grabber. This approach ensured minimal disturbance to the bees.

As the title suggests, my sixth portfolio work—*Machair Impressions*—consists of a series of audible habitat representations: a handful of gradually evolving sonic vignettes, constructed out of the detailed source recordings gathered during my time on South Uist. Rather than focusing on my own impressions of the machair habitat, the work's composition was driven by the imaginary sonic perspectives of the great yellow bumblebee, as informed by the intimate gestures, textures and habitat spaces revealed through my recording methodologies (especially close miking techniques, and recording at or near ground level).

Whilst familiar themes of landscape, the subterranean, rootedness and montage are once again carried forwards and explored, it was the rare species focus of the piece which bound together and drove composition at the most fundamental level, guiding approaches to processing, arrangement and spatial articulation to a much greater degree than any other work in the portfolio. In *Machair Impressions*, we experience South Uist at composed bumblebee level, never far from the earth as we are slowly led through open grasslands, machair stems and roots towards a great yellow nest, before resurfacing amongst wind-buffeted machair vegetation overlooking the turbulent surf of the North Atlantic.

With these rare bumblebee perspectives in mind, considerable processing effort was

directed towards drawing out and augmenting the sense of vulnerability/exposure conveyed by the raw source recordings: especially when working with inherently gestural material such as wind (e.g. 00:00 to 02:29) and internal vegetation sounds (02:29 to 04:28). Using a combination of granular synthesis (Appendix 4a: Instrument 3; GRM Tools SpaceGrain), amplitude modulation (ibid: Instrument 5) and playback speed reduction (Reaper), gesturally rich sources were carefully re-sculpted to augment their existing, high-level energy contours and convey the natural forces acting on the exposed island habitat. Texturally orientated materials were often simply left as they were, or treated sparingly in a single processing pass using both standard and resonant EQ to enhance their existing spectromorphological and spatial attributes.

From 04:28, the sense of species vulnerability underpinning *Machair Impressions* is intentionally turned on its head, as we descend into the claustrophobic depths of an apparently empty bumblebee nest; here, at 05:06, we suddenly find ourselves in the close company of a great yellow bumblebee queen and her workers.[46] As the nest scene unfolds, *B. distinguendus* males are distantly audible (e.g. 05:53 to 06:10), awaiting the queen's emergence for mating (06:33).

46 This portion of the piece represents an inside-out reversal of my own recording perspective, placing the listener within the nest as opposed to outside: an impossible recording situation, imagined in the field and subsequently composed via studio-based methodologies (described in Ferguson 2021: 54:37–55:17).

Following this, the powerful sounds of the North Atlantic surf draw the piece to a close, from a vantage point within dried machair vegetation (07:11 to END).[47]

2.4.2 Habitats (2020)

Oak Trunk — Woodland Understorey — Pond Sediment — Seabed

Following the completion of *Machair Impressions* in early 2020, COVID-19–related institutional closures, national lockdowns and regionally enforced travel bans put a stop to the vast majority of my field and studio practice for several months. Although highly frustrating—especially from a wildlife sound recording perspective—the resulting additional time at home provided a useful opportunity to focus on headphone-based listening and composition.

This transition raised a number of fascinating questions concerning the use of headphones in my work, most of which centred around the perceptual modulations inherent to field-based headphone monitoring, and the potential for exploring these modulations directly via the compositional re-creation of monitored field situations.[48]

47 A tabular overview of *Machair Impressions* can be found in Appendix 7a, incorporating condensed notes on recorded sources, recording/processing methodologies, and compositional themes explored in each section of the piece.

48 I am referring here to the modulatory effects of headphone monitoring on the perception of space and time in the field. Simultaneously monitoring multiple, separately positioned microphones, for example, essentially carves-up the field, redistributing multiple species and habitat perspectives into an intimate stereo listening space. In my own experience, such fragmented, otherwise impossible scenes often develop into separate realities when listened to for extended periods, altering one's perception of the overall soundscape and the temporal progression of events within it. At this stage in the portfolio and building on the habitat foundations laid by *Machair Impressions*, I became very interested in using such experiences to inform the composition of imaginary field monitoring situations, using carefully selected, pre-recorded source materials to build convincing environmental cross-sections.

Related questions also emerged regarding close-miked and quasi-binaurally captured sources: how they could be exploited for headphone-orientated works in the portfolio; whether studio-encoded, binaural sonic materials could be convincingly layered over them; and whether conventional stereo recordings (made using AB, XY and ORTF configurations) could be successfully interwoven with these sources to create a kind of hybrid, stereo-binaural work which came across effectively over both headphones and loudspeakers.[49]

49 The resulting works could then function both as immersive headphone pieces, and as brief, loudspeaker-based concert interludes, complementing longer works in the portfolio and diversifying my output for future festival submissions. In addition to the hybrid binaural/contact methodology used for *The Sunlit Thawing* (described in Section 2.2.2: 52–53), there was substantial influence here from binaural recording methodologies used for earlier, MusM works such as *Invader* and *Mancunian Canvas* (see Appendix 1b), which come across remarkably well over conventional stereo loudspeaker configurations despite being composed primarily out of binaural field recordings.

Plate 25 (previous page)
The author, recording the drumming sounds of a great spotted woodpecker using a headphone-monitored parabolic reflector. This methodology dramatically modulates the recordist's spatial focus, directing most of it towards a single, distant point: the audio equivalent of a zoom camera lens. Because of the highly selective nature of this methodology, I find it useful to occasionally remove my headphones and recalibrate my ears to the surrounding habitat.

With these questions in mind, in March 2020 I began intensive composition on what became known as the *Habitats* suite: four, binaurally infused stereo works, each briefly immersing the listener in a highly detailed environmental cross-section.

Intended primarily for headphone listening, the suite carries forwards the vignette-based habitat theme of *Machair Impressions* in the form of separate pieces. Individual species recordings once again play a crucial role, this time as spatial articulators placed around four composed microphone positions 'monitored' by the listener: a hollow oak trunk; broadleaf woodland understorey; pond sediment; and a shallow seabed.

Alongside—and in sympathy with—notions of spatial and temporal modulation, *Habitats* is fundamentally concerned with the interplay between reality and representation. In attempting to convincingly recreate monitored field situations, each piece deliberately exploits the blurred boundaries between recorded and composed experience; any explanations of the real and the composed (whatever these concepts may mean to the listener) have been omitted, and we are left somewhat uncertain as to whether the suite consists of genuine field recordings, composed

experiences, or combinations of both.[50]

This sense of uncertainty is further reinforced by the accompanying, ostensibly factual programme notes for each work, deliberately styled as recordist's field jottings. In contrast to the factually orientated textual approach taken for earlier works such as *Deadwood* and *Shorelines* (see Appendices 2a, 2b), in *Habitats*, the textual blurring of recorded and composed experience is taken one step further through the incorporation of precise field data such as species observation time (*Oak Trunk*; see Appendix 2g: i), temperature (*Woodland Understorey*; see ibid: ii), hydrophone depth (*Pond Sediment*; see ibid: iii) and a passing jet airliner's universal flight identifier (*Seabed*; see Figure 4 below). This is a direct influence from my own wildlife sound cataloguing system (described in Section 1.4; full catalogue available in Appendix 5b), and a deliberate, compositional attempt to impart a sense of recorded authenticity, blurring the boundaries between field and studio.

> Shallow waters on Irish coast. Underwater perspective of breaking waves through kelp. Fleeting glimpse of raven. Passing greylag geese, beneath United Airlines flight UA2789 (Frankfurt to Houston).

Figure 4
Programme notes for *Seabed* (taken from Appendix 2g: iv).

In this apparently simple set of works, then, a multitude of deeply embedded perceptual and interpretative elements are at play; indeed, they have been

50 As Andrew Hill (2017) explains, this level of uncertainty will depend largely on the real-world contexts and level of listening experience brought to each work by the individual.

deliberately composed into the sonic fabric as part of a reconstructed field, raising, in the process, profound questions concerning recordist-composer intent, the relationship between composer and listener (and their respective presentational and interpretative responsibilities), and the ethical issues underlying species' sonic representation.[51] The suite also raises important questions regarding methodological symbiosis between crafts, some of which are of particular relevance to the portfolio: where the roles of recordist and electroacoustic composer begin/end, how these roles are weighted, and how each craft interacts over the duration of a creative project (see Section 3.2 for further discussion of methodological symbiosis).

Whilst a thorough discussion of these questions lies well beyond the scope of this commentary, their exposure through compositional practice has laid considerable groundwork for future research. The ethical issues surrounding wildlife representation, for example, would be particularly interesting to explore via a series of installations and concerts, in investigating how/whether endangered or misunderstood species should be given a more audible presence than others, whether species sounds should be presented entirely honestly, and whether this matters for the recordist, composer, listener and wider public.

A complete, tabular overview of the *Habitats* suite can be found in Appendix 7b,

51 Many of these ethical issues are informatively discussed by James Andean (2014), whose thoughts and arguments were very useful during critical reflection on compositional approaches to the suite. Concerning composer/listener responsibilities, he notes: 'The artist is clearly responsible for the presentation of a symbol [a mental and cultural construct of a sound], and this will have a significant, possibly defining, impact on its interpretation; however, it is in fact the *listener* who performs the interpretive act, and who must therefore share responsibility for this interpretation' (2014: 177).

incorporating condensed notes on composed microphone positions, recorded sources, recording/processing methodologies, and compositional themes explored in each work.

2.5 Sound(field) Strata

My final portfolio piece was realised in the latter stages of research, as new protocols were being put in place at the University of Birmingham to enable studio-based work during the second year of the COVID-19 pandemic.

The resumption of studio activities provided an ideal opportunity to make my first foray into higher-order ambisonics composition: a natural route to take following the three-dimensional, binaurally infused groundwork laid by the *Habitats* suite, and an approach that would challenge me to explore well-established portfolio themes such as spatial simultaneity and the subterranean in fresh ways (by enabling, for example, the composition of elevation directly into a piece, as opposed to relying on spectromorphological transformations and performative methodologies to articulate height).

Since the B-format components of an ambisonics piece would also offer considerable flexibility for playback as the COVID-19 pandemic continued to evolve,[52] and since

52 One of the main issues impacting electroacoustic composers during the COVID-19 pandemic was a lack of certainty about which (and indeed whether) arts and cultural venues would be available

most of my works were under ten minutes' duration, I decided to conclude the thesis with a long-form, site-agnostic ambisonics installation, drawing together key themes and sonic characteristics from all of my compositions to date.

2.5.1 Oolitic Processes (2020–2021)

Oolitic Processes is a durational meditation on the fossilised organisms, geological processes and sedimentary limestone layers of the Cotswolds (SW England), taking the listener on an imaginary journey through vast geological time periods and hidden subterranean spaces.

Drawing together key themes and characteristics from earlier portfolio works, the piece marks a return to the incorporation of highly processed materials source bonded to imaginary species and behaviours (in this case, reanimated Jurassic flora and fauna), once again exploring themes of sedimentation, submersion and tectonic action (see *Deadwood*, Section 2.1.1 and *Shorelines*, Section 2.1.2). These sounds and their associated behaviours are juxtaposed with a series of temporal shifts to the present-day Anthropocene, where recordings of unprocessed species and phenomena draw the sound world back towards the mimetic/representational discourse (Emmerson 1986: 17–20) articulated in *Cassiano's Blackbird* (see Section 2.2.1).

for playback/diffusion in the near future. Composing an ambisonics piece therefore seemed like an informed choice at the time, in order to provide maximum flexibility for dissemination from late 2021 onwards.

Slowly evolving frequencies are again used as expressive and structural tools, building on earlier approaches taken with *The Sunlit Thawing* (see Section 2.2.2: 55) and *Mud Roots* (see Section 2.3.1: 61–63). The slow montage basis of *Mud Roots* and its sense of enclosure/spatial simultaneity are also carried forwards and developed, as is the vignette-based formal outline of *Machair Impressions* (see Section 2.4.1 and Appendix 7a*),* which is now greatly expanded to encompass vast, geological time periods and processes.

Oolitic Processes was inspired by my own discoveries of oolitic[53] limestone rocks during recording trips through the Cotswold valleys bordering Bisley, Painswick and Stroud. Dating from the mid Jurassic period (approximately 175 to 165 million years ago) and formed in warm, tropical seas, many of these rocks contain fossilised marine organisms such as sea urchins, molluscs and bottom-dwelling brachiopods. A long-form meditation on these and other long-dead species, the piece attempts to resurrect their imaginary sonic fabric through detailed compositional manipulations of present-day species and naturally occurring environmental phenomena, reaching back through time from the studio to reanimate powerful geological processes, biological behaviours and environmental forces within an isotropic, third-order soundfield.

53 Round-grained and concentrically layered.

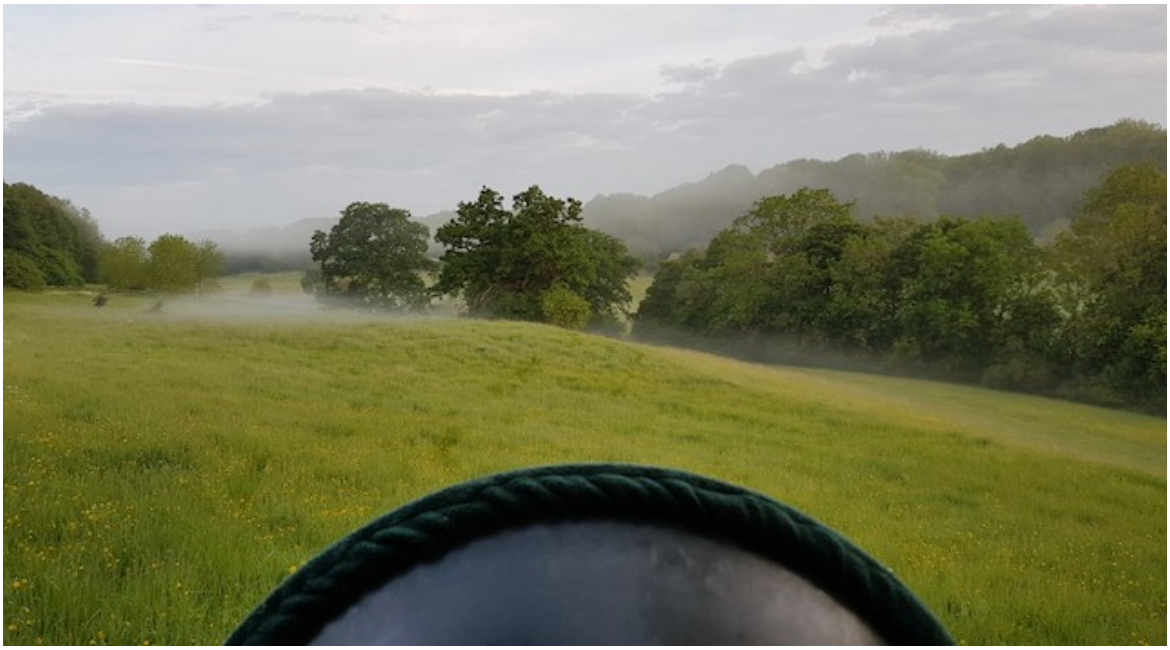


Plate 26
A shallow valley near the village of Bisley, in the Cotswolds (parabolic reflector in foreground). This area—a favourite recording spot—is littered with oolitic limestone fragments, which I frequently pick up and examine during field trips.

Plate 27
A piece of oolitic limestone from the mid Jurassic period, gathered from the edge of deciduous woodland in the Cotswolds. About 95% of the visible fossil remains on this rock are pieces of broken oyster shell. Oysters were very common during the Jurassic period, and were often caught in severe

coastal storms; these would have ripped into their colonies with considerable ferocity, smashing their shells into small fragments (Lawrance 2021).

———

Oolitic Processes is structured into a series of transitions between past and present geological ‘scenes’, built around the natural contours of a richly detailed textural/microgestural layer of roughly nineteen minutes’ duration. This complex layer was generated by reversing, speed-reducing and reshaping entire sections of earlier pieces in Reaper, including fully composed and unused compositional drafts of *Deadwood*, *Shorelines*, *The Sunlit Thawing*, and two works from the *Habitats* suite (*Pond Sediment* and *Woodland Understorey*). The resulting stereo file was encoded with a 90˚ width setting using the IEM ambisonics plug-in suite, then duplicated and encoded with azimuth and rotation settings of 180˚ to create a virtual, quadrophonic loudspeaker array around which all other material in the piece was layered.

From 0:00 to 04.28, we find ourselves enveloped by the intricate, sedimentary/oceanic sound world of reanimated Jurassic organisms, whose microgestural behaviours propagate randomly within the soundfield between 0 to 45˚ elevation and 0 to 360˚ azimuth. All of these imaginary species sounds were derived exclusively from a contact microphone recording of a fern (Appendix 3h: rec. 0023-2015), which was heavily fragmented using combinations of GRM Tools Reson, Shuffling and SpaceGrain, then gesturally shaped and randomly encoded in Csound (Appendix 4a: Instruments 5, 14).

Following this Jurassic introduction, powerful, sedimentary flows and permeating

glacial water (04:28 to 06:20) carry us slowly through multilayered strata and soil particles to a present-day Cotswold meadow scene, occupied by a male song thrush (encoded to -45˚ azimuth, 58˚ elevation) and a gently flowing stream (137˚ azimuth, 32˚ elevation). The end portion of this transition (06:09 to 06:20) is enhanced by a linearly automated, second-order highpass filter which rises gradually from 70Hz to 1000Hz, dramatically lightening the main, subterranean textural/microgestural layer; this reduction in spectral density through highpass filtering (Smalley 1997: 121) clears the soundfield for the placement of thrush/stream sources within the open-air, surface environment of the composed meadow.[54]

From here, we move back and forth on a timeline between subterranean Jurassic and open-air Anthropocene environments: voices of long-extinct mammals (e.g. 09:03 to 10:22) are juxtaposed with the sounds of bubbling mud and amphibian tail sweeps (09:50 to 10:25); sounds of lapping glacial water and mineral formations (10:53 to 12:49) crossfade into delicate branch impacts, flaking bark and gnawing rodents (12:53 to 14:22); and a present-day corvid roost (14:00 to 15:41) slowly gives way to fracturing glacial ice and meltwater flow, interspersed with snowfall, surface winds and mammal barks (16:15 to 18:36).

In what is arguably the most powerful transition in the piece (18:47 to 20:08), our final

54 Textural lightening through highpass filtering became a signature transitional element of the piece as composition progressed, with the natural, spectromorphological contours of the main textural/microgestural layer used to inform the positioning of filter automation breakpoints. This represents a subtractive approach to spectromorphological shaping, using aggressive, highpass filtering to dramatically alter spectral density and modulate sense of distance within the soundfield. Concerning this, Smalley notes that ‘spectral density is related to distance perspective and needs to be considered along with space in general’ (1997: 121).

approach to the Anthropocene is cut short. Rather than emerging to an expected, open-air soundscape, we find ourselves locked several metres below the surface, trapped within ploughed farmland amongst fragments of Jurassic oolite. The expected, high frequency sonic freshness of the surface never materialises; instead, we find ourselves locked within the Cotswold earth, surrounded by fossilised organisms whose subterranean voices reach forwards to us in the present, hinting (perhaps) at the eventual, sedimentary fate of *Homo sapiens sapiens*: the species behind the work's composition.

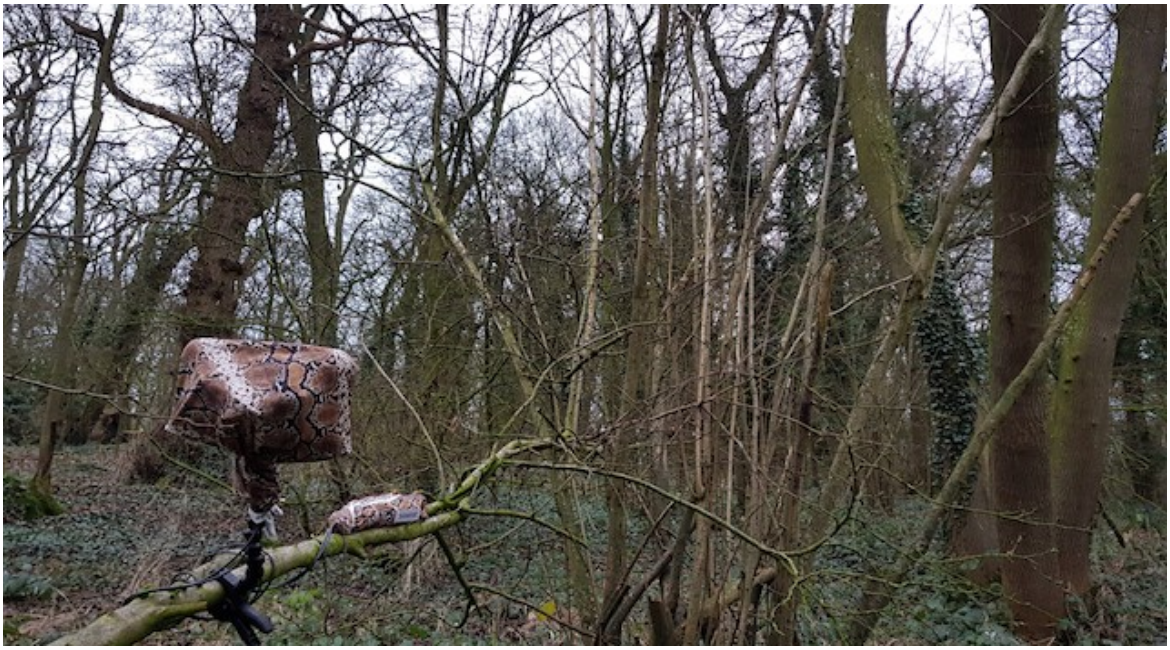


Plate 28
The corvid roost featured in *Oolitic Processes* (audible from 14:00 to 15:41) was recorded using two cardioid mics spaced at 23cm and angled at 90˚ (an approximation of DIN stereo). These were attached to a fallen tree branch using a flexible arm and angled upwards towards a known corvid roosting site. This methodology guided subsequent roost processing and placement within the soundfield: bird calls were encoded to 90˚ elevation, and a lowpass filter was applied to augment the sense of distance naturally captured in the recording.

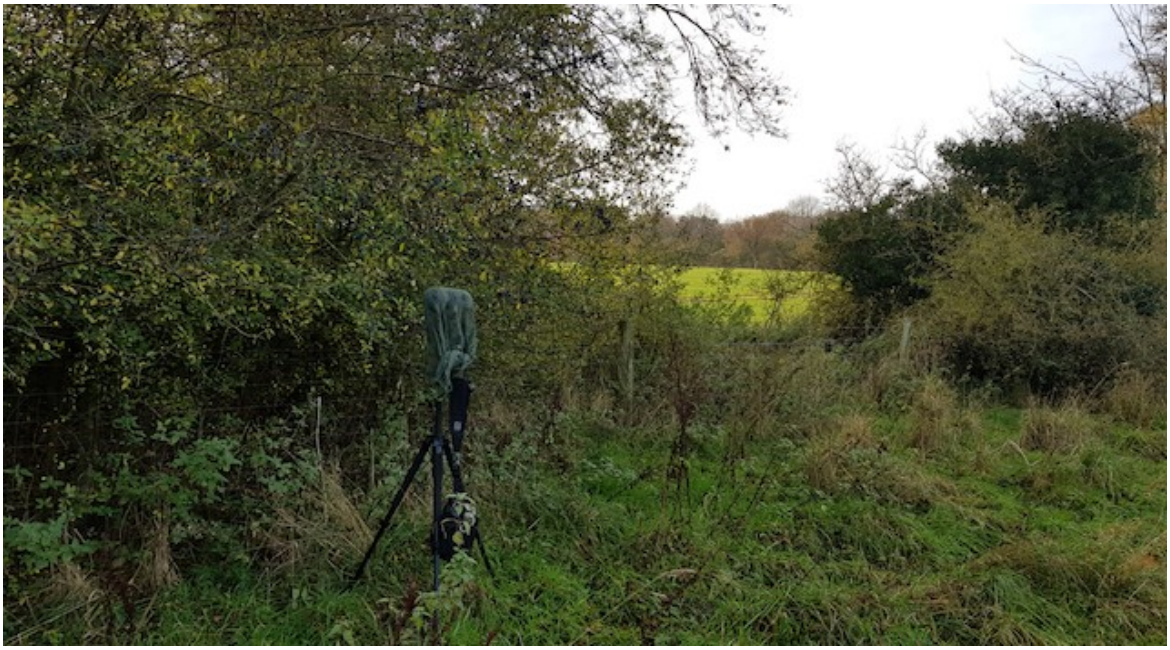


Plate 29
The recording site for the final, anthropocenic scene in *Oolitic Processes* (audible from 18:35 to END), along the edge of a raised meadow overlooking a Cotswold valley. It took several weeks to successfully record aircraft passes and distant anthropogenic sounds in a single take: a challenging and often highly frustrating approach, which eventually resulted in a satisfying, nuanced snapshot of human influence on the wider Cotswold environment.

At the time of writing, I am exploring a range of options for disseminating *Oolitic Processes* in venues throughout the UK.

One concept involves premiering the work in a listening room or other quiet space within a geologically themed museum, such as the Lapworth Museum of Geology at the University of Birmingham: perhaps as a complementary installation for an educational display focusing on Jurassic fossils or similar exhibits. It may also be worth exploring the possibility of physically reconstructing the audible strata, marine organisms and environments explored in the piece through collaborations with visual artists, which may make it more appealing to museums whose primary means of

conveying information is via visual display.

Whatever route is taken with the work's dissemination, its realisation as a third-order ambisonics piece should provide ample flexibility for adaptation to a range of installation spaces and contexts, both within and beyond the academic environment.

3. PORTFOLIO CONCLUSIONS

3.1 Key Themes and Characteristics

As Section 2 will hopefully have made clear, a number of key themes and sonic characteristics—and their associated methodologies—have come to define the overall aesthetic of the portfolio. These have coalesced into the basis of what could be regarded as a compositional style, and laid considerable groundwork for future research into the creative potential of wildlife sound.

3.1.1 Subterranean and Underwater Environments

Perhaps the most prominent, recurring portfolio theme has been the exploration of composed subterranean and underwater environments.

The aesthetic foundations for this were laid in *Deadwood* (see Section 2.1.1), whose main compositional source—a dead branch—is subjected to, and eventually consumed by, the immersive effects of tidal flow. *Shorelines* (see Section 2.1.2) builds on these foundations, further developing themes of sediment, submersion and tidal energies, and dramatically expanding the spatial range experienced by the listener. *Mud Roots* (see Section 2.3.1) takes the exploration of composed subterranean environments to its most extreme level, placing the listener amongst mud-enveloped common reed roots with only the barest traces of surface life

breaking through.

Further subterranean explorations in the portfolio include: the composed bumblebee nest space of *Machair Impressions* (see Section 2.4.1: 73); the composed, underwater microphone placements of *Pond Sediment* and *Seabed* (from the *Habitats* Suite; see Section 2.4.2 and esp. Appendix 7.2); and the various geological spaces, behaviours and reanimated Jurassic organisms propagating throughout *Oolitic Processes'* third-order ambisonic soundfield (see Section 2.5).

My interest in exploring subterranean and underwater spaces and the species/phenomena acting within them has been heavily influenced by my field practice: in particular, the utilisation of contact microphones to reveal the rooted, internal structural sounds of floral species, and the use of hydrophones to explore natural phenomena such as sand, mud, rivers, streams, waterfalls, lakes and ponds. At the drafting stage of each work, I have frequently turned to recordings made using these methodologies when laying down textural bases in the studio, and it is therefore no accident that the sense of subterranean enclosure captured through them has profoundly influenced the sonic palette of the portfolio.

3.1.2 Spatial Simultaneity

Spatial simultaneity (Smalley 1997: 124) has also emerged as a key compositional theme in the portfolio, becoming deeply interwoven with explorations of the subterranean as my research has progressed.

In many works, we are aware of two or more composed spaces existing at the same time. For example, at various points in *Shorelines*, quasi-infinite, subterranean spaces (articulated through reverberant, composed tectonic shifts) are dramatically juxtaposed with mid-distance, bubbling water currents and highly proximate species sounds. In *Mud Roots*—a piece largely constructed around the notion of spatial simultaneity—surface activity unfolds concurrently above the composed listening position (amongst reed roots, in densely packed, riverbank mud), with reed stems serving as connection points between each environment. *Deadwood*, *The Sunlit Thawing*, *Pond Sediment* and *Oolitic Processes* also explore spatial simultaneity extensively.

How I listen to species and habitats when recording—in the vast majority of cases, through headphones—has undoubtedly had a profound influence on my exploration of spatial simultaneity: notably through the juxtaposition of proximate sound worlds emanating internally from my headphone drivers, and the environment perceived beyond/around the physical structure of the headphone earpieces (also discussed briefly in Section 2.1.1: 34–35). Continuing this line of thought, I find it intriguing to note that the various emergences, submergences and other spatially orientated transitions composed into works such as *Deadwood*, *Shorelines*, *Machair Impressions* and *Oolitic Processes* (and the processing methodologies underpinning them, such as lowpass filtering) essentially mirror the removal and replacement of

headphones in the field: a frequent requirement in wildlife sound recording, especially when tracking individual species across complex habitats.[55]

Curiously, then, it seems that the performative embodiment of filter adjustment through headphone earpiece removal/replacement in the field has fed into compositional decision-making at the processing stage, complementing other methodological guiding factors.

3.1.3 Microgestural Species Sounds

The exploration of microgestural species sounds, behaviours and life processes has also emerged as a key portfolio theme, especially in works such as *Deadwood*, *Shorelines* and *Oolitic Processes*.

Invertebrate body part sounds, jellyfish propulsion mechanisms, internal and external tree creaks, the mechanical action of bumblebee wings, thistle vibrations, tadpole body friction, and reanimated Jurassic organisms have all been explored, propagating through a range of composed subterranean and surface spaces and drawing the listener into hidden, proximate sound worlds of my own (re)imagining.

Many of these intricate species sounds have been creatively 'grown' using Csound

55 For example: when tracking an actively foraging bird through closed canopy woodland, using a headphone-monitored parabolic reflector. If the bird quickly moves into cover unobserved (a common occurrence in the field), its new position can often be very difficult to determine using the reflector alone, which functions as the audio equivalent of a zoom camera lens. Removing headphones for a brief period allows rapid re-localisation of the subject, and the reflector can then be quickly repositioned for a new take.

instruments, GRM Tools plug-ins and other software, chained together in various combinations as part of an intensive processing loop designed to draw out intrinsic sonic detail and forge a series of extrinsic, source-bonded connections to imaginary organisms and behaviours (see Section 1.5.2 for further detail on these processing methodologies). Randomly modulated granular, bandpass filtering, amplitude modulation and panning Csound instruments (see Appendix 4a: esp. Instruments 3, 4, 5 and 15) have played a fundamental role in much of this processing, and my use of random number generators in these and other instruments has, to some extent, been informed by the many exciting and unpredictable wildlife behaviours encountered in the field (Ferguson 2019e: 6).

As well as studio-grown species sounds, a substantial number of my source recordings contain species-based microgestural detail inherently, without the need for explicit generation through processing (e.g. tadpole body friction, bumblebee wing impacts, flexing plant stems). This is particularly true of material captured using lavalier microphones, hydrophones and contact microphones, since these kinds of transducers often need to be positioned just centimetres from—or mounted directly onto—animals and plants in the field. When dealing with such sources in the studio and using their associated recording methodologies as guiding influences, a lighter approach to processing is normally taken, with granular and other processing techniques employed at a much higher level to fine-tune spectromorphological detail and augment existing gestural contours.

Machair Impressions provides one of the best examples of this lighter, complementary processing methodology. In this work, intimate great yellow bumblebee flight sounds were speed-reduced and layered within Reaper (without any further processing) to draw out the inherent intimacy of the species' wing mechanics, and granular synthesis was used sparingly to augment the existing gestural contours of open-air/contact mic recordings of wind and vegetation (see Section 2.4.1: 72–73).

3.1.4 Documentary and Fictional Interplay

The interplay between documentary and fictional elements in the portfolio has evolved into a key compositional interest in its own right, raising fascinating questions regarding the juxtaposition of realism and abstraction in my creative practice which I hope to explore in future projects.

This interplay emerged during composition of my two early works, *Deadwood* and *Shorelines*, whose imaginary species sounds (crafted in the studio from intensively processed, real-world sources) propagate within and around a range of real-world habitats and composed soundscapes. In addition to framing microgestural species material, habitat recordings in these pieces also serve as real-world points of reference and structural markers, delimiting sections and defining overall formal outline (e.g. Talisker Bay Beach soundscape at 04:45 and 06:11 in *Shorelines*).

Cassiano's Blackbird represents the purest form of documentary composition in the portfolio, with unprocessed recordings of common blackbirds, streams, wind and dawn chorus soundscapes layered and blended via a series of extended crossfades. In stark contrast, *The Sunlit Thawing* embarks on a complex navigation of the real and abstract, forcefully juxtaposing my own emotional response to place (via the shaping of a highly distorted, abstract textural layer) with an unprocessed, real-world documentary source recording of a gently creaking hazel tree.

Mud Roots and *Machair Impressions* both rely on processed habitat recordings to spatially frame species sounds, in order to construct a series of fictional perspectives which place the listener at 'species level' (a kind of composed realism informed by low-level microphone positioning in the field). In both of these works, lowpass filtering was utilised extensively to articulate composed spaces such as bumblebee nests and mud-enveloped reed roots, reducing the spatial cues inherent in raw soundscape recordings to create a sense of envelopment and enclosure.

Documentary/fictional interplay is arguably at its most complex in the *Habitats* suite, whose four works are fundamentally concerned with investigating the perceptual distortions of headphone monitoring in my own practice. This is undertaken through the compositional recreation of monitored field situations, designed (with the aid of ostensibly factual programme notes) to give the impression of raw field recordings. As part of this process, both raw and highly processed materials are used to create realistic listening situations, blurring the boundaries between field and studio and

leaving the listener uncertain as to whether the suite consists of genuine field recordings, composed experiences, or fusions of both (see Section 2.4.2: 76–77).[56]

Throughout the portfolio's development, I have frequently used programme notes to modulate listener expectation and highlight the compositional foci of each piece, in many cases imbuing fictionally crafted material with documentary elements through text (e.g. quasi-scientific programme notes used for *Deadwood* and *Shorelines*; see Appendices 2a, 2b). This descriptive approach has been heavily influenced by my wildlife sound cataloguing practice (see Sections 1.4, 4.2), which involves the transcription and organisation of detailed field observations. At the same time, I have found that catalogued materials often prompt strong emotions and feelings connected with their documented, real-world contexts, and this has frequently led (along with influences from literature by Heaney, Oswald and others; see Section 2.2.2: 54, fn. 31) to a more poetic approach to programme note writing, where memories and field experiences are more freely interpreted. This is particularly true for works bound up with notions of, and reflections on, place and landscape (e.g. *Mud Roots* and *The Sunlit Thawing*).

56 An interesting problem is raised here with regard to the legitimacy of synthesised or highly processed materials in representing reality, and whether such materials can (and indeed should) be elevated to the level of 'true original'. These ideas are informatively discussed by Charles Underriner (2017: 21–22), who argues that 'In audio mimesis...synthesised versions of real-world sounds are just as legitimate as field recordings and environmental sounds in representing reality– there is now an overlap, and even unity, between the synthetic, the concrete and the real.' Underriner also draws attention to related ideas from literary theory, specifically from the critique of Roland Barthes, who argues that 'realism is not actually tied to reality at all, but is a mere social construction based on a convention of what constitutes an effective representation of reality' (1982, cited in ibid.).

Framing these observations more broadly in terms of my compositional practice, it appears that much of the interplay between documentary and fiction in the portfolio has emerged out of the inherent friction between the fields of acousmatic and soundscape composition, which the bulk of the portfolio freely navigates. The documentary basis of wildlife sound gathering has, of course, fed into these mingling compositional domains throughout my research, as have the more imaginative approaches to the presentation of species and field perspectives influenced by literature, the visual arts and other domains.

3.1.5 Extended Crossfading

Extended crossfading (slow montage) emerged as a key portfolio theme with *Cassiano's Blackbird*, and this technique was developed in considerable detail for the remainder of the research period. In many cases, extended crossfades work hand-in-hand with highpass and lowpass filters to articulate source-bonded transitional and transformational processes, including descents into bumblebee nests (*Machair Impressions*: 04:28 onwards), the comings and goings of surface species (*Mud Roots*: 01:50 to 02:45) and journeys through geological strata (*Oolitic Processes*).

My use of extended crossfading has been influenced to some extent by other artists (esp. Lawrence 2011; Watson 2013, 2017), but arguably to a much greater degree by the natural pacing of the wildlife sound recording craft, which often involves careful, gradual transitions through habitats and microhabitats, and painstaking monitoring of microphone placements for hours at a time. On many occasions in the studio, I have

found myself reliving the gradual field transitions and experiences associated with my source recordings; this has had a considerable bearing on crossfade shaping within Reaper, and the pacing of sectional transitions within each portfolio work.

3.1.6 Ancientness and Ancestral Connections

Many works in the portfolio—notably *Shorelines*, *The Sunlit Thawing*, and *Oolitic Processes*—explore themes of ancientness, and embedded themes of ancestral connections to landscape. These elements stem from a deep interest in my own family history within and beyond the UK, as well as a fascination with the imaginative recreation of historical species, spaces and habitats. Many of these themes tend to surface when recording in my Northern Irish homeland, and in areas throughout Scotland where strong ancestral connections are known to exist: where a sense of place has been cultivated, and roots put down.[57]

In some works (e.g. *Mud Roots, Machair Impressions*), these themes are not revealed explicitly, and are instead hinted at through the slowly evolving character of sonic materials and/or programme note content.

3.2 Methodological Symbiosis

57 See Section 2.1.2: 38, fn. 17 for further notes on my personal ancestry and its relevance for *Shorelines*, and Section 2.2.2: 51, fn. 28 for notes on the concept of place as it relates to *The Sunlit Thawing*.

One of the most fascinating and unexpected developments of the thesis has been the emergence of what I call ‘methodological symbiosis’ between field and studio. As noted in the preface (see Section 1.1), rather than a one-way, methodological workflow between practices remaining constant throughout my research (with wildlife sound recording informing a separate, subsequent compositional process), a two-way workflow has occasionally emerged, with the methodologies of each craft guiding the other in various ways and to varying degrees.

This symbiosis sometimes forged unexpected links between works in the portfolio. For example, the intensive re-processing methodologies employed in *Deadwood* (described in Section 2.1.1: 36; see also Appendix 4b: 2–3) ended up having a profound influence on bumblebee recording methodologies, spurring the refinement of close miking techniques for capturing intimate body detail and foraging activity in the field, and drawing my ear deeper inside associated bumblebee habitats such as wildflower meadows and flower beds.[58] This proved crucial during source recording for *Machair Impressions* (see Section 2.4.1), when the sounds of great yellow bumblebee mating activity were documented in remarkable detail, and the proximate/internal sound worlds of the species’ machair habitat were successfully captured using ground-level AB stereo placements and contact microphones.

58 For example: rather than simply following bees in flight, I began placing mics inside flowers, in an attempt to capture detailed body sounds and close-up perspectives of mandibles, leg scratches, etc. I also began using contact mics to record detailed, internal vibrations from the floral species being foraged on, and using AB stereo placements at ground level to capture complementary, open-air vegetation sounds. When successfully combined and contrasted, these methodologies revealed the multifaceted sonic characteristics and behaviours of bumblebee species and their associated habitats in remarkable detail.

I have also been struck by the performative symbiosis between wildlife sound recording and electroacoustic composition.[59] During live diffusion (which I regard as part of the compositional process; see Appendix 8a for diagrammatic context), I have often attempted to relive the various microphone placements, species encounters and journeys behind my recorded source materials, as part of a conscious effort to inform spectromorphological and spatial articulation in-concert; in other words, I have consciously transplanted my own field experiences into live diffusion situations. Working in the opposite direction, the act of concert diffusion itself has re-informed my recording approaches in the field, by influencing (for example) how avian flight trajectories are recorded in open habitat spaces, and informing how and where stereo microphone configurations are deployed to best facilitate future performative manipulation.

All of this has been incredibly exciting for me on an artistic level, especially given my early assumptions about wildlife sound recording's one-way influence on electroacoustic composition. I am now very conscious of the capacity of studio methodologies to re-inform my field practice, and shape my approaches to species and phenomena recording in new and interesting ways as my work continues to evolve.

59 I regard wildlife sound recording as a fundamentally performative activity: a view which has largely been informed by the words and works of Isobel Anderson. In a fascinating article written in early 2015, she notes: 'I no longer see my recordings as just invisible audio files, but instead, the product of a performative act. In my opinion, field recording is a performance. From the time I start to attentively listen, to when I'm packing up my equipment, I provide a spectacle to be observed by others (both human and non-human)' (2015).

3.3 Notes on Listening Space

The spatial subtleties and high level of proximate, microgestural detail in the majority of portfolio works mean that playback in reflective or semi-reflective concert venues (e.g. buildings with tiled or wooded walls and floors) is far from ideal; in my own experience, the intricate sonic behaviours and spatial juxtapositions of the portfolio are often lost in such listening environments.[60] Pieces composed with site-flexible installation in mind (notably *Oolitic Processes*) may also struggle to project well in reflective spaces, or in environments with a high level of human activity such as cafes, retail outlets and transport hubs. In almost all cases, small- and medium-sized, quiet spaces with a dry or relatively dry acoustic will provide the best listening experience.[61]

These spatial requirements were highlighted all too clearly during the March 2019 premiere of *Deadwood*, in the University of Birmingham's Bramall Dome concert space.[62] Whilst other works came across subjectively well in the Dome, there was a noticeable loss of proximate, microgestural detail and spatial definition during live

60 The only exception to this would perhaps be *The Sunlit Thawing*, whose powerful, textural basis would presumably have little difficulty projecting through busier/larger venues. It is worth noting, however, that despite its forceful character, this work also features delicate tree creaks which would likely become lost in larger, busier spaces. (Note: Due to the restrictions of the COVID-19 pandemic, *The Sunlit Thawing* has not been publicly played at the time of writing.)

61 A notable exception is the Elgar Concert Hall at the University of Birmingham, whose layout allows remarkable flexibility for projection and spatial augmentation when fully equipped with the BEAST sound diffusion system.

62 Premiered on March 1, 2019 as part of the BEASTdome concert series. See Appendix 8d for a full schematic of the BEASTdome system, as deployed on the night of the performance.

diffusion of *Deadwood*. These elements were discussed critically amongst student colleagues post-concert, and raised during subsequent supervisory meetings, with the main conclusion being that the reflective acoustic of the room (combined with its tall, hemispherically shaped ceiling) had not worked in the composition's favour.[63]

By stark contrast, the work's subsequent playback in the Feldstein Immersion Room at the Elmer Holmes Bobst Library (New York City) was much more successful.[64] In this venue—a relatively small, intimate room with a carpeted floor and absorptive wall panels—the piece came across very well indeed, with a high level of microgestural definition and effective rendering of composed spatial detail: elements which were positively commented on during sound checks at the venue.

Following my experiences with *Deadwood*, I have understandably been much more careful about selecting performance and playback venues for my works, favouring acoustically dry, intimate spaces with low levels of public activity. Where possible, I now try to discuss piece requirements with managers, curators and event organisers in considerable detail before committing to a particular venue.

63 This is not to imply that work was poorly received; on the contrary, listener feedback was overwhelmingly positive.

64 Given during the ICMC-NYCEMF concert series from June 16 to 23, 2019.

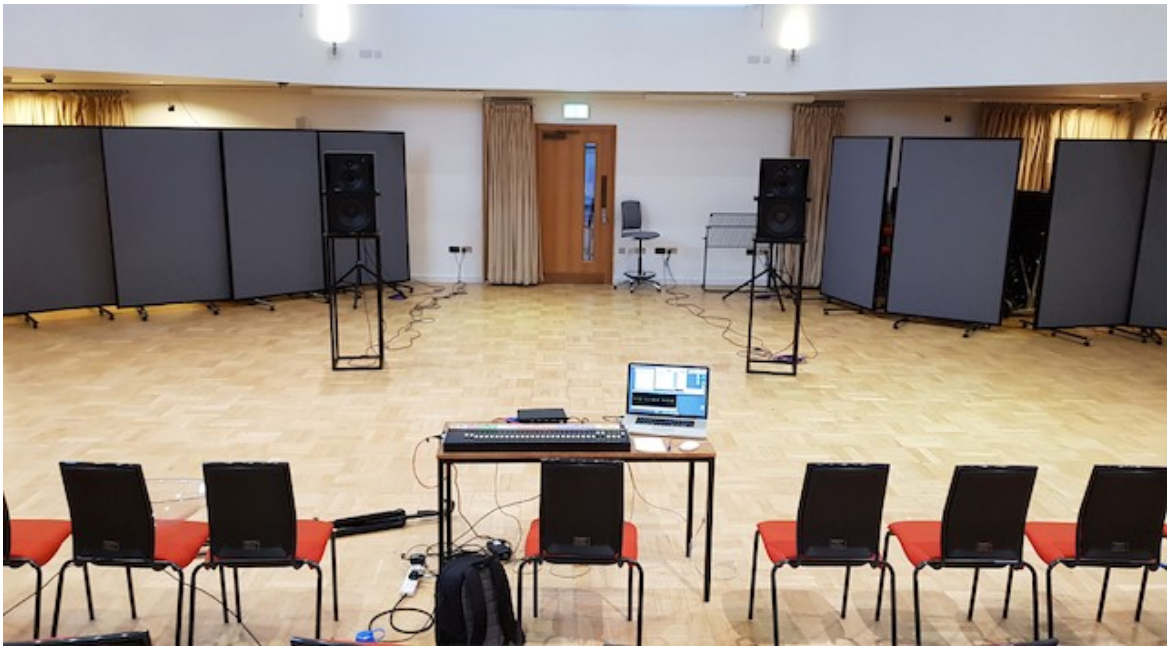


Plate 30
The Dome rehearsal and concert space, Bramall Building, University of Birmingham. The majority of surfaces in this space are highly reflective; coupled with the unusual, hemispherical layout of the ceiling, this contributed to a loss of sonic detail and spatial definition during the premiere of *Deadwood*.

Plate 31
The Feldstein Immersion Room (Elmer Holmes Bobst Library, NYC), which features a carpeted floor and acoustic wall treatments. The size and intimacy of the venue proved favourable for *Deadwood*,

whose microgestural detail and spatial contrasts came across well on the 12-channel playback system.

As a closing note on listening space, it is worth pointing out that the vast majority of my wildlife recordings to date have been made in non-reflective, acoustically dry environments such as meadows, grassy hillsides, open moorland, machair vegetation and coastal habitats. Even where reverberant habitats (e.g. conifer forests) are encountered in the field, their acoustic characteristics have often been significantly negated by the use of close miking and parabolic reflector recording methodologies.

This points to yet another guiding influence from wildlife sound recording, with the technical methodologies and approaches of the craft guiding spatial decision-making in the studio and subsequently feeding into the selection of suitable playback venues.

3.4 Work Diversity and Genre

The portfolio as a whole shows considerable spectromorphological, spatial, durational and aesthetic diversity, and is therefore suitable for a wide range of performance and playback situations. These include, amongst others: concert-based stereo and multichannel diffusion; private loudspeaker and headphone listening; site- and non-site-specific installations; small-, medium- and large-scale educational events; and academic/non-academic presentations.

To my mind, this diversity is largely a by-product of the wildlife sound recording craft, which exposes the practitioner to a correspondingly diverse set of spectromorphological, spatial and durational monitoring situations. These have undoubtedly guided the character of each work, and informed—subconsciously or otherwise—decisions regarding piece duration, format and dissemination.

On a personal level, the diversity of the portfolio has also emerged for simple reasons of enjoyment: because I find the myriad sound worlds and intimate sonic fabrics revealed by wildlife sound recording truly fascinating to explore compositionally. In the same vein, it should also be noted that whilst existing research in this area (summarised in Section 1.2) has provided a useful *path* towards my own explorations, it has not dictated them; rather than follow existing approaches for the creative utilisation of wildlife sounds, I have instead allowed my work to be guided at the most fundamental level by my field practice and the various methodologies underpinning it.

This relatively pure methodological focus may explain why I find it difficult to assign a particular genre to my work. Whilst some pieces arguably veer towards broadly accepted styles of composition (e.g. soundscape, acousmatic), none sits evenly within them; to my ears, the portfolio, when taken as a whole, occupies its own compositional niche which has grown directly out of the wildlife sound recording craft.

4. ADDITIONAL RESEARCH INTERESTS

Over the course of the PhD, two additional research interests have grown out of, and alongside, work on the portfolio. Apart from having considerable influence on my creative practice, these have the potential to develop into research projects in their own right as I look beyond 2021 towards postdoctoral study.

4.1 Wildlife Conservation

Considering both the focus of the thesis topic and the fundamental interest most wildlife sound recordists have in looking after the natural world, it is perhaps unsurprising to note that many works in the portfolio explore sounds and themes of particular relevance to wildlife conservation.

In many cases, these have been explored indirectly. For example, by creatively showcasing the microscopic behaviours of detritivore species and rendering the imaginary internal/surface sound world of their rotting branch habitat in detail, *Deadwood* (see Section 2.1.1) indirectly raises awareness of these ecologically crucial organisms and their biological requirements. Marine species and their supporting coastal/oceanic habitats are explored in considerable detail in *Shorelines* (see Section 2.1.2), whilst *The Sunlit Thawing* (see Section 2.2.2) draws attention to the unique, centuries-old sounds of ancient woodland habitat and the value these

sounds have in defining place.

By far the best example of conservation themes feeding into and informing my research directly is *Machair Impressions* (see Section 2.4.1), whose source sound gathering was driven at the most fundamental level by my desire to record one of the UK's rarest bumblebee species: the great yellow bumblebee (*Bombus distinguendus*). Building on existing bumblebee recording experience and a background of public engagement with their sounds (Bumblebee Conservation Trust 2018, 2019; Cribbs Causeway 2019; Ferguson 2019b, 2019c; Winterbourne House and Garden 2019), the composition of *Machair Impressions* was underpinned from the outset by extensive collaboration with experts from the Bumblebee Conservation Trust, whose advice regarding species identification and recording locations led to the successful sonic documentation of *B. distinguendus* mating activity on the Hebridean Island of South Uist. As noted in Section 2.4.1 and in addition to featuring prominently in the finished composition, these sounds were widely publicised via the BBC, AHRC and other organisations, directly raising awareness of one of the UK's rarest species and its associated machair habitat.[65]

Shortly after the completion of *Machair Impressions*, I released a collection of unique bumblebee sounds via the *Humble* album (Ferguson 2020).[66] Initially offered as a Bandcamp fundraiser for the Bumblebee Conservation Trust (in conjunction with the

65 The piece itself was streamed online via Twitch, and featured in two concerts at the University of Birmingham in 2020/2021.

66 The title *Humble* was chosen for the allusion to both the old English name for bumblebee ('humble bee'), and as a nod to the album's underlying fundraising element.

online fundraising platform JustGiving), *Humble* features some of the most challenging and interesting bumblebee sounds I have ever attempted to record, including bumblebee footsteps, mandible bites during nectar robbing[67], and buzz pollination[68] activity beside one of New York's busiest freeways. At the time of writing, all tracks on *Humble* have a collective total of over 1000 plays on Bandcamp from listeners worldwide.

Additional conservation-related output during the research period can be summarised as follows:

- Various blog posts and conservation-orientated radio interviews/features, focusing on local community engagement and awareness-raising (e.g. Ferguson 2019a; Cube Microplex Radio Hour 2020).
- A series of talks and presentations at prominent UK conservation events, including the Bumblebee Conservation Trust's 2019 AGM (Ferguson 2019g) and the 2019 *Nature Matters* conference (Ferguson 2019i).
- A recording of corvid roost disturbances during 2019/2020 new year celebrations in Gloucestershire (UK), which won a nomination and special jury mention in the 2020 *Phonurgia Nova* Competition field recording category. The competition entry—entitled *Présage*—drew special attention to the effects of anthropogenic noise on animal behaviour (see Appendix 8e, 8f for full competition entry and programme notes).[69]

67 A feeding process used by bees, where the underside of a flower is bitten into in order to extract nectar. This inhibits pollination, since the bee does not enter the open portion of a flower in the usual manner.

68 A process used by some bees to extract pollen from a flower's anthers. In buzz pollination (also known as sonication), a bee's wing muscles are rapidly contracted to produce strong, high-pitched vibrations. These vibrations are directed through the bee's body parts onto the flower's anthers, in order to trigger the release of tightly packed pollen.

69 Jury remarks for *Présage* can be found at: http://phonurgia.fr/2020/10/05/and-the-winners-are-3/.

Reflecting more broadly on the portfolio's interwoven conservation threads, it is interesting to observe that these have, in all cases, been allowed to grow and develop naturally. Rather than overtly building pieces around conservation-orientated sounds and themes, conservation elements have instead emerged as a natural consequence of my underlying wildlife sound recording interests and a deeply respectful, personal desire to explore interesting species and habitat sounds. Another way of putting this is that conservation concerns have never been forced into my material, or incorporated as a point of protest; instead, they have emerged subtly within and around it, becoming a naturally embedded component of my work.[70]

There is clearly much to investigate in terms of how such low-key approaches to conveying conservation and environmental issues can be cultivated in future sonic arts research, and, in particular, how the unique complexities of electroacoustic music can be harnessed to facilitate deeper connections with other species. As Chris Bocast notes:

> People must be moved if they are to act; electroacoustic musicians can bring both artistic perspective and the emotional persuasion of music to environmental issues while bridging multiple disciplines, and provide the media expertise to see that their work accomplishes its professional objectives. The

70 Environmental sound artist Cheryl Leonard's work has been influential in this regard. She notes of her own practice: 'I strive foremost to create works that are sonically engaging whether or not listeners are aware of the extra-musical issues behind them… I try not to hit people over the head with issues I care about because I think the public is weary of being told to panic about the environment […] I prefer a more subtle approach that includes sharing my personal experiences of nature within the music itself' (Leonard 2016: 51).

> safety of the biophysical world has now become an urgent priority in the lives of many people across the planet; the contribution that electroacoustic music can make to the environmental debate is not trivial. (2012: 246)

However my practice develops, I am certain that issues relevant to wildlife conservation will remain deeply interwoven with my creative output for years to come. Some early ideas for future research in this area include: in-depth, collaborative projects with conservation organisations representing culturally maligned and misunderstood species (e.g. snakes, spiders and bats); a series of detailed compositions exploring the hidden sound worlds of critically endangered species; and multidisciplinary arts projects with other creative practitioners (e.g. street artists, sculptors, printers and writers), whose work also explores issues of environmental and conservation concern.

4.2 Wildlife Sound Cataloguing

As discussed in Section 1.4, the process of cataloguing my own recordings and their accompanying metadata has served as a valuable working basis for the portfolio, enabling the intuitive selection of sources, behaviours and spectral features, and functioning as a highly effective bridge between the crafts of wildlife sound recording and electroacoustic composition.

Whilst it has been satisfactory for this research project to simply develop and utilise a

bespoke cataloguing system, fundamental questions remain with regard to *how* cataloguing, recording and studio practices are interacting in my work, and how information is flowing between them. What influence does the physical layout and design of a wildlife sound catalogue have on creative sonic practice? Exactly how are written field observations guiding the selection and intuitive processing of wildlife source materials in the studio? To what extent do recording and studio practices feed back into the cataloguing process for wildlife sounds? How are documented behavioural relationships between species and habitats (conveyed within a catalogue's contextual metadata) being explored sonically? These are just some of the research questions which could be addressed, as secondary or main foci, in future academic projects.

The historical evolution of wildlife sound cataloguing and the concurrent development of recordist-specific cataloguing documents such as index cards, notation sheets, etc. remains deeply fascinating to me; to the best of my knowledge at the time of writing, this area remains entirely unresearched. Future projects may therefore explore how the bespoke designs of these historical documents have informed the design of my own, digitally orientated wildlife cataloguing system, and how these physical, 'analogue' objects could be incorporated into multimedia projects/installations featuring images or text.

By looking comparatively at some of the earliest cataloguing approaches used by wildlife sound recording pioneers (e.g. Ludwig Koch; Arthur Allen; Paul Kellogg;

Tsuruhiko Kabaya), current archival models for wildlife sounds (e.g. British Library 2018; FNJV 2018; Niven Library 2018; Tierstimmenarchiv 2018; eBird 2021), and publicly available, commercially orientated file management applications (e.g. Soundly 2021; SoundMiner 2021), new standards for wildlife sound cataloguing could also be developed. These new models could be designed from the ground up to better facilitate the use of wildlife sound sources within sonic arts practice, incorporating suggestions for processing, spatial manipulation and other creative elements as part of an enhanced metadata framework built around the spectromorphological and behavioural characteristics of recorded species and phenomena.

I am also very intrigued by how wildlife sound cataloguing could be regarded—and explored in the future—as an extension of phonographic practice (Meireles 2016: 104). Since, throughout my work, cataloguing has acted as a fundamental link between field and studio (transplanting location experiences, behaviours, spatial impressions, observations, memories and technical approaches via a set of text-based organisational strategies), it would be fascinating to foreground the textual metadata which has underpinned this link as part of (for example) an interactive multimedia work incorporating printed metadata elements. Extending the scope of wildlife sound recording to encompass the cataloguing process through such projects could serve to ‘augment the experience of place and its communication’ (Meireles 2016: 104), shedding new light on how field experiences with wildlife are documented and how they inform electroacoustic composition.

5. TOWARDS POSTDOCTORAL RESEARCH

5.1 Thoughts on Future Work

Reflecting on the submitted thesis and with an ear now turning towards postdoctoral research, one element is clear: the crafts of wildlife sound recording and electroacoustic composition will continue to define and underpin my creative practice for the foreseeable future.

What is less clear is how these crafts will evolve. At the moment, I find myself particularly drawn towards the narrative possibilities of my practice (outlined in Section 1.5.4), and have some early ideas about how this could develop into a key research focus going forwards. One concept would involve exploring the untold stories of culturally maligned animals (bats, snakes, spiders, and so on), combining wildlife sound recording and composition with elements of wildlife conservation and cataloguing practice. How do we record, document and portray species that have overwhelmingly negative connotations, and what are their stories? How do people who live close to these species feel about them, and how do they interact with them? These and related questions appear to be chronically underexplored within the sonic arts, and numerous interactions over the course of my doctoral research—both within and outside academia—have convinced me that there is much to do in terms of forging new relationships between creative practitioners and conservation

organisations, with regard to exploring culturally maligned, misrepresented species.

Looking back on the last two years and with the impact of COVID-19 restrictions on performative and collaborative work all too evident, I am now very keen to broaden my practice and explore more ambitious approaches to sonic presentation and listener interaction: perhaps through cross-disciplinary collaborations with coding experts, sculptors, painters, ceramicists, writers and other creative practitioners. I also remain very enthusiastic about developing new relationships with experts working outside the sonic arts, whose work is intimately bound up with wildlife: especially those working in the biological and environmental sciences. In this regard, I have taken considerable inspiration from the work of composer and sound artist David Dunn, who, in the liner notes to *The Sound of Light in Trees* (2006), explains:

> My argument for a fruitful exchange between art and science […] includes a vision for how artists might influence the evolution of science by providing richer imaginative and metaphorical tools. Art can contribute to real world problem solving by enriching the communication of what science reveals through seeking the facts of nature. I believe this to be of historical necessity because of where we currently stand in relationship to an earth in crises. How can art participate in the discovery of solutions that can accelerate those of science?

Standing in the midst of what many now scientists now refer to as the ‘sixth mass extinction’, Dunn’s considerations may prove crucial for all sonic arts researchers, prospective and current: particularly those with an interest in exploring the creative possibilities of wildlife sound.

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