

Bangor University

DOCTOR OF PHILOSOPHY

An interdisciplinary understanding of coastal resource collection in Wales

Morris-Webb, Elisabeth

Award date:
2021

Awarding institution:
Bangor University

[Link to publication](#)

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal ?

Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Download date: 19. Apr. 2024



PRIFYSGOL
BANGOR
UNIVERSITY

An interdisciplinary understanding of coastal resource collection in Wales

A thesis in submission for a Degree of Doctor of Philosophy (PhD)

Elisabeth S. Morris-Webb BSc (Hons), MSc (Distinction)

October 2021

Supervised by Professor Stuart Jenkins and Dr Freya St John

School of Ocean Sciences, Bangor University, Menai Bridge, Anglesey, UK, LL59 5AH

Declaration

I hereby declare that this thesis is the results of my own investigations, except where otherwise stated. All other sources are acknowledged by bibliographic references. This work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree unless, as agreed by the University, for approved dual awards.

Signed



(candidate)

Date March 30th 2020

Declaration of competing interest

The PhD candidate confirms that there have been no involvements that might raise the question of bias in the work reported or in the conclusions, implications, or opinions stated. The PhD candidate has a long-standing interest as founding Director of the funding company partner, Marine Ecological Solutions Ltd., and has worked as a consultant to Natural Resources Wales on projects regarding coastal resource collection in the past. However, she has not been involved with any projects that involve the monitoring or management of coastal resource collectors in Wales or the UK since 2014 (two years before the conception of this PhD).

Declaration of competing interest

Funding for this research was provided by a Knowledge Economy Skills Scholarship (KESS 2) with support from partner company Marine Ecological Solutions Ltd. KESS 2 is a pan-Wales higher level skills initiative led by Bangor University on behalf of the HE sector in Wales. It is part funded by the Welsh Government's European Social Fund (ESF) convergence programme for West Wales and the Valleys.

Acknowledgements

None of this work would have been possible without the coastal resource collectors of Wales. For both their inspiration, but also for the enthusiasm and passion from those who took part. It made me enthusiastic to tell their stories, and I hope my work does their involvement justice. This work was also inspired by my previous work with Sue Burton, Dr Paul Brazier, Rowland Sharp, Harry Goudge and Dr Frances Perry at Marine Ecological Solutions. I am grateful for the ideas we generated during those conversations that made me determined to seek a better understanding of the people interacting with our coast and to find new approaches to coastal collection.

I am eternally grateful to my supervisors Professor Stuart Jenkins and Dr Freya St John who have given a great balance of overwhelming enthusiasm and quiet scepticism at times, not to mention a lot of patience and faith in my unconventional approach and writing style. Without them I would not have pushed myself to deliver my thesis at all.

Dr Penny Dowdney also showed confidence in my ability to deliver this PhD whilst running a small consultancy, so I am very grateful for her support. I am thankful to all the team at the Knowledge Economy Skills Scholarships (KESS 2) for their friendly support getting me through the paperwork hurdles. And I am ever grateful to Matt and Lin for helping keep Marine EcoSol busy for the duration of my PhD.

I was accompanied on my fieldwork by an enthusiastic and energetic field team at different times. Lynn Sorrentino, Holly Date and Thea Moule joined me for different bits of many chapters and provided me a boost to my morale when we spent hours looking for respondents or suitable boulder shores. In addition, Arianna Liconti, Molly Heal, Hana Amir, Eleanor Falch, Serinde van Wijk and Jamie Thorpe joined me for marking and relocating boulders. I will always be extra especially grateful to Jamie for getting wet to find our record-breaking bouncing boulder. Thanks Jamie!

I'd like to thank my colleagues in the School of Natural Sciences and Conservation and Human Behaviour (ConHub) Research Group; Leeijah, Corinna, Harriet, Simon, Julia, Katie and David for helping me see the bigger picture, and feeding me with stories of fantastic conservation research, birds, lemurs and giant anteaters around the world. Particularly Dr Mariana Catapani (University of Sao Paulo) for her

PhD: Understanding coastal resource collection in Wales

statistical opinions and moral support during our wrangles with GOLRM, and Dr Heli Gittins for learning to code together and sense checking my qualitative analysis.

Within the School of Ocean Sciences, I am forever grateful for my friends and colleagues in the Nautilus Suite. Sarah Bond, Katrin Frosin and Alistair Feather for assistance with R-coding. Peter Lawrence, you always have great enthusiasm for my work, and offer tea and cake at the right time. Tim D'Urban Jackson for laser scanning and processing, Guy Walker-Springett and Drs Martin Austin and Matthew Lewis for help with oceanographical modelling and loan of ADV.

Finally, beyond the two Schools in which I sat, I also thank the members of the Bangor University Well-Being Group. An enthusiastic group of well-being researchers across the University who helped to sense check my rationale and methods, and provided a fun sounding board and learning forum. Thank you to all of you for your inspiration and clarity, especially Andrew, Heli, Patri and Elizabeth.

I would not have managed to deliver my PhD during a global pandemic without our virtual office – Drs Anna Woodhead and Laura Richardson, Sarah Bond, Kati Frosin, and the rest of the Shut up & Write Team have made being at my computer focussed but also fun. Anna, I would have been lost without your advice and your tomatoes!

My biggest thanks must go to my family. Firstly, my mum and dad, who helped me chase the dreams of my 14-year old self. Particularly my mum, who learned Welsh to home school through the final months of my write up. Brother Robert for proof-reading and my sister for her enthusiasm and cheery smiles. Dad would have been proud of us all. Grandpa, you are my link to the sea, you inspire me, and through this project we have been drawn closer. Urban sister Alice has helped keep us sane and together through both the pandemic and final write-up hurdles. Finally, to those whom this PhD has affected the most, I am ever grateful to my husband Steve Webb and son Toby. They provided excellent field support from the start, in the rusty old van purchased specifically for early morning beach interviews. Life has changed a lot through a PhD and global pandemic, and I am grateful to you both for the sacrifices you have made, for giving me the excuse to get outside and have fun, but also for letting me work endless antisocial hours. Toby, I hope you always keep your enthusiasm for picking the local seaweed delicacies wherever you go in life! I look forward to our next, PhD-free, family adventures together.

An interdisciplinary understanding of coastal resource collection in Wales

Elisabeth S. Morris-Webb. PhD Thesis, Bangor University

Abstract

Coastal collection, also known as foraging, harvesting, gleaning or gathering, has been essential to the success of the human species but there has been little contemporary exploration of its ecological or social importance in developed economies. In this thesis, I begin by reviewing existing socio-ecological research into intertidal harvesting and previous attempts at engagement and management of collectors, before exploring the growing need for an innovative, or transformative, approach to future management.

Teasing the impact of collection activities from other shoreline activities has proved difficult by researchers, but there are growing concerns that collecting can have significant ecological impacts. There is evidence that, under certain conditions, even a single intense collection event can have long lasting effects on both the target species and habitat, whilst low level collection of multiple species over time can also have detrimental impacts to local ecological communities. Management of hand collection activities grounded in principles of ecological sustainability has often failed to get to implementation stage through lack of understanding of the activities being undertaken. If implemented, non-compliance from collectors is frequently a problem, driven by a lack of understanding from managers about the importance of the activities to the people undertaking them. Despite warnings that management strategies based solely on principles of ecological sustainability are unlikely to be successful, nor their enforcement cost-effective, few have attempted alternative management approaches, and collection activities remain largely misunderstood by, and beyond the reach of, policy makers. My thesis provides evidence to enhance the understanding of both the socioeconomic and ecological importance of coastal collection activities, paving the way to a more holistic and inclusive management approach.

Despite significant knowledge gaps, policy makers in Wales are increasingly interested in managing intertidal collection activities. Until now, no peer reviewed research has specifically focussed on how collecting in the UK links to people's well-being, which may offer information to guide future management approaches. Driven by policy interests, coupled with the requirements of the Well-being of Future Generations Act (Wales) 2015, I undertook research with the coastal collectors of Wales. Questionnaires revealed what is collected, motivations underpinning collection activities, and how engaging in coastal

PhD: Understanding coastal resource collection in Wales

collection relates to the well-being of collectors. Ninety-one coastal taxa were collected by respondents, with 33 different taxa considered of great importance to collectors. People were motivated to collect intertidal resources for provisioning purposes, for example collecting mussels to eat, crabs for angling bait or cockles for money. The experience of collecting was also important. Many reported collecting for fun, thrill, and excitement, or as an excuse to enjoy the environment and fresh air. Some collected for solitude whilst others as a social activity. Analysis revealed complexities in the relationship between collection activities and human well-being. For example, the act of collecting reduced anxiety levels of collectors, those of lower well-being were more likely motivated to collect for provisioning purposes whereas those of higher well-being were motivated by experiential factors.

My second data chapter further explores the experiential meanings behind collection activities through thematic analysis of interviews with coastal collectors. Although all participants acknowledged some provisioning motivation, there were three other intertwined themes through which participants were benefitting from their activities – personal identity, nature connectedness and overall health and well-being. Benefits are discussed in relation to psychological theories of biophilia, attention restoration, self-actualisation, and my concept of a modern hunter-gatherer persona. Overarching concerns about the sustainability of both stocks and the art of collecting were expressed by most collectors, with many feeling misunderstood or ignored by managers and policy makers. My qualitative research revealed the importance of coastal collection for some people, and their dependence on it. This chapter provides a foundation for tailored engagement with different types of collectors as Wales strives for sustainable use of coastal resources for current and future generations.

The challenge of assessing the anthropogenic impact of intertidal collection on rocky shores led me to develop, in my final chapter, a suite of experiments designed to ascertain human impacts on sheltered, tide swept shores. Any disturbance of this habitat is usually attributed to people turning rocks, often for the collection of crabs. My use of novel technology to tease natural from anthropogenic disturbance demonstrates that the disturbance of tide swept boulders is little understood, and can occur via natural, peripatetic, movement in high tidal velocities, in addition to people turning rocks at low water.

Overall, my thesis takes an interdisciplinary approach to address some of the social and ecological knowledge gaps that can feed conflict between collectors, policy makers and managers. I suggest new framings to persistent management conundrums, beyond traditional ecological and subsistence narratives, that will enhance understanding of, and future engagement with, intertidal collectors whilst promoting advocacy for future management amongst collectors themselves.

Table of Contents

Acknowledgements.....	i
Abstract.....	iii
Table of Contents	v
List of Tables	viii
List of Figures	ix

Chapter 1. Finding a transformative approach to understanding and managing the collection of coastal resources in a global context..... 1

1.1 Background.....	2
1.2 Persistent problems in marine governance affecting the management of coastal resource collection	7
1.3 Coastal collection: a symptom of a persistent problem with three main knowledge gaps.....	9
1.4 Transformative approaches to better understand coastal collection	11
1.4.1 Understanding the implications of coastal collection on psychological well-being.....	12
1.4.2 Novel, interdisciplinary, tools for understanding cumulative ecological impacts	14
1.5 Aims and Objectives	16
1.6 Structure of Thesis	17

Chapter 2. Motivations for the collection of bait and other living coastal resources, and their well-being implications..... 20

2.1 Introduction	22
2.2 Methods	28
2.2.1 Well-being context.....	28
2.2.2 Questionnaire design.....	29
2.2.3 Data collection	34
2.2.4 Analysis	34
2.3 Results	37
2.3.1 Living resources collected from the Welsh coast and beaches	38
2.3.2 Who collects coastal resources	38
2.3.3 Primary motivations for collecting specific taxa	39

PhD: Understanding coastal resource collection in Wales

2.3.4	Multiple motivations for the collection of coastal resources	41
2.3.5	The well-being of Welsh collectors	43
2.3.6	Links between the meanings behind collection, the mental well-being of collectors and their motivations to collect.....	48
2.4	Discussion.....	51
2.4.1	Overview of collection activities and the community collecting coastal resources	51
2.4.2	Links between mental well-being and motivations to collect coastal resources	52
2.4.3	Collection of coastal resources as a therapy to increase affective well-being	55
2.4.4	Collection activities, nature connectedness and evaluative well-being	55
2.4.5	Coastal proximity and mental well-being	56
2.4.6	Implications.....	57
2.4.7	Limitations and recommendations	58
2.4.8	Conclusions	59

Chapter 3. The hidden meanings of coastal resource collection: cockling, recreational foraging and other informal gathering

62

3.1	Introduction	64
3.2	Methods	68
3.2.1	Study area	68
3.2.2	Data collection	69
3.2.3	Analysis	70
3.2.4	Researcher Positionality and Assumptions.....	71
3.3	Results	73
3.3.1	Provisioning	75
3.3.2	Nature Connectedness	76
3.3.3	Health and Well-being	77
3.3.4	Personal Identity	79
3.3.5	Cross cutting themes, and relationships between themes.....	84
3.3.6	Coastal collector typologies	89
3.4	Discussion.....	91

Chapter 4. Teasing natural from anthropogenic disturbance of cobbles and boulders on sheltered macroalgal dominated shores using novel technology

.....	100
4.1 Introduction	102
4.2 Materials and Methods.....	106
4.2.1 Study site.....	106
4.2.2 Establishing the distance rocks travel: 'Measure, mark and recapture'	107
4.2.3 Establishing rock movement using tri-axial accelerometers	110
4.2.4 Use of laser scanning technology to detect boulder movement.....	114
4.3 Results	116
4.3.1 The distance rocks travel: 'Measure, mark and recapture'	116
4.3.2 Establishing rock movement using tri-axial accelerometers	118
4.3.3 Use of laser scanning technology to detect boulder movement.....	126
4.4 Discussion.....	132

Chapter 5. General Discussion: Contributions of this thesis to understanding and managing the collection of coastal resources in a global context..... 138

5.1 Contribution to understanding the social importance of coastal resource collection activities in a developed economy	142
5.2 Contribution to developing a better ecological understanding of coastal collection activities in wave sheltered, tide swept, rocky shores	145
5.3 Introducing social triggers affecting coastal collection activities around the world	148
5.4 Limitations and implications for further research	151
5.5 Implications for policy: Towards a transformative solution to the persistent management conundrum of engaging with collectors and the sustainable management of long held foraging practices	156
5.6 Conclusions.....	158

References..... 160

APPENDICES..... 192

APPENDICES A: Chapter 2	194
APPENDICES B: Chapter 3	220
APPENDICES C: Chapter 4	268

List of Tables

Table 2.1. The three most important taxa to collectors of wild coastal resources in Wales.	39
Table 2.2. Multiple motivations for collecting coastal resources in Wales.	42
Table 2.3. Model 1: Associations between circumstantial predictors (sociodemographics and nature exposure) and well-being amongst collectors of coastal resources in Wales..	44
Table 2.4. Model 2: Associations between predictors related to coastal collection and well-being..	46
Table 2.5. Model 3: Identifying factors most affecting the well-being of collectors of coastal resources in Wales..	49
Table 4.1. Summary of movement of bare rocks and those with large <i>Ascophyllum</i> attached over a period of 31 days between October and November 2017.....	116
Table 4.2. Average movement of algal rocks, with large <i>Ascophyllum</i> attached (n = 6), compared to bare rocks (n = 5)	123

List of Figures

Figure 2.1. Predicted drivers of well-being for the collectors of coastal resources in Wales	33
Figure 2.2. Primary motivations to collect important coastal resources (a), and the top five targeted intertidal taxa in Wales.....	40
Figure 2.3. Meanings behind the collection of coastal resources from the Welsh coastline for respondents of different well-being groups (low, medium and high) ...	50
Figure 3.1. Meanings coastal collectors in Wales associated with their activities grouped into four main themes: Health and Well-being, Provisioning, Nature Connectedness and Personal identity. Sustainability Concerns was an overarching super-theme.	74
Figure 3.2. Four collector typologies suggested based on similarities in what coastal collection means to them.....	90
Figure 4.1. Experimental location used to determine peripatetic movement of <i>Ascophyllum</i> topped rocks at the foreshore of Treborth, Menai Strait and Conwy Bay Special Area of Conservation, Wales.	106
Figure 4.2. Forces acting to move rocks on the seabed with and without seaweed.	108
Figure 4.3. Onset HOBO Pendant G logger UA-004-64 placed in a plastic housing on rocks to measure acceleration and change in inclination of loose intertidal rocks..	111
Figure 4.4. Total distance rocks moved across a tide swept shore with increasing algal load of macroalgae, <i>Ascophyllum nodosum</i> , over a period of 31 days.	117
Figure 4.5a. Acceleration of intertidal rocks using ONSET Hobo Pendant G accelerometers attached to a bare rock (A), a bare rock turned at low tide (B) and an algal loaded rock moving with the tide around high water (C)	119
Figure 4.5b. Change in inclination of intertidal rocks using ONSET Hobo Pendant G accelerometers to a bare rock (A), a bare rock turned at low tide (B) and an algal loaded rock moving with the tide around high water (C).....	120

Figure 4.6. Movement of six algal rocks, with large <i>Ascophyllum</i> attached, compared to bare rocks measured as the 'frequency of accelerometer readings' over six days of spring tides in the Menai Strait, November 2017	122
Figure 4.7. Differences in movement of algal rocks (n = 6) with large <i>Ascophyllum</i> attached with different predicted tidal flows tested using one-way analyses of variance over six days of spring tides in the Menai Strait, November 2017..	125
Figure 4.8. Point cloud of the experimental shore taken by terrestrial laser scanner at Treborth, the Menai Strait, November 2 nd 2017.....	126
Figure 4.9. Laser scanned Digital Elevation Map (DEM) of a section of the experimental shore at Treborth, the Menai Strait, found a median 1cm loss in elevation between November 2 nd and 8 th , 2017 (A).....	127
Figure 4.10. Laser scanned Digital Elevation Map (DEM) of a section of the experimental shore at Treborth, the Menai Strait, showing change in elevation over 23 months, between November 8 th , 2017, and October 10 th , 2019, with a median value of no net loss or gain (A).	128
Figure 4.11. Laser scanned Digital Elevation Map (DEM) of a section of the experimental shore at Treborth, the Menai Strait, showing a change in elevation around tracked rocks between November 2 nd and 8 th , 2017.	130
Figure 4.12. Laser scanned Digital Elevation Map (DEM) of a section of the experimental shore at Treborth, the Menai Strait, showing a change in elevation around tracked rocks between November 2 nd , 2017 and October 10 th , 2019.....	131

Chapter 1.

Finding a transformative approach to understanding and managing the collection of coastal resources in a global context

Authors: Elisabeth Morris-Webb, Freya A.V. St John, Stuart R. Jenkins

Author contributions: The general introduction was all work of the PhD candidate, Liz Morris-Webb, with support of supervisors Dr Freya St John and Prof Stuart Jenkins

Chapter 1. General Introduction:

Finding a transformative approach to understanding and managing the collection of coastal resources in a global context

1.1 Background

The human species has long depended upon coastal resources. Easily accessible invertebrates and seaweed provided vital nutrients to Neanderthal and early human diets (Fa et al. 2016), contributing to our success as a species over other *Hominids* (Broadhurst et al. 2002). People and wealth still accumulate in close proximity to the coast in the 21st Century (Kummu et al. 2016) and collection from the shore for bait, food and income has continued. However, coastal collection in economically developed countries remains little understood, as for most of the 20th Century governance has instead focussed on large scale intensive agriculture and fishing practises and their management (Underwood 1993, Siegfried 1994, Anderson et al. 2011). Contemporary coastal collection of marine invertebrates and algae (seaweed) is often referred to as 'foraging', 'gleaning', or 'subsistence fishing' when conducted for non-financial purposes, or 'intertidal harvesting' 'hand-collection' or 'fishing' when undertaken for monetary gain. Globally, harvesting of coastal resources for recreational and commercial purposes went largely unresearched and unregulated until the late 20th Century (Odendaal et al. 1994, Anderson et al. 2011, Venerus and Cedrola 2017b). Coastal collection was largely forgotten by researchers, managers and policy makers (Furkon et al. 2019, Harper et al. 2020), with its economic and social value probably underestimated (Barnes-Mauthe et al. 2013, Watson et al. 2016, Furkon et al. 2019, Harper et al. 2020, Grantham et al. 2020). In addition, many confounding activities and other factors affecting the intertidal means that the direct ecological impacts of coastal collection are little understood (Siegfried 1994, Crowe et al. 2000, Thompson et al. 2002). There are significant social and ecological knowledge gaps facing policy makers trying to create resilient management advice for sustainable seaweed and invertebrate collection from rapidly changing coastlines, with shifting societal needs (HLPE 2020, Steven et al. 2020).

Chapter 1: Understanding coastal resource collection in a global context

In the late 20th Century, ecologists and local site managers around the globe started to raise concerns about the impacts of coastal collection activities on local stocks and habitats. The concept of man as a predator evolved from work on extensive collection of grazing (including keyhole limpets, *Fissurella* species) and predatory ('loco', a gastropod, *Concholepas concholepas*) species in Chile which resulted in the modification of coastal habitats particularly in close proximity to local population centres (Moreno et al. 1984, Castilla et al. 1994). As with any population, the overexploitation of a species results in a reduction in abundance, breeding stock and size of the target species, threatening extinction if collection persists (Moreno et al. 1984, Underwood 1993, Martins et al. 2010). For example, over-zealous hobby collectors of Victorian times are thought to have caused an 87% decline in the fine red 'bearded' seaweed, *Anotrichium barbatum*, popular in natural history herbariums (JNCC 2010). A single intense collection event where species refugia are not hidden from collectors can have long lasting direct effects on the target species and habitat (Martins et al. 2011, Coppa et al. 2016). Whilst the reason for exploitation of coastal species may vary, extraction of vulnerable taxa has the same effect on the target population.

Overexploitation also has indirect effects on associated assemblages, such as trophic cascades caused by reduced food availability for predatory species (Lindberg et al. 1998, Goss-Custard et al. 2004, Darimont et al. 2015), or in the long term, extinction of the predators of the exploited species (Hockey 1987). The persistent removal of keystone species can result in dramatic changes in the structure of the community, a community divergence, or even the function of an ecosystem, known as a regime shift (Castilla 1999). The uncontrolled exploitation of grazing limpets in the Azores changed from one driven by local sustenance to the sixth largest regional fishery in the 1980s, leading to the collapse of the target population in 1985 and subsequent divergence from a community dominated by sessile filter feeders (barnacles) to one of primary producers (turf forming algae) (Martins et al. 2010). A community divergence like this can reach an alternative stable state, or one that is constantly unstable due to repeated disturbance (Martins et al. 2010).

Whilst the loss or reduction in abundance of single species can have important effects, it is important to recognise that realistically collection can result in the simultaneous removal of multiple species. Simulation of such collection activities by

Chapter 1: Understanding coastal resource collection in a global context

researchers has led to mixed results, possibly because long term experiments are required to show significant effects. For example, the simultaneous removal of two grazing gastropods had no impact on micro-algal abundance (an important primary producer on rocky shores) over six months (Sharpe and Keough 1998). Conversely, the removal of the brown canopy alga, *Ascophyllum nodosum*, together with grazing gastropods over a four year period effected the abundance of specific macroalgae and barnacles until the habitat achieved an alternative state comprising a canopy of fucoid species within 18 months (Cervin et al. 2004). Wild harvesting of sixty species from New Caledonian reef flats for five months per year has resulted in changes in the functional composition of invertebrate assemblages on reef flats and in sediment habitats (Jimenez et al. 2016) demonstrating the long-term impacts that harvesting can have on the functional diversity of both hard and soft substrate communities.

Deciphering the impact of intertidal collection is compounded not only by extraction of multiple species, but also multiple stressors on the shore. The effects of removal of multiple grazing species, known to be the primary drivers of ecosystem functioning on rocky shores, may have unknown effects on the shore against a background of environmental change (Mrowicki et al. 2015). Removal on the edge of a species geographical range, where populations are being squeezed by climate change, may be of particular concern (O'Connor et al. 2011, Ferreira et al. 2015). In addition, the effects of collection activities are often indecipherable from cumulative impacts of other shoreline activities, such as trampling, vehicle access, removal of other species, boulder turning for interest rather than species removal, or external influencers such as pollution or climate change (Crowe et al. 2000, Thompson et al. 2002, Halpern et al. 2007, Tyler et al. 2008).

The impact of coastal collection goes beyond the removal of species. Physical disturbance during collection can have important effects. For example the act of turning boulders to find the catch, such as crab or octopus, can disturb underlying habitats and affect associated species assemblages (Cryer et al. 1987, Addressi 1994). Digging for bait worms and bivalves can cause depletion of long lived infauna in addition to changes in both sediment composition and community assemblages (Watson et al. 2007, Evans et al. 2015). In Wales, bait digging resulted in a change of habitat from one of diverse sheltered muddy gravels to one of more homogenous

Chapter 1: Understanding coastal resource collection in a global context

mud with opportunistic species (Evans et al. 2015). Many researchers have focussed on investigating the effect of disturbance on sediment shores showing that sediments can recover from 'gross disturbance' but that subtler effects of small scale disturbance on community structure will depend on site, species and disturbance type (Whomersley et al. 2010).

Although the impacts of overexploitation can cause irreversible changes to habitats, or even whole ecosystems, habitat disturbance caused by collectors can benefit those keen to develop cash crops of opportunistic species that thrive on regular disturbance. For instance, removal of grazing gastropods increased seaweed stocks for export in Chile (Moreno et al. 1984), and repeated digging for bait worm changed a sedimentary habitat to provide a refuge for a more profitable, short lived species of bait worm in Wales (Evans et al. 2015). However, the opening-up of new markets associated with opportunistic cash crops that develop when habitats or species change, conflicts with the ethos of sustaining natural ecosystems, and adds new conflicting interests amongst collectors, thus adding complexity to management options.

The preceding paragraphs demonstrate that the perceived ecological risk of impact from a collection activity could be the same regardless of scale: one person collecting a key species daily from a shore on which there are no refugia may have a comparable impact to 100 people collecting a few times a year on a less sensitive shore, or less functionally important species. The pre-occupation of researchers and managers to ascertain the scale of specific impacts attributable to collection activities and the extent of exploitation of intertidal species (ie: where they occur and by how many people) may be hindering the development of effective management.

Globally, since the 1990s various methods of management of these long-standing collection practises have been attempted. Until recently, researchers, fisheries managers and policy makers have rooted their decision-making in their single disciplines, often interested in either regulating the collection of a single species, or protecting a single site, at any one time, usually with little consideration for the factors driving the collection activities. In cases where management went ahead, often without engaging the stakeholders, various combinations of regulations have, in many cases, proved unsuccessful. For example, the overexploitation of the

Chapter 1: Understanding coastal resource collection in a global context

limpets in the Azores triggered several management measures, all focussed around the limpet stock and its commercial exploitation. Eight years after the species crashed, Limpet Protection Zones were introduced to enable recovery of both the stock and the habitat impacted by the collection of limpets. Commercial limpet collection was prohibited inside the zones, recreational collectors were limited to 1kg total bag limits, and additional seasonal prohibition was announced for areas outside of the protected areas (Martins et al. 2011). Nine years after implementation, limpet stocks had not improved, and there was no evidence of a reversal of the community divergence, most likely as a consequence of non-compliance with regulations (Martins et al. 2011). Additional prohibitions were introduced to the recreational harvest of, and snorkelling for, limpets, but again non-compliance with regulations meant the stocks showed little sign of recovery (Diogo et al. 2016).

Other examples where attempts at managing coastal collection have failed to achieve their objectives include: the introduction of bag limits limiting the collection of shellfish in New South Wales, Australia (Underwood 1993), the introduction of marine reserves to limit harvests of sea urchins in Sardinia, Italy (Ceccherelli et al. 2011), and exclusion of bait diggers at a local creek within Portsmouth Harbour Special Protected Area (Natura 2000), UK, a site protected under a Special Nature Conservation Area (Watson et al. 2015). All of these examples draw on combinations of the standard regulatory toolbox of ecological and fisheries management: minimum landing sizes based on reproductive biology; limitations on catch (quotas) of single species and / or total catch (bag limits); legal exclusion of collectors through highly protected marine protected areas or marine conservation zones; and placement of hard physical barriers to block access to sites (Hartill et al. 2005). Evidence from failed management attempts indicates that legislation and fisheries based stock assessments alone are insufficient to protect stocks targeted by intertidal collectors, or their associated habitats (Odendaal et al. 1994, Keough and Quinn 2000a, Hartill et al. 2005).

Left un-managed, and therefore un-monitored for centuries, recent attempts at management of some coastal resources collection using established ecological and fisheries management regulatory tools have often failed to get to the implementation stage due to reluctance of collectors to engage with site managers, researchers or policy makers and the resulting lack of understanding of the activities being

Chapter 1: Understanding coastal resource collection in a global context

undertaken. If management is implemented, non-compliance can be driven by a lack of understanding about the importance of the activities being undertaken coupled with absence of enforcement (Martins et al. 2011, Diogo et al. 2016). With very little background information on coastal collection and very little engagement with collectors, collectors have become invisible (Furkon et al. 2019, Harper et al. 2020). However, doing nothing is no longer an option, as lack of robust and transparent legislation of even recreational fisheries can result in their development into small-scale commercial fisheries that are neither controlled, nor monitored (Venerus and Cedrola 2017b), further exacerbating any ecological and governance problems. Struggles to manage coastal collection may be considered a symptom of an increasingly apparent, yet unrecognised, 'persistent problem' for marine governance.

1.2 Persistent problems in marine governance affecting the management of coastal resource collection

The term 'persistent problem' is used by those focussing on transition studies *"to label (symptoms of) problems that appear to be complex, uncertain, difficult to manage, and difficult to grasp"* (Schuitmaker 2012). Persistent problems can be considered the governance equivalent of 'wicked problems' (Schuitmaker 2012, Kelly et al. 2019), which are social policy issues that are difficult to solve due to the many interconnected, interdependent social problems that make finding a single solution impossible (Rittel and Webber 1973). Often, persistent problems are governance conundrums that are historically embedded in society, that repeatedly undermine governance, cross governance borders or agencies and are ultimately difficult to overcome with modern site management policies (Kelly et al. 2019). These problems arise from system structures that have evolved over decades and cannot be adjusted by markets or current policies, and if addressed in isolation from the interdependent issues, will result in negative knock-on consequences (Schuitmaker 2012). Schuitmaker (2012) specified three main factors that need to be identified before a successful solution to a persistent problem can be found: 1) the systemic problems (such as habitat change or climate change); 2) the concrete symptoms (such as evidence of a loss of species or habitat change); and 3) the proof that this is

Chapter 1: Understanding coastal resource collection in a global context

a persistent, or enduring, problem (such as repeated examples, or failed attempts at management).

Kelly et al (2019) applied this framing to reveal six persistent problems that resulted in unsuccessful Integrated Coastal Zone Management attempts in Ireland: path dependency (the process, or pathway, by which new policies emerge, closely resembling old policies); institutional inertia and policy layering¹; conflicting sectoral priorities; uncertainty of resources; failing to address complexity (particularly at the land-sea interface, and links between marine socio-economic systems and biodiversity); ongoing lack of engagement and obstructive vested interests (Kelly et al. 2019). Layering of new policies over old is blamed for repeatedly 'locking in' problems, systematically reproducing the problems rather than addressing the underlying problems (Kelly et al. 2019). The systematic 'locking in' of management problems, through repeatedly using and layering established marine fisheries and ecological based management tools is clear from my previous exploration of many failed attempts at managing coastal resource collection around the world.

An additional persistent problem in marine governance relates to the lack of monitoring of social contexts, drawn from research into similar systemic problems with governance that led to four iconic major marine regime shifts (Hicks et al. 2016a). Using a different lens to the one of persistent problems, but a similar argument, Hicks et al (2016b) demonstrated that the demise and loss of swathes of Pacific kelp beds (a systemic problem) could have been prevented if the rapidly growing lucrative otter exploitation had been noticed (a concrete symptom) and quickly acted on by managers. Instead, by the time legislation had caught up with the ecosystem impacts of otter removal, the otter fishery had collapsed and their prey species, urchins, had started to decimate the giant kelp beds (Hicks et al. 2016a). This work concluded that obvious 'proximate' drivers, such as overexploitation or pollution, cause direct impacts on species or habitats, but they do not act alone to create persistent problems in the marine environment. 'Distal' drivers affect the proximate drivers. 'Distal' drivers include policy, economies and markets, technology, demographic, cultural and socio-political factors (including values, morals, social

¹ Pathways that lead to new policies being layered onto existing policies, which are often fragmented across organisations or institutions that are not always joined up in thinking, processes or for easy navigation by stakeholders (Kelly et al. 2019)

Chapter 1: Understanding coastal resource collection in a global context

preferences or meanings) and are constantly changing under differing environmental, political and economic climates (Hicks et al. 2016a). As most marine management is reactive, and derived from an ecological perspective, often distal drivers are left unmonitored and more marine regime shifts occur (becoming proof of persistence). In the context of coastal collection, it is also clear that many factors will drive the demand on the easily accessible coastal resources, and that these should be accounted when developing policies that are both sustainable for the environment and coastal residents. Countries and regions may have very different social contexts (such as reasons for demand for a species), but managers should be aware that these can change rapidly, particularly with new markets emerging through trade or immigration. Establishing social monitoring which includes indicators of these distal drivers is essential to preventing future marine shifts (Hicks et al. 2016a).

1.3 Coastal collection: a symptom of a persistent problem with three main knowledge gaps

The collection of coastal resources is a classic, as yet unrecognised symptom of persistent problems in marine governance. Collection activities are historically and societally embedded activities for which there is often little social, economic or ecological information. Coastal collection is undertaken at the land-sea interface, often by highly invested stakeholders with unclear legislation that traverses terrestrial and marine policies and regulatory bodies.

Typically, research and policy around coastal collection have been derived from the single disciplines of ecology or fisheries science, neither of which traditionally incorporate the human dimensions of the activities they aim to manage. To find a solution to the persistent problem of coastal collection, rather than focussing on the scale of exploitation or impacts as is typical of ecology and fisheries science, we need to move to better understand people, their interactions with nature, and what drives their perceptions of reality and likelihood to engage and comply with any management legislation, as are increasingly common questions in broader conservation science. However, framing research around the negative impacts of collection fails to encourage collector engagement and indeed, drives people away from engaging with decision-makers. Focussing on the economic value of coastal

Chapter 1: Understanding coastal resource collection in a global context

collection similarly dissuades collectors from engaging as they fear participation might lead to regulation and financial loss.

Collectors gathering in the often regulatory grey area between land and sea have been noted as unwilling to engage with researchers, site managers and policy makers around the world. In the Azores, limpet pickers were unwilling to engage, probably for fear of retribution as a consequence of their actions in illegal harvesting (Diogo et al. 2016). In Australia, some intertidal bait harvesters were unwilling to be interviewed or have their catch counted, whilst others substantially underestimated their catch (Mcphee and Skilleter 2002). In Wales, winkle pickers and bait diggers would not engage in a sustainable management pilot project, expressing concerns about revealing locations of fishing grounds or having their grounds restricted (Aron et al. 2014). As a result of limited active collector engagement, research justifying management plans has used roving creel surveys in an attempt to intercept collectors, or covert counts (in some cases utilising surveillance cameras) of collectors in an attempt to understand the extent and intensity of activities (Martins et al. 2011, Morris et al. 2012, Watson 2014, Diogo et al. 2016). In these contentious examples, few studies have robustly assessed the motivations for the collection activities, and no peer reviewed literature has made quantitative links between the motivations to collect and different aspects of the well-being of collectors.

A robust understanding of behavioural motivations, grounded in genuine engagement with people will aide in designing successful interventions that ensure sustainable resource use, and foster custodianship amongst collectors themselves (St John et al. 2010b, 2013, Pope and Weber 2019). Understanding what drives the collectors of coastal resources (from need to more emotional motivations) is particularly important not only for management now, but also to forecast changes in the demand for these resources in future as the coast face economic, social and climate crises that challenge both humans and environments simultaneously (HLPE 2020, Steven et al. 2020).

Globally, there are three major knowledge gaps in better understanding intertidal collection activities to aide with better future decision making, that together bind this PhD together:

Chapter 1: Understanding coastal resource collection in a global context

1. Lack of understanding of motivations to collect coastal resources in a rapidly changing global economy and climate;
2. Lack of understanding of what collecting means to people (what it represents, its' significance or purpose) or how it relates to human well-being; and
3. Lack of evidence of all confounding impacts on popular shores, sometimes leading to assumptions of direct impact from collection activities.

There is one major hindrance in filling these gaps, the reluctance of collectors to engage with decision-makers. Assumptions made by managers about these three knowledge gaps (the motivations for collection, or the meanings behind them and their impacts) have contributed to a lack of trust in management across the collecting community, and the resulting problems in engaging the community with conservation agendas.

Researchers that have managed to engage collectors are often in developing or subsistence economies, including Chile, South Africa, Timor Leste, Mozambique. Successful engagement has used a more positive and inclusive approach to engagement through identifying the needs of the people involved (Siegfried et al. 1985, Hockey 1987, Chaigneau et al. 2019, Grantham et al. 2020). Similar positive, inclusive approaches have been rarely attempted in developed economies.

1.4 Transformative approaches to better understand coastal collection

To address persistent problems, researchers and policy makers need to search beyond their own fields of experience and adopt transformative approaches that draw on other disciplines and research paradigms (Kelly et al. 2019). In addition, development of contextual monitoring of social indicators within future research and policy advice, is essential in identifying suitable and appropriately timed policy responses to potential triggers that may increase demand for collecting activities (Hicks et al. 2016b, 2016a). Specifically, people trying to monitor and manage coastal environments must think beyond disciplinary silos, into the market drivers (such as recreational foraging trends, growing migrant populations or emerging markets) and embrace interdisciplinarity to build a complete knowledge of social-ecological systems in order to govern them and prevent future regime shifts (Chaffin et al. 2016).

Chapter 1: Understanding coastal resource collection in a global context

Transformative approaches for coastal collection can usefully draw upon and combine elements from disciplines including terrestrial ecology, human geography, fisheries science, environmental economy (including ecosystem services research), human ecology, psychology, health and social sciences (including anthropology and ethnobotany). One increasingly common theme that transcends and connects these disciplines is one of well-being research, offering a positive lens through which to focus on the collection of coastal resources. Well-being and the environment are intrinsically linked – researchers, policy makers and the public are increasingly realising that without the good health of our environment, the human race cannot be healthy (Fleming et al. 2019). Globally, marine governance, driven by the Millennium Ecosystem Assessment, is progressing towards aligning well-being and conservation agendas through three core values of care, protection and sustainability, to ensure future sustainability of natural resources and a growing human population (Watson et al. 2005, Kelly 2018).

1.4.1 Understanding the implications of coastal collection on psychological well-being

A growing body of interdisciplinary science warns that tracking economic growth as a method of measuring societal success has been detrimental to social and environmental progress or sustainability (Stiglitz et al. 2009, White 2016, Caswell et al. 2020). Instead, a suite of quantitative social indicators by which to assess human well-being, rooted in psychological value systems should be developed (Hicks et al. 2016b). However, few, if any, researchers have applied this specifically to coastal collectors.

Research has identified the importance of fishing to fisher identity, and foraging to the gatherer's sense of place, both of which are key foundations to well-being. Fisheries researchers looking at job satisfaction amongst commercial fishers across the Caribbean and United States have exposed a variety of non-monetary motivations and benefits for their small scale fisheries, (which include intertidal gleaning), that relate strongly to a reliance on their activities for fisher identity, agency (ability to provide food and money by their own choice) and social status

Chapter 1: Understanding coastal resource collection in a global context

(Pollnac and Poggie 1988, 2006, Seara et al. 2017b, García-Quijano and Poggie 2019). Human geographers, social scientists and anthropologists trying to better inform ecosystem based management and planning have demonstrated that shellfish gathering can strengthen people's sense of belonging through the act of collecting, involvement in cultural or family practises, the sensory and emotional experiences it affords, and the strengthening of social connections (Poe et al. 2016). The same has been found for terrestrial foragers in forests of Latvia (Grivins 2021), and urban foragers seeking connection to place in an unfamiliar, or un-natural environment (Poe et al. 2014, Nyman 2019).

Researchers have only recently started to explore the well-being benefits associated with shoreline species collection from an ecosystem services perspective, focussing often on developing economies where initially the benefits were thought to be primarily those of subsistence, but where qualitative research enabled non-material benefits to emerge (Chaigneau et al. 2019, Grantham et al. 2020). These have enlightened researchers to the many non-material benefits gained from collection including: peace, connection to nature, social opportunities in Timor Leste (Grantham et al. 2020); cultural experiences, identity and way of life, independence in Chile (Elwell et al. 2020); respect, or social status, and social relationships in Mozambique and Kenya (Chaigneau et al. 2019). Money, use and experience can be viewed as mechanisms which each contribute to different well-being domains (Chaigneau et al. 2019).

The provisioning (e.g. food and money) and recreational benefits of collection activities are intertwined, affecting many domains of human well-being that are not easily mapped onto the existing ecosystem services frameworks (Chaigneau et al. 2019, Elwell et al. 2020). As such the importance of these activities is largely lost in translation to ecosystem based management policies (Daniel et al. 2012, Poe et al. 2016, Gould et al. 2020). Interestingly, when urban and terrestrial foragers have in the past simply been asked their reasons, or motivations, to collect, they have given a suite of answers which closely link to many dimensions of comprehensive (material) and personal well-being including those discussed above (Hall 2013, Synk et al. 2017).

Chapter 1: Understanding coastal resource collection in a global context

Using well-being as a lens to understand the meanings and benefits people derive from an activity should not be constrained by an approach from a single discipline, or by empirical research questions. Deductive quantitative research designs can miss some depth of understanding of both conservation issues and well-being that reflection on philosophical or theoretical perspectives could add using more inductive qualitative designs, such as interviews (Moon et al. 2019). Therefore, my thesis researches the effects of coastal collection on the psychological, personal well-being of collectors using both quantitative and qualitative research and discusses the findings in relation to research from many disciplines.

1.4.2 Novel, interdisciplinary, tools for understanding cumulative ecological impacts

My earlier introduction to the ecological impacts of collection highlighted that ecological evidence of the impact of collection activities is sometimes indistinguishable from the cumulative pressures affecting shores. Anthropogenic disturbance from collecting could include trampling, raking seaweeds, digging or the deliberate moving or turning of rocks and small boulders on shores, often occurring alongside other beach activities with their own impacts. Anthropogenic impact is particularly important given the anticipated increasing frequency of storms, sea level rise and warming seawaters impacting our coasts with climate change, further compounding the existing cumulative impacts (Steven et al. 2020). Thus, in addition to seeking a transformative understanding of the social context of collection activities, policy makers also need transformative approaches to better understand cumulative impacts of collection activities that are not grounded in ecological science and traditional understanding of fisheries. To do this, researchers must seek alternative methods to confidently tease different anthropogenic impacts from each other, and from natural disturbance. With a growing suite of novel technologies in the interdisciplinary toolbox, this could come from engineering sciences, oceanography, geography or geology.

Examples of rapidly developing novel technologies that could be explored to tease apart natural from anthropogenic disturbance may include very localised methods of

Chapter 1: Understanding coastal resource collection in a global context

monitoring movement, such as accelerometers used to monitor wave disturbance on boulders (Brayne 2015, Stephenson and Abazović 2016), or methods appropriate at a larger (e.g. whole beach) scale such as photogrammetry and laser scanning (D'Urban Jackson et al. 2020). Aerial imagery has successfully been used to consider the frequency and impacts of bait digging in Poole Harbour in the UK (Fearnley et al. 2013). CCTV and drones have been used to replace roving creel surveys to assess the extent and intensity of activities. However, the use of CCTV and drones in the UK, Belize and Kenya to assess non-compliance in illegal, unregulated or unreported fisheries could raise questions about legitimacy. Care is needed to ensure that remote monitoring technologies do not impinge on human rights, or undermine efforts to engage with stakeholders (Wright 2015, Watson et al. 2015).

To ensure trust with all stakeholders, methods by which to monitor collection activities and assess their impacts must be perceived as transparent, legitimate and fair (Glaser et al. 2018) and safeguard the human rights of collectors and other beach users (Gallagher 2004, Wright 2015).

1.5 Aims and Objectives

The main aim of this thesis is to increase the understanding of coastal collection activities in an economically developed and stable nation, Wales. My overarching research question is '*Can novel interdisciplinary approaches to understanding the collection of coastal resources in Wales be used to fill both research and policy evidence gaps?*'. Linking gaps in understanding both in policy and research, I hope to aide evidence-based decision making in future by offering two angles to coastal collection, each with novel research approaches: the first strives to understand the people who collect; the second aims to provide better means by which to tease apart natural from anthropogenic disturbance on a rocky shore.

Given the main barrier to understanding the human dimensions of coastal collection is in finding and engaging stakeholders, a major part of this thesis was building trust with stakeholders. Assumptions made by managers about three knowledge gaps (the motivations for collection, or the meanings behind them and their impacts) have contributed to a lack of trust in management across the collecting community and have resulted in problems engaging the community with conservation agendas. Part of the aim of the thesis is to rebuild this trust, both through engagement and research, thus strengthening future sustainability agendas for both collection activities themselves and conservation of stocks and habitats.

Taking an interdisciplinary approach, together with a listening ear, independent from policy debates, my thesis attempts to better understand the collecting community, their motivations to collect, and the importance of their activities on their well-being. I draw knowledge from previous anthropological, psychological, sociological, geographical, ecological, health sciences and fisheries research to build a more human ecological perspective to understanding the complex relationships mediating both collecting communities and their environment. Furthermore, I use an interdisciplinary approach to tease natural from anthropogenic disturbance on boulder shores, a habitat that is difficult to monitor due to varying degrees of natural disturbance. The latter aims to increase the evidence base for the development of more robust biodiversity indicators to confidently monitor anthropogenic disturbance in future.

Chapter 1: Understanding coastal resource collection in a global context

The main objectives of my research thesis were to assist evidence-based decision making in future by:

- ascertaining what coastal resources are collected in Wales;
- understanding what motivates collectors to gather coastal resources;
- investigating the meanings, well-being and non-material benefits gained through collection activities; and
- exploring whether novel technologies can be used to tease apart anthropogenic from natural disturbance on boulder shores.

My overall hypothesis is that the motivations for, and meanings behind collection activities, and impacts of collection activities, vary across different collecting communities (depending on social contexts rather than target species) and habitats. These variations make collecting activities difficult to make assumptions about, and even more difficult to manage using a single policy approach. Understanding the motivations and meanings behind collectors' activities will arm policy makers with background knowledge by which to better assess how social triggers may influence their actions. In the current climate of a major global economic downturn, together with pressures of climate change, understanding people, as well as environment, is key to ensuring resilient coastal communities, both human and non-human.

1.6 Structure of Thesis

My thesis comprises three independent data chapters, each written to stand alone and each interdisciplinary. Chapter 1 is this introduction.

Chapter 2 introduces the collectors of coastal resources in Wales and the concept of well-being. The chapter hypothesises that the collecting behaviour and motivations are related to the mental well-being of collectors. I draw on psychological well-being literature to quantitatively assess five established measures of well-being amongst Welsh collectors using questionnaire data. I go on to link aspects of well-being to multiple motivations to collect. I discuss my findings in relation to established theories of nature connection and attention restoration. Finally, I highlight the importance of being aware of the dependencies of some vulnerable collectors on their activities in policy making, both for site management and health agendas, through conservation interventions and nature-based social prescribing.

Chapter 1: Understanding coastal resource collection in a global context

Chapter 3 recognises that empirical assessments of collection motivations and collector well-being are limited in explaining why these links are relevant, or important. As a result, I ask '*What is the significance and purpose of collecting coastal resources to the people in Wales?*', hypothesising that collection of coastal resources goes beyond simply a need for food, money or fun, and has deeper meanings for many of the people involved. The chapter takes a reflexive approach to qualitative interviews with the collectors of coastal resources in Wales, to explore how collecting practises contribute to meaning-making and place-making for the participants. Reflexive thematic analysis of interviews draws on many of the disciplines introduced in Sections 1.3 and 1.4 to generate themes reflecting the meanings of contemporary collection to the collectors. I then develop conceptual coastal collector typologies to better inform decision-makers about what drives contemporary Welsh collectors, and what their sustainability concerns are. Typologies reveal useful information that could be used to take different approaches to engagement and management in future.

Chapter 4 considers coastal collection activities from a different perspective, namely providing robust evidence of ecological impact to ensure decision makers take into account all impacts on a shore before making their decisions. Using a case study of sheltered, tide swept boulder shores where collection of peeler crabs is common, I attempt to tease natural from anthropogenic disturbance. I hypothesise that movement of rocks on these shores can be by people, but also by the seaweed they host, and that this movement can be differentiated and monitored using novel, rapidly developing technology. I use high accuracy GPS, tri-axial accelerometers and laser-scanning technology, drawing on the disciplines of marine ecology, oceanography and geology to test whether technology can be used to detect anthropogenic disturbance at fine scales, and long term changes on larger scales.

In **Chapter 5** I highlight how my thesis contributes new information on the social importance of coastal resource collection activities in developed economies and brings us closer to developing more robust indicators and monitoring tools to tease apart cumulative disturbances of the intertidal in future. Finally, I discuss the implications of my work in a policy context, moving towards a transformative solution to the persistent management conundrums of engaging with collectors and creating

Chapter 1: Understanding coastal resource collection in a global context

sustainable management for long held practises associated with collecting coastal resources.

Chapter 2.

Motivations for the collection of bait and other living coastal resources, and their well-being implications.

Authors: Elisabeth Morris-Webb, Stuart R. Jenkins, Freya A.V. St John

Author contributions: Liz Morris-Webb conceived the idea, inspired by previous work, with support of supervisors Dr Freya St John and Prof Stuart Jenkins. The PhD candidate carried out all analysis and writing.

Chapter 2.

Motivations for the collection of bait and other living coastal resources, and their well-being implications

2.1 Introduction

Over the last 20 years the public eye has been drawn to the ancient practise of foraging for wild products (Sachdeva et al. 2018). Urban and rural people around the world are collecting fruits, roots, herbs, leaves and mushrooms from their supporting habitats (Grivins et al. 2016, Synk et al. 2017, Chamberlain et al. 2018). Coastlines are utilised for seaweed and a plethora of invertebrates including shellfish, octopus, shrimps, crabs, urchins, annelid and peanut worms (Perry et al. 2014, Thurstan et al. 2018, Furkon et al. 2019, Tilley et al. 2020). Generally, the term ‘foraging’ refers to collection of natural resources for non-commercial purposes. Collection of ‘non-timber forest products’ and ‘wild product picking’ are common terms used by terrestrial researchers, yet in the marine context we have not yet agreed common terminology for comparable activities. Coastally, ‘gathering’, ‘gleaning’ and ‘subsistence fishing’ may all be viewed as types of foraging, whilst the terms ‘harvesting’, ‘intertidal hand-collection’ and ‘fishing’ often refer to more commercial activities. We know that coastal collection of living resources is the oldest fishery in the world, embedded in long-lived traditions and known to date back to the time of the Neanderthals (Fa et al. 2016). Historically, research has focussed on nations where coastal collection is important for commercial, cultural or sustenance reasons, including Chile, South Africa (Siegfried 1994) and Australia (Keough and Quinn 2000b). Elsewhere, collection has been largely forgotten by researchers, managers and policy makers; collectors have become invisible (Furkon et al. 2019, Harper et al. 2020).

The historic lack of research and regulation has resulted in little information about the levels of extraction of many coastal resources, whilst the cumulative impacts of other beach activities make it hard to confidently assign impacts to collection. However, concerns over the sustainability of targeted stocks, the impacts of collection on habitats and conflicts with other beach users has resulted in increased

Chapter 2: Linking motivations for coastal resource collection to well-being

interest in researching and managing these activities. What is known is that there has been a global rise in shellfish harvests (Anderson et al. 2011). There are cases of non-commercial harvested species suffering declining stocks, such as surf clam and cockles in New Zealand (Cranfield and Michael 2001, Hartill et al. 2005) and limpets in the Azores, which saw a stock crash and ecological change after rapid unregulated commercialisation (Martins et al. 2011). Perceived political injustices have resulted in conflicts between commercial and traditional fisheries of Alaska (Raymond-Yakoubian et al. 2017), and between cockle and bait diggers in Wales (Bean and Appleby 2014).

The Food and Agriculture Organization of the United Nations 'Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries' is the first internationally agreed instrument dedicated to small-scale fisheries. Such fisheries, including coastal collection, are often rooted in communities, traditions and values, and changes in them can impact food security as well as social, cultural and overall well-being. The Guidelines recognise this and hence put high priority on protecting human rights of vulnerable and often marginalised fishers (FAO UN 2015), stating that governments should *"involve small-scale fishing communities in the design, planning and (as appropriate) implementation of management measures, and that participatory management systems, such as co-management, should be promoted in accordance with national law"*. Globally, however, coastal collection is generally not viewed as a fishery, and consequently the current review found such guidelines are rarely followed by managers, particularly in developed economies.

Resource managers in the UK have been trying to understand coastal collection as a recreational activity, rather than as a fishery, since the 1980s, but with little success (Fowler 1999, Perry et al. 2014, Tinlin-Mackenzie 2018). UK legislation around collection activities is complex at a national level and both confusing and inaccessible at a local level, making management difficult to apply and enforce, and resulting in several failed management attempts across the country (Bean and Appleby 2014). Lack of robust and transparent legislation and good governance can result in small-scale collection activities transforming into commercial ventures, or 'informal economies', that are neither controlled nor monitored (Agnew and Barnes 2004, Venerus and Cedrola 2017a, Grivins and Tisenkopfs 2018), sometimes referred to as 'blackfish' or 'unregulated and unreported fishing' in a fisheries

Chapter 2: Linking motivations for coastal resource collection to well-being

context. Once such a transformation has occurred, collectors become increasingly reluctant to discuss their activities and there is a risk of harvests and markets becoming hidden, or invisible (Scoones et al. 1992, Cummins et al. 2002, Agnew and Barnes 2004, Venerus and Cedrola 2017a, Tinlin-Mackenzie 2018). Non-participatory rulemaking processes which ignore the expectations and psychological needs of stakeholders are known to result in rule rejection by individuals (DeCaro and Stokes 2013, Epstein et al. 2015). A radical transformation of approach, away from traditional fisheries and stock-based assessments and towards integrated governance is required to ensure consultation with collectors and successful long-term sustainability of stocks and associated habitats.

The Millennium Ecosystem Assessment highlighted the need to align well-being and conservation agendas to ensure future sustainability of natural resources and a growing human population (Watson et al. 2005). Very little research has explored the effects of resource use and species management on human well-being, especially in the marine environment (McKinnon et al. 2016). Understanding people, including their motivations for interacting as they do with the environment, is as important as understanding the environment itself (Johnson 2018), as without understanding their interactions and uses of nature, it is difficult to understand the condition of the environment or the pressures it is under or the best approaches to management. A robust understanding of behavioural motivations, grounded in genuine engagement with people will aid in designing successful interventions that ensure sustainable resource use, and foster custodianship amongst collectors themselves (St John et al. 2010b, Pope and Weber 2019). Thus, combining an understanding of what motivates people to collect coastal resources and how it relates to their well-being can make an important contribution to coastal resource management.

Motivations for the collection of wild products are generally assumed by site managers to be for food, money (either commercial or informal markets) or recreation. However, motivations may change over time and differ according to cultural and geographic contexts. During times of conflict or economic hardship, foraging offers food security or income (Grivins and Tisenkopfs 2018, Sachdeva et al. 2018). In more stable economies, wild harvesting may be more connected to nostalgia or as a way to embrace more alternative lifestyles (Hall 2013, Fischer and Eastwood 2016, Grivins and Tisenkopfs 2018). Culturally important food preferences

Chapter 2: Linking motivations for coastal resource collection to well-being

and foraging practices may provide migrants with a sense of place and cultural belonging wherever they are in the world (Hall and Mitchell 2000, Poe et al. 2014). To date, nothing has been published about the motivations driving the collectors of coastal resources in the UK. However, reflecting on what is known about the motivations of terrestrial foragers, it is clear that non-material benefits are probably associated with coastal collection and are often intrinsically linked to well-being.

Human well-being is a complex experience indicative of a good quality of life. “*Well-being can be understood as how people feel and how they function, both on a personal level and a social level, and how they evaluate their lives as a whole*” (New Economics Foundation 2012). It is often assessed in a policy context by addressing three constituent parts: **comprehensive well-being** (materials with which basic needs can be met, the relevance of which depend on circumstances such as freedom, and how people perceive the availability of these materials to them); **subjective well-being** (how one thinks and feels about their life, including measures of happiness or life satisfaction); and **personal well-being** (a more psychological assessment of ‘more than just feeling good, but also doing well’, or flourishing) (White 2017). These three well-being components each include external drivers, connections or relationships, and each element is in part related to or complementary of the others. Well-being has been acknowledged as a ‘bridging concept’ in social science fisheries research “*to better understand competing interests that often generate conflict and undermine existing policy framings*” (Coulthard et al. 2011, Britton and Coulthard 2013), and as such is proposed as a promising approach for understanding coastal collection and enhancing the governance of coastal resources (Brueckner-Irwin et al. 2019).

Exposure to nature, particularly blue space, is known to impact well-being. For example simply living near the coast is known to lead to increased mental and physical health (Wheeler et al. 2012, White et al. 2013b, 2014). Regular leisure visits to the coast are known to increase happiness and feelings of worthwhileness (White et al. 2017), whilst general exposure to nature is known to affect well-being measures such as happiness, anxiety and self-esteem (McMahan and Estes 2015). Interactions with nature, such as outdoor activities, are known to increase life satisfaction and have attention restorative and stress relieving properties (Ulrich et al. 1991, Ohly et al. 2016a, Biedenweg et al. 2017). Furthermore, up to 40% of

Chapter 2: Linking motivations for coastal resource collection to well-being

one's happiness can be explained by 'chosen activities' (referred to as 'intentional activities' by Lyubomirsky et al. 2005), such as coastal collection by choice rather than need.

Wales, one of the UK's four constituent countries, has approximately 1,680 miles (2,794 km) of coastline where 1.8 million people live or work. It was the first country in the world to introduce policy that brings together well-being and conservation agendas. The Well-being of Future Generations (WBoFG) Act states that all management decisions made by public bodies need to take into account the impact their decisions will have on people living in Wales today and in the future (Welsh Government 2015). The country is famed for its seafood delicacies of cockles (Jenkins 1984) and 'Welsh laverbread' (a European protected food name for a seaweed delicacy, DEFRA 2013). At least 41 other taxa are collected for a plethora of reasons, but little is known about many of the coastal collection activities or the people involved (Perry et al. 2014).

There is no standard 'right to fish', commercial or otherwise, for bait, fertiliser or food, or as a customary right in Wales (Bean and Appleby 2014). Instead, there is a complex array of legislations which prohibit some activities at some sites² and the main governmental body for managing the Welsh environment (Natural Resources Wales, NRW) is moving towards more efficient and active management of coastal collection (Bean and Appleby 2014, NRW 2016a, 2018). However, attempts to engage with coastal collectors have had limited success; research with anglers regarding a Proposed National Nature Reserve in 1982 saw only 5.5% of questionnaires returned from bait collectors (Coates 1983); whilst in 2011-12 a sustainable management pilot project, FishMap Môn, failed to engage many wrinkle pickers and bait diggers as they often expressed concerns about revealing locations of fishing grounds or having their grounds restricted (Aron et al. 2014). Ongoing conflicts associated with an increasing drive towards management, such as the complexities associated with introducing zoned bait worm digging areas on 'The

² Legislation governing coastal collection can be divided into five broad categories, most directly related to a specific habitat or fishery, each governed and little enforced by different Relevant Authorities: 1) access to, and ownership of, the foreshore and the requirements for associated suitable permissions to collect either organic or inorganic matter; 2) conservation legislation protecting Natura2000 sites, Sites of Special Scientific Interest and species or habitats of conservation concern 3) fisheries laws (byelaws and several orders); 4) shellfish waters and 5) food hygiene regulations (CCW 2010, AFBI 2011, Bean and Appleby 2014)

Chapter 2: Linking motivations for coastal resource collection to well-being

Gann' in Pembrokeshire (Bean and Appleby 2014, Evans et al. 2015), underpin the need to embrace a new approach to opening dialogue between policy makers and both commercial and recreational collectors in Wales. There is requirement to engage with stakeholders under NRW's principles of Sustainable Management of Natural Resources, which embeds the WBoFG Act within the Welsh Government's Marine Statement, underpinned by the Environment (Wales) Act 2016 (NRW 2016b). Engaging in a way that respects the personal and social values of collectors' activities driven by the WBoFG Act, serves both to add knowledge and build trust for future engagement, making Wales the perfect location to trial the use of a well-being approach.

The current research engaged the collectors of living wild coastal resources from around Wales with the aim of increasing understanding around:

- i. who collects;
- ii. which resources are collected;
- iii. motivations for collecting;
- and
- iv. how collecting relates to the subjective and personal well-being of collectors.

From a human ecologist's perspective, I use knowledge from philosophy, anthropology, psychology, health sciences, geography, ecology and sociology to build novel conceptual model to explain the complex predictors of well-being for the collectors of coastal resources. Overall, I hypothesise that collecting behaviour and motivations are related to the mental well-being of collectors. Armed with such information marine managers will better understand the implications of their decisions and be better positioned to develop sustainable management policies that are mindful of the well-being benefits of coastal collection. Ultimately this information will encourage future engagement, fostering of management and compliance amongst collectors.

2.2 Methods

2.2.1 Well-being context

Well-being is often split into two broad philosophical domains: *Evaluative well-being* and *affective well-being*:

"Evaluative well-being (EWB) is defined as a global, contemplative long term assessment, a state of well-being reflective on one's sense of quality of life" (Eger and Maridal 2015), and emanates from *livability*, defined as environmental and societal factors which affect a person, usually beyond their own control. Often variables measured relating to evaluative well-being pertain towards life satisfaction and quality of life and include *comprehensive, objective or material* well-being variables which integrate quantifiable social and economic indicators which theorise 'quality of life'. Surveys of individual's feelings or experiences (subjective well-being) can also contribute through population surveys, interviews or self-reporting.

Eudaemonic measures, which evaluate the feelings of whether what one does in life is worthwhile, are also often used to measure ones 'reward from activities' (Dolan et al. 2011).

"Affective, or experiential, well-being (adapted from hedonic well-being), defined as a person's immediate, present or experienced state of well-being" emanates from **lifeability**. **Lifeability** is the internal and personal dynamics that enable people to benefit from their environments (Eger and Maridal 2015). Dolan et al. (2011) describe these as either positive (happiness) or negative (anxiety) experiential feelings, usually measured on sliding scales. Subjective well-being methods, which investigate a respondent's personal experience or emotions, sometimes as stand-alone one off surveys but often monitoring emotions over time (Eger and Maridal 2015) can be used to assess affective well-being.

The Office for National Statistics standard well-being scales can be used which separately measure evaluative and affective dimensions using a subjective approach to life satisfaction, feelings of worthwhile, happiness and anxiety (Dolan et al. 2011). However, policy makers often seek to assess both aforementioned well-being domains, with scales such as the Warwick-Edinburgh Mental Well-being Scale

Chapter 2: Linking motivations for coastal resource collection to well-being

(Tennant et al 2007), which transcends both evaluative and affective domains by measuring both subjective and personal well-being in one assessment.

Well-being, specifically positive affective well-being, or happiness, can be driven by a combination of three major life circumstances: 1) genetic predisposition; 2) circumstantial, external drivers including socioeconomics, sociodemographics and environmental factors; and 3) motivations, activities and practises (Lyubomirsky et al 2005 [18]). My work seeks to examine relationships between collector's well-being, their circumstantial characteristics (i.e. demographics) and motivations for collecting coastal resources.

2.2.2 Questionnaire design

A piloted questionnaire assessed what coastal resources were collected, by whom and what their motivations were, together with the subjective and personal well-being of participants ([Appendix A.1](#)).

Respondents first listed all the species, or taxa, that they had collected from Welsh beaches over the last two years and indicated which taxa were their top three in terms of importance to them (this could be importance for any reason, but if asked, the surveyor would state that 'important to them' was the one they targeted most often). Results are presented at the most appropriate taxa level due to respondent uncertainty over species names.

An open-ended question, '*what is the main reason you collect the three species most important to you?*', recorded respondents' primary motivation for collecting their top three taxa. Respondents also reported if this reason had changed since they first started collecting.

A literature review together with suggestions offered by respondents during the pilot phase resulted in 14 statements for measuring the motivations underlying respondents' collection activities. Answers to statements such as '*I collect because ... I like the feeling that I can provide food; ... practise my survival skills; ... a earn a bit of money from it*', were provided on an 11-point scale, where 0 indicated '*is never a reason I collect*' and 10 was '*I feel strongly this is a reason I collect*'. The 11-point scale was chosen to enable easy visualisation where 1 might represent 10% of the time, or 10 could equate to 100% of the time. Scalar responses were used to seek

Chapter 2: Linking motivations for coastal resource collection to well-being

relationships between the importance of motivations to collect and well-being scales. Responses from each of these 14 statements were collapsed to a more robust six point scale for analysis (Floyd and Widaman 1995). Respondents were also asked to list any 'other' reasons or motivations to collect in an open-ended question.

To build a picture of the collecting community, respondents were asked if they started collecting as a child (12 or under), a teenager (13-17), young adult (18-23), adult (24-retirement) or since retiring; whether they collect throughout the year or seasonally; how far they generally travel to collect (less than 1 mile, 1-4.9 miles; 10-19.9 miles; 20-49.9 miles; 50+ miles); the number of beaches they collect from (one beach; 2-4 beaches; 5 or more beaches); and whether their collecting activities were restricted to Wales, the UK or anywhere in the world. Collectors were also asked to sum up '*what gathering from the seashore means to them*' in three words, to qualitatively explore the meaning of collection activities to people.

Sociodemographic attributes known to be key circumstantial predictors of well-being from psychology, human geography, social science and health and well-being research (Lyubomksky et al. 2005, Dolan et al. 2008, White et al. 2013a, Stranges et al. 2014, Stewart-Brown et al. 2015) were collected from respondents utilising question wording from the UK Census where available, including gender, age, National identity, ethnicity, marital status, employment status, job satisfaction and health (Office for National Statistics 2011).

Residential proximity to the coast has been found by human geographers and environmental psychologists to positively affect overall life satisfaction and mental health (White et al. 2013a) and general health, particularly in socio-economically deprived communities (Wheeler et al. 2012). Respondents' coastal proximity was derived from the distance of their residential postcode in a direct line to the nearest mean highwater mark. Where respondents did not provide postcodes, they were asked to self-report their residential coastal proximity for descriptive analysis (response categories: <1mi, 2-6mi, 7-10mi, 11-20mi, >21mi from the coast). Due to heavily skewed data with most respondents living within the first category, these data were categorised from postcode data as either coastal (≤ 1 km from coast) or non-coastal (>1km from coast) prior to further analysis as predictors of in well-being,.

Chapter 2: Linking motivations for coastal resource collection to well-being

Generally physical outdoor activities, particularly those involving interactions with nature, in marine and coastal environments are known by health and well-being researchers, environmental psychologists and human geographers to be some of the most rewarding activities in terms of happiness, compared to similar activities when undertaken in inland, urban environments (White and Dolan 2009, MacKerron and Mourato 2013). The duration of the outdoor activity is less important than the experience itself (MacKerron and Mourato 2013), although other research suggests that longer and more frequent visits promote wider health benefits (White et al. 2013b, Shanahan et al. 2016, Kruize et al. 2019). Acknowledging this, a standard outdoor leisure activity question from the National Survey for Wales was used to measure '*how many days have you (respondent) spent outdoors for leisure activities in the last four weeks?*'. This question, together with coastal proximity were included as an indication of the respondents' time spent in nature, or 'nature exposure'.

Personal and subjective approaches to well-being, taken from psychology, were combined to assess the 'mental well-being' of collectors. Mental well-being was measured using the Warwick-Edinburgh Mental Well-being Scale (WEMWBS), which comprises fourteen questions related to both affective and evaluative well-being (Tennant et al. 2007, Stewart-Brown and Janmohamed 2008). There is growing evidence that people surviving at the lower end of well-being scales are affected by different factors, and subject to different social circumstance, to those thriving, or flourishing, at the higher end of these scales. For this reason, causal relationships across continuous well-being scales are unlikely (Stewart-Brown et al. 2015, Ng Fat et al. 2017). Well-being was therefore converted to low, medium and high well-being groups prior to analysis. For the WEMWBS, where the maximum possible score is 70, low mental well-being corresponds to greater than one standard deviation (SD) less than the mean; medium is mean \pm one SD; and high mental well-being is more than one SD greater than the mean.

A subjective approach to the evaluative well-being of collectors utilised the Office for National Statistics well-being (ONS4) questions, used both in the UK Census and National Survey for Wales: i) '*Overall how satisfied are you with your life nowadays?*', ii) '*Overall to what extent do you feel that the things you do in your life are worthwhile?*' (Office for National Statistics 2011). Affective well-being was measured using more ONS4 questions: i) '*Overall, how happy did you feel*

Chapter 2: Linking motivations for coastal resource collection to well-being

yesterday?; ii) *Overall, how anxious did you feel yesterday?*. Answers were given on an eleven-point scale where 0 was *Completely* and 10 was *Not at all*.

Responses for anxiety were reverse coded prior to analysis (low anxiety was coded 3, high anxiety 1) to reflect the anticipated negative correlation with well-being (well-being increases with decreasing anxiety levels). Due to data skew, ONS4 scores were split around the median to provide three well-being groups: low (>0.5 SD less than the median), medium (0.5 SD around the median) and high (>0.5 SD greater than the median), with scores rounded up where necessary to create well-being groups.

Collection behaviours used as predictors of well-being included whether the respondent collected on the date of questionnaire completion; the total number of taxa collected (derived from which taxa they collected); and the fourteen scalar motivation statements described above. I hypothesised, from philosophical, anthropological, human geographical and fisheries research presented in the introduction, that collecting behaviour and motivations of collectors would be somehow related to mental well-being, as well as the individual subjective measures of affective well-being (happiness and anxiety) and evaluative well-being (both life satisfaction and eudaemonic well-being, ie. feelings of worthwhile) (Fig. 2.1). Some motivations may be negatively related, for instance collecting for food may be inversely related with mental well-being or life satisfaction (the more food was important as a reason, could indicate a need for food, therefore be linked to lower well-being). In contrast, connecting to the environment as a motivation to collect overall may be positively correlated with well-being. The directions and strength of these relationships would likely depend on individuals' sociodemographic circumstances and their nature exposure. Questions with scalar (ordinal) responses were coded to reflect the anticipated relationship with well-being (e.g. self-perceived general health was assessed using a five point scale of very poor, coded 1, to very good, coded 5, anticipating that those with better health would have higher well-being).

Chapter 2: Linking motivations for coastal resource collection to well-being

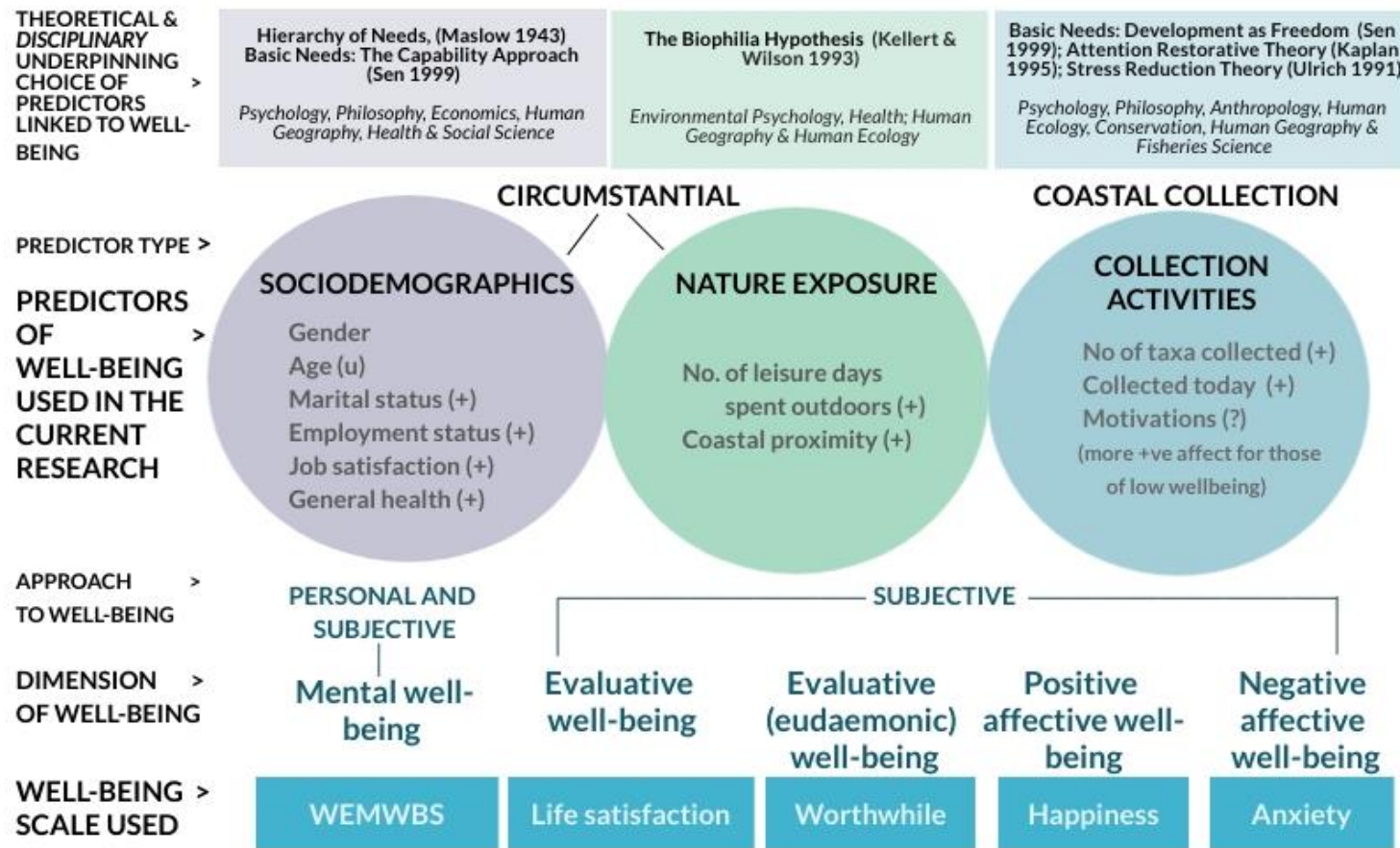


Figure 2.1. Predicted drivers of well-being for the collectors of coastal resources in Wales. Circumstantial predictors were selected from evidence in the literature, whilst coastal collection drivers are grounded in theories that ‘chosen activities’ can drive aspects of well-being. Psychological theories behind the three main predictor types, and disciplines from which specific predictors are drawn are provided in rectangles of the same colour above. Mental well-being was assessed using the Warwick-Edinburgh Mental Well-being Scale (WEMWBS, Tennant et al. 2007). Standard UK Office for National Statistics well-being questions were used to assess aspects of subjective well-being (ONS4, Office for National Statistics 2011). Predicted relationships with well-being are indicated as positive (+), expecting higher well-being in those of younger and older age (u) or uncertain (?), likely to have more positive effect for those of lower well-being). (Maslow 1943, Ulrich et al. 1991, Kellert and Wilson 1993, Kaplan 1995, Sen 1999). Infographic created in Visme.

Chapter 2: Linking motivations for coastal resource collection to well-being

2.2.3 Data collection

Accessing collectors of coastal resources can be challenging due to tidal and weather restrictions, but also due to issues surrounding topic sensitivity. Acknowledging these challenges, we administered the questionnaire opportunistically on beaches (two hours before and after low water on spring tides) using Open Data Kit on Samsung Tablets, and online (disseminated via the platform 'Online Surveys', promoted through social media forums, national and local press). Other respondents were recruited via snowball sampling. Collectors were asked to participate in a study investigating what gathering from the seashore means to them. To be eligible, respondents had collected from a Welsh beach in the past 12 months. Some respondents were questioned whilst collecting, or immediately after, whilst others were questioned at pre-arranged times in person or by telephone. Free prior informed consent was sought from all respondents prior to participation ([Appendix A.2](#)). Respondent information sheets detailed the project, what would happen to participant's data and how anonymity would be protected. Respondents were informed that residential and collection locations would not be published as part of this research to protect anonymity of respondents, collection sites and wild stocks. The study was approved by Bangor University Ethics Committee (approval number CNS2018EMW01).

2.2.4 Analysis

Sociodemographic answers dominated by a single category, such as national identity and ethnicity were used in a description of the collector community but excluded from well-being analyses. Questions where response options contained a low number of responses were combined or collapsed prior to well-being analysis to increase statistical rigour, including coastal proximity, where 61% of respondents lived within 1km of the coast, and marital status, where only 10% of respondents were either separated, divorced or widowed and were therefore combined ([Appendix A.3](#)).

Prior to seeking links between well-being and motivations, Exploratory Factor Analysis (EFA; Norris and Lecavalier 2010, Field 2018) was conducted to explore

Chapter 2: Linking motivations for coastal resource collection to well-being

whether the 14 multiple motivation statements could be grouped into motivational 'domains', indicative of latency within the variables. EFA seeks to group of related variables that could be measuring similar things that are difficult to measure using one metric (latent variables), and therefore only variables with moderate collinearity (Pearson's $r \geq 0.4$, < 0.8) were included in the EFA. Independent motivations (showing multicollinearity Pearson's $r < 0.4$) were excluded from EFA but taken forward to the next step of analyses as separate motivational predictors of well-being. EFA utilised principal axis factoring extraction with an oblique, direct oblimin rotation. Where communalities were greater than 0.5, and resulting factors had Eigenvalues > 1 , the factors were retained (following Kaiser's criterion for datasets with less than 30 variables Field 2018), and contributing variables grouped and labelled as latent 'motivational domains' (domains that represent similar types of motivation). Reliability of internal consistency within domains was confirmed using Cronbach's alpha, testing how closely related each set of variables within each domain were. As data was non-normal, parallel analysis using an Eigenvalue Monte Carlo simulation confirmed the statistical significance of domains (O'Connor 2000). Where multiple motivation statements were found to heavily load onto one domain, their values were averaged, and the resulting domains were taken forward as potential motivation variables affecting well-being.

Circumstantial and coastal collection predictors of well-being were explored using a series of Generalised Ordered Logit Regression (GOLR) models, utilising the Stata® 13.1 Gologit2 package and following methods developed by Williams (2005). The autofit GOLRM, also known as partial proportional odds models (PPOM) or cumulative non-parallel regression, has several benefits over other models: i) enabling the identification of predictors with non-linear, or asymmetric effects on well-being (such as different drivers of well-being in low well-being groups compared to people with high well-being); and ii) identify variables that affect the direction and / or intensity of the response variable. If all variables in a GOLR model meet the global parallel line assumption, the GOLRM automatically suggests the appropriate, standard proportional odds model.

Three autofit GOLR models were fitted to each of the five different measures of well-being (WEMWBS, life satisfaction, worthwhile, happiness, anxiety). The combinations of predictors were: (1) circumstantial (sociodemographic and nature

Chapter 2: Linking motivations for coastal resource collection to well-being

exposure); (2) related to coastal collection; and (3) both circumstantial and coastal collection. Prior to modelling, Pearson's correlation coefficients were calculated for each pair of normally distributed variables, Spearman's Rho for non-normal variables, and strongly correlated variables (>0.8) were removed to avoid issues of multi-collinearity. Final models were either proportional odds (PO) models where all variables met the global parallel line assumption (LR χ^2 $p > 0.05$ for constrained vs unconstrained models), and hence all variables were constrained, or partially constrained partial proportional odds (PPO) models where some variables failed the parallel line assumption (LR χ^2 $p < 0.05$), and were consequently unconstrained. Likelihood ratio tests were used to test the fit of models. All analysis was undertaken using IBM SPSS v24 and Stata ® 13.1. Models were interpreted using guidance from Williams (2016).

Thematic analysis (Braun and Clarke 2006) was used to analyse the three words provided by respondents to sum up what gathering means to them, revealing 29 'meanings'. Meaning codes were then themed as either 'provisioning' or 'experiential' ([Appendix A.7](#)), to enable content analysis of themes. Meanings behind collection were then explored in the context of respondents with low, medium, and high mental well-being (using the WEMWBS categories previously described).

2.3 Results

Between July 2018 and February, 2019, 236 collectors of coastal resources were observed over 94 visits to 72 beaches across Wales. Online data collection ran over the period November 2018-April, 2019. Data were collected in person from 49 people; 41 people completed the questionnaire online. Missing data were between 0-8% for sociodemographic variables and 5-7% for well-being questions, with the exception of job satisfaction which was skipped by 12% of respondents and was not applicable to a further 3%.

Most respondents were male (64%) with an average age of 47 (mean, SE=2). Only 36% of respondents identified as Welsh, with English, Scottish and British accounting for a further 49%, and Canadian, European, Irish, Italian, and Malaysian totalling 10% of respondents. The majority considered their ethnicity White British (83%), with others identifying as Chinese British, Asian: Oriental, Mixed Race British/Oriental, Jewish, New Age Traveller, Canadian and White European (totalling 11%). Only 3% of respondents considered themselves unemployed, whilst 62% of respondents were in full or part-time employment ([Appendix A.4](#)).

Respondents were mostly Welsh residents (73%) whilst 12% were residents of England or Scotland. Most respondents lived less than 1 mile from the coast (61%), with the majority living within 6 miles (10km, 83%). Only 9% of respondents were on holiday at the time of questioning; one had travelled from outside of Wales to collect but did not consider themselves on holiday.

Delivering the questionnaire in person and online ensured access to a wide variety of collectors. However, there were significant differences between face-to-face and online respondents regarding gender, whether on holiday or not, frequency of and reason for collection ([Appendix A.4](#)). Therefore, survey method was included as a predictor in the final well-being model.

Chapter 2: Linking motivations for coastal resource collection to well-being

2.3.1 Living resources collected from the Welsh coast and beaches

Respondents reported collecting 91 different coastal taxa ([Appendix A.5](#)). Of these, 21 were coastal plants (angiosperms) and 70 were purely marine taxa. Enough information was contributed for 85 taxa to be included in further analysis. On average, seven different taxa were collected per person (SE=1), with 13% of respondents collecting only one taxon and a single person collecting 30.

The ten taxa collected by most respondents (accounting for 56% of all the taxa listed) were blue mussels *Mytilus edulis* (collected by 60% of respondents), cockles *Cerastoderma edule* (42%), any seaweed (39%, indiscriminate in their target), green shore or peeler crab *Carcinus maenas* (36%), prawns or shrimp *Caridea* (33%), razor clams *Ensis* (33%), periwinkles *Littorina littorea* (28%), lugworm or blow lug *Arenicola marina* (27%), marsh samphire *Salicornia europaea* (27%) and other 'unspecified' seaweed (26%, these respondents had already listed their specific preferred algal species, listing 'other' due to not knowing the taxa title or being reluctant to specify). Respondents (n=88) classified 33 different taxa as 'their most important' including many non-commercially important taxa (Table 2.1, [Appendix A.5](#)).

2.3.2 Who collects coastal resources

Many collectors had been collecting since childhood (pre-teenage years, 40%), whilst 42% started collecting between 18 years and retirement ([Appendix A.4](#)). Most collect throughout the year (82%), from five or more beaches (54%). Most stated that their collection activities were restricted to Wales (53%) with, 27% of respondents travelling less than 5miles to collect and 49% travelling 5 - 49.9miles. Twenty-four percent stated that they have collected outside of the UK in the last two years. Of the 61 collectors asked, 33% considered themselves to be occasional, or 'ad hoc' collectors, collecting several times per year, whilst 18% collected at least monthly and 14% at least once per week. Fifty six percent of respondents agreed that their time spent exercising reduces in periods when they don't collect. Almost one quarter of respondents (22%) had already collected on the day of survey, whilst 51% had collected at least once in the last seven days.

Chapter 2: Linking motivations for coastal resource collection to well-being

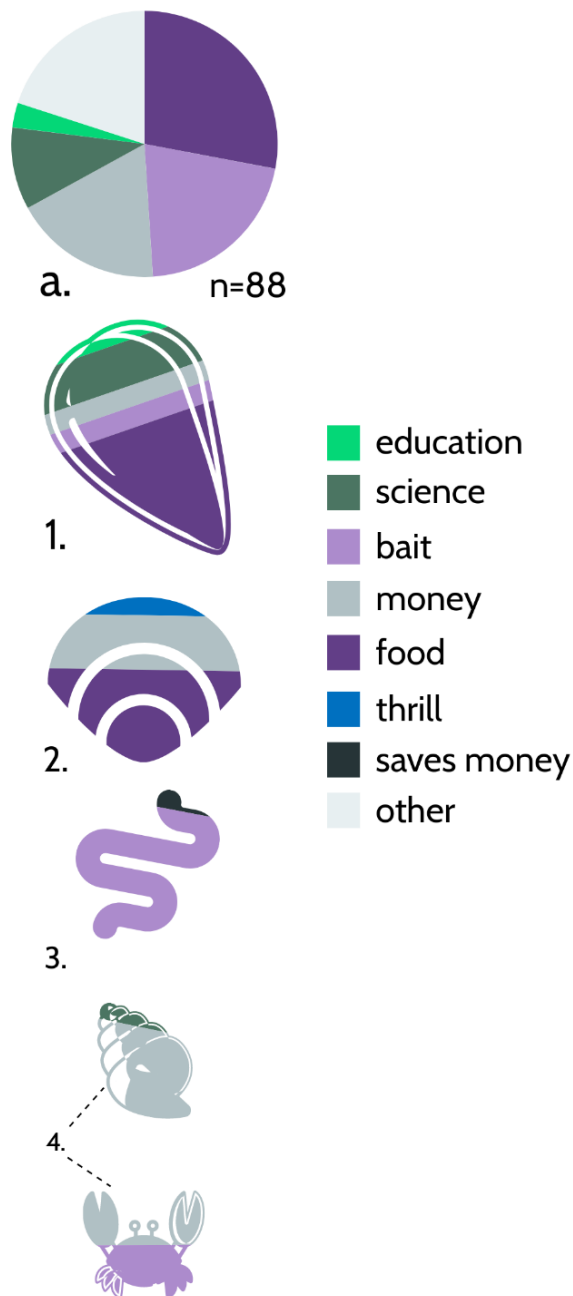
Table 2.1. The three most important taxa to collectors of wild coastal resources in Wales. Taxa are ranked based on the percentage of respondents who reported a taxa as being their first (n=88), second (n=77) and third (n=66) most important taxa for collection; 'importance' was interpreted broadly and could be for any reason. Several taxa may hold a joint ranking. * Taxa currently not considered of commercial interest in Wales.

Rank	Most important taxa	Rank	Second most important	Rank	Third most important
1	Mussels (13%)	1	Periwinkle (12%)	1	Razor shell / clam (10%)
2	Cockles (10%)	2	Cockles (10%)	2	Mussel (9%), Peeler / Shore / Green crab (9%)
3	Lugworm / Blowlug (9%)	3	Lugworm / Blowlug (8%)	4	Cockle (4%), Periwinkle (4%), Prawns / Shrimp (4%)
4	Peeler / Shore crab (7%),	4	Marsh samphire (6%), Peeler / Shore crab (6%)		
6	Periwinkle (7%) Laver (4%)	6	Razor clam / shell (4%)		
	Lobster (4%), Ragworm (4%)	7	Ragworm (3%)	7	Lugworm / Blow lug (3%)
9	Black lugworm (3%), Bladder wrack (3%)*, Pepper dulse (3%)*, Unspecified seaweed (3%)*	8	All seaweed (2%)*, Limpets (2%)*, Mussel (2%), Oarweed / Kelp (2%)*, Oyster (2%), Prawns / Shrimps (2%), Unspecified seaweed (2%)*	8	All seaweed (2%)*, Carrageen (2%)*, Dulse (2%)*, Lobster (2%), Marsh samphire / glasswort (2%), Sea beet / sea spinach (2%)*
13+	21 additional taxa (25%)	15+	17 additional taxa (19%)	14+	14 additional taxa (15%)

2.3.3 Primary motivations for collecting specific taxa

Overall, of the respondents who answered the question (n=88) pertaining to the main reason they collected their most important taxa, 80% stated that it was for one of five main provisioning motivations: food, bait, money, science or education (Fig. 2.2). As many respondents were paid to deliver science or education, these were considered provisioning motivations. Thrill, garden fertilisers, cosmetics, crafts, home aquaria, health or veterinary supplements were amongst other primary motivations to collect the most important taxa for the remaining 20% of respondents.

Chapter 2: Linking motivations for coastal resource collection to well-being



The five most important species to coastal collectors were gathered primarily for provisioning motivations (Fig. 2.2). Of the 12 people reporting mussels as their most important target taxa, 58% collected primarily for food but 42% collected for other motivations including 17% for science (Fig. 2.2). Of the nine respondents for whom cockles were their most important taxa, 56% collected for food, 33% for money and 11% for the 'thrill'. Of those reporting lugworm (*Arenicola marina*) as their primary target taxa, no one reported collecting for money. Peeler crab (*Carcinus maenas*) were collected for both bait and money. Periwinkles (*Littorina littorea*) were collected primarily for money (83%), but also for science (17%, Fig. 2.2).

Figure 2.2. Primary motivations to collect important coastal resources (a), and the top five targeted intertidal taxa in Wales: 1. Mussels, *Mytilus edulis* (n=12); 2. Cockles, *Cerastoderma edule* (n=9); 3. Lugworm, *Arenicola marina* (n=8); 4. Periwinkles, *Littorina littorea* and joint 4. peeler crab, *Carcinus maenas* (n=6). Infographic created in Piktochart.

Chapter 2: Linking motivations for coastal resource collection to well-being

The primary motivation for collecting their most important target taxa had changed for many (17%) of the respondents since they first collected that taxa. For example, five of the 12 respondents who stated that mussels were their most important target species have changed their motivation; some used to collect mussels primarily for money but now collect for personal consumption, whilst others used to collect primarily for food, but now collect for science.

2.3.4 Multiple motivations for the collection of coastal resources

Generally, individuals reported one or two 'provisioning motivations' accompanied by several 'experiential motivations'. Most (77%) collected, at least in part, for food (66%), money (49%), science (44%) or bait (42%). More than 90% acknowledged that part of their motivation was to feel connected to nature, natural history interest, stress relief / escapism, or to spend time alone.

Analysis of the 14 motivation statements revealed that the provisioning motivations of money, bait, science and food were all independent from other motivation statements (Pearson's $r < 0.4$), and therefore were retained as independent variables to be explored as potential predictors of well-being. Exploratory Factor Analysis (EFA) of the remaining ten motivational statements produced a three factor solution identifying three experiential domains: 'intrigue/learning', 'challenge/life skills' and 'connecting to others and/or the environment' (Table 2.2).

The motivational domains of 'intrigue/learning' and 'connecting to others and/or the environment' were carried forward to explore their relationship to well-being amongst respondents. The relationship between well-being and the motivational domain of 'challenge/life skills' (which combined collecting for foraging, challenge, and to practise survival skills) was not investigated further since it was strongly correlated (Pearson's $r = 0.8$) with the provisioning motivation, collecting for food.

Chapter 2: Linking motivations for coastal resource collection to well-being

Table 2.2. Multiple motivations for collecting coastal resources in Wales. Data were derived from respondents answering the following question: “Thinking about other reasons that you collect all or any of your species, please tell me the how important the following statements are to you....”. Responses were given on an 11-point scale, collapsed to 6 points for analysis (1 = not a reason; 6 = a very important reason). Factor loadings taken from Exploratory Factor Analysis structure matrix (post extraction and rotation), and Cronbach’s Alpha used as a measure of reliability in the resulting domain. Where factor loadings = n/a the variable was independent from other variables, Pearson’s $r < 0.4$, and was therefore excluded from EFA but retained as an independent motivation. CI = confidence interval.

Items comprising the domains of ‘motivation’ to collect from the shore	Factor Loading	Median	Lower CI	Upper CI	Cronbach’s Alpha
Collecting for money <i>I collect because I make a bit of money from it.</i>	n/a	1.00	2.34	3.18	
Collecting for bait <i>I collect for angling bait.</i>	n/a	1.00	2.20	3.11	
Collecting for science <i>I collect for research, field or citizen science.</i>	n/a	1.00	2.47	3.44	
Collecting food for the table <i>I collect food for the table (for personal consumption).</i>	n/a	4.50	3.28	4.22	
Collecting for ‘intrigue / learning’ <i>I collect because I enjoy looking at species on beach (natural history interest).</i> <i>I collect because I enjoy the environment and fresh air.</i> <i>I collect because I’m visiting the beach and thought I’d have a look.</i> <i>I collect because I enjoy the time alone on the beach.</i> <i>Collection gives me reason to explore new beaches.</i>	0.812 0.752 0.707 0.584 0.525	4.3 5.00 4.5 5.00 3.00	3.84 4.17 3.45 4.27 2.57	4.41 4.85 4.26 4.98 3.43	0.802
Collecting for ‘challenge / life skills’ <i>I am foraging or I enjoy the challenge of finding my own food. It is fun.</i> <i>I like the feeling that I can provide food / practice survival skills. It’s a serious activity for me.</i>	0.852 0.730	4.0 4.00	3.39 3.23	4.22 4.12	0.767
Collecting to ‘connect’ to themselves, others or nature <i>I collect because I find it a good form of stress-relief / escapism.</i> <i>I collect to feel more connected to nature.</i> <i>I collect as a social activity with my friends / family.</i>	-0.831 -0.739 -0.539	5.0 6.00 5.00	4.45 4.89 3.81	4.98 5.41 4.57	0.722

2.3.5 The well-being of Welsh collectors

The mean Warwick Edinburgh Mental Well-being Scale (WEMWBS) score for collectors was 50.91 (SE = 1.1, $n=85$, [Appendix A.6](#)). Respondents were categorised into those of low (total WEMWBS score <41); medium (41-61) and high (>62) mental well-being. Median life satisfaction, feelings of worthwhile and happiness were all found to be 8 (SD = 2.2, 2.1, 2.4 consecutively, $n=89$) on the Office for National Statistics (ONS4) scales, resulting in groups of low (ONS4 <7), medium (7-9) and high (10) well-being. To reflect that low anxiety is equivalent to high well-being for all GOLR analysis low anxiety was coded 3, high anxiety 1.

Proportional odds models of circumstantial predictors of well-being (sociodemographics and nature exposure) explained 34.9% of variability (Pseudo R^2 , $p<0.001$) in mental well-being, 32.3% of variability in life satisfaction, 40.8% of feelings of worthwhile and 29.0% of happiness (Table 2.3, [Appendix A.6](#)). Job satisfaction followed by general health were significantly and positively correlated with all well-being measures except anxiety. People with higher job satisfaction, or higher self-perceived general health, had significantly higher mental well-being than those with lower job satisfaction (β coefficient 2.560, $p < 0.001$), or lower self-perceived general health (β 1.145, p 0.007). The number of leisure days spent outdoors in the past four weeks was also positively and significantly related to life satisfaction (β 0.497, p 0.025), whilst employment status was positively and significantly related to feeling worthwhile (β 0.812, p 0.018). Although circumstantial predictors modelled together did not significantly explain anxiety levels (Pseudo R^2 explained 6.6% of variability, p 0.237), job satisfaction alone was significantly related to anxiety as job satisfaction increased, anxiety declined (β 0.984, p 0.025).

Chapter 2: Linking motivations for coastal resource collection to well-being

Table 2.3. Model 1: Associations between circumstantial predictors (sociodemographics and nature exposure) and well-being amongst collectors of coastal resources in Wales. Mental well-being was derived from the total Warwick-Edinburgh Mental Well-being Scale (WEMWBS) scores, whilst four constituent dimensions of well-being of life satisfaction, feelings of worthwhile, happiness and anxiety were answers to four standard Office for National Statistics well-being questions (ONS4). Anxiety: 1 = high anxiety; 3 = low anxiety. All other well-being measures: low = 1; high = 3 representing high well-being. Significant variables (* $p < 0.05$ and ** $p < 0.001$) were determined from proportional odds models following Generalised Ordered Logit Regression analysis (Stata package Gologit2, as described by Williams 2005); n/a indicates both model and variable are insignificant predictors of well-being measure.

Circumstantial predictor	Mental wellbeing WEMWBS ^{!PO}				Life Satisfaction ^{!PO}				Feelings of worthwhile ^{!PO}				Happiness ^{!PO}				Anxiety ^{!PO}			
	n	LR Chi ²	p	Pseudo R ²	n	LR Chi ²	p	Pseudo R ²	n	LR Chi ²	p	Pseudo R ²	n	LR Chi ²	p	Pseudo R ²	n	LR Chi ²	p	Pseudo R ²
Gologit2 model fit:	70	42.01	<0.001**	0.349	73	45.11	<0.001**	0.323	73	53.44	<0.001**	0.408	73	45.17	<0.001**	0.290	73	10.41	0.237	0.066
		β Coef	St. Error	P>Z		β Coef	St. Error	P>Z		β Coef	St. Error	P>Z		β Coef	St. Error	P>Z		β Coef	St. Error	P>Z
Gender		-0.387	0.656	0.555		-0.610	0.608	0.920		0.687	0.667	0.919		0.416	0.555	0.940		0.620	0.509	0.223
Age		0.288	0.026	0.263		0.010	0.223	0.657		0.002	0.026	0.952		0.349	0.021	0.090		0.149	0.019	0.428
Marital status		-0.239	0.412	0.562		0.267	0.378	0.479		0.512	0.444	0.249		-0.098	0.351	0.780		-0.296	0.309	0.338
Employment status		0.306	0.316	0.334		0.279	0.29	0.336		0.812	0.343	0.018*		0.510	0.297	0.086		0.726	0.223	0.745
Job satisfaction		2.560	0.688	<0.001**		2.453	0.65	<0.001**		2.640	0.65	<0.001**		2.223	0.578	<0.001**		0.984	0.436	0.025*
General health		1.145	0.426	0.007*		1.010	0.381	0.008*		0.941	0.392	0.016*		0.828	0.344	0.016*		0.086	0.274	0.751
Number of leisure days		0.145	0.244	0.552		0.497	0.221	0.025*		0.310	0.239	0.194		0.095	0.198	0.630		0.596	0.177	0.736
Coastal proximity		0.731	0.654	0.262		0.506	0.596	0.396		0.045	0.645	0.944		0.806	0.554	0.145		0.027	0.489	0.955

[!] Final model 1 used all proportional odds models ^{PO} as variables met the global parallel line assumption (LR Chi² $p > 0.05$ for constrained vs unconstrained models), indicative that the association was consistent across those with low, medium and high well-being.

shaded cells: model not significant

Chapter 2: Linking motivations for coastal resource collection to well-being

Predictors of well-being associated with coastal collection, explained 16.6% (Pseudo R^2 , $p = 0.001$) of the variability in mental well-being (Table 2.4). The number of taxa collected was positively and significantly related to mental well-being (β coefficient 1.093, p 0.047) whilst collecting for bait was significantly and negatively related to mental well-being (β -0.421, p 0.004). Motivations for engaging in collection activities did not explain significant levels of variability in life satisfaction (Pseudo R^2 7.3%, $p = 0.231$), feeling worthwhile (R^2 7.7%, $p = 0.260$), happiness (R^2 6.7%, $p = 0.231$) or anxiety (R^2 5.5% $p = 0.368$). However, respondents who collected on the day of questionnaire completion reported significantly higher life satisfaction (β 1.398, p 0.036) and lower anxiety (β 1.218, p 0.049) than those who had not.

Chapter 2: Linking motivations for coastal resource collection to well-being

Table 2.4. Model 2: Associations between predictors related to coastal collection and well-being. Mental well-being was derived from Warwick-Edinburgh Mental Well-being Scale scores, whilst four constituent dimensions of well-being of life satisfaction, feelings of worthwhile, happiness and anxiety were answers to four standard Office for National Statistics well-being questions (ONS4). Anxiety: 1 = high anxiety; 3 = low anxiety. All other well-being measures: low = 1; high = 3 representing high well-being. Significant variables (* $p < 0.05$ and ** $p < 0.001$) were identified using Generalised Ordered Logit Regression analysis (Stata package Gologit2, as described by Williams 2005); n/a indicates both model and variable are insignificant predictors of well-being measure.

Hypothetical predictor related to collection activity	Mental wellbeing WEMWBS ^{IPO}				Life Satisfaction ^{IPO}				Feelings of worthwhile ^{IPPO}				Happiness ^{IPO}				Anxiety ^{IPO}			
	n	LR Chi ²	p	Pseudo R ²	n	LR Chi ²	p	Pseudo R ²	n	LR Chi ²	p	Pseudo R ²	n	LR Chi ²	p	Pseudo R ²	n	LR Chi ²	p	Pseudo R ²
Gologit2 model fit:	80	21.76	0.001*	0.166	82	11.70	0.231	0.073	82	11.23	0.260	0.077	82	11.700	0.231	0.067	82	9.79	0.368	0.055
	β	Coef	St. Error	P>Z	β	Coef	St. Error	P>Z	β	Coef	St. Error	P>Z	β	Coef	St. Error	P>Z	β	Coef	St. Error	P>Z
No of species collected		1.093	0.549	0.047*		0.733	0.486	0.132		0.671	0.491	0.172		0.809	0.474	0.088		0.501	0.471	0.287
Collected today?		1.112	0.728	0.127		1.398	0.668	0.036*		0.846	0.669	0.206		0.584	0.631	0.355		1.218	0.619	0.049*
Motivation: Bait		-0.421	0.144	0.004*		-0.134	0.117	0.253		-0.153	0.122	0.209		-0.098	0.113	0.385		-0.208	0.115	0.072
Motivation: Food		-0.209	0.140	0.136		0.066	0.116	0.567		0.099	0.121	0.412		0.590	0.112	0.599		0.056	0.109	0.606
Motivation: Money		0.372	0.209	0.075		<-0.001	0.170	0.997		0.094	0.177	0.596		-0.072	0.160	0.654		-0.081	0.158	0.605
Motivation: Science		-0.056	0.122	0.648		-0.033	0.108	0.760		0.018	0.111	0.868		0.002	0.103	0.832		-0.069	0.100	0.491
Motivation: Intrigue		0.037	0.309	0.905		0.147	0.273	0.591		0.134	0.286	0.638		0.350	0.267	0.190		-0.004	0.560	0.987
Motivation: Connecting		0.127	0.242	0.599		-0.166	0.217	0.444		0.089	0.221	0.685		-0.140	0.208	0.499		-0.115	0.207	0.576
Survey method		0.162	0.259	0.532		-0.030	0.220	0.893		-0.024	0.227	0.918		-0.173	0.205	0.398		-0.015	0.202	0.939

[!] Final models used were either constrained proportional odds models ^{PO} if variables met the global parallel line assumption (LR Chi2 $p > 0.05$ for constrained vs unconstrained models) or partially constrained partial proportional odds models ^{PPO} where variables failed the parallel line assumption (LR Chi2 $p < 0.05$). ^{PO} models indicate that the association was consistent across those with low, medium, and high well-being.

shaded cells: model not significant

Chapter 2: Linking motivations for coastal resource collection to well-being

The final model combining circumstantial and coastal collection predictors explained almost double the variability in mental well-being compared to circumstantial predictors alone (Pseudo R^2 61.4%, $p = <0.001$, Table 2.5). Coastal residency (β 3.742, p 0.022), job satisfaction (β 3.075, p 0.007), and collecting for money (β 1.462, p 0.031) were significantly and positively related to collectors' mental well-being, across all well-being groups. Those living >1 km from the coast, reporting greater job satisfaction, better self-perceived health, or collecting for money had higher mental well-being. Bait collection was significantly and negatively related to mental well-being (PO β -2.177, p 0.006).

The model also revealed more nuanced relationships between circumstantial factors according to collector's level of well-being (i.e. low, medium or high mental well-being, Table 2.5). General health was three-times more strongly associated with mental well-being for collectors of low well-being (β 8.387, p 0.005) compared to those of higher well-being (β 2.513, p 0.038), suggesting health issues impact those of lower well-being to a greater extent than those of higher well-being. For those in the low mental well-being group, collecting coastal resources for food was significantly and negatively related to mental well-being (β -2.160, p 0.013); as the motivation to collect for food increased, mental well-being declined. Food as a motivation for collecting was not significantly related to mental well-being where collectors had medium or high mental well-being (β -0.434, p 0.224). Age was significantly and positively associated with mental well-being when well-being was low (β 0.376, p 0.021), but this relationship was not significant for those of higher well-being (β 0.058, p 0.321).

The combined model also explained slightly greater levels of variability in the other well-being measures than circumstantial predictors alone: 41.1% of variability in life satisfaction (Pseudo R^2), 45.7% of feelings of worthwhile and 30.1% of happiness (Table 2.5). As with the model of circumstantial predictors alone, job satisfaction followed by general health were significantly and positively related to life satisfaction, feelings of worthwhile and happiness amongst collectors. Number of leisure days was also positively related to life satisfaction (β 0.509, p 0.045), whilst employment status was significantly related to feelings of worthwhile (β 0.856, p 0.027). However, the combined model explained more than three times the variance in anxiety levels (Pseudo R^2 21.8%, p 0.014). Collecting today was the strongest predictor of anxiety;

Chapter 2: Linking motivations for coastal resource collection to well-being

people who collected today had lower anxiety than those who did not (β 2.238, p 0.007). Job satisfaction and marital status were also found to be significantly related to anxiety levels, with married people having higher anxiety than those who were separated, divorced or single (β 1.76, p 0.003).

2.3.6 Links between the meanings behind collection, the mental well-being of collectors and their motivations to collect.

Respondents assigned 121 different meanings to their collection activities through their 'three words' (Fig. 2.3; [Appendix A.7](#)). Content analysis, following thematic analysis of codes into themes, found most of the three-word meanings related more to an 'experiential' theme (83%, $n=157$). 'The 'experiential meanings' theme comprised 23 codes generated from responses including enjoyment, peace and relaxation, connecting with nature, exercise and way of life (blue, Fig. 2.3). When these three-word meanings were split by low, medium and high well-being, it becomes evident that no one in the high well-being group associated provisioning meanings with their collection activities, whilst 28% of meanings ($n=7$ of 25 words) provided by those of low well-being were associated with provisioning (Fig. 2.3). Within the experiential meanings, a higher proportion of words given by those of low (12%, $n=3$ of 25 words), and medium (7%, $n=5$ of 139 words) mental well-being gave meanings related to societal independence and freedom as important reasons for their collection compared to those meanings given by those of high well-being (3%, $n=1$ of 100 words; [Appendix A.7](#)). Provisioning meanings revealed six codes, relating to food, bait, saving money, making some money, science, or research (pink, Fig. 2.3).

Chapter 2: Linking motivations for coastal resource collection to well-being

Table 2.5. Model 3: Identifying factors most affecting the well-being of collectors of coastal resources in Wales. Mental well-being (MWB) was derived from the total Warwick-Edinburgh Mental Well-being Scale scores, whilst four constituent dimensions of well-being of life satisfaction, feelings of worthwhile, happiness and anxiety were answers to four standard Office for National Statistics well-being questions (ONS4). Anxiety: 1 = high anxiety; 3 = low anxiety. All other well-being measures: low = 1; high = 3 representing high well-being. Significant variables (* $p < 0.05$ and ** $p < 0.001$) were identified using Generalised Ordered Logit Regression (Stata package Gologit2, as described by Williams 2005). Relationships (β Coef) between some variables and well-being varied across well-being groups (*italicised*, ^U*unconstrained in PPO models*).

Predictor	Mental wellbeing (MWB) WEMWBS ^{IPPO}				Life Satisfaction ^{IPPO}				Feelings of worthwhile ^{IPPO}				Happiness ^{IPPO}				Anxiety ^{IPPO}			
	n	LR Chi ²	p	Pseudo R ²	n	LR Chi ²	p	Pseudo R ²	n	LR Chi ²	p	Pseudo R ²	n	LR Chi ²	p	Pseudo R ²	n	LR Chi ²	p	Pseudo R ²
Model significance:	67	70.65	<0.001**	0.614	68	54.94	<0.001**	0.411	68	54.36	<0.001**	0.457	68	43.06	<0.001**	0.301	68	32.33	0.014*	0.218
		β Coef	St. Error	P>Z		β Coef	St. Error	P>Z		β Coef	St. Error	P>Z		β Coef	St. Error	P>Z		β Coef	St. Error	P>Z
Gender		-1.182	1.129	0.340		-1.298	0.932	0.164		0.047	0.991	0.962		-0.042	0.831	0.959		1.028	0.795	0.196
Age ^U						0.014	0.027	0.611		0.006	0.301	0.852		0.040	0.025	0.103		0.044	0.025	0.076
Low v Medium & High MWB		0.376	0.163	0.021*																
Low & Medium v High MWB		<i>-0.058</i>	<i>0.586</i>	<i>0.321</i>																
Marital status		0.238	0.670	0.733		0.412	0.462	0.330		0.026	0.544	0.961		-0.228	0.414	0.582		-0.787	0.392	0.045*
Employment status		0.709	0.645	0.272		0.283	0.327	0.387		0.856	0.387	0.027*		0.470	0.306	0.125		0.223	0.264	0.391
Job satisfaction		3.075	1.139	0.007*		2.865	0.811	<0.001**		2.940	0.889	0.001*		1.869	0.648	0.004*		1.760	0.593	0.003*
General health ^U						1.587	0.530	0.003*		1.259	0.555	0.023*		0.855	0.340	0.031*		0.240	0.340	0.482
Low v Medium & High MWB		8.387	2.987	0.005*																
Low & Medium v High MWB		2.513	1.209	0.038*																
Number of leisure days		0.567	0.434	0.191		0.509	0.253	0.045*		0.191	0.284	0.501		0.146	0.217	0.501		-0.086	0.212	0.686
Coastal residency		3.742	1.631	0.022*		1.088	0.736	0.139		-0.273	0.812	0.736		0.793	0.657	0.227		-0.570	0.637	0.371
No of species collected		1.260	1.028	0.220		0.234	0.691	0.734		-0.080	0.708	0.910		1.040	0.688	0.131		0.696	0.628	0.267
Collected today?		-1.418	1.488	0.341		1.000	0.980	0.307		1.268	1.030	0.219		0.947	0.892	0.288		2.238	0.833	0.007*
Motivation: Bait		-2.177	0.791	0.006*		-0.278	0.218	0.204		0.060	0.214	0.778		-0.097	0.187	0.606		0.007	0.171	0.968
Motivation: Food ^U						0.126	0.178	0.480		0.329	0.211	0.120		-0.084	0.154	0.585		0.141	0.149	0.345
Low v Medium & High MWB		-2.160	0.868	0.013*																
Low & Medium v High MWB		<i>-0.434</i>	<i>0.357</i>	<i>0.224</i>																
Motivation: Money		1.462	0.679	0.031*		0.138	0.269	0.607		-0.086	0.266	0.746		-0.139	0.229	0.545		-0.150	0.212	0.479
Motivation: Science		-0.643	0.330	0.051		-0.033	0.158	0.837		-0.025	0.179	0.891		-0.001	0.141	0.994		-0.226	0.137	0.098
Motivation: Intrigue		-1.504	0.961	0.118		-0.185	0.441	0.675		0.140	0.487	0.773		0.137	0.396	0.729		-0.225	0.381	0.554
Motivation: Connecting		0.840	0.706	0.234		-0.590	0.370	0.110		-0.421	0.393	0.284		-0.222	0.230	0.456		-0.307	0.292	0.294
Survey method		0.601	0.591	0.309		0.273	0.349	0.434		-0.225	0.372	0.545		0.018	0.295	0.952		-0.046	0.279	0.868

[!] Final models used were either constrained proportional odds models ^PO if variables met the global parallel line assumption (LR Chi² $p > 0.05$ for constrained vs unconstrained models) or partially constrained partial proportional odds models ^PPO where variables failed the parallel line assumption (LR Chi² $p < 0.05$).

Shaded cells: model not applicable for predictor (see different β coefs for low vs medium & high MWB, and low & medium v high MWB)

Chapter 2: Linking motivations for coastal resource collection to well-being

Thematic analysis of 'three' open words defining 'meaning' from all respondents: 17% provisioning 83% experiential



To those with
LOW WELLBEING



28% provisioning 72% experiential



To those with
MEDIUM WELLBEING



23% provisioning 77% experiential



To those with
HIGH WELLBEING



0% provisioning 100% experiential

Figure 2.3. Meanings behind the collection of coastal resources from the Welsh coastline for respondents of different mental well-being groups (low, medium and high). Meanings are the responses to 'sum up what collecting from the seashore means to you in three words', thematically analysed to reveal their provisional or experiential value. Mental well-being groups have been defined from the categorisation of respondents' scores on the Warwick-Edinburgh Mental Well-being Scale.

2.4 Discussion

This chapter provides an insight into coastal collection activity in Wales and the many ways collecting relates to the well-being of collectors in the context of other factors affecting their lives. I hypothesised that collecting behaviour and the motivations underpinning collection activities would be positively related to well-being, but that the strength of these relationships may depend on individuals' circumstance, specifically key sociodemographic factors informed by the literature together with general nature exposure. Overall, the act of collecting itself reduced anxiety levels of collectors regardless of their circumstance. However, motivations to collect were less important to the mental well-being of collectors compared to sociodemographic factors including general health, job satisfaction and age. Relationships of the provisioning motivations and possibly societal independence, or freedom, were found to be particularly important to those of low mental well-being, whilst those of high mental well-being reported only experiential meanings behind their activities. My discussion unpicks the complexities of how collecting affects the mental, affective, and evaluative well-being of collectors. First, I introduce the activity and collecting community. Second, I present relationships with motivations to collect and the circumstances that affect these relationships. Third, I discuss how frequency of outdoor visits, regardless of whether for collecting or not, increases life satisfaction. Finally, I explore why the residential proximity to coast did not appear to have as strong a relationship with collector well-being as reported elsewhere (Wheeler et al. 2012, White et al. 2013b, 2014, Garrett et al. 2019).

2.4.1 Overview of collection activities and the community collecting coastal resources

Ninety respondents reported collecting 70 marine taxa from the Welsh shoreline, adding 27 new taxa to previous estimates (Perry et al. 2014). My results demonstrate the variability of collection activities with the average collector gathering seven taxa, whilst only 13% collected a single species. Thirty-three different taxa were reported as being the most important collected yet many of these are not considered commercially important by managers in Wales.

The Welsh community of coastal collectors is complex, diverse in age, gender and motivation and difficult to engage. The effectiveness of using multiple engagement

Chapter 2: Linking well-being with motivations to collect coastal resources

methods was confirmed by the differences in people responding online compared to face-to-face on beaches. Online surveys accessed a higher proportion of women whilst data collected on beaches were more successful in engaging those collecting for money and more regularly.

Many collectors (40%) had been collecting since childhood, indicative of skills, or traditions passed between generations. On average collectors reported 11 different motivations for collecting. Most respondents stated their primary motivation for collecting their preferred taxa was for a provisioning reason. However, no conclusions can be drawn as to whether the motivation to collect for food represented a significant dietary contribution, as is the case in studies of urban foragers in the USA (Synk et al. 2017). The range of motivations observed is similar to those described for urban foragers in London where few foragers were collecting for subsistence, but many were motivated by economic benefits, including replacement of food items that would otherwise be bought (Nyman 2019). Nearly half of the Welsh collectors questioned were collecting at least in part for money, which depending upon the type and quantity of taxa collected, may provide substantial income.

2.4.2 Links between mental well-being and motivations to collect coastal resources

Collecting for food, bait and money contributed to the mental well-being of collectors in Wales. Links between mental well-being and provisioning motivations were strongest in people of low well-being. Often sociodemographic factors can be considered 'circumstantial' and beyond the individual's control (Lyubomirsky et al. 2005), particularly for those of lower well-being, and their perception of these circumstances can change the influence of these factors on their well-being (Dolan et al. 2008). It could be further hypothesised that some control of one's life can be regained by increasing their own income or self-sufficiency, which could be attained through coastal collection as evidenced by the strong links between collection and well-being in low well-being groups. Reflecting on theories of motivation (Maslow 1943), the Theory of Human Need (Doyal and Gough 1984) and the Capability Approach (Sen 1999), fundamental physiological human needs, or basic needs,

Chapter 2: Linking well-being with motivations to collect coastal resources

need to be met before people have the capability to function, thrive or achieve higher well-being. It is difficult to separate the objective drivers of well-being (e.g. need for food) from the subjective, self-perceived experience of well-being (such as someone with other options to feed themselves but chooses not to for other reasons). Amartya Sen has already hypothesised that the latter contributes to a person's autonomy (self-directing freedom, self-determination, or self-governance) under the theory of 'Development as Freedom' (Sen 1999 as summarised in a marine fisheries context by Coulthard et al. 2011).

Recent research into ecosystem services have also found that gleaning from coastal habitats made important contributions to the well-being of survey participants through mechanisms relating to money and use, but also autonomy. In Kenya and Mozambique, the perceived contribution of octopus gleaning to the well-being domains of food and economic security was high, but so too were the contribution of activities to the experiential domains including autonomy (Chaigneau et al. 2019). In the Puget Sound, USA, researchers found that wild resource gathering had a negative relationship with well-being in some rural areas where participants of low life satisfaction were using resource access and gathering for subsistence, whilst potentially those gathering for culture and recreation were living in more urban areas with higher average life satisfaction (Biedenweg et al. 2017). In Wales, the links between provisioning motivations and well-being were particularly pertinent in the low mental well-being groups. Using the same experiential domains explored by Chaigneau et al (2019), and the concept from Biedenweg et al (2017), collecting coastal resources in Wales could be contributing to domains of economic security, food, and possibly autonomy.

Experiential, or non-catch motivations for fishing have been linked to well-being in several recent studies (Pollnac et al. 2015, Skubel et al. 2019, Chaigneau et al. 2019; Grantham et al 2020). In the East African case, octopus gleaning strongly contributed to the well-being domains of relationships, respect, and education (Chaigneau et al. 2019). In Timor-Leste gleaners have been found to collect to be more connected to nature and for knowledge (Grantham et al. 2020). In the Americas, challenge is regarded as one important factor in the self-actualisation, or realisation of their true selves, for fishers (Seara et al. 2017a, 2017b). In this chapter I provided evidence that collectors of coastal resources are also motivated to collect

Chapter 2: Linking well-being with motivations to collect coastal resources

for multiple experiential reasons, specifically: 'connecting to themselves, others or nature'; 'intrigue and learning'; and 'challenge and life skills'. No statistical relationships were identified between these motivations and mental well-being but, when asked what collecting means to them, people in the high well-being group only reported experiential reasons well-being. Those in lower well-being groups also reported meanings associated with experiential and provisioning purposes.

The experiential meanings that collectors associated with collecting indicate that the Five Ways to Well-being (Connect, Be Active, Take Notice, Keep Learning, Give) recognised by policy makers (Aked et al. 2008, New Economics Foundation 2011, White 2017, Kelly 2018) can be achieved through coastal resource collection. Each of the Five Ways to Well-being can be linked in some way to experiential meanings reported. For example, collection was linked to '*socialising with friends*', '*exercise*', '*nature*', '*learning*', '*knowledge*' and '*cooking outdoors*' as well as '*self-sufficiency*' and '*freedom*'. My work contributes to a growing body of literature documenting the prominence of experiential factors to the human experience. Indeed, a review of innovative 'experience economies' identified four experience categories behind the success of harvest-based forest microbusinesses (including one selling foraging and wild cookery courses in Wales); entertainment (spend time in nature, often with family or friends); education; aesthetic (being in sensory-rich environments); and escapism (Živojinović et al. 2020). Furthermore, a socioeconomic review of recreational angling in England revealed that motivations to fish were often linked to spending time with friends and family, being outdoors and relaxation (Brown et al. 2013). Additionally, self-actualisation, which is the human need for challenge, adventure, and independence, has been noted as an important motivation affecting job satisfaction amongst commercial fishers (Pollnac and Poggie 2008). Experiences underlying the popularity of harvest-based forest businesses (Živojinović et al. 2020) and the British angling industry (Brown et al. 2013) link to the Five Ways to Well-being (Aked et al. 2008) highlighting the importance of understanding experiential motivations in policy and decision making, particularly with respect to developing informal, nature and experience-based rural economies.

2.4.3 Collection of coastal resources as a therapy to increase affective well-being

The act of collecting living resources from the seashore was found to be related to reduced anxiety amongst collectors; those who collected immediately before completing my questionnaire, had lower anxiety than those who had not. People who engage in outdoor physical activity are known to have lower anxiety and higher nature connectedness than those who exercised indoors (Lawton et al. 2017). Close interactions with nature are known to have attention restoration and stress relieving properties (Ulrich et al. 1991, Ohly et al. 2016a) which can reduce anxiety (McMahan and Estes 2015). In line with Attention Restoration Theory (Kaplan 1995), the focussed, repetitive activity of collecting enables collectors to benefit from being away from everyday stresses whilst engaging in an activity which they are intrinsically motivated to undertake, in an expansive environment. In doing so, collectors restore their attention, or focus, arming themselves with a better mood, clearer mind, better decision making skills, increased feelings of self-control as well as improving other aspects of health (Kaplan 1995, McMahan and Estes 2015, Ohly et al. 2016a). Qualitative research conducted with anglers in Western Australia suggested relaxation and stress-relief are key benefits of angling (Hunt and McManus 2015). Further, angling interventions for disaffected young people in the UK identified stress and anxiety reduction as key outcomes (Djohari et al. 2018).

2.4.4 Collection activities, nature connectedness and evaluative well-being

In line with evidence that direct engagement with nature through outdoor activities positively affects evaluative well-being (Biedenweg et al. 2017), my model exploring collection-related predictors of well-being identified a positive relationship between collecting (on the day of questionnaire completion) and life satisfaction. Similarly, a positive relationship between the frequency of gathering wild resources and life satisfaction was identified in the Puget Sound, USA (Biedenweg et al. 2017). Participants in some rural areas of the Puget Sound had significantly lower well-being, reducing gathering to a subsistence variable of need. Thus, people gathering frequently had lower life satisfaction in these areas (Biedenweg et al. 2017). In another study, comparing foragers to non-foragers of similar sociodemographics, the coastal resource foragers of Puerto Rico were found to have higher life satisfaction

Chapter 2: Linking well-being with motivations to collect coastal resources

and higher job satisfaction than non-foraging members of the community (García-Quijano et al. 2015).

Combining both circumstantial and coastal collection predictors of well-being, my data revealed that the number of leisure days spent outdoors was positively related to life satisfaction, highlighting the importance of outdoor activities on evaluative well-being. Although no conclusive research has been identified that links the number of outdoor visits to life satisfaction, Natural England's Monitoring Engagement with the Natural Environment (MENE) survey found that before models were adjusted for sociodemographic variables, number of leisure visits to the outdoors was positively related to life satisfaction (White et al. 2017). Once adjusted for sociodemographics, visiting nature more frequently (gaining more nature exposure) was positively related to eudemonic well-being, an aspect of evaluative well-being, specifically more positive feelings that the things adults do in their life are more worthwhile (White et al. 2017). The same research found that visiting nature yesterday also had a positive impact on affective well-being (happiness).

Visits to the coast have been found to elicit much stronger positive, restorative feelings (calm, relaxed, refreshed and revitalised) than visits to urban parks or open countryside, but not as positive as spending time in mountains, woodlands or inland waterways (Natural England 2019). Increases in life satisfaction due to leisure days outdoors coupled with the unclear impact of the act of collecting, may fit the 'biophilia hypothesis'. This states that ancestral humans' well-being was inextricably linked to engaging with the environment (for food and water), which manifests itself in modern humans as a deeply-engrained desire to interact with nature increasing overall subjective, positive affective and evaluative well-being (McMahan 2018).

2.4.5 Coastal proximity and mental well-being

Coastal proximity has been found to be positively related to mental and physical health (Wheeler et al. 2012, White et al. 2013b, 2014), with the biggest effect within 5km of the coast (Garrett et al. 2019), whilst I found that collectors living more than 1km from the coast had higher mental well-being than those living closer to the coast. However, this finding should be treated with caution due to several limitations.

Chapter 2: Linking well-being with motivations to collect coastal resources

Heavily skewed data, with most respondents living within 1km of the coast, meant that the current study was forced to categorise data into coastal (≤ 1 km from coast) or inland (> 1 km from the coast), rather than using established coastal proximity categories of previous research. With the high number of collectors living both rurally, and within 1km of the coast, several key determinants could account for the differences in results, as could national, urban, and rural differences, or the small sample size leading to more variance in the current study. For instance, in England the benefit of the coast to mental health has been found to be highest for low income, urban adults (Garrett et al. 2019) and the strongest association between coastal proximity and good health is in the most deprived areas (Wheeler et al. 2012). Broadly, visits to nature are thought to mediate the negative impacts of socio-economic deprivation (Bauman et al. 1999, Wheeler et al. 2012, White et al. 2014). Therefore any further work aiming to research the coastal proximity effect on well-being of coastal residents should determine coastal as < 5 km from the coast, and consider the use of income (which can result in higher proportions of missing data) and categories of rural / urban residency, taking advice from the most recent information available (White et al. 2020)

2.4.6 Implications

My results provide important impetus to the development of policies related to access and use of the natural environment that are mindful to the needs of those who are most vulnerable to change. For the collectors of coastal resources who participated in the current study, bait collectors appear the most 'well-being vulnerable' group. The effect of nature exposure on positive affective well-being (happiness) has previously been found to be stronger in older age groups (McMahan and Estes 2015) but there were a higher proportion of young collectors with low mental well-being amongst collectors, so the effects of nature exposure may be reduced, or less clear in these groups. Policies focussing on provisioning services afforded by coastal resources (ie. money or sustenance), potentially by reducing access to them, risks putting some coastal collectors at serious harm if they do not include more subjective and relational needs (ie. for those depending on the activity for their mental well-being) (Doyle and Gough's Theory of Human Need, 1984,

Chapter 2: Linking well-being with motivations to collect coastal resources

described in fisheries context by Chaigneau et al. 2019). These findings provide evidence and areas for future work not only for the array of disciplines that informed my predictions, but also to human ecology researchers seeking to explain complex human-environment relationships and social-ecological systems researchers working towards transformative governance for more resilient and sustainable environments in future.

Furthermore, in a time when nature-based health interventions are being embedded in health policies around the world, aiming to provide multiple physical and mental health benefits especially to those of low well-being (Shanahan et al. 2019, Howarth et al. 2020), it seems collecting natural resources could already be providing those benefits to some of my respondents. Evidence already indicates there are individual and social benefits to engaging in activities including angling and wild resource collection, particularly for vulnerable groups (Freudenberg and Arlinghaus 2009, Monkman et al. 2015). In a rapidly changing world, both environmentally and economically, protecting the activities that bolster both human and environmental well-being is paramount, and therefore policy makers need to consider both in their decision making.

2.4.7 Limitations and recommendations

The results of this chapter must be taken in the context of several limitations. I highlight a method that can be used in future to engage and build trust with a wider audience, but the low number of respondents together with the high number of factors known to affect well-being mean that results should be interpreted cautiously before inferring casual relationships between collecting and well-being. However, this work paves the way for future work with a larger sample of collectors.

Future research should incorporate questions about income (Dolan et al. 2008, Stewart-Brown et al. 2015) to account for more variability in the well-being data and ensure more robust interpretation in relation to the Theory of Human Need. I have highlighted the effects of questioning collectors about well-being during or directly after the activities that may influence their affective well-being. Future interviews and participatory observations must consider this in their design and consider maximising

Chapter 2: Linking well-being with motivations to collect coastal resources

the positive affect on mood by undertaking discussions whilst, or immediately after collecting. A larger sample size, ideally sampling an equal number of respondents who have collected on the day of questioning and those who have not, is required to confirm the effects of collection on the different aspects of well-being.

My project has overcome major challenges of encouraging the participation of stakeholders who have been reluctant to declare their use of coastal resources. Future research can take several lessons from this. Asking about 'meanings' rather than 'reasons' for collection is shown here to offer a less contentious, yet similarly effective method. I have used quantitative, scalar questions to ascertain the importance of provisioning motivations to collect on well-being. However, qualitative questions are better at revealing more experiential values (meanings) behind collection. Focussing on the overall experience rather than, or in addition to, specific taxa is also a useful approach to understanding the motivations behind more experiential economies.

Finally, understanding the collectors through a well-being approach has successfully highlighted important factors motivating different users, their potential vulnerabilities and resilience to change. Further understanding these motivations by teasing need from choice may be important in understanding management implications and future compliance (Poe et al. 2014, Biedenweg et al. 2017, Nyman 2019). In the past, the taxa targeted by collectors together with the intensity and location of their activities have been the central focus in attempting to understand management of coast resources. However a more holistic approach to future management (Magee et al. 2018, Skubel et al. 2019, Thomas-Walters et al. 2020) may be gained by focusing more on how different 'typologies' (or 'user groups') and their well-being vulnerability motivates collectors, and hence drives demand for coastal resources.

2.4.8 Conclusions

The collection of coastal resources in the UK has been of interest to conservation managers since the 1980s, but as yet remains largely unmanaged and requires a transformative way of thinking to better understand the people and the activities involved (Fowler 1999, Hall 2013). My well-being approach has for the first time

Chapter 2: Linking well-being with motivations to collect coastal resources

successfully engaged a variety of Welsh collectors to learn about them, their target species, motivations and meanings, thus providing background information to inform methods for future research and management of these little researched, complex small-scale fisheries. The act of collecting has immediate restorative benefit, or stress relief, to collectors not gained by nature exposure alone. In a time where nature-based intervention programmes are being introduced to improve mental health and promote well-being (Shanahan et al. 2019), heavily regulating nature based activities on which people rely for food, income or as a means of stress reduction could cause undue instability to the people involved. Guidance aimed at reducing hunger and poverty, and including vulnerable and marginalised people in small-scale fisheries management using a human rights based approach, is already available but rarely consulted by managers of coastal resources in developed nations (FAO UN 2015). Alternatively, a positive well-being approach may provide collectors of coastal resources common ground and agency whilst encouraging their active engagement in a more sustainable future of both the resources and the practises most important to some. Incorporating this information into future management would ensure that interventions aimed at sustainable behavioural change are suitably tailored, and therefore more successful, and that conflict between different stakeholders and the environment is understood, reduced, or even resolved.

Chapter 3.

The hidden meanings of coastal resource collection: cockling, recreational foraging and other informal gathering

Authors: Elisabeth Morris-Webb, Stuart R. Jenkins, Freya A.V. St John

Author contributions: Liz Morris-Webb conceived the idea with support of supervisors Dr Freya St John and Prof Stuart Jenkins. Drs St John and Gittins assisted with theme development by reflecting on my interpretation and assumptions. The PhD candidate carried out all analysis and writing.

Chapter 3.

The hidden meanings of coastal resource collection: cockling, recreational foraging and other informal gathering

3.1 Introduction

As far back as the Middle Palaeolithic Period, up to 300,000 years ago, the collection of wild coastal resources contributed to Neanderthal and human diets (Fa et al. 2016), securing vital nutrients that contributed significantly to human evolution (Broadhurst et al. 2002). Coastal collection, also known as foraging, gleaning and hand gathering, remains important, contributing to food security and income for many people in both low income and more developed nations (Sachdeva et al. 2018, Grantham et al. 2020). With growing pressures on our global coastal populations from climate change and the major economic downturn following the 2020 Coronavirus pandemic, availability of these resources may deplete whilst simultaneously the human need for them increases (HLPE 2020, Steven et al. 2020). The 'lockdowns' of 2020 have already resulted in residents of urban areas in developed countries, including the USA and UK, exploring their green spaces in search of food (Allan and Abadi 2020, Ponsford 2020), in line with recent research in the United States and historical evidence in Europe, that reliance on wild harvests increases during times of hardship (Łuczaj et al. 2012, Sachdeva et al. 2018).

Researchers and policy makers are increasingly recognising that the collection of wild resources provides participants with benefits in excess of food and income. In Timor-Leste, coastal gleaners value the social opportunities, knowledge, peace and connection to nature afforded through their activities (Grantham et al. 2020). Coastal communities in Puerto-Rico have developed their own cultural 'consonance', a shared cultural understanding where people forage less out of need, but instead as a preference to the stability offered by more formal economies (García-Quijano and Poggie 2019). In New Zealand, immigrant mushroom foragers reported that their activities connect their nostalgia for 'what they grew up with' to their present habitat, giving them a new 'sense of place' (Hall 2013). In the same study, second-home owners expressed that collecting shellfish was an integral part of their second-home

Chapter 3: Hidden meanings behind coastal resource collection

lifestyle, a healthy recreation and leisure behaviour that adds to their culinary enjoyment. The collection of wild food from salt marshes in the UK has also been linked to the human well-being domains of health, social cohesion, spiritual and cultural fulfilment, connection to nature and living standards (Rendón et al. 2019). Reviews of ecosystem services provided by wild cockle gathering revealed strong cultural and heritage values, including symbolic value in folklore and art that have been linked to national identity (van der Schatte Olivier et al. 2018, Carss et al. 2020), whilst anthropological research has revealed the importance of laverbread as a cultural keystone species for Wales (O'Connor 2009). Beyond these reviews, there is scant research examining the non-material benefits (e.g. well-being, way of life, personal identity) of contemporary coastal collection in the UK.

Many of the benefits deemed non-material by human geographers, or cultural by ecosystem services researchers, could be explored as 'meanings' by environmental psychologists and social scientists, and contribute to the difficult to measure 'relational values' increasingly explored to explain links between people and ecosystems from interdisciplinary perspectives (Klain et al. 2017, Stålhammar and Thorén 2019, Ryfield et al. 2019). A meaning can be defined as what a situation or action represents to a person, or the significance, purpose or underlying truth of something (OED 2021). Meanings make up a person's perception of reality that often defines, justifies or aides them in interpreting their actions or behaviour (Krauss 2005). What something means to a person will be defined by their underlying value system (including core, fundamental, personal moral and social values), together with their lived experiences (Krauss 2005). The meanings themselves will, in turn, provide guidance to the person on how to deal with life-experiences (Krauss 2005). 'Meaning-making' is the psychological process by which people construe, understand, or make sense of life, events, relationships, and the self (Ignelzi 2000), put simply a person's interpretation or personal opinion of a subject. Urban foragers make their meanings at the moment of picking, and in that moment attribute significance to that act for them (Nyman 2019). Analysis of meanings amongst shellfish gatherers in the Puget Sound found their nearshore activities important to their sense of place and belonging, through the process of 'place-making' (Poe et al. 2016). Meaning-making is also known to occur during the preparation and consumption of the forager's harvest (Nyman 2019). How people define the

Chapter 3: Hidden meanings behind coastal resource collection

meanings of these activities can be difficult to unpick as it is often taken for granted or axiomatic (considered self-evident, or unquestionable). As meanings can underlie motivations and interpretation of knowledge and situations (Krauss 2005), and link strongly to well-being and sense of place and belonging (Tsaur et al. 2014, Poe et al. 2016), it would be useful to understand meanings associated with coastal collection to better understand collectors motivations, and potentially their interpretation of future management implications on them as individuals.

In Wales, the Well-being of Future Generations Act states that public bodies must consider the impact of its decision making on the people living in Wales today and in the future (Welsh Government 2015). Policy makers and resource managers in the UK have been trying to engage collectors of coastal resources since the 1980s (Fowler 1999, Perry et al. 2014, Tinlin-Mackenzie 2018), so that dialogue on potential future management might take place (Bean and Appleby 2014). However, a reluctance to engage with managers, partly due to confusion over existing legislative frameworks, and fear of future management (Aron et al. 2014), has been a barrier to creating effective management plans (Bean and Appleby 2014).

Elsewhere in the world, fisheries researchers have started to acknowledge that engaging stakeholders using a well-being approach offers a 'bridging concept' to better appreciate competing interests, thus minimising future conflict (Coulthard et al. 2011, Britton and Coulthard 2013). To fulfil their obligations under the new Well-being Act, resource managers in Wales need to engage people undertaking currently unregulated activities to comprehend how any future management might impact upon them and their collection activities. This includes understanding both instrumental values (e.g. income or food) that people gain from coastal collection, which can easily be replaced, and relational values (e.g. sense of place or cultural identity, often built from the meanings people place on their activities) that are irreplaceable for some people (defined by Grantham et al. 2020).

In this study, I ask '*What is the significance and purpose of collecting coastal resources to the people in Wales?*'. Building on previous philosophical, anthropological, psychological, sociological, geographical, ecological, health sciences and fisheries research around the world, I hypothesise from a human ecologist's perspective that collection of coastal resources goes beyond simply a need for food, money or fun, and has deeper meanings for many of the people

Chapter 3: Hidden meanings behind coastal resource collection

involved. I sought to unpack the meanings (significance or purpose) behind coastal resource collection as reported by both regulated and unregulated collectors of any coastal species in Wales.

Human ecologists and psychologists have increasingly been calling for investigations that recognise and explore the complexities of human-nature relationships and their meanings whilst avoiding narrow, reductionist tendencies, to work towards a more holistic approach to managing our 'one system' planet, referred to by psychologists as 'One Health' (Borden 2008, Brymer et al. 2019). Consequently, I used a critical realist epistemology, with an open, almost semantic approach, grounded in participant data (Krauss 2005, Braun and Clarke 2020), to understand meanings behind people's coastal collection. Through engaging with coastal collectors, I examined: 1) what gathering from the seashore means to collectors; 2) associations between collection and personal identity; and 3) heritage values of collection. Recognising that there are some 'universal solidarities' in critical realism (Bhaskar 2020), the data are explored to elucidate if 'types' of collectors can be defined based on common meanings or values associated with their collection activities. Identification of collector types reveals nuances in the priorities and concerns of different collectors and their vulnerabilities to changes in management (Grantham et al. 2020, Grivins 2021), highlighting the importance of identifying different common ground with which to engage participants from a breadth of stakeholder groups and, if necessary, using this information to tailor future conservation interventions. These insights are discussed in terms of their applicability to policy and management.

3.2 Methods

3.2.1 Study area

Situated on the western side of the UK and with 2,794 km of coastline, Wales is a country famous for its seafood. Traditionally for cockles (Jenkins 1984) and its seaweed delicacy, laverbread (O'Connor 2009), but also for being home to the biggest shellfish (mussel) farming area in the UK (Hambrey and Evans 2016). No peer-reviewed studies exist on the non-monetary benefits associated with these traditional activities in Wales in the ecological or fisheries literature. However, strong heritage values are reported in grey literature and recent anthropological research on both laver and cockle industries (Jenkins 1984, O'Connor 2009, 2016). In 2014, a review into intertidal collection revealed that at least 41 species were being collected around the Welsh coast, including a range of intertidal invertebrates and seaweed for food, bait, and money (Perry et al. 2014). This review highlighted the gaps in knowledge of who is collecting these species and why.

Commercial cockle fisheries at selected sites are the only regulated and actively managed 'hand gathering' coastal collection activity in Wales under the Sea Fisheries (Shellfish) Act 1967 (Bean and Appleby 2014), with licenses for the hand gathering of mussels for commercial purposes (Welsh Government 2021a) and a recent Byelaw prohibiting the collection of razor clams at one site (Welsh Government 2021b). A historical 'Right to Fish' is often cited by collectors (Hall 1875), but there is no standard customary right to collect food, bait or fertiliser, commercial or otherwise, and instead there is a confusing suite of complex legislation (CCW 2010, AFBI 2011, Bean and Appleby 2014). Despite the Well-being of Future Generations Act, introduced in 2015, none of the current Welsh legislation regarding coastal resource collection references or makes provisions for the contribution of gathering activities to human well-being. However, as the Welsh Government and its national conservation agency, Natural Resources Wales, moves towards future management of coastal resources (Bean and Appleby 2014), it is important that the hidden meanings of coastal collection and the importance of the 'Right to Fish' are better understood. This will ensure future management is achievable, encourage compliance to any new management measures, and also

minimise the potential effects of management on vulnerable groups of collectors in Wales.

3.2.2 Data collection

Between July 2018 and April, 2019, participants were either approached by me during 94 beach visits across Wales, identified via snowball sampling, or contacted me having seen project adverts distributed through social media forums, national and local press. To be eligible for inclusion in the study, respondents must have collected living resources from a Welsh beach in the preceding 12 months.

Free prior informed consent was sought from all respondents prior to participation. Personal Information Sheets (PIS) detailing the project aims (*“Assessing the well-being and heritage values of beach collecting in Wales: Personal value. Family. History. National Identity”*)³, how data would be used, and how anonymity would be protected were given to all participants ([Appendix B.1](#)). The study was approved by Bangor University Ethics Committee (approval number CNS2018EMW01).

A qualitative approach to data collection was utilised, through semi-structured interviews that enabled spontaneity and the emergence of related meanings from collectors. The semi-structured interviews were based around a topic guide ([Appendix B.2](#)) comprising three topics (asking them what gathering means to them, their personal identity and if they consider it to have any cultural or heritage values) together with one probing, reflective question prompting collectors to express how they felt the last time they collected on a day of exceptionally bad weather. The reflective question was longer, giving the respondent time to think and provide a more in depth response (Newing 2011). The opportunity to reflect aimed to draw more personal experiences and feelings from participants to compliment meaning-making, particularly in relation to axiomatic (taken for granted, or self-evident) values people place on nature (Stålhammar and Pedersen 2017, Young et al. 2018). Interviews were conducted in person after a beach collection, at pre-arranged times at non-beach locations, or by telephone. Wherever possible, interviews were

³ If asked, I explained to participants that my research was driven by my realisation that collectors are largely unrepresented, under-appreciated or forgotten in both the literature and management decision-making processes. This ambition was printed within the PIS and associated brochure with the overarching ambition to *“provide evidence towards preserving gathering from the seashore for future generations, whilst showing that our Welsh activities have value on a global stage”*.

Chapter 3: Hidden meanings behind coastal resource collection

undertaken with a single collector, although some interviews were with two collectors simultaneously. Sampling continued until a sufficient range of collectors were interviewed, no new ideas were being discussed and saturation was reached (Newing 2011). All interviews were audio recorded and transcribed verbatim prior to analysis.

3.2.3 Analysis

The aim of the research is to inform ecosystem services frameworks and ecosystem based management approaches, whilst avoiding a theoretical or codebook method utilising existing cultural ecosystem services literature that often relegates foraging activities either to recreational or provisioning services (Poe et al. 2016, Stålhammar and Pedersen 2017, Gould et al. 2020). In recognition of the researcher's previous knowledge and assumptions, a (critical) realist epistemological approach, more semantic than constructive, was taken to reflexive thematic analysis (Braun and Clarke 2019), acknowledging that both my values together with those of the collectors themselves will affect my development of meanings (Krauss 2005), but recognising that these also may show some common characteristics between individuals (Bhaskar 2020). Initial codes were developed line-by-line based on interesting features in the data. Following Braun and Clarke (2006), coding was a systematic, iterative process conducted in NVIVO. Each time a new code was generated, all previous interviews were revisited to check for its presence. Codes included anything that the collectors felt was relevant to the meaning of their collection activity to them (including what may be considered interesting digressions from the topic guide, such as threats including fears for the future, management, or user conflict).

Themes were generated based on common patterns in the words, concepts or ideas within and across codes (central organising concepts, Braun and Clarke 2019). To minimise impact of my preconceptions and bias from previous experiences, themes were developed from further exploration of the data, reflecting and returning to the themes in context of newly explored theoretical anchors as recommended by Braun and Clarke (2020). After identifying and re-analysing the interviews and codes within themes, subthemes were generated from codes that appeared to stand alone. The same data were frequently coded against multiple themes, suggesting a high level of

Chapter 3: Hidden meanings behind coastal resource collection

pluralism and associations between themes that are discussed as mutual, or cross cutting, subthemes below.

Reflexive analysis is grounded in the interpretation of qualitative data and is therefore typically a deep and thoughtful subjective process undertaken by a single researcher. Whilst all coding was conducted by myself, Drs St John and Gittins assisted with theme development by reflecting on my interpretation and assumptions. To do this, they looked at my research questions, theme descriptions, 10% of the interviews and the initial code book complete with example quotes from the data.

Finally, cluster analysis, whereby interviews are clustered by coding similarity was conducted. Cluster analysis groups interviews together based on similarities in all codes and sub-codes (utilising Jaccard's coefficient). Collector type summaries consider the main codes which were applicable for 100% of respondents in the cluster, and also note codes contributing to greater 60% similarity within the group. This analysis enables the identification of 'types' of coastal collectors based on what collecting means to them.

3.2.4 Researcher Positionality and Assumptions

The grounded generation of meanings, personal identity and heritage can be sensitive topic areas for participants, particularly if reflecting on any lived experiences during an interview has resulted in a realisation of the importance of their activities to them. I was also aware of the reluctance of many collectors to engage with researchers and managers in the UK (Aron et al. 2014, Tinlin-Mackenzie 2018). As a result, I was cautious about how I and my research was presented, as it would affect both the understanding of the project and the information participants might be comfortable to give (Moser 2008). I have previous experience of working with collectors, fishers and conservation agencies in Wales as a marine ecologist, and am a collector myself, so I was keen to present an honest and balanced view of myself and my research ambitions. Importance was stressed in both the transparency of research aims and in ensuring a positive, relaxed, conversational approach to build trust to talk freely about any sensitive, sometimes

Chapter 3: Hidden meanings behind coastal resource collection

personal meanings or issues surrounding their activities. In writing this chapter, I now consider myself more a human ecologist in seeking relationships between nature and the environment, and hope that explaining these relationships will be useful in developing more holistic, reactive and sustainable (transformative) governance in future.

3.3 Results

Thirty-two collectors were interviewed in 27 interviews ranging from five minutes to one hour and twenty minutes in length. What collecting from the seashore means to participants generated 65 codes for analysis from which four main themes were developed: Provisioning, Nature Connectedness, Health and Well-being, and Personal Identity, together with nine subthemes (eg. Being outside, Social and giving, Enjoyment, Nostalgia, Knowledge, Way of life, Sense of place, Heritage, and a Hunter-gatherer persona) and one super-theme, Sustainability Concerns (Fig. 3.1). The results highlight the complexity of meanings participants associated with coastal collection, with several examples of pluralism between themes and subthemes, resulting in three strong mutual subthemes (Being Outside, Knowledge and Nostalgia) that could not be allocated to a single theme. In the following sections, using quotes for illustrative purposes, I present each theme and explore relationships between themes. Detailed summaries of all codes and themes, with more quotations, are provided in [Appendices B.3 and B.4](#).

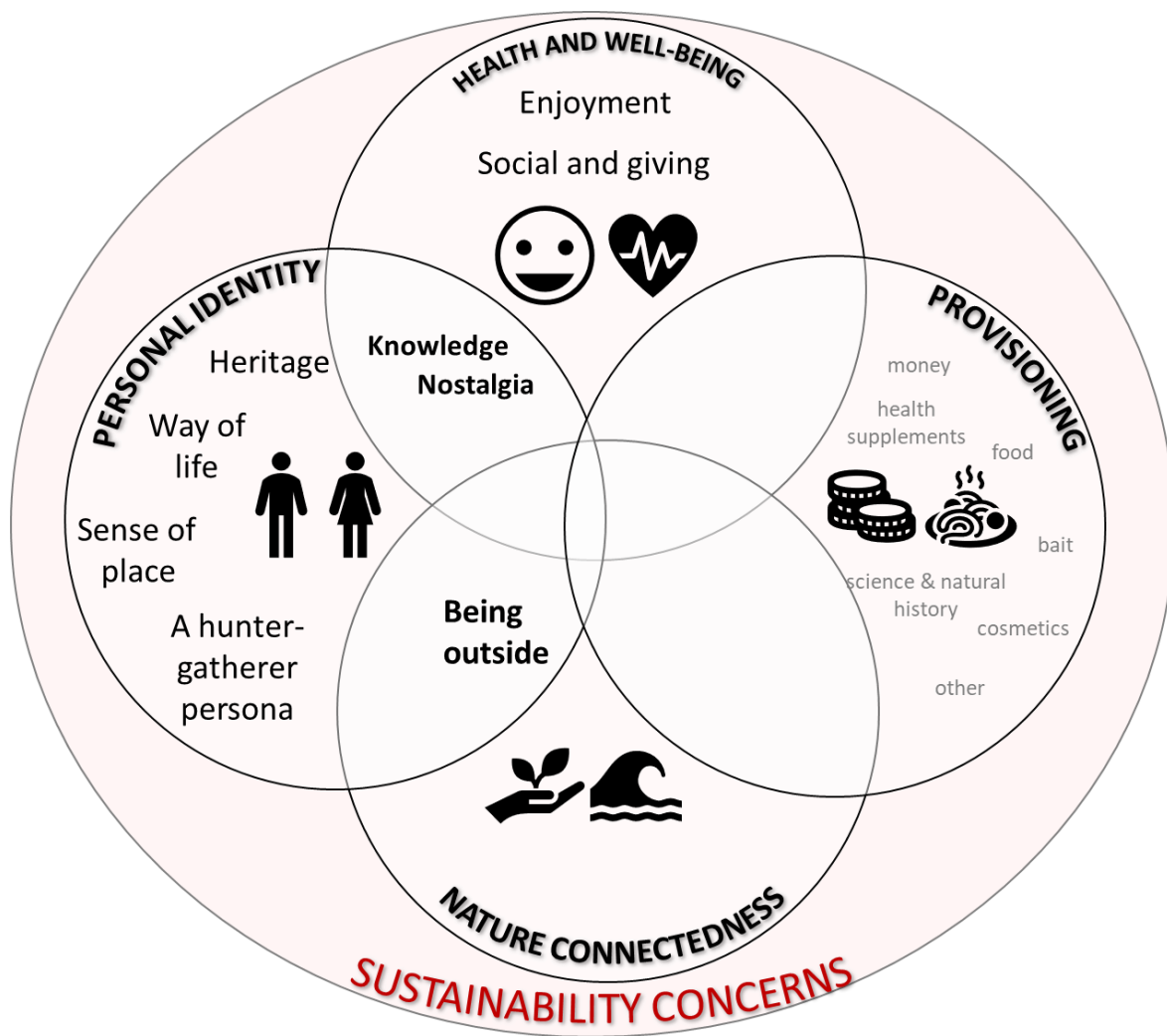


Figure 3.1. Meanings coastal collectors in Wales associated with their activities grouped into four main themes: Health and Well-being, Provisioning, Nature Connectedness and Personal identity. Nine “meanings” subthemes are depicted using black lowercase text; seven “material” sub-themes associated with the provisioning meaning of coastal resources are provided in grey lowercase text. The subthemes of Knowledge and Nostalgia were mutual subthemes of both Health and Well-being and Personal Identity whilst Being Outside spanned Personal Identity and Nature Connectedness. Sustainability Concerns was an overarching super-theme.

Chapter 3: Hidden meanings behind coastal resource collection

3.3.1 Provisioning

(relevant to 31 respondents)

Whilst most interviewees collected coastal resources for food or money, others collected for reasons including bait, health supplements, medicine and making their own art materials. Some also collected for research, citizen science or natural history interest, including creating herbariums. Their target species were not discussed at length, but included everything from commercial shellfish, laverbread, bait worms, other seaweeds and coastal plants. When discussing collecting coastal resources to eat, interviewees reflected on an appreciation of knowing where their food comes from, the joy of preparing it, the independence it gives them from supermarkets, and even from societal expectations:

"The freedom you know for me, I am obviously creative. So, it's nice to learn more about you know the creative side of things and having that freedom to, to create stuff with, well the stuff that surrounds us like ... You know what you are gathering so you know what you are eating, that's for one. So, it's a good source of you knowing where your food comes from." Participant 1.

Discussions around both food and money revealed that some collectors would rely on their harvest for sustenance or money, particularly in times of hardship:

"Well, one time it was almost a way of staying alive [laughing] because when I was young, things were very hard to come by ... So, I had it in me from an early age for some reason to provide or supply food for the house and for myself as well." Participant 2.

"I think everybody in [a coastal town] collected [winkles] at one time. Everybody I see. They might go out of work for a few months and, you know, do the winkles. Just like a step forward towards another job. So, it's something to fall on ... It helps people if you're on hard times." Participant 3.

Chapter 3: Hidden meanings behind coastal resource collection

3.3.2 Nature Connectedness

(relevant to 22 respondents)

"It's understanding the way of the shore works, and the way the beaches work. It's understanding it all. You know, seeing nature, and working alongside nature." Participant 4.

Many collectors mentioned their collecting activities in relation to nature and the environment. Some feel they develop a greater appreciation and closeness to nature whilst collecting. Others sense that the environment and nature elicit feelings of insignificance. Several people speak of foraging as a tool to help children develop a deeper connection with nature:

"You know kids have stopped going out. You know there is no connection there anymore. They are all on their X boxes or ... on their phones ... I think foraging could be a massive thing just to get people back to the planet you know. You know getting that connection back ..." Participant 1.

Observing the seasons pass whilst interacting closely with the species and habitats seemed to give participants a deeper connection with nature. They notice changes on the beach or in the species they find, often with great attention for detail. For some people this helped them plan their year, for others its watching nature take its course over the months and years:

"There is just something really special about being out there, sitting on a rock and watching things... I've been sea-weeding in the same places, it's interesting to see how things have changed on those particular beaches." Participant 5.

"I look forward to the seasons and what animals are about and what crustaceans are there ... it gets me through the year. " Participant 6.

3.3.3 Health and Well-being

(relevant to 30 respondents)

"I feel the best when I am out foraging, I forget about everything and I properly get excited about finding stuff." Participant 6.

This broad theme comprises eight codes all directly related to health and well-being, although some aspects, as illustrated in the quote above, were intrinsically linked to identity. Meanings encapsulated in the Health & Well-being theme ranged from collecting giving participants a reason to get out of the house, physical fitness and exercise (particularly for digging activities) to a suite of sub-codes related to mental health including solitude. Many collectors appeared to 'seek refuge', solitude, escapism or even freedom from their collection activities:

"We are becoming increasingly overpopulated and there's so many crowds. Going to the beach collecting gets you away from that ... we need a bit of alone time and space and that's becoming increasingly more difficult to find." Participant 7.

Many collectors suggested that the repetitive act of picking provides feelings of restoration or respite from anxious thoughts, or a stressful life, helping to focus the mind:

"It's really strange because you get into a rhythm, you get into a routine and all of a sudden, the movement of gathering cockles ... that rake, you are moving, moving, moving ... So, before you know it you are on this treadmill and you are starting to get this competitiveness in yourself where you are trying to keep up with the water, keep up with the cockle flow ... and before you know it you are into this rhythm of pattern that's almost like a frenzy." Participant 8.

Some collectors described how their collection activity was a therapy for stress at work, clinical depression, anxiety, bereavement or helping them cope with learning disabilities or differences, and life in general. One recreational forager believes his new-found hobby has saved his life:

Chapter 3: Hidden meanings behind coastal resource collection

"I have had 10 operations ... My passion was [hobby], I played [hobby] for 34 years and literally overnight I couldn't play [hobby] again ... this has replaced that passion that I had. Just be on the beach and the science side of it has replaced that passion that I had ... It's, it's massive, massive, massive value yeah, even save your life value ... I ended up with severe depression ... And until it hits you don't understand ... I don't think I am completely back to where I was, but I am a lot, lot nearer than I was. And [collecting] has helped immensely with that." Participant 9.

For some, coastal collection has become a career, and whilst this was positive for most, with commercialisation comes demand and work-related pressures and stresses:

"I did for a couple of years forage for a restaurant where they asked me to get specific things ... And I found that incredibly stressful ... To the point where I was not enjoying doing it." Participant 10.

For others the work-related stresses of commercialisation were amplified by depleted stocks and perceptions of poor management decisions:

"But then since 2000 it's all upside down and we thought then this mass mortality the government will go and sort this out. Now we are 19 years later, and we are still none the wiser. So ... the stress, everything and that I have seen, and we have all gone old And none of us put anything away for our pension ... because you haven't earned enough money..." Participant 11.

Health & Well-being sub-theme: Enjoyment (relevant to 17 respondents)

Enjoyment was cited in many forms by most participants: entertainment, fun, the thrill of the find, the excitement of the identification or the wonder at what you might find tomorrow. When discussing collecting, interviewees referenced feelings of happiness and excitement:

"There's nothing more fun than being at the beach at super low tide and you have got this little razor clam squirting jets of water at you that you are trying to catch." Participant 6.

"You have got to do it [picking winkles]. We don't have to do it, but I love doing it..." Participant 12.

Health & Well-being sub-theme: Social and Giving (relevant to 23 respondents)

Connecting with people, be it through collecting together (*“something you are sharing together as a family, having fun”*), working the sands together (*“and the banter, you know, with the boys like”*), teaching, or connecting virtually with like-minded people was another strong sub-theme within Health and Well-being. For some, connection can be through giving or sharing their catch, like the seaweed picker below, or for others it is sharing stories and experiences.

“We sometimes have whole dinners where everything has seaweeds in it, including the pudding. And they don’t realise it, until you tell them.” Participant 5.

For many passing on knowledge to others was an important part of collecting for them, sharing and giving through teaching skills or as data towards citizen science projects:

“I started off looking at the beaches because I was horrified with school children who didn’t seem to know where simple food stuffs came from. I then devised survival activities for school children ... The idea being that we wouldn’t have a supermarket in sight, and they would learn how to survive. And it was good for children’s problem solving, decision making, cooperative working, communication skills, but also learning about the environment in which they live, and they need to respect.” Participant

13.

3.3.4 Personal Identity

(relevant to 31 respondents)

Collecting from the seashore was found to be an integral part of all participants’ identity. However, this is not unexpected as the study likely only recruited people who have a strong affinity for coast collection. Some participants explicitly stated that their activities were part of their identity, often giving a reason why. However, a more nuanced understanding of how coastal collection is intrinsically linked to personal identity is revealed through reporting of the four sub-themes of Personal Identity.

Personal Identity sub-theme: The Hunter-Gatherer Persona (relevant to 22 respondents)

Some participants described themselves as hunter-gatherers and survivalists keen to use their ancestral knowledge and pass on survival skills to the next generation. There was a strong feeling that collecting from the intertidal is part of our human hunter-gatherer instincts:

"Foraging is very important because it's something that appeals, if you like, to the human spirit because it's our link with when we were, you know, hunter gatherers, long, long ago. ... You know we have lost that, we expect you just go along to the shop and you buy whatever you want from the shop. But if you can get people to see that they can also still go out hunting, gathering then that is something which connects them with their past, connects them with life." Participant 14.

The "joy of the treasure hunt" was important to many who revelled in the challenge, satisfaction, reward, but also the achievement and pride in their activities. Particularly prominent under this theme, were the participants who lived for this challenge, as suggested by this commercial cockle gatherer:

"That's the thrill of it, it's that's who you are and its' challenging conditions that you are kind of privileged to be in the position to do ... The best stories you have got to take with you is on those challenging days. You will always remember those challenging days, you have been out on the sands for hundreds of days over your life however the ones you remember are the ones you shouldn't have gone, the days that it was probably the day you should have had a day off. But you went there, and you can say it because you went." Participant 8.

Different people find challenge and satisfaction in different ways. The same commercial gatherer says that collecting laverbread and winkles does not present the same challenge for him as gathering cockles, despite collecting all three species himself:

"You don't get the same satisfaction [with laver picking] ... anybody can do it really, it's not a skill involved ... I challenge [the kids] to pick cockles and they couldn't.... and even winkles, ... they could fill the bottom of a bucket. But when they go to the sands and pick cockles it's very different."
Participant 8.

Chapter 3: Hidden meanings behind coastal resource collection

Conversely, a commercial periwinkle picker reflects on what the satisfaction and sense of achievement he gets from a good haul of winkles, compared to his alternative income in a factory:

"It doesn't matter what I feel good or not. I go on the winkles, and when I get home then I know that's something." Participant 15.

In addition to their thirst for challenge, many participants viewed coastal collection as their human right, which appeared key to their persona. One recreational forager described his right to collect as “*sacrosanct*”, others as a “*fundamental human right to access nature in any way*”. Although some realise that coastal resources are finite and that as collectors, it is fortunate that not everybody has an urge to collect:

"I view it as something that is inherently my right to do. And [it] is everybody's right to do should they choose to collect these things from the shore. And it's beneficial to me that everybody doesn't exercise their right to do so." Participant 16.

Personal Identity sub-theme: Sense of Place (relevant to 14 respondents)

"It makes you feel part of everything, it makes you feel insignificant." Participant 17.

Connections to place, or a heightened sense of belonging in a physical context emerged through participant's descriptions of either feeling connected to their local area through their activities bonding them to their beach, or through sensing place through their activities after moving to the area. Some have found their place in the community they have met through their activities. The participant below describes his wife, who moved to the country as an adult, providing a rich narrative on how she seems happiest when on the shore:

"[my wife] comes from Indonesia... she has been raised foraging. All of her life, medicinal... plants, food, spices, grown freely and, and that was, that's part of her make up. And then it comes to marsh samphire there's nobody like her gathering marsh samphire because she can squat with her bum an inch above the mud for an hour ... she is really, really good at it." Participant 7.

Chapter 3: Hidden meanings behind coastal resource collection

Personal Identity sub-theme: Heritage

(relevant to 20 respondents)

Participants discussed heritage under three main areas: family, local or cultural heritage. Many participants linked their activities to a strong family tradition, or heritage, some as commercial cockle gatherers, laver or winkle pickers, others as recreational foragers whose parents had needed, or wanted, to collect for the table.

"Our history is very, very deep... My earliest recollection of working in the industry was ... as a young kid just my dad going to work every day ... He would come home and tell you and your mum, because your mum was involved as well, my grandparents were involved ... It was a family environment, so I would come down to work here or play here as a kid, see them all doing what they are doing, take a ride out on the sands on the tractor." Participant 8.

The same cockle gatherer is proud of his family heritage, but also the local traditions of cockle gathering in South Wales, as a laver picker also recollects:

"I want to pass that onto the next generation. My next investment is to make a shop with a heritage centre there so that people can come in and learn about cockles and know what I have done, my father has done, my grandfather has done, my great grandfather has done, and I want to celebrate that. And not just us because everybody did it in this village, people continue to do it. And I want to celebrate what they do." Participant 8.

"Before that [1972, when his family started processing] laverbread was predominately made in South Gower. It was processed then by local market gardeners for the local markets in Swansea, Neath, Carmarthen, Port Talbot. And that is generally, to this day, where the laverbread market lies. Although it's not such a big market as it was years ago ... It was made to feed the copper industry, the tin industry, you know, in the South Wales area, you know, years ago. And the coal miners. It was a working man's food." Participant 18.

Often the laver and cockle industries were perceived more as a local tradition, possibly a cultural practise, rather than as part of the Welsh cultural identity. Foraging instructors and local businesses use the local heritage angle to advertise products or experiences (*"We tend to use laver in things because it's Welsh, and it*

Chapter 3: Hidden meanings behind coastal resource collection

has that historic attachment to Wales.”), or develop new culinary ideas based on local traditions:

“The food I’m producing is based on the Welsh landscape. So, we might look at the littoral zone and things like that. There’s a new dish that I’ve been working on today actually that will be based around rock pools you know” Participant 1.

Cultural heritage was most often discussed with respect to non-British cultures, with participants sometimes claiming that the British have lost this popular tradition still practised in many nations, instead linking the ‘culture’ of shoreline collection more with European, Russian and Asian heritage. For some, like the recreational forager below, these were personal connections, others made observations regarding other collectors they had met.

“I was born not long after the war and my parents had moved from London to live in a very small place in [Wales]. My father was Russian [and] my mother was a Londoner, so they both came fresh to living in the country really ... And he was interested in what could be foraged from the outdoors, because he was Russian he was part of the tradition of collecting mushrooms in the forest every Autumn ... it was kind of in the blood in a way, he had been doing that all his life really ... So, it’s always come naturally to me to use what I can get for free out of doors.” Participant 19.

Some collectors reflected on the ‘human heritage’ of collecting, how our species was built on foraging, which related to the ‘hunter-gatherer persona’ subtheme previously presented. Others reflected on how foraging for food was very common until the mid-20th century, especially post-war, and was almost considered a ‘pauper’s need’ rarely introduced to the next generations, rather than a local commodity to be proud of.

Personal Identity sub-theme: Way of Life (relevant to 13 respondents)

“It is part of my everyday existence now. I live, breathe and sleep seaweed”. Participant 13.

Chapter 3: Hidden meanings behind coastal resource collection

Often collectors specifically mention that foraging, collecting or picking is their way of life. Sometimes 'way of life' developed through interviews during thick descriptions of their lives.

"Just totally considering how much fun I have from foraging and what it means to me, obviously it is part of my life ... You know foraging is really and basically my, like my hobby, not my hobby, my true love of the foraging turned into be a job." Participant 6.

"I needed to do something to get myself off the dole and that's opened the door. But obviously since then the gathering has become my way of life ... sometimes you are working in the early mornings, then you are working lunchtimes, late afternoons, early evenings ... Unless you actually work at the sea you are not going to work with those sorts of cycles. But over the years you start to get used to it and you start appreciating it." Participant 20.

3.3.5 Cross cutting themes, and relationships between themes

Describing the interviews makes it clear that most themes and subthemes overlap. However, three subthemes were strongly related to multiple themes, indicative of particularly important pluralistic relationships.

Mutual subtheme: Being Outside (relevant to 16 respondents)

Being outside, invigorated by the weather or challenged by the environment, was a key feature of both Nature Connectedness and the Hunter-Gatherer Persona aspect of Personal Identity:

"When you leave the shore to pick cockles you are going into unknown territory where no other man wants to go [laughing]. Where people lose their lives, where it's that excitement that adrenaline and then your skills come into it ... So, you are going into an environment where you feel you have got control of." Participant 8.

Chapter 3: Hidden meanings behind coastal resource collection

Mutual subtheme: Knowledge

(relevant to 25 respondents)

Interest, intrigue, fascination, learning, knowledge of the environment and the species and practising learned skills are all key aspects of subtheme 'Knowledge', which contributes to both Health and Well-being and Personal Identity.

"When you are gathering things, you are learning more as well." Participant 1.

"The experience he's got of it is phenomenal. He can tell what beach a seaweed comes from by the colour of the sand by the colour of the sand that's washed out of the seaweed ... And my mother... she knows by the feel and the look, and how the laverbread is being processed, you know, it's gonna set ... He learned it from a guy, you know, that he was supplying. He bought laverbread in Bishopston. And he taught him the ropes step by step, and in later years then, he bettered it ... we bettered the process." Participant 18.

Mutual subtheme: Nostalgia

(relevant to 16 respondents)

Nostalgia for childhood memories, ancestral 'ideals' and as a way of connecting to people of the past (deceased or absent) were commonly discussed by participants, both in the context of Heritage but also Enjoyment and Knowledge, practising their learned skills and through sharing (Social and Giving).

"It's been a personal thing to me, when I was a very young, probably you know six or seven years old my grandad used to take me down the beach picking periwinkles and mussels and you know whatever was on the seashore. So, I think it's always been a part of my life." Participant 21.

Supertheme: Sustainability Concerns

(relevant to 24 respondents)

Sustainability concerns were underpinned by perceptions of changing society, environment or policies and management, but also potential conflict other beach users and managers or regulators. The resulting fear of loss of collection practises and species reveal hidden meanings behind their activities that were not always

Chapter 3: Hidden meanings behind coastal resource collection

expressed by interviewees through line of questioning in the standard interview guide.

Threats to heritage was the most prevalent discussion point, partly due to lack of uptake from younger generations and partly due to regulations on some commercial activities:

"I know there was another [species] man locally, but he seems to have faded away ... I understand that's what's happening in Scotland ... people are just retiring there's no one else, nobody wants to come in and take them over ... Because the other issues that you have today which you never really had in the past is permits and licensing and requisites to attend courses to be able to do simple activities ... As soon as you go above the personal use it becomes a commercial activity which is now regulated ... I have even had to attend a hand gatherers course [every three years] with no guarantee of being given a license or permit." Participant 20.

Threats to stocks from pollution, lack of regulation or poor management of declining stocks were the second most prevalent type of sustainability concern introduced by the interviewees, often revealing areas of conflict between different collectors as well as other beach users and managers:

"Look at all the restaurants in London that are using wild and gathered stuff. There's a guy actually that gathers commercially. And you know he has got guys going through the lanes and stuff at this time of year, and they are gathering like bucket loads of primroses to sell to chefs in London. So, there's this knock-on effect there you know if you are gathering that many you know that many flowers that are important to the bees and the insects and then in turn the birds. You know on that scale it's not right really is it? It's not meant to be that way I don't feel." Participant 1.

In the minds of some, the conflicts were not always well placed, with local residents also starting conflicts with collectors, leading to managers making assumptions about the motivations of collectors and legislating. When describing 'mass collection events' seen across Wales, where hundreds of collectors have been noted to descend on beaches, one recreational forager and informal gatherer described:

"...very soon you had hundreds of people coming and it would become a sustainability issue. And they had to obviously they had to legislate in the end. But the funny thing was the people that were

Chapter 3: Hidden meanings behind coastal resource collection

complaining the most hadn't set food over that bridge onto the beach for 15 years. And these are the people that were complaining about other people coming there and making off with their shellfish you know?" Participant 7.

Misperceptions over what people are collecting for was mentioned by several collectors, raising concerns again over mismanagement, but also the nuances related to how collectors see themselves compared to other collectors:

"Someone did describe us as foragers, and that's part of the problem. We were educating people of the huge benefits of seaweed and what lay on the shore, and then people would go down, as they saw it, and collect. We have been regarded as part of the problem. I've never heard of education being part of a problem before, but it's something that has stuck in my mind. Stuck in my throat in fact. Because I don't regard us as part of the problem, because ... we are actually telling people about sustainability, and conservation, looking after the environment, how the environment is inter-twined between the flora and the fauna, and how to we have to look after it." Participant 13.

Lack of standardisation and transparency in the regulations, permitting and subsequent management was reiterated by several collectors, both commercial and recreational. Some collectors were concerned for their stocks, some for their business, and some for the sustainability of both. One foraging instructor talked at length about how she had tried to get the correct permissions to take groups to coastal forage on their local foreshore and sand dune:

"I should have more permission than I do, but I have an understanding locally... it could get me into trouble ... I am happy to be open about that because I have genuinely tried to be legal if you like ... professional about it, and contact the people I need to contact to ask permission to do what I'm doing. And it's almost impossible ..." Participant 10.

A long description followed on how they been referred to local landowners, their solicitors, and a chain of people in the Government's conservation agency Natural Resources Wales. Comparing the process to getting permission to undertake similar activities in woodlands, they claim the process is not joined up for coastal foragers, with different people in different organisations leading permissions for different

Chapter 3: Hidden meanings behind coastal resource collection

habitats, sites and species. In addition to a chain of permissions, in some cases it is not financially viable, as some applications request that commercial businesses donate profits as part of licensing. Another foraging instructor has successfully managed to gain the correct permits for their area, but calls for more transparent legislation and active management to protect the sustainable future of their industry:

"I would have got a license but NRW said we are taking such a small amount anyway we will sort you out with a license if the Crown Estate were being a bit funny about it ... You know with the seaweed you don't need a license so like anybody can go out and do it ... So, I think there does need to be some kind restriction on there because ... people are not doing it properly, not cutting it properly ... You have got to be careful who you are taking out as well ... that stuff would be on Marks & Spencer's shelf ... before we know it. And then you know we won't have a business and the whole area will be wrecked." Participant 13.

A commercial shellfish gatherer has made it his mission to try and make the industry more 'formal', with his perception of how many are currently working in his sector:

"I'd like to see it develop properly, and I like it when I travel and see other organisations how they do it. I'd like to be involved in that, trying to make it a professional industry, rather than hap-hazard (with respect to people out there) of a few quid in pocket and down the pub. I'm trying to come away from that, give it a professional image. Because there are professionals out there for sure."
Participant 23.

The only actively regulated wild coastal hand gathering activity in Wales is the cockle industry, but the cockle gathering respondents with a long history of local and family gathering have lost confidence in the management of the fishery and have strong fears for the stock, their heritage, their livelihoods and their way of life, with an over-riding feeling of the system being unjust:

"In 2004 ... we had thousands and thousands and thousands of tons of cockles dying on the sands ... It wasn't killing the small cockles it was killing the ... larger cockles. So, what the Sea Fishery decided to do then was reduce the [minimum landing] size ... They reduced the size from 17.5 mm to 12 mm. So, I disagreed with that because what was happening there was you were taking the small cockles before they had even matured. 12 mm is very, very small. We had no market for them ... because of the mismanagement of the industry to be honest they still kept on with this 12 mm.... And what you

Chapter 3: Hidden meanings behind coastal resource collection

find then every year mass mortalities, mass mortalities.... it's still ongoing now ... I am not a scientist, but I have been led to believe that if you have sewerage in the water that's the best way to take oxygen out of the water ... And this is what kills the cockles, the fish in the rivers in Wales, there isn't a river in Wales which is not polluted." Participant 24.

The consequence of all the concerns raised by many collectors was the over-riding fear that long held practises associated with coastal collection are being lost:

"I think the art of foraging is slowly dying to be honest, the true art of it ... there's many people who won't experience it in generations to come." Participant 22.

3.3.6 Coastal collector typologies

Cluster analysis generated four typologies (Jaccard's coefficient >0.3) of coastal collector (Fig. 3.2, [Appendix B.5](#)):

- 'Foragers and Educators' collecting for food but also shared knowledge, with many of them making income from foraging based education businesses. Their collection activities connect them to nature, people and cultural heritage which is important to them. Some have concerns over sustainability of their activities and lack of transparent regulation / management.
- 'Collecting for Mental Health' were unified by collecting for knowledge (primarily science and natural history interest) but foraging as a coping strategy for life, specifically dealing with anxiety, depression or bereavement.
- 'Collecting for lifestyle' who collected food for the table and as income, usually by lifestyle choice, rather than heritage ties. Their collection activities appear to feed their self-actualisation needs through establishing their Hunter-gatherer persona (challenge, survival skills, knowledge, having control over their lives and providing).
- 'Collecting for Life' comprises commercial and informal collectors with extensive knowledge of their species, places and practises. They rely on their activities for their livelihoods and way of life, often embedded in family heritage, and have strong fears for the future of their industry related to stock depletion and perceptions of mismanagement.

Chapter 3: Hidden meanings behind coastal resource collection

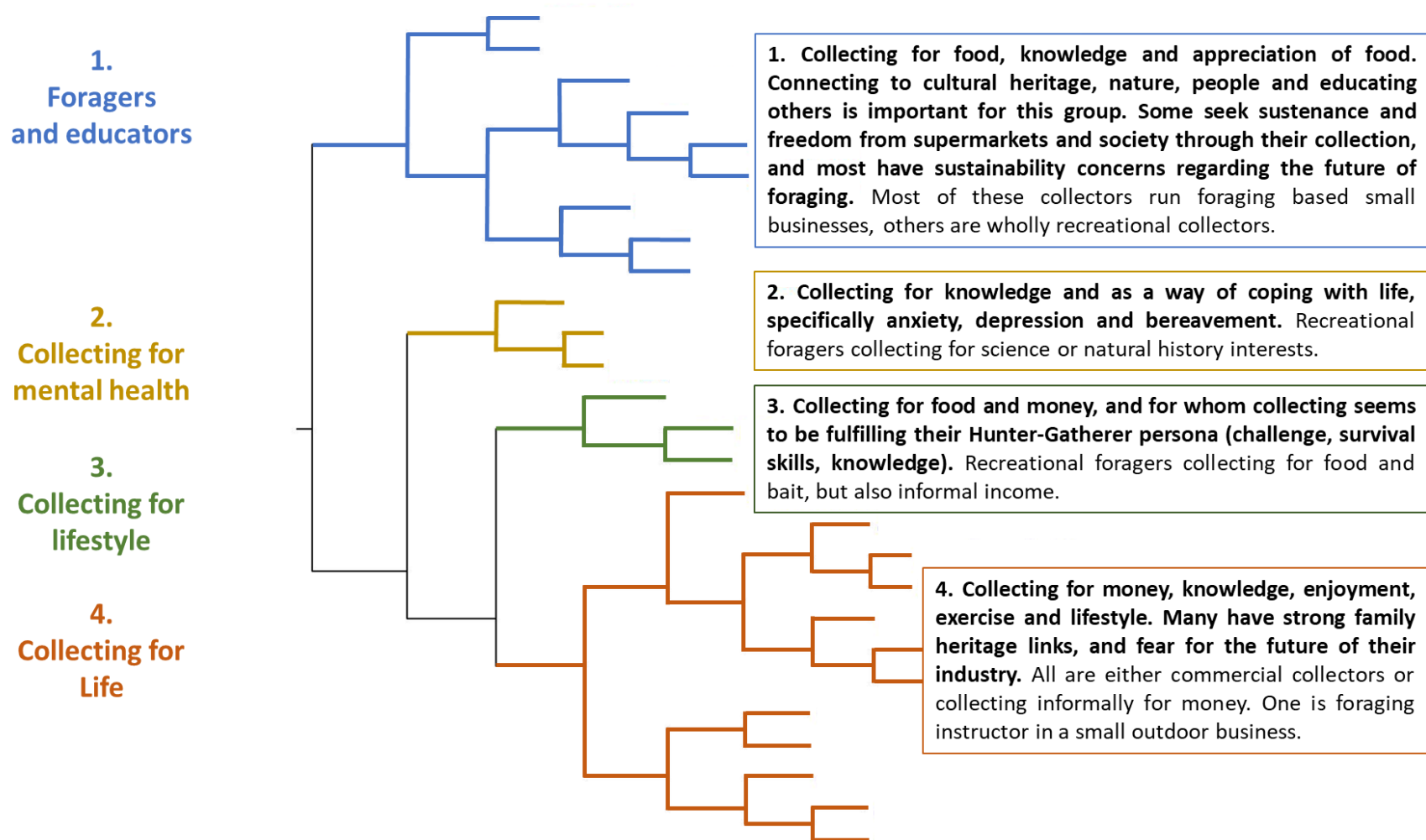


Figure 3.2. Four collector typologies are suggested based on similarities in what coastal collection means to them. Collector types are overlaid onto a dendrogram resulting from cluster analysis of all interviews where respondents are clustered based on coding similarities (Jaccard's coefficient >0.3 between respondents in cluster, with 60% similarity in codes within each cluster).

3.4 Discussion

My study revealed that coastal collection offers people much more than material benefits such as food or income, providing valuable insights into a wide range of significance and purpose (meanings) actualised by collectors. Collection activities have a multiplicity of inter-related meanings providing relational values associated to personal identity, health and well-being, and connectedness to nature that would be difficult to replace. For some, collection offers a coping mechanism for daily struggles or helps them find their place; for others, collecting helps them to realise their true personalities, and for many it has become a way of life. These findings in general support recent research in the ecosystem services literature including work on collecting wild food from UK saltmarshes contributing to the human well-being domains of health, social cohesion, spiritual and cultural fulfilment, connection to nature and living standards (Rendón et al. 2019); and that intertidal gleaning in Timor-Leste supports participants relational and instrumental values including social, peace, nature, knowledge and sharing (Grantham et al. 2020). My discussion takes a more detailed examination of the ways that collecting contributes to well-being, including an introduction to psychological mechanisms by which this is attained, before discussing the relevance of identity, sense of place, and collector typologies to managers and future researchers.

Many meanings behind coastal resource collection to collectors in Wales have been exposed through the theme 'Health and Well-being', connecting collectors to people, places and giving them enjoyment as well as practising and sharing knowledge. Foraging has previously been linked to helping people achieve well-being, partly in the attention paid to picking or choosing food is known to give pleasure through awakening the senses (taste, smell, touch and sight), sharing and a quest for authenticity and sustainability (Mugel et al. 2019). Māori gatherers see foraging as something that connects them to their *iwi* (people / tribe), *hapū* (clan) and *rohe* (territory) (Hall 2013). This supports the concept that there are 'Five ways to Well-being' that can be attained by resource collectors through their activities (as introduced in Chapter 2): Connecting, Being Active, Taking Notice, Keep Learning and Giving, which are well advertised strategy for improving individual well-being in the UK (Aked et al. 2008, White 2017). Often these Five Ways are acknowledged UK

Chapter 4: Teasing natural from anthropogenic disturbance on a boulder shore

policy makers and sometimes used to evaluate the effectiveness of nature based social-prescribing activities on achieving greater well-being (Aked et al. 2008, White 2017).

The Health and Well-being meaning of collection was especially prominent in a small group of particularly vulnerable participants that I spoke to and who described their activities as helping them cope with bereavement, clinical anxiety and depression, learning disabilities (dyspraxia, attention deficit hyperactivity disorder or severe dyslexia). These people were split between the groups of 'collecting to cope' and 'collecting for lifestyle', the former of which may be targeted for the aforementioned prescription of nature-based activities, whom have instead found their therapy independently. Angling and harvest based forest experiences have both been found to have experiential well-being benefits (Brown et al. 2013, Živojinović et al. 2020) that link to the Five Ways to Well-being. Angling has previously proved a positive intervention to reduce stress and anxieties in disaffected young people in the UK (Djohari et al. 2018), whilst community gardening programmes have been noted to be important to unemployed and depressed participants, offering them physical activity, distraction from their daily worries, motive to leave the house and worth, or purpose (Pitt 2014).

The mechanisms by which collecting from the seashore appeared to be offering relief to collectors may be via three key processes: attention restoration (Kaplan 1995), mindfulness (Schutte and Malouff 2018), or positive psychology 'flow theories', or 'being in the zone' (Nakamura and Csikszentmihalyi 2014), the first two of which of which correlate with aspects of well-being and nature-connectedness (Howell et al. 2011, Schutte and Malouff 2018). Attention Restoration Theory is well rooted in the *Biophilia hypothesis* which argues that humans have evolved to be closely connected to nature (Kaplan 1995), whilst mindfulness is rooted in Buddhist principles linked to reconnecting self as part of nature (Schutte and Malouff 2018); both are related to restoring attention in one form or another. Attention restoration improves a participant's ability to focus or specifically to perceive, think, distinguish and remember whilst reducing reaction times (Kaplan 1995). Selected nature based activities, including tending to plants and bird watching, have been found to restore

Chapter 4: Teasing natural from anthropogenic disturbance on a boulder shore

the attention of women after breast cancer surgery, increasing their ability to focus and, in doing so, improving their quality of life (Cimprich 1993). Attention Restoration Theory is built on four key pillars, each of which could be applied to the act of collecting things from the seashore (Ohly et al. 2016b). Collectors benefit from (1) “being away” from everyday stresses, (2) “fascination”, (3) “extent” of wilderness or environment, (4) “compatibility” with intrinsic motivations (such as fishing, observing animals, practicing survival skills) (Kaplan 1995).

Being in a mindful state is to focus one's attention on the emotions, thoughts and sensations occurring in the present moment (Brown and Ryan 2003), as can be done during collecting, and is known to reduce stress, with greater effect for those feeling more connected with nature (Schutte and Malouff 2018). If one regularly enters a mindful state, this can transform into a mindful personality trait associated with several longer-term benefits to human well-being, such as life satisfaction (Schutte and Malouff 2018). Finally, flow, or being ‘in the zone’ is the mental state of operation in which a person performing an activity is fully immersed in a feeling of energised focus, full involvement, and enjoyment in the process of the activity (Nakamura and Csikszentmihalyi 2014). Although the theory of flow is only recent, women in the Victorian era were noted to take up seaweed picking as a pastime, in a conscious effort to make sense of, and impose meaning upon, an uncertain world (Hunt 2005). More recently, emplaced flow has been recognised in weeding and digging, in places that contrast to everyday environments and stresses, where participants feel in control of their own activities, supporting the concept of gardening therapy where participants can maintain a sense of control (Pitt 2014). Emplaced flow can also be applied to the cockle gatherer getting into his ‘rhythm’ on the wild sands, or the winkle picker filling his bucket away from their other daily stresses.

Self-actualisation has been described as “*manifesting an ideal conception of ourselves into reality*”, the result being well-being (Fabian 2020). Thus, personality, identity and well-being are intrinsically linked. My results support this position; all participants expressed ways in which coastal collection formed part of their personal identity. The hunter-gatherer persona was particularly prominent amongst people ‘collecting for their lifestyle’ and ‘collecting for life’, who enjoyed the challenge, the

Chapter 4: Teasing natural from anthropogenic disturbance on a boulder shore

practising of survival skills and knowledge whilst being outside. Studies from across the United States and the Caribbean identified challenge, being outside, adventure and doing something worthwhile as being core to the self-identity of fishers, with being curious and having knowledge of their environment and target species being important to their self-actualisation (Pollnac and Poggie 2006, Smith and Clay 2010, Seara et al. 2017b). Similarly, compared to non-foragers, coastal resource foragers in Puerto-Rico were found to place more importance on self-actualisation, economic independence and family and friends than material wealth and conventional jobs (García-Quijano and Poggie 2019). These factors all featured within the hunter-gatherer persona described in this chapter.

Sense of place, or belonging, often talked about in terms of personal identity and in the well-being literature, seemed an important part of the gathering experience to more than half of my participants. People's sense of place is defined by individually-held, or community-wide, meanings and values that are made through practices, social engagement and history as well as the environment itself (Poe et al. 2016). In the UK, the concept of urban foraging sends an invitation to visit places the person may never have otherwise have visited, connecting the forager to both the physical space, but also the non-human world, and providing a sense of belonging in an often unfamiliar environment (Nyman 2019). In Latvia, terrestrial 'rooted foragers', for whom collecting was a nostalgic practise often tied to specific territories, had strong, personal and emotional bonds with their chosen foraging places (Grivins 2021). In the Puget Sound, USA, shellfish gathering has been identified as a key 'place-making' activity, which strengthens people's sense of belonging through the act of collecting, involvement in cultural or family practises, the sensory and emotional experiences it affords, and the strengthening of social connections (Poe et al. 2016), traits of collection which have all been identified amongst the Welsh collectors interviewed. Collection has been found to offer a sense of place and belonging to both the local forager and the new-comer who seeks a new connection and sense of belonging through practises that can be either nostalgic experiences or entirely new to them (Wiersum et al. 2004, Hall 2013, Poe et al. 2016, Nyman 2019).

Chapter 4: Teasing natural from anthropogenic disturbance on a boulder shore

In a recent anthropological exploration of how local identity and sense of place are linked through consumption of cultural keystone species, laverbread has been used as an example of a food that “*makes community real through consumption*” and prompts feelings of belonging in the consumer (O’Connor 2009). Laverbread links local ecology with cultural and national heritage, not only locally but also globally, and is named by some as “The Weed of *Hiraeth*”, a Welsh word meaning an irrational bond to some place, person or thing that elicits a deep sense of desire, longing or nostalgia embedded, that feels like home. Despite changing traditions, foods such as laverbread have gone through changes from nutritious, affordable (or free), available foods for local peasants, to global superfoods and haute-cuisine over the last two centuries, both of importance to meanings and place in different ways, and each putting different pressures on the environment from which they are taken (O’Connor 2009, Łuczaj et al. 2012). The act of cockle and laver picking were recognised by interviewees in the current study as a key part of local heritage, and fundamental aspects of family and local heritage, linked to knowledge and way of life, as well as livelihoods. Welsh ‘cultural heritage’ was not as strong as suggested by recent reviews of the ecosystem services afforded by the cockle industry (van der Schatte Olivier et al. 2018, Carss et al. 2020), but it was clearly a local ‘cultural practise’ for traditional gatherers and often used more for promotion of Welsh products and experiences than key to the personalities of the collectors themselves.

Many collectors had fears for the future of coastal collection, loss of the cultural keystone species, but also the practises. Often these concerns were rooted in concerns about lack of regulation, management, lack of engagement from managers and policy makers. Sustainability concerns also revealed some of the nuances, and potential conflicting perceptions when collectors compared themselves to other people gathering from the shore. Similar concerns regarding sustainability arose when Hall (2013) researched the meaning of foraging in New Zealand, particularly with respect to the perceptions of local foragers compared to newcomers taking advantage of local resources. Grivins (2021) used observations on the self-perceived impacts of one group of foragers activities compared to their perceptions of others’ activities as a warning to managers on how best these typologies may be further explored to maximise the success of future management by using different

Chapter 4: Teasing natural from anthropogenic disturbance on a boulder shore

approaches to each. For example, 'rooted foragers' in Latvia often emerged as a guardian of a place, and complain about loss of their favourite 'places' due to restrictions in access, whilst 'commercial foragers' whom collected mainly for money without the strong ties to their places or practises would be more likely to have high impacts and stop collecting if management was put in place (Grivins 2021).

Of my participants, those collecting for money could be divided into three typologies ('Collecting for Lifestyle', 'Foragers and Educators' and 'Collecting for Life') underpinned by different meanings which were often attached to place or heritage. The first Welsh typology, 'Collecting for lifestyle', reflects collecting as a lifestyle choice undertaken by people in pursuit of self-actualisation and a desire to meet hunter-gatherer needs. 'Foragers and educators' included both recreational foragers and artisanal foraging based businesses, many of whom, despite their own activities, feared for the sustainability of largely unregulated stocks with the increasing popularity of 'wild food products' (both for recreation and for commercial purposes). References to confusing legislation, unclear permitting processes, and failing management, coupled with examples of an unwillingness of managers and policy makers to actively engage with collectors, demonstrated that they are becoming increasingly unhappy with decision-making processes that make it impossible to comply in some instances. However, these same people were clear that they are keen to be consulted in future decision-making. Finally, traditional cockle gatherers often with strong attachment to both practise and place, who were of the 'Collecting for Life' typology, expressed loss of faith in management reporting that managers are not protecting the stock, the environment, or the traditional local heritage. Cockle gathering is the only actively managed wild intertidal collection activity in Wales and since 2004, stocks have severely declined (Murray and Tarrant 2015). These stock declines are seen as a huge threat to a cockler's way of life. Several commercial collectors perceive the management system as unjust and want their stories heard, as illustrated by one participant below:

"I say, to the people in power, do they want this type of thing or not? You know what I mean? ... You have got Natural Resources Wales who are supposed to be the environment champion. 19 years [of mass mortalities of cockles] ... Nothing has been said this is what's killing the cockles. 'Inconclusive',

Chapter 4: Teasing natural from anthropogenic disturbance on a boulder shore

[laughing] that's the word they use ... It's just a waste of time to be quite honest with you, they are not interested." Participant 25.

Most similar to the four Welsh collector typologies presented here for types of people are four different dependencies that rural communities place on their foraged products in Europe: for *physiological* need (subsistence), for *safety* (to fall upon in times of hardship – emergency extra income or shelter afforded by forest products); for *belongingness* (important for sense of place and enabling contributions to group identity) and for *esteem and self-actualization* needs (providing opportunities to be involved with socially and culturally esteemed activities, or activities that increase your standing in society through the perception of others) (Wiersum et al. 2004).

Although the current study aligns with similar findings in other environments, I must acknowledge its limitations. Advertising, snowball sampling and provision of fully transparent Personal Information Sheet increased the risk of creating response or social desirability bias in the data, such as the respondents 'aiming to please', in their responses (Bryman 2016). I was mindful of this both when interviewing and during analysis but it was deemed necessary as a means to mitigate the risk that potential respondents see the research as a threat and facilitated a more positive, constructive tone to elicit more honest responses. When participants chose to take part, assumptions were made that collecting meant something to every participant, therefore may have missed people for whom it meant less. The research aimed to explore the range of meanings, identities and values and potential typologies so a wholly representative sample was not essential. I was clear in conversation that I wanted to remain true to the collector's stories, and continued this ethos in my reflexive approach to analysis to ensure that I represented participants fairly in any resulting publications, whilst acknowledging my own theoretical sensitivities and experience influencing my preconceptions.

Time limitations meant that interviews were often steered away from lengthy negative discussions surrounding management or conflict and steered back towards meanings through further questions confirming potential interesting features from earlier in the conversation. At the time, these were thought to be digressions from the 'meaning-making' but analysis revealed that these were intrinsically linked to

Chapter 4: Teasing natural from anthropogenic disturbance on a boulder shore

deeper meanings, therefore there may be limitations in the data to reveal 'threats to meanings'. Including discussions about sustainability concerns and conflict in analysis was deemed important as often people place a higher importance on their social identities when they come under threat, and this can in turn influence behaviours. For example, the threat of removal of laverbread from the shelves of the supermarket giant Tesco in 2007, elicited a strong local and international response that laverbread is still important to the identity of Wales (O'Connor 2009).

To operationalise the new understanding presented in my research, further work should aim to create a framework by which to better understand behavioural drivers behind coastal collection in a management context. My work supports other findings that asking direct questions about identity and heritage does not prompt strong responses, and that these interlinked meanings to nature interactions do not sit neatly into the current cultural ecosystem services frameworks or methodologies (Stålhammar and Pedersen 2017). More valuable detail could be gained by asking collectors to reflect more on the importance of specific places and practises, or to explore their previous experiences of engagement with decision-makers and any experiences of attempted management with potential management scenarios. Reflective questions about the moral struggles collectors have regarding their activities (Grivins 2021) utilising a well-being approach may further enlighten managers on potential conflicts and pathways to more successful management propositions and practise.

My research in this chapter will be of interest to the many disciplines that have informed its development, including environmental economists seeking to explain cultural ecosystem services and policy makers, managers, and human ecologists looking to develop and inform future transformative marine governance. Human geographers and environmental psychologists can learn and develop the theme explored as health and well-being. Human geographers, psychologists, fisheries researchers and even anthropologists may develop the research explored as part of collector's personal identity, and critical realists may be particularly interested in the self-actualisation of the modern 'hunter gatherer persona'. Finally. the sustainability concerns and use of typologies can be developed by decision makers and those working on social-ecological systems to inform indicators future governance.

Chapter 4: Teasing natural from anthropogenic disturbance on a boulder shore

The collection of coastal resources is an ecosystem service often forgotten by policy makers, or misplaced in current frameworks, but this research suggests that it is a fragile service, currently little understood or valued by resource managers in Wales. Currently, most coastal collectors in Wales are not viewed as fishers. As such, they, and their impacts – both positive and negative – go largely unnoticed. However, my study reveals that collectors are utilising coastal resources as fishers do, and that they have concerns over the sustainability of their activities and lack a voice to ensure the future resilience of coastal collection. As increasing popularity and insufficient regulation leads it into a vastly changing environment with more challenging societal needs, a sustainable future for the coastal collection of wild products hangs in the balance. The Millennium Ecosystem Assessment asks policy makers to “*assess the consequences of ecosystem change on human well-being and provide a scientific basis for action needed to enhance the conservation and sustainable use of those systems and their contribution to human well-being*” (UN 2001). The Well-being of Future Generations Act in Wales states that policy makers need to consider the impact of decision making on the people living their lives in Wales today and in future generations. My personal well-being approach, from a critical realist perspective, to understanding the meanings behind coastal collection has proved a successful method to engage collectors and recognise the importance of their activities. The meanings of coastal collection to health, well-being and personal identity explored in this research should empower researchers, managers and policy makers to engage participants of different vulnerabilities in a more meaningful way in future decision-making processes, thus nurturing future custodianship and encouraging compliance with future policy.

Chapter 4.

Teasing natural from anthropogenic disturbance of cobbles and boulders on sheltered macroalgal dominated shores using novel technology

Authors: Elisabeth Morris-Webb, Tim D'Urban Jackson, Martin Austin, Matthew Lewis, Freya A.V. St John, Stuart R. Jenkins

Author contributions: Liz Morris-Webb conceived the idea, inspired by previous work, with support of supervisors Dr Freya St John and Prof Stuart Jenkins, and with some early stage input on methods from Michel Kaiser. Tim D'Urban Jackson provided field assistance and expertise in the terrestrial laser scanning and processing scanned imagery, providing the PhD candidate with raster files of the digital elevation models (DEM) used. A team of postgraduate volunteers assisted with marking and relocation of boulders (see PhD acknowledgements), Peter Lawrence with developing categorisation of water velocities, Alastair Feather assisted with R coding to extract DEM data from raster files.

Oceanographers Martin Austin, Matthew Lewis and Guy Walker-Springett provided interpretation advice and direction regarding sediment transport and hydrodynamics. The PhD candidate carried out all analysis and writing.

Chapter 4.

Teasing natural from anthropogenic disturbance of cobbles and boulders on sheltered macroalgal dominated shores using novel technology

4.1 Introduction

One of the goals of the Convention on Biological Diversity's Aichi Targets is to “*reduce the direct pressures on biodiversity and promote sustainable use*” by 2020 (Conference of Parties 10; UN 2010). This, and the UN Agenda for Sustainable Development's aim to “*Conserve and sustainably use the oceans, seas and marine resources for sustainable development*” by 2030 (Sustainable Development Goal 14; UN 2015), require clear dialogue between researchers and decision-makers. However, first and foremost is the requirement to develop indicators to assess ‘*Cumulative human impacts on marine ecosystems*’ (BIP 2010). Indicators can be tools by which to assess individual or multiple impacts at local, national or even global scales to evaluate progress towards sustainability targets, or inform management action and future policy (Halpern et al. 2007, BIP 2012, McQuatters-Gollop et al. 2019). A Catalogue of Marine Biodiversity Indicators aimed at informing the development of the Marine Strategy Framework Directive for EU member states found that only 4.3% of indicators being developed focussed on anthropogenic activities, with a total of only 9% concentrating on pressure indicators (Teixeira et al. 2016). Indicator researchers and decision-makers aiming to manage, minimise or prevent human activities in conservation sites must provide robust evidence of anthropogenic disturbance to minimise conflict with stakeholders and prevent litigation measures. However, this is a non-trivial task, not least because of the difficulty of teasing apart cumulative human impacts on marine ecosystems from natural disturbance.

Intertidal boulder habitats are a good example of how natural and anthropogenic disturbance can be difficult to distinguish, complicating any indicator development. In the UK anthropogenic disturbance on rocky shores through rock turning activities, including winkle picking and bait collecting, has been of conservation concern since

Chapter 4: Teasing natural from anthropogenic disturbance on a boulder shore

the 1980s (e.g. Liddiard et al. 1989), particularly in relation to unregulated activities inside Special Areas of Conservation (SAC, European Marine Sites protected under the EU Habitats and Birds Directive; Fowler 1999, Brazier et al. 2013). In response, the Joint Nature Conservation Committee suggested a boulder-turning indicator under the Marine Strategy Framework Directive (Burrows et al. 2014). A boulder-turning index was put forward as a method to respond to the pressure of rock turning on intertidal rocky shores, which threatened achievement of Good Environmental Status (referenced in Burrows et al. 2014). However, the tool was rejected due to lack of ecological validation together with insufficient data on the intensity of collection activities (Burrows et al. 2014). It may also have been used as an 'operational indicator to trigger management action' (McQuatters-Gollop et al. 2019) if pressure of boulder turning was threatening Good Environmental Status at specific sites. The proposed indicator, based on work on boulder fields of the open coastline of California by Addessi (1994), was adapted and developed within the tidally swept Menai Strait and Conwy Bay SAC in Wales (Boyes and Allen 2004 discussed in Morris et al. 2012, Brazier et al. 2013). Welsh researchers questioned the viability of assessing the percentage of rocks that had been recently turned by collectors, due to signs of potential natural movement on the shore (Morris et al. 2012). Key differences between the American and Welsh research sites were the wave exposure and macroalgal cover of the sites.

Current knowledge of natural movement on boulder shores has been extrapolated from particle transport models of smaller 'grains' of sediment (Shields 1936, Einstein 1951, Soulsby 1998), based on large-scale, open coast sediment transport models, lacking dense macroalgal cover (Oak 1984). Most recently, changes in sea level, storm frequency and intensity as a consequence of climate change has motivated a research focus on coastal morphodynamics (Stephenson and Naylor 2011, Brayne 2015, Naylor et al. 2016, Stephenson and Abazović 2016). In line with the Intermediate Disturbance Theory (Connell 1978), medium sized rocks on open coasts, subject to intermittent wave and storm disturbance, are known to be more diverse in terms algal and invertebrate diversity, than smaller, regularly disturbed and larger more stable boulders, where competitive exclusion can develop (Sousa 1979b, 1984). Sousa went on to describe the size, shape, force and conditions required for a wave to disturb a rock, concluding that force (newtons of pull) was the

Chapter 4: Teasing natural from anthropogenic disturbance on a boulder shore

best measure of a boulder's 'disturbability', but that this was correlated with the top surface area of a rock (Sousa 1979a). Sousa found rocks with surface areas $<25\text{cm}^2$ were regularly wave disturbed and therefore relatively bare. However, very little ecological disturbance or morphodynamic research has focussed on tide-swept boulder shores sheltered from storm exposure.

Boulder shores sheltered from waves and storm disturbance, but exposed to high tidal velocities, are usually rich in long-lived macroalgae and host diverse underboulder communities. They are often protected for their relatively stable fragility (Brazier et al. 2013, Burrows et al. 2014). In the UK, these sites are often perceived as stable due to the dominance of large bladdered egg wrack, *Ascophyllum nodosum*, which can reach 17+ yrs in age (Stengel and Dring 1997), over two metres in length (Hill and White 2008) and 100% cover of the underlying substrates. This habitat attracts seaweed harvesters, interested rock turners, winkle pickers and peeler crab collectors, to whom any disturbance is generally attributed both through extraction of taxa and trampling (Addessi 1994, Araújo et al. 2009). Extraction of herbivorous gastropods is known to cause changes in community structure. For example, the over-exploitation of limpets in the Azores allows the persistence of extensive beds of turf forming algae on the rocky shore (Martins et al. 2010). In California the density and species richness of under-boulder communities have been correlated with proximity to easy access points to the shore, providing strong evidence for the large-scale impact of excessive trampling and collecting (Addessi 1994). Disturbed rocks that are not returned to their exact position will desiccate or damage sensitive under-boulder communities, whilst trapped algae under the rock can cause anoxia of the habitat and mortality of associated species (Sousa 1979b, Cryer et al. 1987, Chapman and Underwood 1996). Frequent incorrect placement of rocks may also result in a change in the under-boulder substrate due to scour, changing the habitat for its residents (Addessi 1994). If the algae die or are removed from the base, *Ascophyllum* habitat is known to show unpredictable and ineffective recovery over long time scales due to sporadic recruitment coupled with slow growth and recruitment mortality (Jenkins et al. 2004).

This chapter aims to tease natural from anthropogenic disturbance on a tide swept, *Ascophyllum* dominated boulder shore in the Menai Strait and Conwy Bay SAC. Previous work in this environment has speculated that disturbance of rocks on the

Chapter 4: Teasing natural from anthropogenic disturbance on a boulder shore

shore may not solely be a consequence of human activities, but caused by drag imparted by macroalgae in high tidal currents. Buoyant algae such as *Ascophyllum nodosum* could potentially lift rocks into the water column resulting in significant movement (Morris et al. 2012). This process has been described incidentally by ecologists, mostly during unrelated field work (Garden and Smith 2015). The brown macroalgae, *Colpomenia perigrina*, is commonly known as the ‘Oyster thief’ due to its propensity to pick up and move its own substrate (Bunker et al. 2017).

‘Peripatetic’ or ‘stone walking’ movement has been noted as a pathway for the transport of the invasive non-native bladdered macroalgae, *Sargassum muticum*, on cobbles (Strong et al. 2006a). Macroalgal-mediated sediment transport has been observed for 25 other genera of macroalgae, including other intertidal species common in the UK such as *Fucus vesiculosus*, *F. serratus*, *Desmarestia*, *Laminaria*, but there has been little quantitative research on the ecological or oceanographical consequences of this (Garden and Smith 2015). None of these observations focus on how peripatetic pathways may be confused with anthropogenic disturbance or change intertidal habitats under protection. For macroalgal dominated boulder shores in tide swept channels, natural peripatetic movement may have the potential to change a whole habitat once algae reach a critical length or buoyancy to lift and move their own supporting substrate.

In this chapter, I hypothesise that movement of rocks on these shores can be by people, but also by the seaweed they host, and that this movement can be differentiated and monitored using novel, rapidly developing technology. My approach was to establish the extent to which a critical algal to rock ratio could be defined leading to peripatetic movement of loose rocks topped with *Ascophyllum*, and whether any indicators for natural movement can be easily assessed by site managers in the field. First, I established whether rocks with *Ascophyllum* move more than bare rocks. Secondly, tri-axial accelerometers were tested to assess whether disturbance occurs at low tide (anthropogenic) or high tide (natural peripatetic). Finally, laser scanning technology was tested as a viable method to detect topographical changes through the movement of loose cobbles and boulders on the shore, over both short and long-time scales. This research will ensure that natural movement is understood prior to the further development of indicators assessing cumulative impacts on boulder shores.

4.2 Materials and Methods

4.2.1 Study site

The Menai Strait and Conwy Bay SAC includes a sheltered, tide swept channel with high tidal flows, separating the Isle of Anglesey from mainland Wales (Fig.4.1). Conservation objectives of the SAC include reference to a ‘particularly high number of decapod crustaceans, including *Carcinus maenas*’ and ‘rich under-boulder intertidal reef communities’, protected under the EU Habitats and Birds Directives (Countryside Council for Wales 2009). Concern has been raised that the collection of peeler crabs for angling bait (particularly *Carcinus maenas* undergoing ecdysis) are compromising both of these conservation objectives (Boyes et al. 2006), with up to 90% of suitable sized rocks overturned and only 40% returned to their original positions (Cryer et al. 1987, Brazier et al. 2013). Fine sediments are known to occur in the main channel, whilst cobbles and larger sediments are generally pushed to the sides by strong tidal flows (Davies and Robins 2017). Tidal velocities up to 4 meters per second in the central Menai Strait coupled with 90% intertidal cover by large macroalgae (Brazier et al. 2013) resulted in questions over whether some boulder disturbance attributed to collection activities could be due to natural ‘peripatetic’ movement caused by macroalgal drag in the high flow environment (Morris et al. 2012).

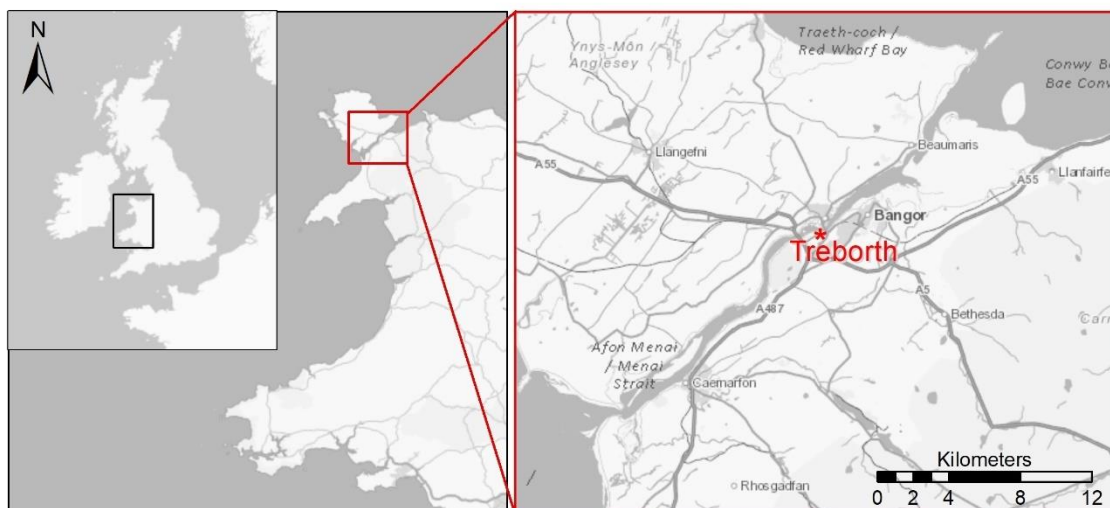


Figure 4.1. Experimental location used to determine peripatetic movement of *Ascophyllum* topped rocks at the foreshore of Treborth, Menai Strait and Conwy Bay Special Area of Conservation, Wales. Contains OS data © Crown Copyright and database right 2020.

Chapter 4: Teasing natural from anthropogenic disturbance on a boulder shore

Potential sites to tease natural from anthropogenic disturbance were identified as areas of *Ascophyllum* dominated boulder foreshore that were infrequently targeted by peeler crab collectors (Morris et al. 2012). Proximity to access points has been found to affect diversity (Addessi 1994) and was considered during site selection to minimise anthropogenic impacts on the experimental site. Tidal models predicted velocities to reach over 2m s^{-1} within the Menai Strait at Treborth (Davies and Robins 2017) where the site is highly protected from wave action; a wave exposure average wave fetch index of 1.1 (\log_{10} km) was calculated using the 200m resolution model of Burrows et al. (2008) making this one of the most sheltered sites in the central Menai Strait (Fig.4.1). Scoping visits confirmed that the site is dominated by *Ascophyllum* with bedrock outcrops, muddy gravel and approximately 10% cover by loose cobbles and boulders. The site's relative inaccessibility means this stretch of foreshore (53.2185, -4.1675 to 53.2186 -4.1659) is not regularly disturbed by peeler crab or winkle collectors.

The site was used to simultaneously collect data on the distance that rocks of varying algal loading travel across the shore using survey accuracy Global Positioning System (GPS), the movement of a subsample of rocks at different predicted tidal velocities using tri-axial accelerometers, and the change of elevation on the shore relative to the loose rock size using digital elevation maps from a terrestrial laser scanner.

4.2.2 Establishing the distance rocks travel: 'Measure, mark and recapture'

To establish whether rocks with large bladdered macroalgae are more likely to move than bare rocks, a minimum of 35 bare rocks and 35 rocks topped with *Ascophyllum* greater than 60cm in length ('algal rocks') were identified, measured and marked (tagged or labelled) for later relocation. Selection criteria for rocks to be included in the movement field experiment were based on known existing factors influencing the displacement of boulders. Peeler crab collectors are known to collect from rocks as small as 10cm diameter (Liddiard et al. 1989). Rocks with an upper surface area greater than 0.05m^2 (24cm circular diameter) have been cited as unlikely to be disturbed by waves, whilst irregular shaped boulders may move more easily than others of smoother shape but similar size (Sousa 1979a), and flatter rocks are less

Chapter 4: Teasing natural from anthropogenic disturbance on a boulder shore

easily turned by waves (Addessi 1994). As the current work aimed to determine if it is possible to tease human from natural disturbance, any loose (not embedded) rocks greater than 10cm upper surface diameter were considered eligible for inclusion. These are defined as cobbles (>6.4cm diameter) and boulders (>25.6cm diameter) on the Wentworth Scale (Wentworth 1922).

Before measuring the rocks and accompanying algae, the forces affecting rock movement were considered. There are three main ways that a rock (or particle) can move (termed entrainment): by lift, fluid force (sliding the grain out of its position, often affected by a buoyancy component), and rotation of the grain about a pivot point (Fig.4.2; Shields 1936). To move, the lift force (L_i) must exceed gravity (the weight of the rock, F_g) and the drag forces (D , the frictional force between flowing water and the underlying substrate) must exceed the combined frictional and gravitational force (or weight, F_g). Once a particle is lifted into the water column, the movement becomes more influenced by its frictional force, and the particle is then pushed (or dragged) in the flow of the water (Soulsby 1998). The presence of large macroalgae on rocks will change both the lift and potential drag through its buoyancy and large surface area (Fig.4.2). The size of algae relative to its host rock will affect the movement that ensues.

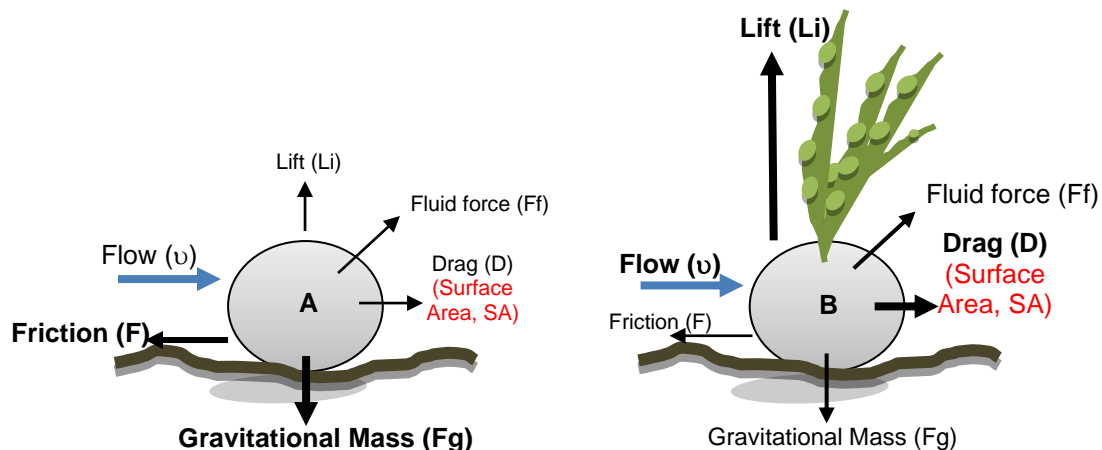


Figure 4.2. Forces acting to move rocks on the seabed with and without seaweed. Wider arrows and larger text are indicative of the relative importance of these forces in moving the rock, following the hypothesis that algae increases the surface area, drag and lift forces, thus reducing the gravitational force and friction on the rock and enabling it to be more easily pushed by the flow of the water.

Chapter 4: Teasing natural from anthropogenic disturbance on a boulder shore

To assess the relative lift, drag and mass, of each rock, the following non-destructive field measurements of rocks and associated algae were taken, as potential predictors of natural movement:

- i. Height (a), diameter (b) and circumference (c) of rock in the widest, highest and longest dimensions, to calculate the volume of the rock assuming it is an ellipsoid boulder (Eq.1: $\frac{4}{3} \times \pi \times (0.5a) \times (0.5b) \times (c / \pi) / 2$);
- ii. Shape of rock (Pettijohn 1957, definitions of shape: angular, subangular, subrounded, rounded or well-rounded);
- iii. Evidence of previous turning (Morris et al. 2012 categories: very recent, recent, historical, unturned and uncertain);
- iv. Longest length (L_{\max} , L) and maximum circumference (C_{\max} , C) of *Ascophyllum*, to provide non-destructive morphological estimates of volume (Eq.2: LC^2) and dry weight biomass (autumn, $0.034 \times LC^2$) (Aberg 1990).

Assessment was also made of the physical pre-transport environment including: the underlying substrate; elevation from substrate (0 = the rock is lying entirely on the underlying substrate; to 3 = rock has a significant proportion of its undersides elevated from substrate); the presence or absence of under-boulder mud, anoxia, running water, specialised community and the number of crabs present. Bare rocks were selected and marked with coloured, numbered washers, whilst algal rocks were marked using coloured, labelled, washers around the base of each macroalga, and long cable ties around the tip to aid relocation. Rocks were replaced to their original position after marking.

Each rock was initially located using a Leica 1200 GPS (receiver GX1230), with post-processing horizontal accuracy of 5mm. Rocks were relocated using the same GPS multiple times wherever possible, on five days of low water spring tides over a 31 day period between October 8th and November 8th, 2017. Seven rocks were relocated 23 months later, in October 2019, and all relocation aides removed. However, dGPS positioning failed resulting in large geographical error, so the distance travelled by these rocks could not be analysed over a longer time period. Student volunteers assisted in searching for marked rocks under the algal canopy.

Analysis of distance travelled

Algal loading of each rock was calculated as a volumetric ratio, where zero would represent no algae and a high number would represent a large algae on a small rock.

$$\text{Algal loading} = \text{lc2 predictor of algal volume (Eq.2)} / \text{predicted rock volume (Eq.1)}$$

The distance travelled by each rock was ascertained using a step-wise analysis of positional data. A rule was applied whereby a rock was assumed to have moved only when the movement was greater than twice the proximal error (positional quality) of the start position and end position. Where distance measures were kept, they were summed to provide total distance travelled over the experimental period. For statistical analysis, distance travelled was converted to average daily movement per rock. Given that rocks were only relocated on five low water visits over a 31 day period, estimates were of minimum movement.

Simple linear regression analysis was used to test whether there was a relationship between the algal loading and average daily movement.

4.2.3 Establishing rock movement using tri-axial accelerometers

Tri-axial accelerometers have previously been used to establish boulder movement on wave exposed shores by geographers and oceanographers (Brayne 2015, Stephenson and Abazović 2016). Here they were used to establish principally at what point during the tidal cycle rock disturbance occurred. Movement around low water is assumed to be anthropogenic, while that around high water is assumed to be natural. It was assumed that acceleration and inclination (tilt, or angular displacement) readings will confirm whether rocks at Treborth move in different tidal flows. The Onset HOBO Pendant G logger UA-004-64 is a relatively low cost (GBP 88), waterproof logger with 64K bytes of memory enabling 'normal mode' logging at 1 minute intervals for 15 days over a complete spring – neap tidal cycle. Acceleration (-3 to +3g, where $1g = 9.8\text{ms}^{-2}$) and inclination (angle of tilt, 0-180°) is measured on three horizontal axes, x, y and z (Moreau et al. 2009), although dynamic acceleration is difficult to analyse in normal mode due to low recording frequencies (Onset 2013).

Chapter 4: Teasing natural from anthropogenic disturbance on a boulder shore

Accelerometers were secured in 140ml (6 x 6 x 5cm) square plastic food storage boxes, to protect from damage during rock movement (Fig.4.3). These were attached using two screws to previously measured and marked bare and 'algal' rocks. Although the attachments will have a subtle effect on the hydrodynamics of their host rocks, this effect was deemed to be negligible, and the approach provides a cost-effective solution to test the feasibility of the technology to detect disturbance.



Figure 4.3. Loose intertidal rocks were marked with coloured, labelled, washers. Onset HOB0 Pendant G loggers (UA-004-64) were placed in a plastic housing on selected rocks to measure their movement (acceleration and change in inclination).

Chapter 4: Teasing natural from anthropogenic disturbance on a boulder shore

Accelerometers were trialled in the field to test the relative effect of recording at different frequencies: 2 Hz, once every 2 seconds in 'fast mode', capable of picking up dynamic acceleration but limited by memory capacity to 12 hrs of data; and 0.016 Hz, once per minute, recording in 'normal mode', which has capacity to record for 15 days. Loggers of each frequency were attached to two measured and marked bare rocks and two algal rocks for a single 22hr trial. Initial trials confirmed that a recording resolution of one minute intervals was better than 2 Hz to pick up movement of algal rocks using changes in force (g) as an indicator, and potentially some changes in rock orientation on both algal and bare rocks ([Appendix C.1](#)).

After initial trials, six loggers recording at one minute intervals were placed on bare rocks and six on algal rocks for a period of six days, November 2nd to November 8th 2017, over a set of large spring tides. One bare rock and one algal rock was purposely moved at low water, and carefully replaced to its exact position, to simulate anthropogenic disturbance. These experiments were nested within the aforementioned mark and recapture experiment, using previously marked and relocated rocks on the mid littoral shore at Treborth, from approximately 1.5 m to 2.5 m above Chart Datum.

Processing accelerometer data

Although HOBOT Pendant G Loggers should not require calibration, the Onset operating principles acknowledge very high tilt error and poor angle resolution in inclinations $<30^\circ$ and greater than 150° (Onset 2013). To establish the residual fluctuations in changing tilt measurements when the loggers were stationary, all loggers were attached to a wooden timber and left undisturbed in a ground floor office environment for 22 hours to provide some calibration figures. Although all placed in uniform orientation in the same environment, the loggers did not produce congruent data on any single axis. Axis error was calculated for each measurement axis for each time point (absolute measurement at time 2 – absolute measurement at time 1), on each logger. Residual Error (RE) was the difference between the maximum and minimum axis error, specific to each logger. As this was the maximum error for each logger, this is an overestimation of error to ensure that only 'real movement' is detected in the field. All data was calibrated by subtracting Residual

Chapter 4: Teasing natural from anthropogenic disturbance on a boulder shore

Error from each respective axis of all field measurements prior to processing, which when summed across axes became the 'calibrated acceleration' and 'calibrated change in inclination' for accelerometer observation. Thus, any measurements greater than zero would count as a movement in activity counts.

Typically, movement from accelerometers could be processed as an 'activity count' on a specific axis of interest. However, this was not possible because the shape of rock determined the placement of loggers, resulting in inconsistent orientation of loggers and therefore different forces acting on different axes on different rocks. Instead, processing of the accelerometer data resulted in four potential indicators of rock movement, to be taken forward as response variables for ongoing analysis:

1) Sum of change in force (g): The change in absolute force (- RE), or calibrated acceleration, between each time point summed across all three axes expressed in absolute force of gravity (g).

2) Movement on any acceleration axis (%): If the calibrated acceleration was greater than zero between two time points, it was counted as a movement. The sum of the calibrated acceleration over all observations of a single rock resulted in the frequency of movement (change in force).

3) Movement on any tilt axis (%): Residual error was subtracted from the absolute angle of tilt. The change in tilt between two time points was summed across three axes to produce the calibrated change in inclination. If change in the resulting inclination was greater than zero it was counted as movement for this observation. The sum of the changes over all observations of a single rock resulted in the frequency of movement on any tilt axis (change in inclination).

4) Any movement on any accelerometer axis (change in force or tilt): If there was movement on any force (2) or tilt (3) axis, it was considered a movement. The sum of any movement over all observations of a single rock resulted in the frequency of any movement.

Each response variable was categorised into movement at different tidal flow categories for further analysis of rock movement with increasing tidal flow and algal loading. 'Predicted tidal flow' was calculated for each timed observation using the

Chapter 4: Teasing natural from anthropogenic disturbance on a boulder shore

rule of twelfths to categorise movement data into flow rates under the assumption that there is minimal flow in the one hour either side of low water (LW) and high water (HW), when $1/12^{\text{th}}$ of the tide floods or ebbs, and the strongest flow for the two hours between LW and HW, when $3/12^{\text{ths}}$ of the tide flows per hour. Predicted tidal flow was calculated as 'weak flow' (LW \pm 1hr, HW \pm 1hr), 'mid flow' (LW \pm 1-2hrs, HW \pm 1-2hrs) or strong flow (LW \pm 2-4hrs, HW \pm 2-4hrs) and 'low water' (<2m above chart datum, when the site was exposed and accessible to surveyors). LW and HW times were taken from Belfield Software Tide Plotter (v5.8).

Analysis of rock movement using accelerometer data

A tidal curve generated from the Belfield Tide Plotter software was overlaid onto both the raw and processed accelerometer data to determine if rock movement coincided with periods where they were theoretically immersed or emersed. Tidal flow categories were used to graphically explore the differences between the movement of individual bare rocks and algal loaded rocks. To test whether algal rocks moved more in strong tidal flows, null data (representing no data) was removed and the four movement response variables were re-processed to represent the percentage of movement that occurred in each tidal flow category (low water and weak, mid and strong flows). Where assumptions of normality and homogeneity of variance were met, the effect of different tidal flow categories on the movement of algal rocks was tested using a series of One-Way Analyses of Variance (ANOVAs). All analysis was undertaken in R-Studio version 1.3.1073.

4.2.4 Use of laser scanning technology to detect boulder movement

Finally, terrestrial laser scanning technology was used at the beginning and end of accelerometer trials to test it as a viable method to detect movement of cobbles and boulders on the shore beneath a macroalgal canopy over short (one week) and long (two year) time scales. A terrestrial laser scanner (Leica ScanStation C10, LMSZ210ii), set to a full field of view (360° horizontal, 270° vertical) with point spacing of 10 cm at 100 m range was used, from four scanning stations. This generated millions of elevation points from surface refracted laser pulses which were

Chapter 4: Teasing natural from anthropogenic disturbance on a boulder shore

aligned into a single analysable point cloud within 6 mm accuracy. Elevation points were processed together to create digital elevation models and rasterised Digital Elevation Maps (DEM, D'Urban Jackson et al. 2020). Laser returns from four laser scans across the shore were georeferenced and transformed to British National Grid (OSGB 1936, Transverse Mercator) using eight reflectors in the survey areas, positioned using the Leica 1200 Global Positioning System. The initial DEMs generated by laser scans were processed to 10cm x 10cm pixel resolution (the minimum size of rock examined) and overlaid with others taken after six days and 23 months, within 6mm horizontal and 1mm vertical accuracy. In this way change in elevation for each pixel over time could be calculated. Elevation was not interpolated between missing points, and instead missing data was excluded from the analysis. Prior to analyses, scans were clipped to a survey area of 2,355m² to remove potential changes in topography due to trees, storm debris, the vertical surfaces of large gullies and the overhang present to the south of the site.

Analysis of laser scanned data for potential boulder movement

The change in elevation data from DEM for each pixel across the site was stored in Raster files and analysed using ArcMap 10.7.1 and Microsoft Office Excel. The change in elevation was categorised at pixel resolution, to represent five classes of elevation change: 1. Loss within the size (height) range of loose rocks on the site; 2. Gain within the size range of loose rocks; 3. No significant change in elevation (between the minimum loss and gain of rock size); 4. Loss greater than rock size; 5. Gain greater than rock size. The frequency occurrence of each category was analysed across the site to determine the relevant (%) change in elevation over a six day and 23 month period.

RStudio was used to further clip the DEM elevation data to the proximal error radius of each rock, providing a mean, maximum and minimum change in elevation in the vicinity of each marked rock, together with standard deviation of the change.

Simultaneous collection and analysis of DEM data with the tracking of rocks of specific size and algal loading with GPS and accelerometers aimed to determine whether changes in surface topography across the site are due to movement of rocks or algal canopy.

4.3 Results

4.3.1 The distance rocks travel: 'Measure, mark and recapture'

30 bare rocks and 36 algal loaded rocks were measured and marked as part of the recapture experiment ([Appendix C.2](#)), and their locations tracked over up to five field visits between October 8th and November 8th, 2017. Small loose rocks were difficult to find on the site, indicative of their potential mobility. Some rocks were not relocated, and others were lost after 18 days, resulting in 25 bare rocks and 31 algal rocks for analyses. Algal loaded rocks were observed to move in a westerly direction across the shore and no rocks were obviously, or entirely over-turned (upside down) when relocated. Over the one month period, 29% of rocks with *Ascophyllum* moved over 1m distance, compared to only 12% of bare rocks (Table 4.1).

Table 4.1. Summary of movement of bare rocks and those with large *Ascophyllum* attached over a period of 31 days between October and November 2017. ** 31 rocks hosted algae >100cm in length.

	Bare rock	Algal Rocks
Size range of rocks measured (diameter)	15 - 46cm	14 – 36cm
Weight range of rocks (with algae if present)	1.9 - 30.7kg	1.8 – 24.2kg
Range in max length of <i>A.nodosum</i> on marked rocks	-	65 – 160cm**
Number of rocks marked	30	36
Number of rocks relocated on 2 or more occasions	25	31
% (of analysed) rocks that did not move or moved <10cm	68%	52%
% (of analysed) rocks that moved 10-99cm	20%	19%
% (of analysed) rocks that 'moved' >1m	12%	29%

Regression analysis on the average daily distance moved confirmed that 30.7% of variability in rock movement may be explained by algal loading (Fig.4.4a; $R^2 = 0.307$, F-ratio = 25.8, df = 55, $p < 0.001$). One rock had an unusually high rock:algae ratio, so was removed from analysis. Without this outlier, the average daily distance moved confirmed that the relationship between algal loading and distance moved was still significant (Fig.4.4a; $R^2 = 0.135$, F-ratio = 9.618, df = 54, $p = 0.003$), although less (15.1%) of variability in rock movement was explained by algal loading. Algal loading, measured as the ratio of algal volume (predicted from maximum algal length and circumference) to ellipsoid rock volume (estimated from circumference, height and diameter measurements in the field), was positively related to the distance that rocks move (Fig.4.4).

Chapter 4: Teasing natural from anthropogenic disturbance on a boulder shore

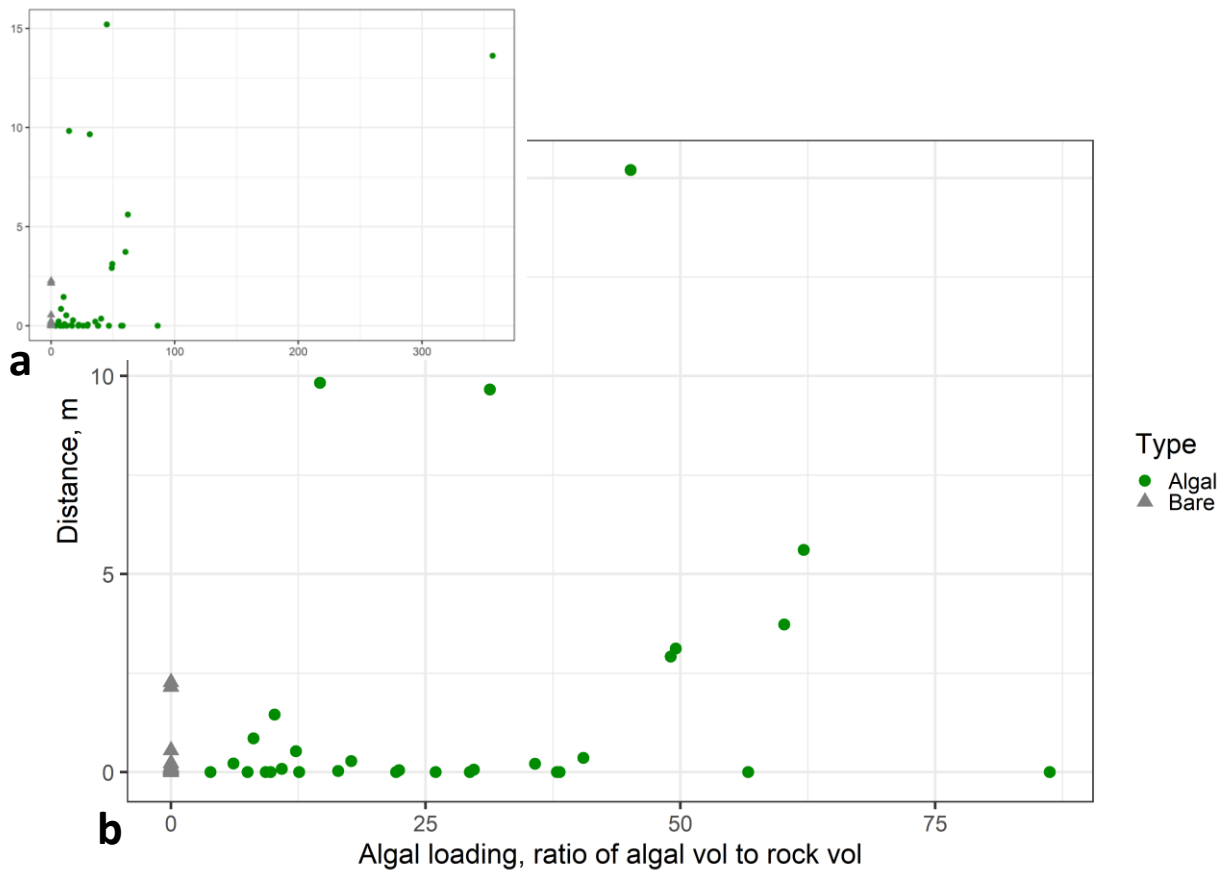


Figure 4.4. Total distance rocks moved across a tide swept shore with increasing algal load of macroalgae, *Ascophyllum nodosum*, over a period of 31 days. a = includes an outlier of unusually high algal loading; b = without outlier. Bare rocks had no algal loading.

All rocks which moved large distances (standardised to an average daily movement) had an algal loading of greater than 30, apart from one rock with an algal loading of 14.6 which moved 9.8m over the 27 days it was tracked (average 0.34m per day). 53% of rocks with algal loadings greater than 30 moved. Boulder weight may be a contributing factor for non-movement - the heaviest boulder with a circumference of over 100cm and an algal loading of >30 did not move. Potential reasons why the remaining rocks with algal loadings >30 did not move were not evident from field observations of under-boulder substrate, elevation, anoxia and running water.

4.3.2 Establishing rock movement using tri-axial accelerometers

Regression analysis of the distance moved on the shore with algal loading identified that 70% of rock movement must be explained by something other than the presence of algae, including localised flow velocity or anthropogenic disturbance. Accelerometers secured to six bare rocks and six 'algal' rocks over peak spring tides between November 2nd and November 8th 2017, identified movement of rocks at different states of the tide ([Appendix C.3](#)). One bare rock logger was lost during this period.

Accelerometer outputs, in terms of raw and processed data are presented in Fig.4.5 for three rocks: Rock A, a bare rock; Rock B, a bare rock moved by experimenter at low water to simulate anthropogenic disturbance; Rock C, an algal loaded rock. Rock A regularly showed large error in the raw outputs of tri-axial gravitational force (g, Fig.4.5a) and tilt ($^{\circ}$, Fig.4.5b). After calibrating the data for residual error significant movement was still evident, particularly on tilt axis and often in an almost cyclical pattern in line with the predicted tidal curve (Fig.4.5a, b). Conventional methods of smoothing the data, which uses an algorithm to remove noise from datasets, also found similar patterns of cyclical 'error', indicating that this was not noise but instead a real phenomenon affecting the loggers. Data smoothing was therefore not applied for any analysis. Rock B appeared to have less overall relative movement, or error, on the raw axes (Fig.4.5a, b). Anthropogenic disturbance near low water was evident in both the raw accelerometer and calibrated data (Fig.4.5a,b).

The raw outputs of tri-axial gravitational force (g, Fig.4.5a) and tilt ($^{\circ}$, Fig.4.5b) of Rock C around the predicted high tide mark, indicating natural, not anthropogenic movement. Calibrating this data for residual error of the individual logger was successful in showing acceleration, or large changes in gravitational force, with predicted tide and, to a lesser extent, on changes in inclination of the rock (Fig.4.5a,b).

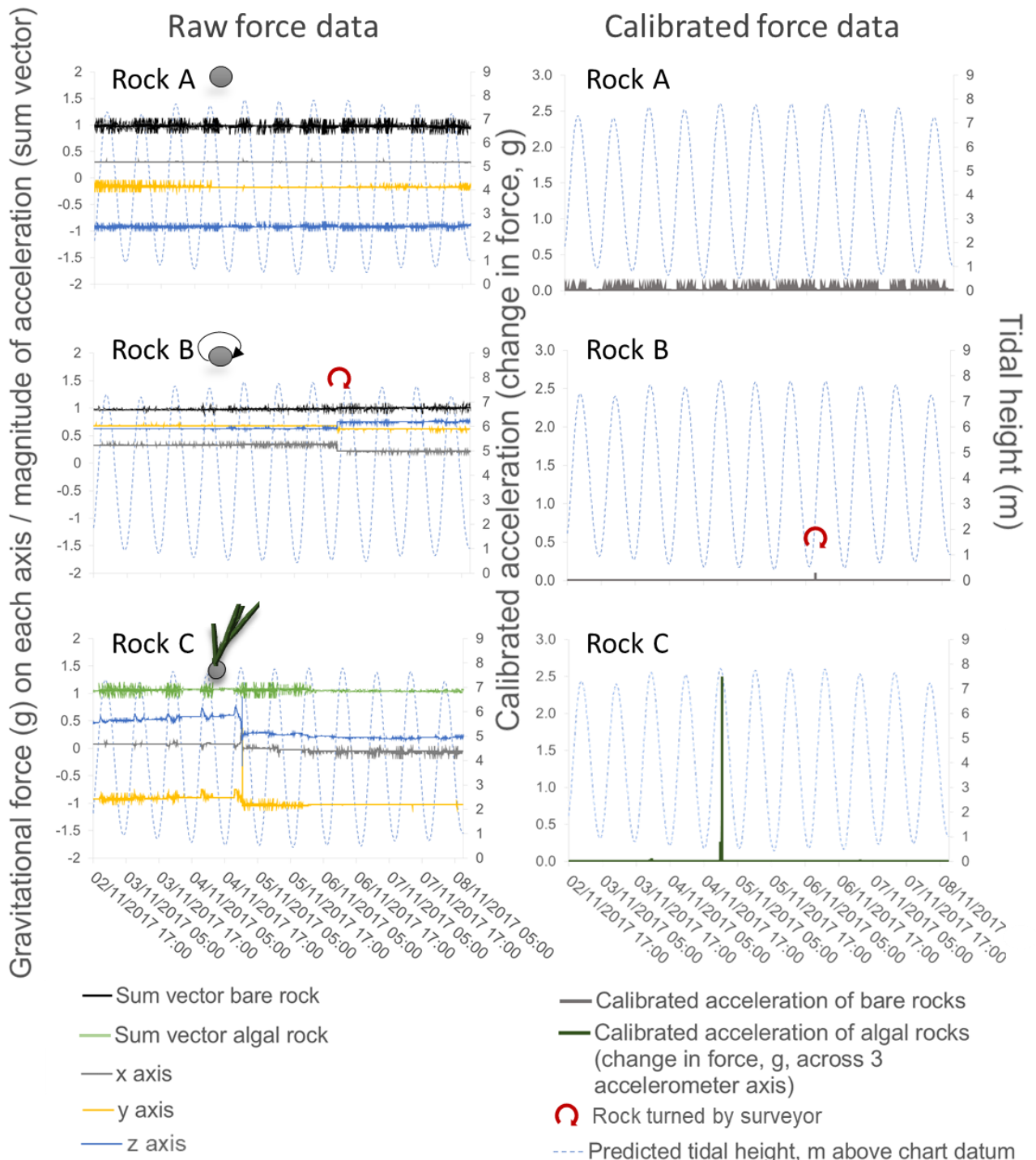


Figure 4.5a. Acceleration of intertidal rocks using ONSET Hobo Pendant G accelerometers attached to a bare rock (A), a bare rock turned at low tide (B) and an algal loaded rock moving with the tide around high water (C). Movement is visible from raw accelerometer readings of gravitational force (g) on three axes, x y z, and the magnitude of acceleration (sum vector: $\sqrt{x^2+y^2+z^2}$) with predicted tidal height (m) on the site. Movement is measured by the summed acceleration across all three axes of each rock (change in force, g, calibrated for logger-specific residual error).

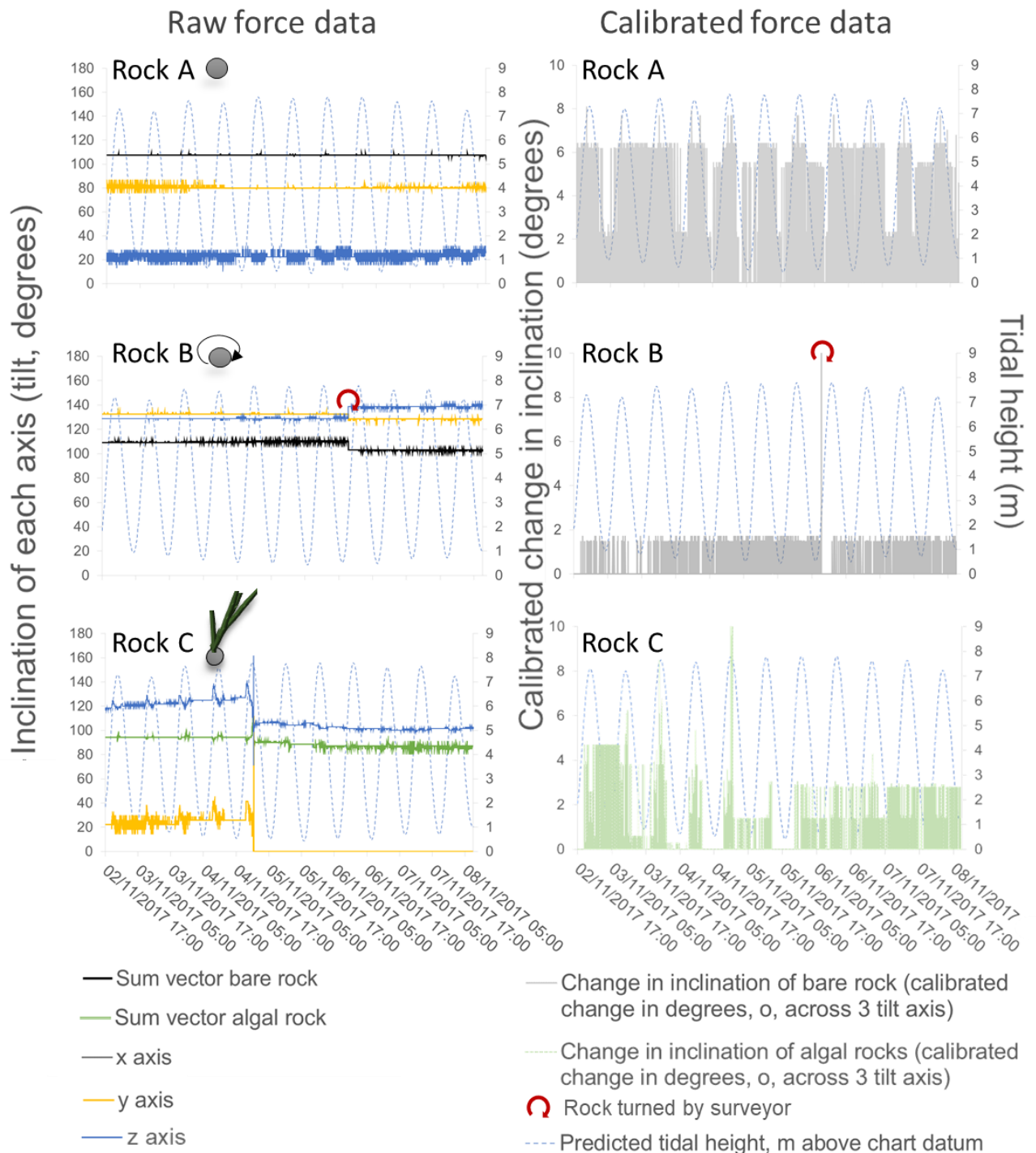


Figure 4.5b. Change in inclination of intertidal rocks using ONSET Hobo Pendant G accelerometers to a bare rock (A), a bare rock turned at low tide (B) and an algal loaded rock moving with the tide around high water (C). Disturbance is visible from raw accelerometer readings of inclination (tilt °) on three axes, x y z, with predicted tidal height (m) on the site. Movement is measured as the summed changes in inclination (°) across all three axes of each rock (calibrated for logger-specific residual error).

Chapter 4: Teasing natural from anthropogenic disturbance on a boulder shore

The frequency of accelerometer readings on any axis (% of observations) was calculated for each rock with a logger to reflect the proportion of no movement, movement at low water, or movement within each predicted tidal flow category (weak flow, mid flow and strong flow, Fig.4.6). Of the algal rocks that moved, there appeared to be a trend of increasing signs of movement on any accelerometer axis with increased algal loading (Fig.4.6). For example, rock T6 with low algal loading (a algal: rock volume ratio of 6) only showed any sign of movement in 20.1% of readings, compared to rock T13 with almost 10x the algal loading (algal loading ratio 62) showed movement in 52.9% of all accelerometer readings. However, there was high variability between the rocks observed: T13 for instance showed a high proportion of movement on the accelerometer over 6 days and moved 5.6 m over the 31 days it was tracked. A similarly high loaded rock (T23, algal loading ratio 50) showed only 22% accelerometer movement yet moved 3.1m over the 30 days it was tracked. Similarly, there was high variability in movement data of bare rocks with mounted accelerometers, although the proportion of movement tended to be less than that experienced by algal rocks. Overall, 22.6% of observations from bare rocks showed any signs of movement, compared to 32.1% of algal loaded rocks (Table 4.2). As this chapter focuses on hypothesised peripatetic movement of rocks facilitated by macroalgae, only algal rocks were taken forward to the next step of analyses.

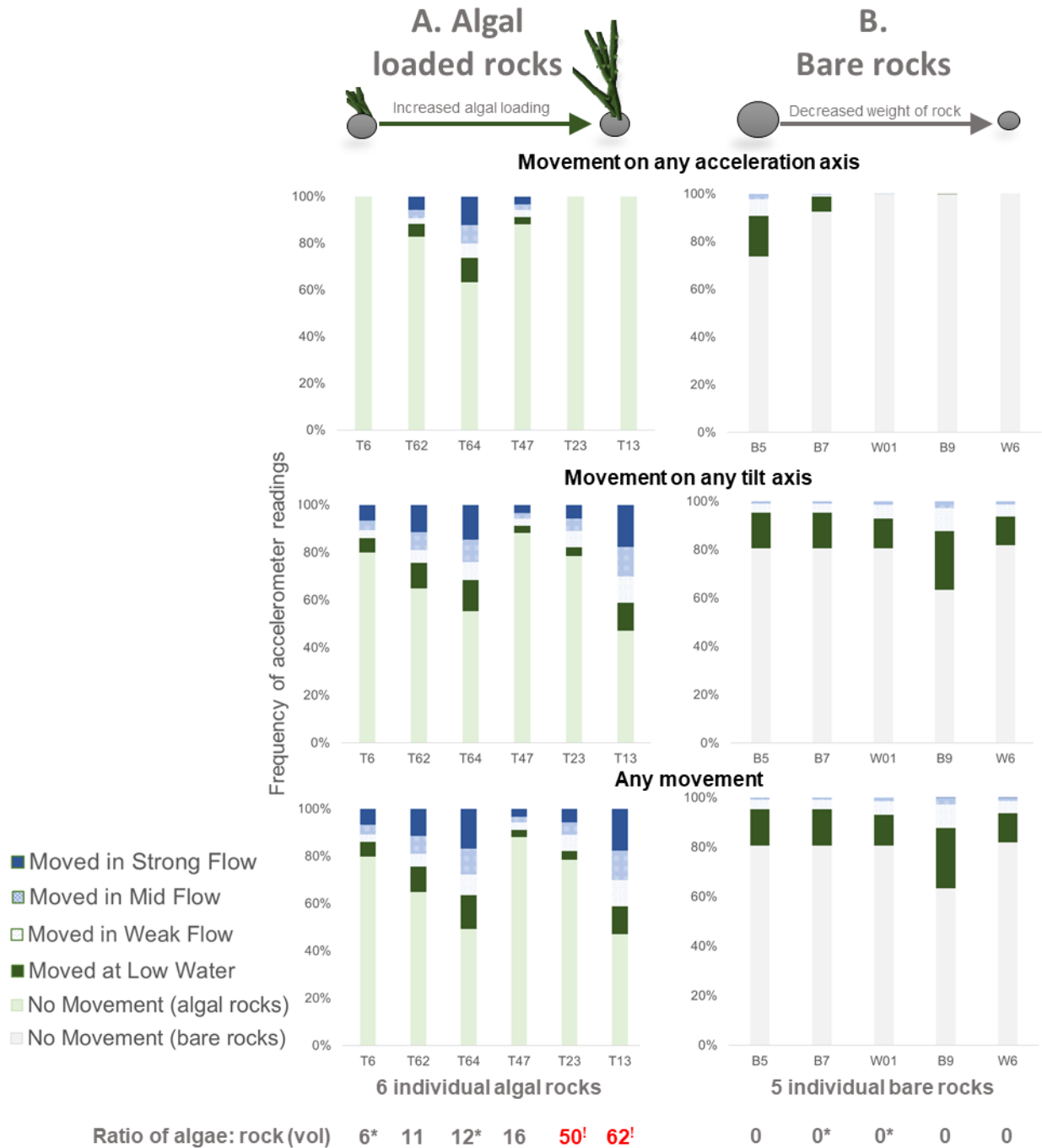


Figure 4.6. Movement of six algal rocks, with large *Ascophyllum* attached, compared to bare rocks measured as the ‘frequency of accelerometer readings’ where the percentage of total points where there was either no movement on axis measuring force, tilt or on any axis of either or both measure, over six days of spring tides in the Menai Strait, November 2017. Any sign of movement on any axis was counted as a movement at low water (predicted tidal height <2m above chart datum), during weak flow (LW+/- 1hr), mid flow (LW+/-1-2hrs, HW+/-1=2hrs) or strong flow (LW+/-2-4hrs, HW+/-2-4hrs) using low water times from Belfield Software Tide Plotter. Algal loading of rocks is calculated as field approximations of algal volume / ellipsoid rock volume. Rock ratios marked with * were observed to move greater than 10cm in one month, whilst those marked with ! moved greater than 1m.

Chapter 4: Teasing natural from anthropogenic disturbance on a boulder shore

Table 4.2. Average movement of algal rocks, with large *Ascophyllum* attached (n = 6), compared to bare rocks (n = 5) measured as the 'frequency of accelerometer readings' where the percentage of total points where there was either no movement on axis measuring force, tilt or on any axis of either or both measure, over six days of spring tides in the Menai Strait, November 2017. Mean % movement in bold (standard deviation, range in brackets). Any sign of movement on any axis was counted as a movement at low water (predicted tidal height <2m above chart datum), during weak flow (LW+/- 1hr), mid flow (LW+/-1-2hrs, HW+/-1=2hrs) or strong flow (LW+/-2-4hrs, HW+/-2-4hrs) using low water times from Belfield Software Tide Plotter.

	% Acceleration obs.		% Tilt obs.		% of Any Movement	
	Algal	Bare	Algal	Bare	Algal	Bare
No Movement	89.00% (14.59, 63.20 - 9.99)	93.23% (11.33, 73.78 - 99.99)	68.97% (15.84, 47.13 - 88.14)	77.40% (7.86, 63.37 - 81.84)	67.94% (17.05, 47.13 - 88.14)	77.40% (7.88, 63.33 - 81.84)
Low Water	7.09% (8.74, 0.00 - 21.39)	4.68% (7.40, 0.00 - 17.03)	20.07% (9.22, 9.05 - 34.22)	15.61% (5.05, 11.86 - 24.34)	20.72% (9.79, 9.05 - 34.22)	15.62% (5.07, 11.86 - 24.39)
Weak Flow	3.13% (4.65, 0.00 - 11.95)	1.58% (3.03, 0.00 - 6.95)	8.55% (5.24, 2.51 - 15.04)	5.52% (2.36, 3.78 - 9.52)	8.83% (5.68, 2.51 - 16.71)	5.52% (2.36, 3.78 - 9.52)
Mid Flow	0.77% (1.32, 0.00 - 3.36)	0.51% (0.97, 0.00 - 2.23)	2.38% (1.63, 0.31 - 4.15)	1.45% (0.77, 0.86 - 2.75)	2.48% (1.77, 0.31 - 4.73)	1.45% (0.77, 0.89 - 2.75)
Strong Flow	0.02% (0.04, 0.00 - 0.10)	0% (0.00, 0.00 - 0.00)	0.03% (0.05, 0.00 - 0.11)	0.06% (0.02, 0.00 - 0.05)	0.03% (0.05, 0.00 - 0.11)	0.02% (0.02, 0.00 - 0.05)

Chapter 4: Teasing natural from anthropogenic disturbance on a boulder shore

The movement for each algal rock was recalculated to present the percentage of observed movement for each rock within each predicted tidal flow category (low water and weak, mid and strong flow, Fig.4.7), omitting all readings of no movement. Boxplots of all categories overlapped significantly for all categories, showing particularly high variability in data of movement on any acceleration axis (Fig.4.7.B). Boxplots with failed assumptions of normality and homogeneity of variance confirmed that analysis of acceleration axes data would not be statistically viable.

Clear patterns in the variability of movement data on the tilt axis and any movement on any axes displayed high variability at low water and in weak flows on boxplots, but less variability in mid and strong flows that were clearly different to one another (Fig.4.7.C and D). One-way ANOVA found significant differences in movement on any tilt axis in different tidal flows ($F = 6.155$, $df=3$, $p<0.001$). Tukey's honest significant difference post hoc test found that there was more movement of algal rocks on the tilt axis in strong flows (mean = 31.22% SD = 2.92) than there was with weak (mean = 21.25%, SD = 6.68) and mid flows (mean = 21.61, SD = 1.87, Fig.4.7). Significant differences were identified between the same flow categories when data was categorised as 'any measure of movement'.

There was no significant difference between the movement of algal rocks at low water and in strong flows. The variability in the movement of rocks in strong tidal flows was much less than that at low water, indicative of either error in the loggers when exposed to air, or regular human disturbance causing such high variability. The unexpectedly large proportion of movement around low water and in weak tidal flows could be explained by changes in temperature, such as differences in air and sea temperature (Onset 2013), which can take time to re-stabilise, particularly with differences amplified by the plastic housing in which the sensor was mounted. Furthermore, where algae covers the loggers, it will provide some insulation thus explaining the high variability between rocks around low water and in weak flows (as the sensor readings stabilise). Given the nature of the site, the raw accelerometer readings and recognition that accelerometers are sensitive to changes in temperature, it was concluded that the high variability in low water readings is likely to be error, rather than frequent anthropogenic disturbance. Despite this, low water readings were included in analysis as the research question was interested in anthropogenic movement at low water as well as movement in high tidal flows.

Chapter 4: Teasing natural from anthropogenic disturbance on a boulder shore

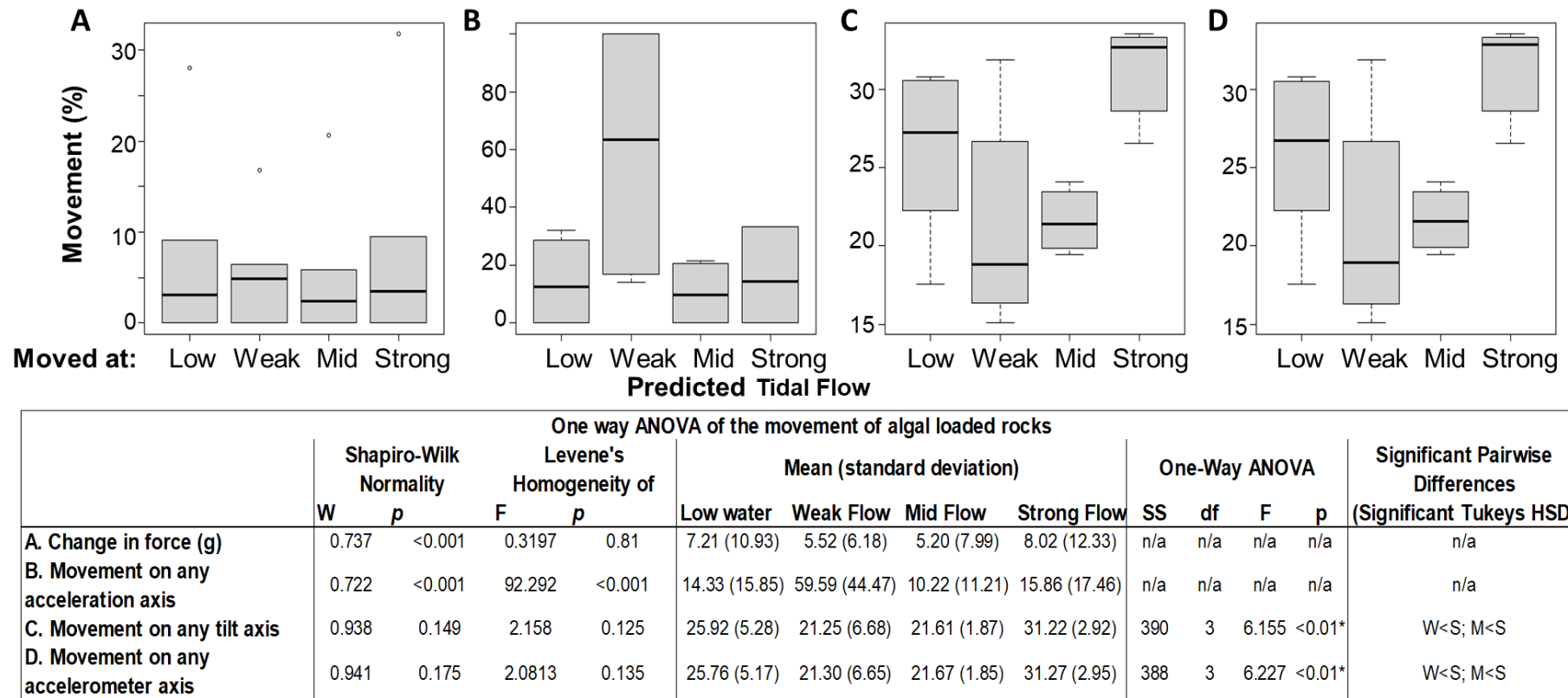


Figure 4.7. Differences in movement of algal rocks ($n = 6$) with large *Ascophyllum* attached with different predicted tidal flows tested using one-way analyses of variance over six days of spring tides in the Menai Strait, November 2017. Movement was measured as change in observed force (g, A), the 'frequency of accelerometer readings' where there was a change in force (B), change in inclination or tilt (C) or on any axis of either or both measures (D). Movement was counted as any change in calibrated readings at low water (predicted tidal height <2m above chart datum from Belfield Software Tide Plotter), during weak flow (LW+/- 1hr), mid flow (LW+/- 1-2hrs, HW+/- 1-2hrs) or strong flow (LW+/- 2-4hrs, HW+/- 2-4hrs).

4.3.3 Use of laser scanning technology to detect boulder movement

Point clouds from the terrestrial laser scanner appear to be able to accurately display the topography of the shore despite thick macroalgal cover by *Ascophyllum* and other fucoids (Fig.4.8, [Appendix C.4](#)).

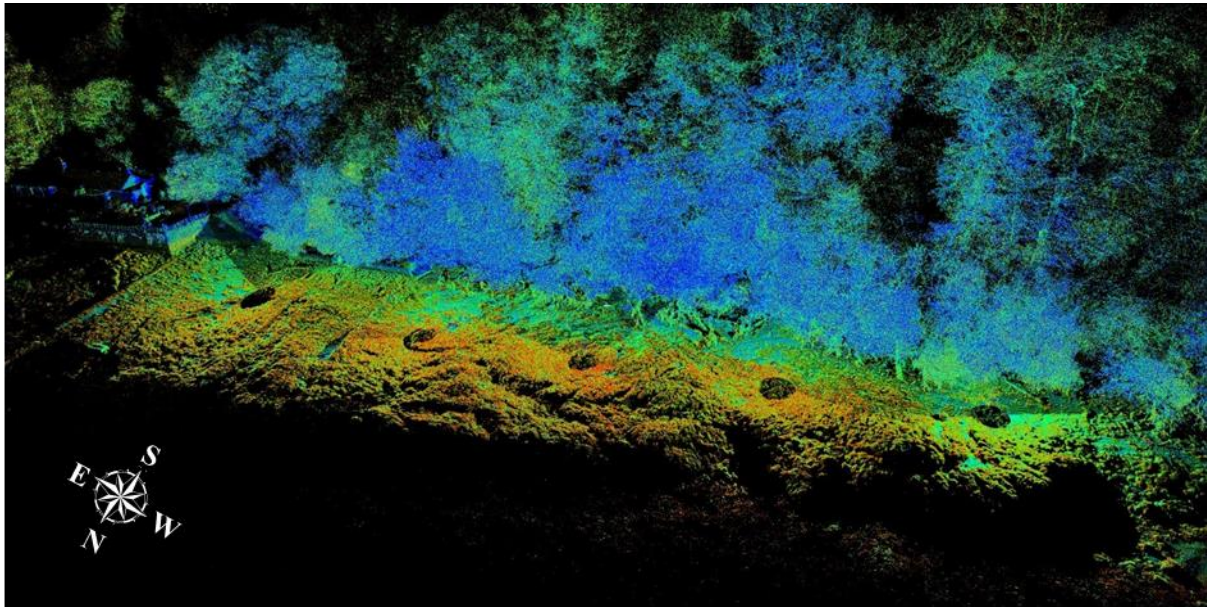


Figure 4.8. Point cloud of the experimental shore taken by terrestrial laser scanner at Treborth, the Menai Strait, November 2nd 2017. The regularly spaced dark circles on the shore show where the Leica ScanStation C10 was placed, representing ‘data shadows’ of occlusion beyond the vertical field of view (270°).

Initial Digital Elevation Maps (DEM) derived from laser scans on November 2nd, compared to post-relocation DEM six days later (November 8th, 2017) identified that the rocky shore was largely stable, with less than 5cm change in elevation on 92.8% of the survey area and a median loss of 1cm across the site (Fig.4.9.A). However, 5.4% of data points on the site showed a loss in elevation that was in the size range of the loose boulders on the site (ranging from 5-27cm in height, marked in red in Fig.4.9). Only 1.7% of the site showed a gain of similar height (marked in green), suggesting that the change in surface topography across the site was likely to be due to mobile cobbles and boulders moving out of the survey area, rather than the movement of the same macroalgal canopy. A higher proportion of data points showed elevation changes around the same size as loose rocks on the site at the western end of the shore than at the eastern end, which was in keeping with some of the biggest distances travelled by rocks during the month long re-location experiment, some of which were observed to move beyond the DEM survey area

Chapter 4: Teasing natural from anthropogenic disturbance on a boulder shore

(Fig.4.9.C). Less than 0.1% of points showed a change in elevation greater than the size in boulders. Most of these were in the western survey area which contained a freshwater outlet and tree debris.

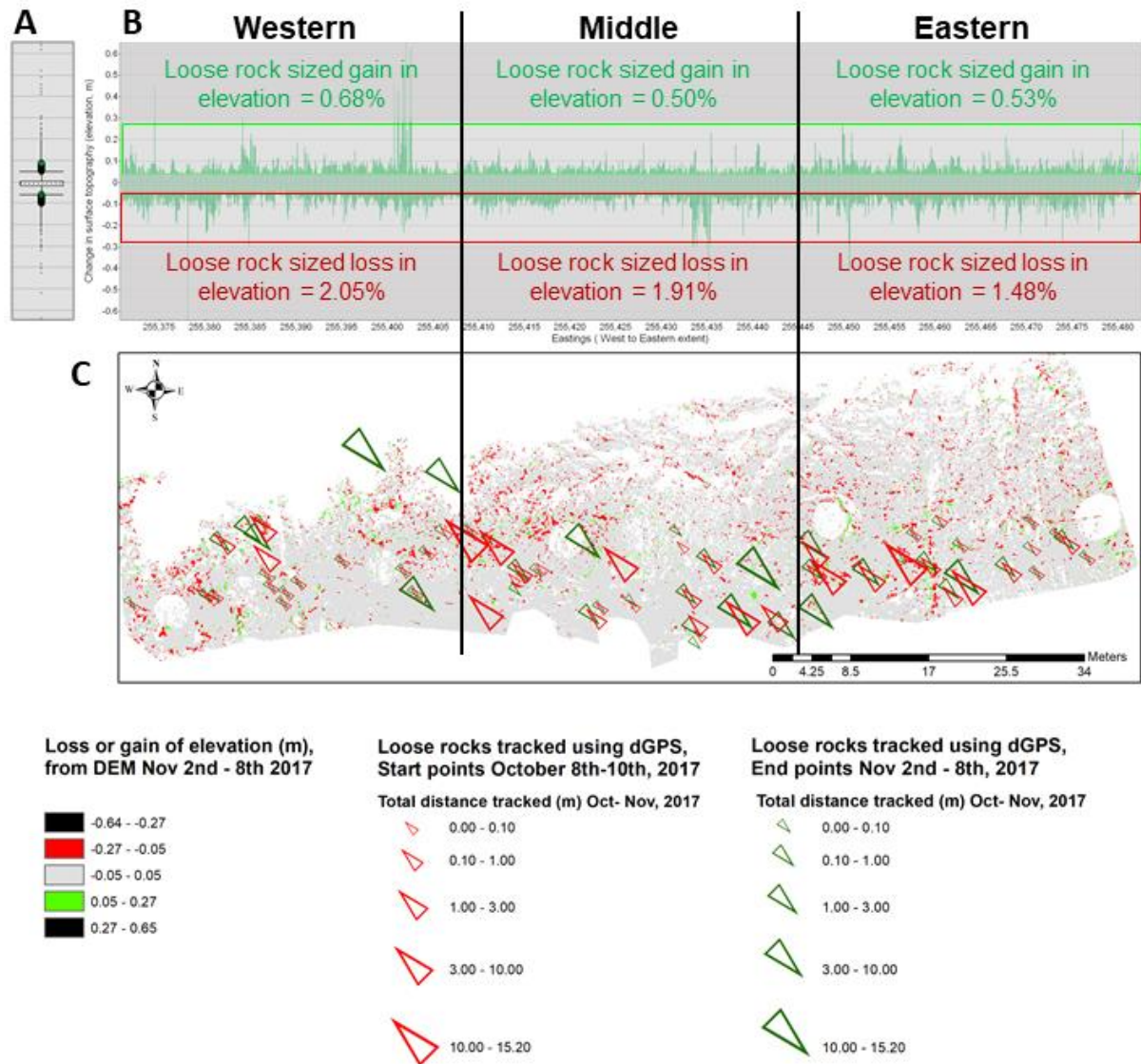


Figure 4.9. Laser scanned Digital Elevation Map (DEM) of a section of the experimental shore at Treborth, the Menai Strait, found a median 1cm loss in elevation between November 2nd and 8th, 2017 (A). Overall, 7% of the change in elevation is within the size range of loose boulders on the site (0.5-0.27m), with greater loss in elevation, highlighted in red, within the east of the site and greater gain, green, in the western portion (B). Change in elevation can be seen in context with rocks that were tracked between October 8th and November 8th, 2017 (A).

A third DEM, taken 23 months later on October 10th, 2019 (Fig.4.10), identified that over the same topographical scales 77.1% of the site was stable, with no median net loss or gain in elevation over the site (Fig.4.10.A). There was 10.2% loss in elevation, red, in keeping with the observed boulder size and a 12.6% gain, green

Chapter 4: Teasing natural from anthropogenic disturbance on a boulder shore

(Fig.4.10.B & C). DEM found more elevation changes of 5-27cm height, within the size range of loose rocks, at the western end of the shore than at the eastern end. Visual analysis of elevation change across the shore (B) shows a pattern of loss, to East, and gains to West, of within a few metres of each other. Less than 0.1% of points showed a change in elevation greater than the size in boulders.

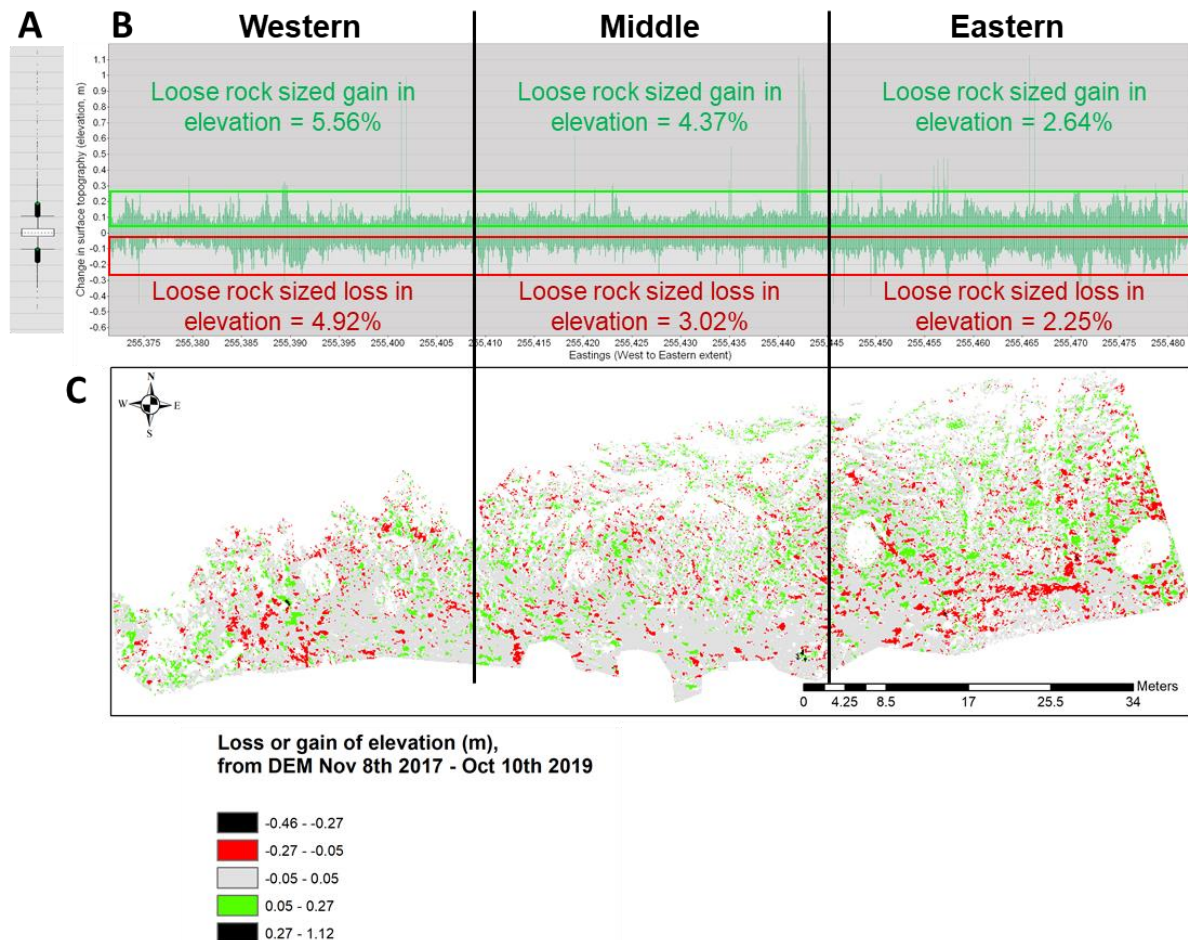


Figure 4.10. Laser scanned Digital Elevation Map (DEM) of a section of the experimental shore at Treborth, the Menai Strait, showing change in elevation over 23 months, between November 8th, 2017, and October 10th, 2019, with a median value of no net loss or gain (A). 22% of the change in elevation is within the size range of loose boulders on the site (0.5-0.27m), with losses and gains in loose rock sized elevation within a few meters of each other evident across the site, with high levels of activity at the western end of the site (B).

DEM together with positional data of simultaneously tracked individual rocks enabled clarification that elevation changes were due to movement of rocks rather than the ever growing and shifting macroalgal canopy ([Appendix C.5](#)). Rock T23, the most algal loaded of the eight rocks monitored over the DEM period with a rock height of 7cm, lost 8cm elevation from its start position on November 2nd, and moved 3.12m

Chapter 4: Teasing natural from anthropogenic disturbance on a boulder shore

(to 1mm accuracy) to a new position before November 8th, which gained 7cm in elevation (Fig.4.11). Accelerometers simultaneously placed on rock T23 (Fig.4.5) also found this rock to move naturally with the tide, rather than by human disturbance. Rocks that did not move significantly have been used to confirm that the elevation changes at their start and end points were within two centimetres difference to the measured height of the rocks (Fig.4.11, [Appendix C.5](#)) with the exception of bare rock B09 (9.5cm height) which was found to move 9cm from its start point via GPS which may have been natural or anthropogenic. DEM analysis only detected the loss of B09 from its start position on November 2nd, but did not detect its end point on November 8th, despite being within the proximal error being smaller than pixel size. It is possible from the DEM to see that it is likely B09 has been turned.

Finally, the difference in elevation for the positions of 38 rocks on November 8th, 2017 was compared to same positions 23 months later, on October 10th, 2019 (Fig.4.12, [Appendix C.6](#)). Two of the most algal loaded rocks, T23 and T13, which both proved mobile in the 2017 shore experiments, showed a loss in elevation within 2cm of their height over the 23 month period, indicative of likely natural peripatetic movement across the shore, although this could not be confirmed as the dGPS failed on the final relocation day. One bare rock showed a loss of elevation, which may be natural or anthropogenic over the same period.

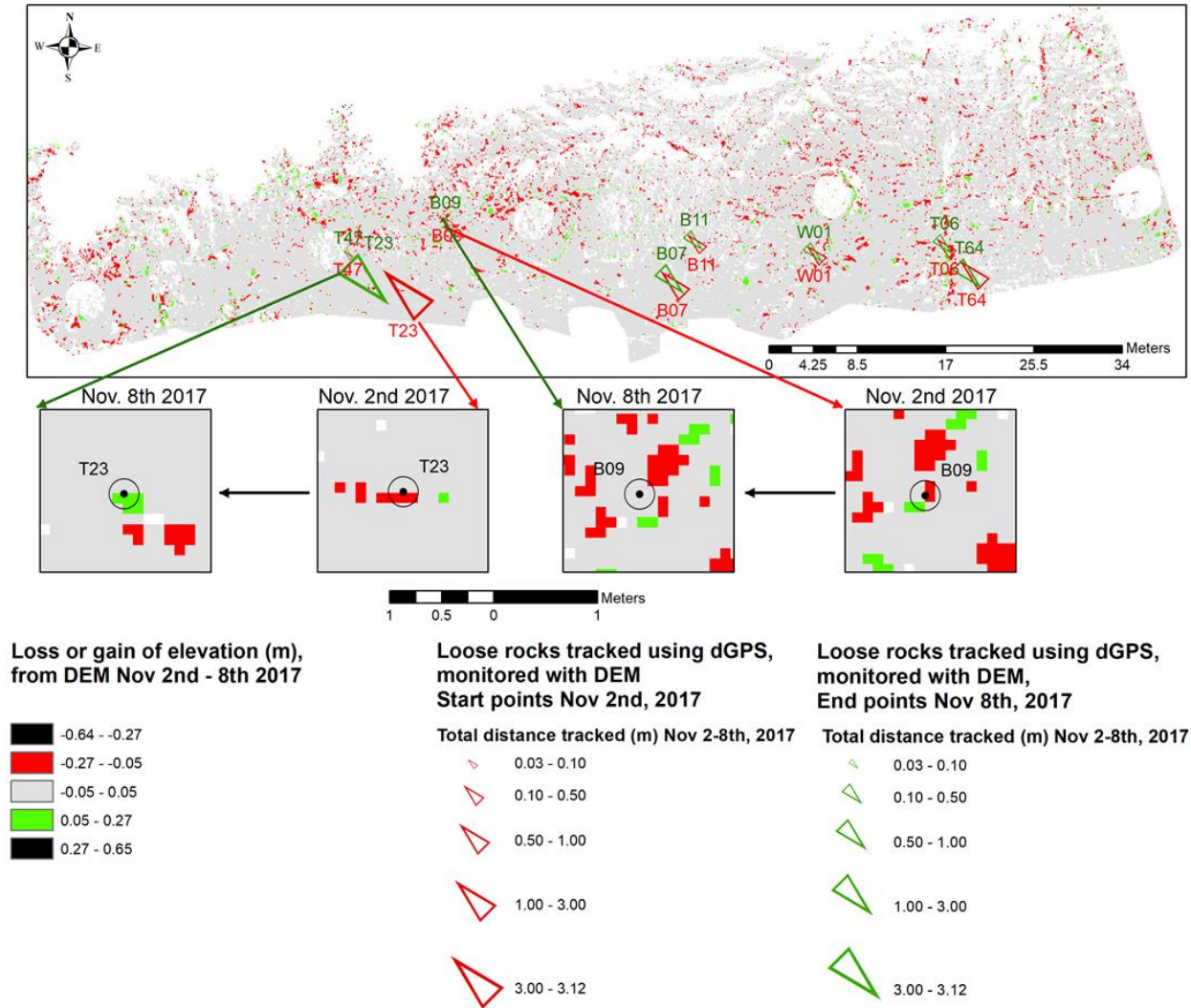


Figure 4.11. Laser scanned Digital Elevation Map (DEM) of a section of the experimental shore at Treborth, the Menai Strait, showing a change in elevation around tracked rocks between November 2nd and 8th, 2017. Triangles around rock centre points indicate residual direction of travel across the shore. Rocks marked with targets provide the exact position of rocks at set times together with the observed change in elevation.

Chapter 4: Teasing natural from anthropogenic disturbance on a boulder shore

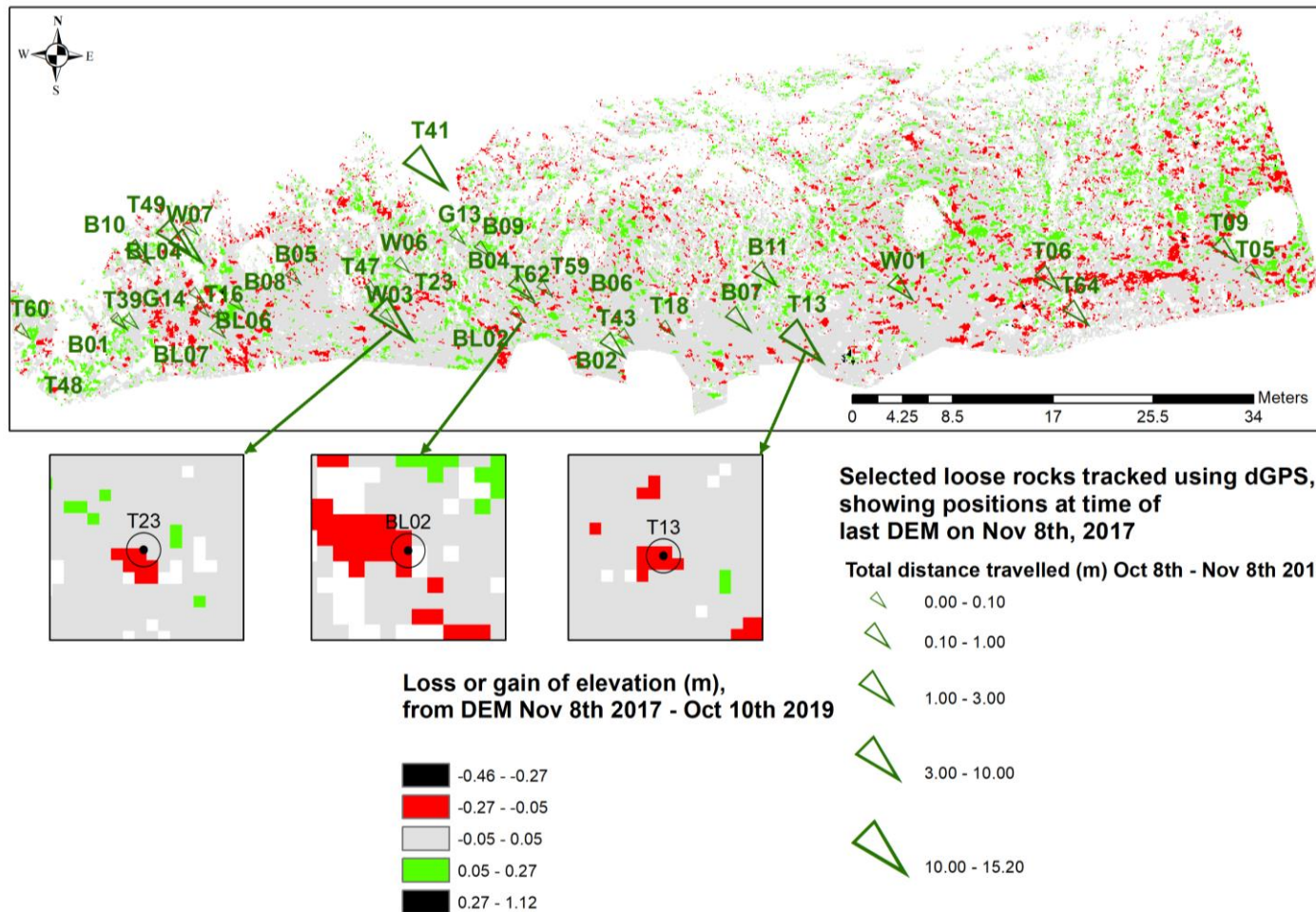


Figure 4.12. Laser scanned Digital Elevation Map (DEM) of a section of the experimental shore at Treborth, the Menai Strait, showing a change in elevation around tracked rocks between November 2nd, 2017 and October 10th, 2019. Triangles around rock centre points indicate residual direction of travel across the shore. Rocks marked with targets provide the exact position of rocks at set times together with the observed change in elevation over the 23 month period.

4.4 Discussion

This chapter started by highlighting a lack of research focussing on natural peripatetic pathways to localised disturbance on tide swept boulder shores, and the potential for that to be confused with anthropogenic disturbance or to cause habitat change over longer time scales. The simultaneous use of survey accuracy Global Positioning System (GPS), accelerometers and Digital Elevation Maps (DEM) from a Terrestrial Laser Scanner (TLS) in my work confirmed the hypothesis that loose rocks with high algal loadings do move in the Menai Strait, although land in an upright position, and that novel technologies could be used to tease this from anthropogenic rock turning.

Geologists have recently taken interest in the macroalgal transport, or macroalgal 'rafting' of rocks and detritus, to explain out-sized 'clasts' (fragments of geological detritus) on beaches (Frey and Dashtgard 2012, Carling 2014, Garden and Smith 2015). Extensive rafts of kelp with large attached substrates have also been found drifting thousands of kilometres over hundreds of days in the Southern Ocean (Smith 2002, Garden and Smith 2015). In the Severn Estuary, UK, cobbles with *Fucus vesiculosus* were found four times more likely to be moved than those without (Carling 2014). In the Menai Strait, my study found that rocks with *Ascophyllum* were 2.4 times more likely than bare rocks to move distances more than one meter, to a maximum of 15.2m, over a one month period. Transport of these rocks was found to run parallel to the shore, and into deeper water, as found by seaweed-assisted benthic gravel transport research in the Juan de Fuca Strait, Canada (Frey and Dashtgard 2012). Although many dislodged algal loaded rocks will be transported to higher ground with high water, slowly moving along the coast via peripatetic movement, it is possible that where currents and conditions allow, particularly with increased storm intensity and frequency that comes with climate change (IPCC 2019), these rocks could raft greater distances as found in the more open Southern Ocean (Smith 2002, Garden and Smith 2015).

Historical observations have noted rocks up to 25kg can be transported by fucoids including *Ascophyllum* (Grieve 1882 in Garden and Smith 2015). The maximum size of rock that moved in this study was 12.3kg total wet weight (algae and rock). This rock was of 35.5cm in diameter and moved 23cm over 31 days. Previous research

Chapter 4: Teasing natural from anthropogenic disturbance on a boulder shore

attempting to assess the critical movement threshold for algal loaded rocks has found that there is a positive relationship between algal biomass and the size of cobbles that can be transported by waves (Scheibling et al. 2009) and oscillatory water movement (Kudrass 1974). When the algal weight is three times that of the rock that it's attached to, transport can be initiated through a combination of drag and lift (Kudrass 1974, Gilbert 1984). This calculation offers a destructive method by which to assess the movement of rocks that is not feasible for use by managers seeking to assess the likelihood of peripatetic disturbance affecting protected sites that are already sensitive to anthropogenic disturbance by rock turning. My work tested the viability of using non-destructive field measurements of rock diameter, height and circumference, and maximum *Ascophyllum* length and circumference to estimate a volumetric ratio of algal loading, by which predictions can be made as to whether they are likely to be subject to natural peripatetic movement. It was not possible to determine a critical threshold after which all algal loaded rocks moved. However there were boundaries. For example, 70% of rocks with algal loadings greater than 30 moved distances of greater than 20cm, whilst 53% moved more than 2.9m. Such outputs form a useful starting point for future research developing non-destructive indicators by which to predict the peripatetic movement by algae, or macroalgal-facilitated sediment transport.

Tidal currents are known to increase the likelihood of transport of algal loaded rocks. Controlled hydrodynamic flume experiments have found a critical current velocity of 0.38 m s^{-1} to lift of cobbles 2-20cm in diameter loaded with the intertidal fucoid *F. vesiculosus* (Carling 2014). Field observations have found the presence of Canadian subtidal kelp *Cymanthere triplicata* reduced the critical movement threshold of flows to 0.3 m s^{-1} for pebbles up to 6cm in diameter, which would usually require velocities of 3 m s^{-1} to initiate any movement (Frey and Dashtgard 2012). Acoustic Doppler Velocimeter measurements taken at Treborth have found peak flows to range between $1.55 - 1.98\text{ m s}^{-1}$ (Dr Martin Austin, Oceanographer, Bangor University, unpublished). However, in the absence of site-specific current velocities for this series of experiments and supporting the concept of using cost-effective predictions of disturbance for site managers, I utilised off-the-shelf tidal curves to predict categories of weak, medium and strong tidal flow by which to assess rock movement. Using calibrated activity frequency counts of changes in inclination

Chapter 4: Teasing natural from anthropogenic disturbance on a boulder shore

across tilt axes from affordable accelerometers attached to rocks, the movement of algal loaded rocks occurred when submerged, and was positively related to tidal flow category (moving more frequently in strong flows).

Affordable raw accelerometer outputs of both force of gravity (g) and inclination, or tilt ($^{\circ}$) can be easily overlaid with tidal curves to ascertain whether movement of individual rocks occurs at low water or in the flow of a tide, and proved a successful method for teasing the disturbance of individual rocks turned by people at low water from natural peripatetic movement. However, detecting movement of bare rocks with increasing tidal velocities using accelerometers proved more difficult. Stationary loggers had difficulty stabilising error between readings, making it difficult to combine for comparable analysis of different loggers, orientated at different angles on multiple rocks. ONSET Hobo Pendant G \copyright logger developers acknowledge its inaccuracies at small changes of tilt (0-60 $^{\circ}$, Onset 2013), and in different temperatures. The change in temperature between air and sea would be amplified by the plastic housing in which the loggers were mounted, resulting in a prolonged period of logger stabilisation after immersion. The presence of algae may insulate the loggers where it covers them, causing reduced variability in readings on these rocks, but not for rocks where algae falls to the side, or on bare rocks. The presence of macroalgae is also known to increase the boundary layer around the seabed, thus reduce current velocities around the bed (Madsen et al. 2001), further reducing erosion from the impact of waves and currents around rocks (Garden and Smith 2015, Innocenti et al. 2018). In this case, accelerometers placed on bare rocks appeared to have cyclical error in readings that could be attributed to fluctuating air temperatures confusing the sensors not protected by macroalgae.

Finally, the comparison of DEM taken by TLS over a one week period was used to demonstrate that this technology can be used to pick up the movement of loose rocks of known heights along a tide swept shore at Treborth. Simultaneous GPS and accelerometer experiments confirmed that movement on this site can be facilitated by natural peripatetic movement. Over a 23month period, DEMs also detected changes in elevation the same height as known rock sizes. The proportion of substrate change observable from DEM on any intertidal shore will depend on the overall composition of the beach. Our experimental site was bedrock with 10% loose

Chapter 4: Teasing natural from anthropogenic disturbance on a boulder shore

cobbles and boulders with patches of muddy gravel. A 10% change in site elevation over a long time period, in line with the height of loose rocks, suggests some at least some loose substrates on the site are mobile, evident from clear losses and gains within meters of each other moving in the direction of the residual flow and rock transport. In Canada, algal-mediated hydrodynamic displacement has been found to determine the types of algae that successfully establish on shallow subtidal habitats, in addition to being important form of physical disturbance (Scheibling et al. 2009). Furthermore, some research suggests that the drag caused by algae attached to fractured bedrock can cause further fracturing and even erosion of bedrock on seemingly stable rocky shores (Garden and Smith 2015).

Laser scan trials have also proved that laborious, expensive field work may not be necessary to monitor the movement of substrates on a macroalgal dominated beach. In combination with accelerometers, DEM may provide an easier way to monitor human disturbance of a beach without surveillance of beach goers and repeated impacts of trampling surveyors. Although previous work has found no effect of researchers on underboulder communities, this assumes the exact replacement of boulder in the same orientation, and the boulders surveyed had low algal cover (Chapman and Underwood 1996). Accelerometers used in this project indicated that even when surveyors carefully replaced boulders to the same position, a change was still detectable on the inclination of, and force on, the rock. Raw accelerometer readings sometimes appeared to show rocks 're-stabilising' themselves soon after the placement of loggers, and rocks can move large distances before they re-stabilise depending on their algal loading. Although the results can not confirm this, moving boulders is likely to destabilise them from substrates and potentially increase the likelihood of initiating movement. Although this movement is highly unlikely to over-turn rocks (as algae will keep them upright due to their streamlining in the water column) it will move the rocks, and thus disturb underboulder communities and any attached assemblages. To minimise the impact of surveyors on these habitats, non-destructive rock:algal measurements can be measured in the field by which to calculate approximate volumetric ratios of algal loading that are related to their potential to move naturally.

Chapter 4: Teasing natural from anthropogenic disturbance on a boulder shore

Future managers of boulder habitats can utilise the findings of this work to develop robust evidence and indicators of cumulative disturbance, whilst minimising their own disturbance. DEM from TLS could be used in combination with information on the proportion of macroalgal habitats comprising algae attached to loose or fractured substrates, to establish how mobile they are over large timescales. Rapidly developing technology (Zheng et al. 2019) used in conjunction with popular tidal charts may soon enable the use of new waterproof, micro-loggers embedded in, or attachable to, rocks which integrated GPS, accelerometers or angular displacement sensors with relocation devices (such as radio frequency identification, RFID, technology) for accurate tracking of intertidal rocks, both for human and natural disturbance. My research suggests that successful use of these technologies may be limited to macroalgal rocks initially, with further research required on their use on bare rocks. This technology would make further work on non-destructive methods by which better to establish the critical threshold for movement of rocks by macroalgae (be it algal loading or characteristics of substrate) more affordable, and would inform surveillance by managers and planners of the likelihood of their substrates and associated habitats of interest, or rock armament around infrastructures, to move naturally with localised tides.

This chapter provides new evidence to inform the future development of the boulder-turning index proposed under Marine Strategy Framework Directive (Burrows et al. 2014), and other cumulative impact indicators. It answers some ecological questions regarding unexplained disturbance, dispersal of non-native species and the arrival or displacement of rocks of unusual geology, in sheltered tide swept environments. My work starts to better understand the feasibility of using novel, affordable and rapidly developing technology by which to tease natural from anthropogenic disturbance. In doing so, I add to the morphodynamicists toolbox for a better understanding of little researched coastal processes which will be called upon as more engineers seek to install marine renewable energy infrastructure in tidal channels (Neill et al. 2017), propose the use of macroalgae as a naturally soft method of coastal defence (Innocenti et al. 2018) and boulder field restoration as a natural method by which to both lessen the impact of erosion and encourage biodiversity (Chapman 2017, Liversage and Chapman 2018). A multidisciplinary understanding of both our abiotic and biotic coastal processes, together with the importance of their application, will

Chapter 4: Teasing natural from anthropogenic disturbance on a boulder shore

ensure that cumulative disturbance along our coasts are better understood and better managed in a time of increasing environmental and economic challenges.

Chapter 5. General Discussion

**Contributions of this thesis to understanding and managing the
collection of coastal resources in a global context**

Author: Elisabeth Morris-Webb

Author contributions: The general discussion was all work of the PhD candidate, Liz Morris-Webb, with support of supervisors Prof Stuart Jenkins and Dr Freya St John.

Chapter 5.

General Discussion

My introduction to this thesis explored the existing knowledge on the contemporary collection of living coastal resources around the world. Attempts at managing these collection activities from fisheries and ecosystem based management approaches have been largely unsuccessful due to a lack of baseline information about the activities or non-compliance (Underwood 1993, Odendaal et al. 1994, Hartill et al. 2005, Martins et al. 2011, Aron et al. 2014, Watson 2014, Diogo et al. 2016). Development of more successful policies and management plans has been hindered by a reluctance of collectors to engage with decision-making processes (Aron et al. 2014, Diogo et al. 2016) and unclear legislative frameworks that traverse terrestrial and marine policies and regulatory bodies (Bean and Appleby 2014). The lack of effective management case studies of coastal collection could be considered a symptom of persistent problems in marine governance (Kelly et al. 2019).

A robust understanding of behavioural motivations, grounded in genuine engagement with people, is likely key to developing sustainable management plans that nurture custodianship amongst collectors and encourage future compliance (St John et al. 2010b, Pope and Weber 2019). Furthermore, a well-being approach to understanding motivations is a positive lens through which to focus on collectors. Well-being is acknowledged as being a ‘bridging concept’ in social science fisheries research “*to better understand competing interests that often generate conflict and undermine existing policy framings*” (Coulthard et al. 2011, Britton and Coulthard 2013).

Wales was selected as a case study for my investigations, primarily due to the lack of information on what is collected (Perry et al. 2014) coupled with the challenges it has faced in engaging collectors in decision-making processes for effective, comprehensive policy solutions (Aron et al. 2014, Bean and Appleby 2014, Evans et al. 2015). Wales was an ideal country in which to trial a well-being approach as policy makers are committed to understand the implications of their decision making on the people of Wales today and in future generations under the Well-Being of Future Generations Act (Welsh Government 2015).

Chapter 5: General Discussion

As a consultant to the UK conservation agencies, local councils and Government I have first-hand involvement in the challenges of understanding recreational activities such as angling and bait collection specifically. I have repeatedly seen and heard of difficulties in engaging with collectors, experienced the complexities in teasing apart the impact of collection activities from other disturbance, and witnessed the conservation process fail due, at least in part, to a lack of understanding of, and engagement with relevant stakeholders. I was aware that managers in the UK needed new perspectives with which to engage stakeholders, and new tools to use in decision-making and monitoring. I was also conscious that decision-makers would not be able to do this alone due to existing conflicts and mistrust between managers and collectors.

My thesis aimed to provide information towards three main knowledge gaps regarding coastal collection: 1) to better understand people's motivations to collect coastal species; 2) to provide information on what collecting means to people and their well-being, and how this links with their motivations to collect; and 3) to provide novel methods by which to make confident claims of impact by collectors (i.e. to tease apart natural from anthropogenic disturbance). In doing this, I drew from many disciplines which can now benefit from this new knowledge, in particular human geography and environmental psychology, fisheries and conservation science, human ecology and environmental economy (ecosystem services research). My data can help to form the stepping stones to solve persistent problems in marine governance by: 1) ensuring that stakeholders have a method through which they are comfortable to engage with decision-makers; 2) in doing so, enlightening decision-makers about conflicting priorities within and between stakeholders and managers; 3) by adding information regarding the uncertainty of impacts whilst recognising the limitations of understanding cumulative impacts (three of the six suggested pathways to solutions to persistent problems advised by Kelly et al. 2019). My discussion guides the reader through the novel contributions my data and interdisciplinary approach make to both social and ecological understanding of coastal collection activities, future policy and research.

5.1 Contribution to understanding the social importance of coastal resource collection activities in a developed economy

When I started researching this thesis, there was very limited published information about the collectors of Wales or their motivations to collect. Beyond anthropological research into cultural keystone species of Wales (laverbread and cockles, O'Connor 2009) there was a limited knowledge base on who collects in Wales or the importance of coastal resource collection financially, personally or culturally. My research from Chapters 2 and 3 now contributes a significant body of new information to the many disciplines that have informed its development including, but not limited to, environmental economists seeking to explain cultural ecosystem services and policy makers, managers, and human ecologists looking to develop and inform future transformative marine governance.

Of those surveyed in Chapter 2, 61% lived within 1 mile of the coast, yet 87% of respondents travelled more than 1 mile to collect, revealing that people are not restricting their activities to their doorsteps and actively seek an array of different species and experiences. My research has exposed that coastal collection is important to people in ways that have never previously been explored, providing them not only with food, bait and other material benefits, but also contributing to their Five Ways to Well-Being (New Economics Foundation 2011). For some people, collecting holds irreplaceable meaning (significance, purpose, or relational values), suggesting that they would be reluctant to stop their activities or have them managed.

My novel approach of quantitatively linking motivations to collect coastal resources with different aspects of well-being in Chapter 2 provides fresh insights into what drives the modern collectors of Wales, whilst my reflexive, qualitative design of Chapter 3 exposes the physical and psychological dependencies that people place on their collection activities. Despite a lot of attention in the global press (Allan and Abadi 2020, Ponsford 2020) and popular literature (Litt Woon 2019) relating to how individuals are taking well-being benefits from foraging activities, to my knowledge, no peer reviewed research has specifically focussed on how collecting or foraging links to people's affective well-being. I found that the act of collecting helped lower anxiety levels of participants regardless of their overall mental well-being or

Chapter 5: General Discussion

motivation to collect (Chapter 2). The words of several collectors interviewed (Chapter 3) also revealed that for some people, collecting was their therapy, helping them cope with life in a variety of ways (typified in the 'Collecting for Mental Health' typology). In both Chapters 2 and 3, I further explored the psychological theories driving the therapies delivered through the act of collecting (Cimprich 1993, Ohly et al. 2016, Hunt 2005), particularly in the context of 'emplaced flow' away from everyday environments (Pitt 2014), enhancing older understandings of 'therapeutic landscapes' (Bell et al. 2015, 2018). My work demonstrates that the practice of collecting was important to participants' well-being as both a meaning-making and place-making activity, important both to psychologists and human-geographers. These types of experiences are actively encouraged by the new trend for nature-based social prescribing (Husk et al. 2018, Djohari et al. 2018, Howarth et al. 2020). Crucially, some collectors have found their therapy without the need for a prescription.

The use of 'motivation to collect' scales in my quantitative research (Chapter 2) revealed the multitude of motivations driving collection in Wales. I identified that most respondents' primary motivation for collecting was provisioning, mainly for food, bait, money, science or education (often as employed scientists or educators, or keen citizen scientists). However, collectors rarely attributed a single motivation, and their provisioning motivations were accompanied by a suite of drivers related to the experience of picking. Previous fisheries and ecosystem services research have also started to reveal similar experiential motivations or benefits to fish or glean, although most of those studies are qualitative in method (Pollnac et al. 2015, Skubel et al. 2019, Chaigneau et al. 2019, Grantham et al. 2020).

I have not identified other research that links motivations to collect to the individual well-being of collectors, or foragers, of wild resources, but believe fisheries and conservation sciences could benefit from linking motivations to well-being in future research, in attempts to better understand compliance with conservation plans. I found strong links between mental well-being and the provisioning motivations (food, bait and money) to collect, whilst experiential motivations were not linked to mental well-being. Relationships between provisioning motivations to collect and well-being could be a symptom of need, or reliance, on collecting for provision, although cause

Chapter 5: General Discussion

and effect could not be assumed. However, interviews with collectors in Chapter 3 revealed that these provisioning motivations were offering a life-line to people who were struggling to cope: be it through an opportunity to earn money where there was no alternative; opportunities to realise personal ambitions for an alternative lifestyle away from modern societal expectations; or to achieve their hunter-gatherer personality (for self-actualisation, or for their chosen or cultural lifestyle).

Cumulatively, my work highlights that some UK residents rely on coastal resources for money and well-being, and possibly their sustenance or autonomy, in a way that is rarely explored in developed economies, although has been alluded to by some work in the USA (Biedenweg et al. 2017, Sachdeva et al. 2018), New Zealand (Hall 2013) and Puerto Rico (García-Quijano and Poggie 2019). Just as the motivations to collect support findings of qualitative research from other countries, the use of my battery of quantitative scalar motivation statements and conclusions may be appropriate to understanding the relative importance of different motivations to collectors across the globe.

One of the most novel contributions my work has made to our understanding of collection activities in developed economies was revealed by open questions asking collectors of different mental well-being groups (low, medium and high, using the Warwick-Edinburgh Mental Well-Being Scale, WEMWBS) (Chapter 2). Results revealed that those of low mental well-being gave both provisioning and experiential meanings behind their collection, whilst those of high mental well-being gave words that reflected only experiential meanings. Although it may seem obvious that a need to rely on the collection of wild resources is accompanied by lower well-being, this phenomenon has been little researched in the context of recreational coastal activities (although suggested by Biedenweg et al. 2017 in the context of urban foragers). Differences in the meanings of resource use for people of low and high well-being in developed economies may be of interest to conservation scientists, human geographers, and environmental economists, both for angles for future research and in broadening the scope of exploring benefits of ecosystem services in social contexts.

Finally, in Chapter 3, I clustered collectors based on similarities in what collecting means to them, resulting in four collector typologies: 'Foragers and educators',

Chapter 5: General Discussion

‘Collecting for mental health’, ‘Collecting for lifestyle’ and ‘Collecting for life’. Identifying collector types based on the ‘bundled’ benefits gained from ecosystems, or by commonality in concerns and priorities, has been suggested as a tool by which to ensure that conservation management is sensitive to the differing needs of coastal users (Grantham et al. 2020). To my knowledge, the development of coastal collector typologies has never been attempted, but should be of use to conservation and fisheries science. My approach took a well-being lens and was grounded in words of collectors discussing the meanings behind their collection activities. The coastal collector typologies I developed exposed common themes and collectors’ vulnerabilities to changes in the target stocks or management which will inform engagement methods with different stakeholder groups in the future. In a similar qualitative approach in Latvia, interviews with wild product foragers focussed around the lenses of practice and culture to develop a classification which exposed the motivations (either motivated by practice or by the product) and knowledge base of collectors (Grivins 2021). I would argue that the more developed economy of Wales has a different complexity to the Latvian case study. Motivations in Latvia are dependent on different social and economic contexts to Wales. Latvian collectors were often driven by either by the practice (i.e. the cultural act of collecting) or by the product (most commercial foragers were not tied to the activity or place) (Grivins 2021). The typologies of Welsh coastal collectors (Chapter 3) found that people could not easily be separated into different groups driven by either practice or product (as provisioning motivations and experiential motivations were intertwined). However, many links can be drawn between the foragers of terrestrial, or non-timber forest products and coastal resource collectors, and that this literature base should be explored in future to add value to future conservation science and fisheries research regarding the collection of coastal resources.

5.2 Contribution to developing a better ecological understanding of coastal collection activities in wave sheltered, tide swept, rocky shores

Chapter 2 has provided new information regarding what is collected in Wales, increasing the previous estimate of 41 intertidal species collected (Perry et al. 2014) to 70 shoreline taxa, plus 21 coastal plants. Respondents classified 33 different taxa

Chapter 5: General Discussion

as ‘most important’ to them, including many species not currently considered as commercially important, demonstrating how little is known about potential markets for wild coastal taxa in Wales, commercial or otherwise. Most collectors gathered multiple species for a plethora of reasons, with only 13% of respondents collecting a single target species. New information on the multiple taxa collected around Wales (Chapter 2) adds valuable data to ecological, conservation and fisheries research and to the manager’s toolbox, indicating that the cumulative impacts on our shores will not easily be attributed to the collection of a single species, nor would it be appropriate to be managed with a traditional fisheries management approach to single taxa, confirming conclusions by Odendaal et al. (1994).

Biodiversity indicators aiming to assess ‘*Cumulative human impacts on marine ecosystems*’ (BIP 2010) are challenged by the multiple small-scale anthropogenic activities on our global foreshore, but are needed to both assess progress towards sustainability targets and to act as ‘*operational indicators to trigger management action*’ and future policy (McQuatters-Gollop et al. 2019). Two of the common problems with developing indicators of cumulative impacts are that often the intensity of activities or impacts is unknown (linking back to the challenges of monitoring and engaging collectors, Aron et al. 2014 and Diogo et al. 2016, discussed in Chapters 2 and 3) and that they are difficult to assess or monitor cost-effectively. To be operational triggers the indicators must be accurate, transparent and confidently attributable to the activities which may need management action. My work in Chapter 4 tested whether novel technologies could be used to further develop robust indicators.

Chapter 4 drew on geological, oceanographical and ecological knowledge to inform the further development of a boulder-turning index (Morris et al. 2012, Brazier et al. 2013), that was previously rejected as a Marine Strategy Framework Directive indicator due to lack of ecological validation and limited understanding of the intensity of collection activities (Burrows et al. 2014). My work exposed levels of natural disturbance that might previously have been attributed to anthropogenic boulder turning. Natural disturbance needs to be accounted for in cumulative impact and operational trigger indices.

Chapter 5: General Discussion

Although incidental observations by ecologists and geologists have in the past observed the phenomenon of ‘peripatetic movement’ (Strong et al. 2006b) or ‘macroalgae-mediated sediment transport’ (Garden and Smith 2015), none have researched its effects on the shore in the context of accounting for this disturbance in the development of biodiversity indicators of cumulative impacts. My work here is of particular interest to ecologists, conservationists and site managers as it shows that the tide can move rocks, leading to signs of disturbance at individual rock level with potential to change the composition of a site, although the tide is unlikely to fully overturn rocks in the same way that anthropogenic boulder turning can⁴. Furthermore, displacement by collectors may destabilise settled rocks, increasing the likelihood of peripatetic movement.

Chapter 4 offers ecological and conservation researchers and managers a new suite of tools. These include survey accuracy GPS coupled with low-cost triaxial accelerometers and terrestrial laser scanning. Survey accuracy GPS proved a labour intensive but successful method by which to monitor the movement of marked rocks across a site. Raw data from accelerometers on individual boulders clearly teased natural from anthropogenic disturbance, showing when a rock was disturbed at low water (anthropogenic movement) compared to high water (natural peripatetic movement).

Terrestrial laser scanning was used successfully to quantify changes in elevation indicative of boulder movement. Other remote monitoring techniques (such as aerial imagery or airborne LIDAR imagery) may not have the resolution to detect substrate changes under dense macroalgal cover (Chust et al. 2010, Hollenbeck et al. 2014, Schneider et al. 2019). Airborne LIDAR imagery has been used to differentiate habitats by their surface characteristics (or species) on digital elevation models, but not to assess underlying substrates (Chust et al. 2010). However it is not cost-effective at a fine enough resolution to look at small scale changes in elevation at site level (Hollenbeck et al. 2014). Terrestrial laser scanning provides a more accessible, cost effective method (Hollenbeck et al. 2014, Schneider et al. 2019) although doubts were initially expressed regarding its ability to quantify substrate

⁴ During the experimental tracking of the movement of rocks on the shore (Chapter 4), rocks were noted to be all upright when relocated. Due to the buoyancy and drag effect that macroalgae has on rocks, it is likely that the macroalgae will keep them upright if, or when, lifted in the water column.

Chapter 5: General Discussion

changes beneath macroalgal canopy cover. My work revealed that by accounting for the height and percent cover of loose boulders on the shore, laser scanning can be used to monitor changes on the rocky shore, providing a long term monitoring solution for these habitats that minimises the need for regular site visits and associated disturbance through trampling of sensitive habitats (Hawkins 1999).

Although my work in Chapter 4 was conducted on a small scale (a single 200m stretch of shore), peripatetic movement facilitated by large macroalgae is occurring around the globe. Once in the water column, and under the right conditions, peripatetic movement is known to move macroalgae and their associated substrates across open oceans, sometimes thousands of kilometres, such as giant kelp rafts found in the Southern Ocean (Smith 2002, Garden and Smith 2015). My work exposed that at sheltered, tide swept sites large rocks may be moving at much lower flows than expected. My work joins together information from a range of disciplines into one that is both digestible and useable by future oceanographers, geologists, ecological researchers, indicator developers and site managers.

5.3 Introducing social triggers affecting coastal collection activities around the world

The presence of wild food products in global markets is increasing (Łuczaj et al. 2012, Azania Jarvis 2015). Social-ecological systems researchers, human ecologists, conservation scientists and decision-makers developing future management plans for collection activities need to be alert to important social contexts (or social triggers) beyond the scopes of their own disciplines that will conflict or affect the success of their agendas, to ensure a harmonious balance between resilient stocks, habitats and people. My thesis provides a snapshot of a group of collectors of coastal resources in Wales before the global COVID-19 pandemic. I did not actively research social triggers that might change the motivations of collection in one direction or another. However, my literature review identified some important, often conflicting, contexts that may affect people's motivations to collect, the intensity of activities, and likelihood of compliance with management. For example, there is growing evidence that needs for money and

Chapter 5: General Discussion

food during national recessions increases resource collection (Łuczaj et al. 2012, Sachdeva et al. 2018, Allan and Abadi 2020). During the lockdowns of 2020, some suggested that the motivation to forage increased with an increasing need for close, intense, nature connectedness or desire to explore more local places, and / or food sources (Ponsford 2020). Social drivers may include:

- the high demand for trendy wild products, such as seaweed (Łuczaj et al. 2012, Natural England 2014, Azania Jarvis 2015, McAfee 2017);
- increasing demand for invertebrate protein, including a policy drive to increase food production of shellfish resources, especially through aquaculture (Anderson et al. 2011);
- efforts by coastal governance to minimise disturbance by collectors, whilst urban planners and researchers around the world explore the feasibility of encouraging urban foraging places to bolster nature connectedness in built up spaces (Synk et al. 2017, Nyman 2019, Garekæ and Shackleton 2020, Sardeshpande and Shackleton 2020, Fischer and Kowarik 2020);
- national and local restrictions on people's time outside may heighten the need for close, or intense, nature experiences in future (Ponsford 2020), including clear pathways to nature connectedness that require sensory contact, emotion, meaning, beauty and compassion (Richardson et al. 2020).
- foraging courses, food experiences and even foraging tourism are of growing popularity (de Jong and Varley 2018) and the 'nature experience' industry is growing (Živojinović et al. 2020);
- growth in the 'experience economy' is supported by public health agendas to increase nature-based social prescribing to boost mental health agenda (Lovell et al. 2018, Tredinnick-Rowe et al. 2018, Husk et al. 2018, Shanahan et al. 2019, Howarth et al. 2020);
- economic downturns will increase the provisioning needs of some coastal residents, even in the most developed economies (Łuczaj et al. 2012, Sachdeva et al. 2018, Allan and Abadi 2020), particularly pushing some coastal people into extreme poverty and food insecurity (HLPE 2020);
- coastal environments are squeezed by many factors beyond their control including the effects of climate change (Steven et al. 2020).

Chapter 5: General Discussion

The awareness of such social drivers reveals opportunities not only for conservation science research into what affects the likelihood of people supporting conservation measures (Redpath et al. 2013, Hicks and Cinner 2014, Hicks et al. 2016b), but most importantly, for more social-ecological systems research aiming for successful, dynamic policy making (or transformative marine governance) that has capacity to actively respond to social trigger points, ensuring both human and non-human coastal communities are resilient to future change (Hicks et al. 2016a, Chaffin et al. 2016, HLPE 2020, Steven et al. 2020).

5.4 Limitations and implications for further research

New evidence regarding social and ecological aspects of coastal resource collection in Wales, and the fresh approaches suggested in my thesis could be applied to research of both commercial and recreational wild product collection anywhere in the world, and by a range of disciplines.

By the end of my ten-month survey campaign (Chapter 2) I had developed a positive rapport with many collectors in Wales. I am confident that the well-being approach to engagement, which provided participants with survey aims as well as a list of contentious topics we would not be asking about (such as the location or intensity of their activities), can be used successfully by managers, fisheries and conservation scientists in the future. I now believe I have gatekeepers and pathways to engage with more collectors of Wales in the future, particularly as many respondents were keen to be kept in touch with the project outcomes. Developing similar trust may be possible through my expanding networks around the UK, and I believe that a genuine interest in what people's activities mean to them is a positive starting point which can be reframed to better understand collectors around the UK and the world. In future, working with researchers in disciplines, such as anthropologists and environmental psychologists specialising in cultural practice, may add to the depth of understanding for collectors who were particularly difficult to engage with, such as bait and migrant collectors.

I often found myself joining in with the coastal collection to keep questionnaire momentum (Chapter 2) and get answers. Future work might also benefit from more anthropological approaches including phenomenological ethnomethodologies, such as participant observation (Puri 2011). Participant observation is a method by which researcher participates in the activities, led by the participants and following the routine of the collectors. By embedding themselves in the same experience participants take time to open up and the researcher can make a more understanding interpretation of the activities. Participant observation is known to be effective at better understanding motivations and things that people find difficult to easily explain, or how people experience conflicts, and as such may work well with both vulnerable groups of collectors or those reluctant to engage for any reason.

Chapter 5: General Discussion

Chapter 2 exposed bait collectors as potentially vulnerable people amongst the collecting community. Research should focus on this vulnerable group to explore their dependencies on collection in greater detail but also their reluctance to engage. Motivation statements could possibly be adapted to focus on perceptions of bait collection, and other collection activities, and barriers to engagement as recently in a similar study with South African wild plant foragers (Garekae and Shackleton 2020).

When I began my research, I was keen to use methods developed by environmental psychologists and conservation scientists specifically to encourage more truthful reporting of sensitive activities (St John et al. 2010a, Lau et al. 2011, Nuno and St John 2014). Specialised questioning techniques such as the randomised response technique (Warner 1965) and the bean method (Lau et al. 2011) have been used with varying success across a range of activities including fisher behaviour (Cerri et al. 2017, Oyanedel et al. 2020). I wanted to test whether they would be successful in exploring informal economies amongst British respondents. It quickly became clear however, that I would not attain the sample size required to test these methods, and that more positively framed research questions, drawing from psychology and health sciences, were more appropriate to better understand the complexities behind collection activity in Wales. Furthermore, collectors appeared happy to declare '*I make a little money from my activities*' as a motivation to collect using a scalar response to reflect its importance to them, without the need for specialised questions in the most part. Specialised questioning techniques may still be useful for future researchers where larger samples can be guaranteed.

Although the positive well-being approach proved successful in delving into the importance of collection activities to participants, my sample size for Chapter 2 was smaller than I would have liked. Some collectors were reluctant to discuss their activities, whilst others were simply sceptical about engaging. The questionnaire was developed for self-completion. However, most participants were unwilling to self-complete due to their wet or muddy hands, thus introducing some challenges, particularly with the WEMWBS questions (Chapter 2). It was particularly awkward asking participants some of the more personal of the 14 agreement statements when we were within ear-shot of other people. Consequently, data were more vulnerable to social desirability bias than might have been the case if respondents had self-

Chapter 5: General Discussion

completed. Further research could explore the use of less personal well-being scales, such as the shortened, 7 statement WEMWBS, although using fewer personal statements is recognised to be less sensitive to some well-documented relationships in between sociodemographic factors, such as income, education and gender specific age differences (Ng Fat et al. 2017).

Despite the limitations, my novel quantitative approach of comparing well-being scales, used within annual National Survey for Wales, to people's motivations to collect (Chapter 2) was particularly effective at identifying links between provisioning motivations and mental well-being (WEMWBS). No significant relationships were identified between more experiential motivations and any of the well-being scales tested. However, the use of scalar motivation statements enabled me to examine the relative importance of different collection motivations (Chapter 2) and these statements could be further refined using the themes explored as “meanings” behind collection (Chapter 3). Further development of these motivation statements using the knowledge revealed in Chapter 3 may enable future human ecologists, fisheries and conservation scientists to empirically link both provisioning and experiential motivations with well-being scales measuring different aspects of well-being. Alternatively, carefully worded reflexive questions used in a mixed methods approach could also be used to link experiential motivations to well-being.

Methods using batteries of motivation statements could be used around the world to link locally relevant motivations with country specific well-being scales, although the motivation statements would need to be adapted or informed by locally relevant qualitative research or social context. Human geography, human ecology, environmental psychology, fisheries and conservation science researchers must consider the limitations of the well-being scales chosen, and whether they have the power to pick up aspects of well-being related to collecting. A suite of circumstantial factors effect the different aspects of well-being, and must be accounted for within multivariate models as tested in Chapter 2.

Further development of motivation statements may also enable human ecology and conservation science researchers to build links with other topical research questions such as the perception of sustainability, conflict, or management options. For example, Garekae and Shackleton (2020) explored the motivations to collect wild

Chapter 5: General Discussion

plants in South Africa and linked these motivations with perceived barriers to gathering wild products in an urban environment.

My development of collector typologies from qualitative data (Chapter 3) can be used to develop a suite of tailored statements to check which typology collectors most identify with, without asking them the full range of questions used in Chapters 2 and 3. A reduced set of classification questions could speed up field surveys, potentially avoiding asking each respondent sensitive questions about their well-being or collecting behaviour, thus enabling the conservation or fisheries researcher to develop more specific research hypothesis. Depending on how typologies are developed, they can be used to inform development of specific social indicators grounded in existing knowledge, identify specific stakeholders by their values, behaviours, perceptions, markets and conflicts, and link to their attitudes towards conservation and potential compliance with different management strategies (Wam et al. 2012, Fredheim and Khalaf 2016, Baynham-Herd et al. 2018, Grivins 2021). However, it is more typical to develop typologies of people using repeatable quantitative scales with techniques such as Latent Class Analysis or mixed methods (Connelly et al. 2001, Magee et al. 2018).

Operationalising typologies, well-being and motivations into social indicators that are useful for a conservation agenda is the next big hurdle for researchers and managers. My work can inform the development of useful tools, such as frameworks that inform suitable conservation interventions based on modern theories of behavioural change. One such tool recently explored the motivations for the use and consumption of wildlife products based on the concept that capability, motivation and opportunity all influence the behaviour of individuals, with an aim of informing best demand reduction interventions within the international wildlife trade (Thomas-Walters et al. 2020). Their study recognised the difference between the 'type of use' of a wild product (eg. food, money) from the 'motivation for use' (eg. sustenance, or trendy culinary experience by choice), which is a similar difference to the 'motivation for product' and the 'motivation for practise' in a collecting perspective. Thomas-Walters et al. (2020) concluded that there are five consumer typologies driving supply chains for illegal wildlife products (Experiential, Social, Functional, Financial and Spiritual) each heavily influenced by demand or social context. Although

Chapter 5: General Discussion

Thomas-Walters et al. (2020) focusses on the motivations for the end users of products (i.e the market for demand on illegal wildlife trade), the framework could be adapted to focus on the collectors of wild products, adapted with knowledge teased from Chapters 2 and 3.

A future concise synthesis, or meta-analysis, of the motivations, meanings and well-being implications explored in my thesis with other quantitative and qualitative data, would provide a pragmatic approach by which to compare successful methods understanding the drivers of the collection of wild species (coastal, commercial, recreational, illegal or otherwise) across disciplines and countries and provide a more holistic knowledge base, or toolbox, for policy and decision-makers (Alexander et al. 2020).

Finally, ecology and conservation researchers developing biodiversity indicators to assess cumulative impacts affecting boulder shores, or operational indicators to trigger management decisions, can further my work in Chapter 4 by further testing the use of digital elevation models on different types of shore. As technology rapidly develops and miniaturises (Zheng et al. 2019), accelerometers or angular displacement sensors with inbuilt GPS and possibly relocation devices (such as radio frequency identification, RFID, technology), of a size that can be embedded in rocks for insulation, could be further researched for accurate tracking of intertidal rocks for both human and natural disturbance. My research suggests that successful use of these technologies may be limited to macroalgal rocks initially, with further research required to minimise error caused by differences between air and water temperatures on uninsulated bare rocks.

Increasing storm frequency coupled with strong tides mean that boulder shores may become increasingly mobile, loosening macroalgal topped rocks under a critical size. Ecologists should consider long term monitoring of boulder shores with high cover of large macroalgae of different species, using laser-scanning technology or otherwise. Further work on non-destructive methods by which ecologists or oceanographers can better establish the critical threshold for movement of rocks by macroalgae (be it algal loading or characteristics of substrate) can be made more affordable with advances in technology.

5.5 Implications for policy: Towards a transformative solution to the persistent management conundrum of engaging with collectors and the sustainable management of long held foraging practices

The introduction to my thesis concluded that understanding people, their interactions with nature and their trust in the legitimacy and equitability of management decisions, are key to the success of future policy affecting coastal collection. My work holds important lessons for decision-makers on how to better engage with collectors, together with how to better understand collectors and incorporate new knowledge into management plans. This same knowledge can be used by human ecologists and social-ecological systems researchers working towards more effective transformative marine governance, for resilient, sustainable ecosystems.

Engaging coastal collectors in Wales was the biggest challenge of my work, but through my determination to meet as many, diverse collectors as possible, my positive well-being lens (Chapters 2 and 3) provided interdisciplinary approaches through which many collectors were both willing to engage, and to be contacted in future. The subsequent success of snowballed participants showed an enthusiasm to engage once project aims were clear. Ethnographers in Seattle have suggested that increased engagement with foragers will enhance environmental stewardship of urban parks (McLain et al. 2017). A well-being framing to engage collectors proved successful, and should be absorbed into the decision-making process and incorporated into advice for successful, positive engagement methods to resolve conflicts within the management of natural resources in Wales (i.e. Nuttall 2016).

Operationalising well-being in a conservation policy context is challenging and requires more work (Section 5.4). Developing social indicators which link motivations to collect with well-being (Chapter 2), whilst incorporating dynamic social contexts driving motivations (Section 5.3), could be used to monitor the provisioning needs and vulnerabilities of some collectors, and inform the best conservation intervention to address their needs. Environmental psychologists and conservation researchers can also develop knowledge of opportunities, motivations and capabilities into psychological behaviour models to better inform the most appropriate interventions (Section 5.4, eg. Thomas-Walters et al., 2020).

Chapter 5: General Discussion

Management options for long held collection practices have been explored by several researchers, revealing that: a single species fisheries approach to management is ineffective; legislation alone that restricts or prohibits collection on seasonal or spatial scales is ineffective; hard barriers to stop collection rarely work whilst active monitoring and enforcement of coastal collection is not cost-effective (Odendaal et al. 1994, Hartill et al. 2005, Martins et al. 2011, Diogo et al. 2016). Just as it has become widely accepted that fishers rely on their fisheries for a variety of non-monetary reasons including identity and status (Pollnac and Poggie 2006), the meanings behind coastal collection in Chapter 3 exposed a plethora of dependencies upon collection. Links between the meanings of collection and people's dependencies on their collecting activities implies that simply providing alternative activities or livelihoods for collectors will not placate their need to collect (Pollnac and Poggie 2006) and managers should consider their motivations to which alternative interventions may be most successful.

Furthermore, lessons from terrestrial collection activities (non-timber forest products) show that no regulation, or late legislation, is not a feasible option. Rapid development of unregulated wild product markets, such as the Latvian wild blueberry market, can move collection for subsistence and cultural value to collection of global market value and lead to the divergence of collecting markets: one formal and one illegal (Grivins 2016, Grivins and Tisenkopfs 2018). Formal supply chains will occasionally rely in part on the illegal to make up supplies for demand, which, in the Latvian case, were often people collecting as a second income or relying on welfare benefits, who wanted to remain invisible (Grivins and Tisenkopfs 2018).

In 1994, Odendaal et al. undertook a socio-economic review of management options for collection activities, concluding that *“legislation needs appropriate and sufficient information upon which to base legislation ... the process needs clear and understandable laws ... and these laws need to be enforceable”*. In the UK we have not yet achieved this, although work is underway. Odendaal (1994) went on to suggest that the best options for legislation should be founded in co-management of resources with stakeholders, with or without private incentives. Territorial user rights for fisheries management, or self-sanctioning cooperatives, can increase compliance as collectors themselves are invested and actively managing their resources

Chapter 5: General Discussion

(Odendaal et al. 1994, Gelcich et al. 2005). Co-management using a human-rights based approach has had proven success around the world, including for the Uruguayan yellow-clam fishery (FAO 2019), with significant work including education and governance to ensure that co-management is fair, inclusive and effective.

Part of building a trusting relationship with stakeholders is through providing robust, unquestionable evidence to support management decisions. Robust evidence includes the confident ability to tease natural from anthropogenic activities. With increasing storm frequency coupled with high tides, it is possible that currently sheltered, tide-swept shores may become increasingly mobile, losing macroalgal topped rocks under a critical size (Chapter 4), and become subject to natural shifts in biotopes and associated communities as a result. As a result, biodiversity indicator developers and site managers of boulder sites should incorporate long term monitoring of protected or sensitive areas of large macroalgae of any species, using digital elevation maps from laser-scanning technology or otherwise. Future, miniaturised accelerometer technology explored in Chapter 4 may enable confident monitoring of boulder-turning activities to positively assign impact without surveillance of people if necessary. Technology has the power to inform surveillance by site managers and planners of the likelihood of their substrates and associated habitats of interest, or rock armament around infrastructures, to move naturally with localised tides.

As the knowledge of the social-ecological systems around our coasts are incomplete, policy makers can use my social and ecological research to inform better adaptive governance to be flexible to social and environmental changes. However, it could also be used to inform transformative marine governance to avoid future regime shifts and create more resilient and sustainable human and non-human coasts in a rapidly changing world (Chaffin et al. 2016, Kelly et al. 2019).

5.6 Conclusions

My thesis has taken an interdisciplinary approach to address some of the social and ecological knowledge gaps that can feed conflict between collectors, policy makers and managers. I suggest new framings to these persistent management

Chapter 5: General Discussion

conundrums, beyond traditional ecological and subsistence narratives, that will enhance understanding of, and future engagement with, intertidal collectors whilst promoting advocacy for future management amongst collectors themselves. Both motivations to collect and how collection contributes to human well-being will change depending on social, economic, policy and environmental contexts. Developers of operational biodiversity indicators that trigger management action need to ensure that they are accounting for natural changes to sites in addition to providing robust evidence for anthropogenic disturbance. My work can contribute to the development of new approaches to future engagement, policy making and management, and can be used alongside monitoring of changing social contexts to better appreciate the collector pressure on the global foreshore.

References

- Aberg, P. 1990. Measuring size and choosing category size for a transition matrix study of the seaweed *Ascophyllum nodosum*. Marine Ecology Progress Series 63:281–287.
- Addessi, L. 1994. Human disturbance and long-term changes on a rocky intertidal community. Ecological Applications 4:786–797.
- AFBI. 2011. Intertidal Harvesting in Northern Ireland.
- Agnew, D. J., and C. T. Barnes. 2004. Economic aspects and drivers of IUU fishing: Building a framework. Report AGR/FI/IUU(2004)2.
- Aked, J., N. Marks, C. Cordon, and S. Thompson. 2008. 5 ways to wellbeing. A report presented to the Foresight Project on communicating the evidence base for improving people's well-being. The centre for well-being (the new economics foundation).
- Alexander, S. M., K. Jones, N. J. Bennett, A. Budden, M. Cox, M. Crosas, E. T. Game, J. Geary, R. D. Hardy, J. T. Johnson, S. Karcher, N. Motzer, J. Pittman, H. Randell, J. A. Silva, P. P. da Silva, C. Strasser, C. Strawhacker, A. Stuhl, and N. Weber. 2020. Qualitative data sharing and synthesis for sustainability science. Nature Sustainability 3:81–88.
- Allan, D. T., and M. Abadi. 2020, May 20. Wild plant foragers are growing in popularity as food insecurity grows. Business Insider.
- Anderson, S. C., J. M. Flemming, R. Watson, and H. K. Lotze. 2011. Rapid global expansion of invertebrate fisheries: Trends, drivers, and ecosystem effects. PLoS ONE 6:1–9.
- Araújo, R., S. Vaselli, M. Almeida, E. Serrão, and I. Sousa-Pinto. 2009. Effects of disturbance on marginal populations: human trampling on *Ascophyllum nodosum* assemblages at its southern distribution limit. Marine Ecology Progress Series 378:81–92.
- Aron, H., C. Eno, and B. Jones. 2014. FishMap MÔN Project Report. A report for Natural Resources Wales and Welsh Government.

- Azania Jarvis, A. 2015, May 20. Sea spaghetti in the supermarket: the unstoppable rise of seaweed. *The Guardian*.
- Barnes-Mauthe, M., K. L. L. Oleson, and B. Zafindrasilivonona. 2013. The total economic value of small-scale fisheries with a characterization of post-landing trends: An application in Madagascar with global relevance. *Fisheries Research* 147:175–185.
- Bauman, A., B. Smith, L. Stoker, B. Bellew, and M. Booth. 1999. Geographical influences upon physical activity participation: Evidence of a “coastal effect.” *Australian and New Zealand Journal of Public Health* 23:322–324.
- Baynham-Herd, Z., S. Redpath, N. Bunnefeld, T. Molony, and A. Keane. 2018. Conservation conflicts: Behavioural threats, frames, and intervention recommendations. *Biological Conservation* 222:180–188.
- Bean, E. ., and T. P. . Appleby. 2014. Guidelines for Sustainable Intertidal Bait and Seaweed Collection in Wales: Legislative Review. A report to the Pembrokeshire Marine SAC Relevant Authorities Group, University of the West of England: Bristol.
- Bell, S. L., R. Foley, F. Houghton, A. Maddrell, and A. M. Williams. 2018. From therapeutic landscapes to healthy spaces, places and practices: A scoping review. *Social Science & Medicine* 196:123–130.
- Bell, S. L., C. Phoenix, R. Lovell, and B. W. Wheeler. 2015. Seeking everyday wellbeing: The coast as a therapeutic landscape. *Social Science & Medicine* 142:56–67.
- Bhaskar, R. 2020. Critical realism and the ontology of persons. *Journal of Critical Realism* 19:113–120.
- Biedenweg, K., R. P. Scott, and T. A. Scott. 2017. How does engaging with nature relate to life satisfaction? Demonstrating the link between environment-specific social experiences and life satisfaction. *Journal of Environmental Psychology* 50:112–124.
- BIP. 2010. The Cumulative Human Impacts on Marine Ecosystems Indicator. The

- Biodiversity Indicators Partnership. Available online at.
<https://www.bipindicators.net/indicators/cumulative-human-impacts-on-marine-ecosystems>.
- BIP. 2012. Indicators Developed towards Strategic Goal B-Reduce the direct pressures on biodiversity and promote sustainable use. The Biodiversity Indicators Partnership. Available online at
<https://www.cbd.int/doc/meetings/pc/rwgspc-nbsap-01/other/rwgspc-nbsap-01-t>.
- Borden, R. J. 2008. A Brief History of SHE: Reflections on the Founding and First Twenty Five Years of the Society for Human Ecology. *Human Ecology Review* 15:95–108.
- Braun, V., and V. Clarke. 2006. Using thematic analysis in psychology. *Qualitative Research in Psychology* 3:77–101.
- Braun, V., and V. Clarke. 2019. Reflecting on reflexive thematic analysis. *Qualitative Research in Sport, Exercise and Health* 11:589–597.
- Braun, V., and V. Clarke. 2020. One size fits all? What counts as quality practice in (reflexive) thematic analysis? *Qualitative Research in Psychology*:1–25.
- Brayne, R. P. 2015. The Relationship between Nearshore Wave Conditions and Coarse Clastic Beach Dynamics. University of Exeter.
- Brazier, D. P., K. Mazik, W. A. Musk, G. Scott, S. Travers, and M. Jones. 2013. Intertidal monitoring of underboulder communities in the Menai Strait and Conwy Bay SAC 2004/5.
- Britton, E., and S. Coulthard. 2013. Assessing the social wellbeing of Northern Ireland's fishing society using a three-dimensional approach. *Marine Policy* 37:28–36.
- Broadhurst, C. L., Y. Wang, M. A. Crawford, S. C. Cunnane, J. E. Parkington, and W. F. Schmidt. 2002. Brain-specific lipids from marine, lacustrine, or terrestrial food resources: potential impact on early African *Homo sapiens*. *Comparative Biochemistry and Physiology Part B: Biochemistry and Molecular Biology* 131:653–673.

- Brown, A., M. Munday, A. Roberts, N. Roche, M. Armstrong, K. Hyder, and E. Outghton. 2013. The Economic and Social Value of Recreational Sea Angling in England. Annex 2 of the Sea Angling 2012 – a survey of recreational sea angling activity and economic value in England. Defra report, © Crown copyright 2013. DEFRA.
- Brown, K. W., and R. M. Ryan. 2003. The benefits of being present: Mindfulness and its role in psychological well-being. *Journal of Personality and Social Psychology* 84:822–848.
- Brueckner-Irwin, I., D. Armitage, and S. Courtenay. 2019. Applying a social-ecological well-being approach to enhance opportunities for marine protected area governance. *Ecology and Society* 24:7.
- Bryman, A. 2016. *Social Research Methods*. 5th Edition edition. Oxford University Press.
- Brymer, E., E. Freeman, and M. Richardson. 2019. Editorial: One Health: The Well-being Impacts of Human-Nature Relationships. *Frontiers in Psychology* 10:1611.
- Bunker, F. S. D., J. A. Brodie, C. A. Maggs, A. R. Bunker, and M. D. Guiry. 2017. *Seasearch Guide: Seaweeds of Britain and Ireland*. Second Edition. Wild Nature Press.
- Burrows, M., R. Harvey, and L. Robb. 2008. Wave exposure indices from digital coastlines and the prediction of rocky shore community structure. *Marine Ecology Progress Series* 353:1–12.
- Burrows, MT, Mieszkowska, Hawkins, and SJ. 2014. Marine Strategy Framework Directive Indicators for UK Rocky Shores - Part 1: Defining and validating the indicators. JNCC Report No:522.
- Carling, P. A. 2014. The role of attached kelp (seaweed) in lowering threshold of coarse gravel entrainment in tidal flows. *Marine Geology* 357:101–107.
- Carss, D. N., A. C. Brito, P. Chainho, A. Ciutat, X. de Montaudouin, R. M. Fernández Otero, M. I. Filgueira, A. Garbutt, M. A. Goedknecht, S. A. Lynch, K. E. Mahony, O. Maire, S. K. Malham, F. Orvain, A. van der Schatte Olivier, and L. Jones.

2020. Ecosystem services provided by a non-cultured shellfish species: The common cockle *Cerastoderma edule*. *Marine Environmental Research*:104931.
- Castilla, J. C. 1999. Coastal marine communities: Trends and perspectives from human-exclusion experiments. *Trends in Ecology and Evolution* 14:280–282.
- Castilla, J. C., G. M. Branch, and A. Barkai. 1994. Exploitation of Two Critical Predators: The Gastropod *Concholepas concholepas* and the Rock Lobster *Jasus lalandii*. Pages 101–130 in W. Siegfried, editor. *Rocky Shores: Exploitation in Chile and South Africa*. Springer, Berlin, Heidelberg.
- Caswell, B. A., E. S. Klein, H. K. Alleway, J. E. Ball, J. Botero, M. Cardinale, M. Eero, G. H. Engelhard, T. Fortibuoni, A. J. Giraldo, J. Hentati-Sundberg, P. Jones, J. N. Kittinger, G. Krause, D. L. Lajus, J. Lajus, S. C. Y. Lau, A. K. Lescrauwaet, B. R. MacKenzie, M. McKenzie, H. Ojaveer, J. M. Pandolfi, S. Raicevich, B. D. Russell, A. Sundelöf, R. B. Thorpe, P. S. E. zu Ermgassen, and R. H. Thurstan. 2020. Something old, something new: Historical perspectives provide lessons for blue growth agendas. *Fish and Fisheries* 21:774–796.
- CCW. 2010. *Sea Fishing Atlas of Wales*.
- Ceccherelli, G., A. Pais, S. Pinna, N. Sechi, and L. A. Chessa. 2011. Human impact on *Paracentrotus lividus*: The result of harvest restrictions and accessibility of locations. *Marine Biology* 158:845–852.
- Cerri, J., A. Ciappelli, A. Lenuzza, A. Nocita, and M. Zaccaroni. 2017. The randomised response technique: A valuable approach to monitor pathways of aquatic biological invasions. *Fisheries Management and Ecology* 24:504–511.
- Cervin, G., M. Lindegarth, R. M. Viejo, and P. Åberg. 2004. Effects of small-scale disturbances of canopy and grazing on intertidal assemblages on the Swedish west coast. *Journal of Experimental Marine Biology and Ecology* 302:35–49.
- Chaffin, B. C., A. S. Garmestani, L. H. Gunderson, M. H. Benson, D. G. Angeler, C. A. (Tony) Arnold, B. Cosens, R. K. Craig, J. B. Ruhl, and C. R. Allen. 2016. Transformative Environmental Governance. *Annual Review of Environment and Resources* 41:399–423.

- Chaigneau, T., K. Brown, S. Coulthard, T. M. Daw, and L. Szaboova. 2019. Money, use and experience: Identifying the mechanisms through which ecosystem services contribute to wellbeing in coastal Kenya and Mozambique. *Ecosystem Services* 38:100957.
- Chamberlain, J. L., M. R. Emery, and T. Patel-Weynard. 2018. Assessment of Nontimber Forest Products in the United States Under Changing Conditions. A report for the United States Department of Agriculture. General Technical Report SRS-232.
- Chapman, M. G. 2017. Intertidal boulder-fields: A much neglected, but ecologically important, intertidal habitat. Pages 35–54 *Oceanography and Marine Biology: An Annual Review*.
- Chapman, M. G., and A. J. Underwood. 1996. Experiments on effects of sampling biota under intertidal and shallow subtidal boulders. *Journal of Experimental Marine Biology and Ecology* 207:103–126.
- Chust, G., M. Grande, I. Galparsoro, A. Uriarte, and Á. Borja. 2010. Capabilities of the bathymetric Hawk Eye LiDAR for coastal habitat mapping: A case study within a Basque estuary. *Estuarine, Coastal and Shelf Science* 89:200–213.
- Cimprich, B. 1993. Development of an intervention to restore attention in cancer patients. *Cancer Nursing* 16:83–92.
- Coates, P. J. 1983. Fishing bait collection in the Menai Strait and its relevant to the potential establishment of a Marine Nature Reserve with observation on the biology of the main prey species, the ragworm *Nereis virens*. A report to the Centre for Environmental Technology.
- Connell, J. H. 1978. Diversity in Tropical Rain Forests and Coral Reefs. *Science* 199:1302–1310.
- Connelly, N. A., B. A. Knuth, and T. L. Brown. 2001. An Angler Typology Based on Angler Fishing Preferences. *Transactions of the American Fisheries Society* 130:130–137.
- Coppa, S., G. A. De Lucia, G. Massaro, A. Camedda, S. Marra, P. Magni, A. Perilli,

- M. Di Bitetto, J. C. García-Gómez, and F. Espinosa. 2016. Is the establishment of MPAs enough to preserve endangered intertidal species? The case of *Patella ferruginea* in Mal di Ventre Island (W Sardinia, Italy). *Aquatic Conservation: Marine and Freshwater Ecosystems* 26:623–638.
- Coulthard, S., D. Johnson, and J. A. McGregor. 2011. Poverty, sustainability and human wellbeing: A social wellbeing approach to the global fisheries crisis. *Environmental Change* 21:453–463.
- Countryside Council for Wales. 2009. Y Fenai a Bae Conwy / Menai Strait and Conwy Bay European Marine Site. Available at <https://sac.jncc.gov.uk/site/UK0030202>.
- Cranfield, H. J., and K. P. Michael. 2001. The surf clam fishery in New Zealand: description of the fishery, its management, and the biology of surf clams. *New Zealand Fisheries Assessment Report* 2001/62.
- Crowe, T. P., R. C. Thompson, S. Bray, and S. J. Hawkins. 2000. Impacts of anthropogenic stress on rocky intertidal communities. *Journal of Aquatic Ecosystem Stress and Recovery* 7:273–297.
- Cryer, M., G. N. Whittle, and R. Williams. 1987. The impact of bait collection by anglers on marine intertidal invertebrates. *Biological Conservation* 42:83–93.
- Cummins, V., S. Coughlan, O. McClean, N. Connolly, J. Mercer, and G. Burnell. 2002. An Assessment of the Potential for the Sustainable Development of the Edible Periwinkle, *Littorina littorea*, Industry in Ireland. Page Coastal and Marine Resources Center.
- D'Urban Jackson, T., G. J. Williams, G. Walker-Springett, and A. J. Davies. 2020. Three-dimensional digital mapping of ecosystems: A new era in spatial ecology. *Proceedings of the Royal Society B: Biological Sciences* 287:20192383.
- Daniel, T. C., A. Muhar, A. Arnberger, O. Aznar, J. W. Boyd, K. M. A. Chan, R. Costanza, T. Elmqvist, C. G. Flint, P. H. Gobster, A. Grêt-Regamey, R. Lave, S. Muhar, M. Penker, R. G. Ribe, T. Schauppenlehner, T. Sikor, I. Soloviy, M. Spierenburg, K. Taczanowska, J. Tam, and A. Von Der Dunk. 2012. Contributions of cultural services to the ecosystem services agenda.

- Proceedings of the National Academy of Sciences 109:8812–8819.
- Darimont, C. T., C. H. Fox, H. M. Bryan, and T. E. Reimchen. 2015. The unique ecology of human predators. *Science* 349:858–860.
- Davies, A. G., and P. E. Robins. 2017. Residual flow, bedforms and sediment transport in a tidal channel modelled with variable bed roughness. *Geomorphology* 295:855–872.
- DeCaro, D. A., and M. K. Stokes. 2013. Public participation and institutional fit: A social-psychological perspective. *Ecology and Society* 18.
- DEFRA. 2013. Protected food name: Welsh laverbread. COUNCIL REGULATION (EC) No 1151/2012 on protected geographical indications and protected designations of origin “Welsh Laverbread.”
- Diogo, H., J. Gil Pereira, and M. Schmiing. 2016. Catch me if you can: Non-compliance of limpet protection in the Azores. *Marine Policy* 63:92–99.
- Djohari, N., A. Brown, and P. Stolk. 2018. The comfort of the river: understanding the affective geographies of angling waterscapes in young people’s coping practices. *Children’s Geographies* 16:356–367.
- Dolan, P., R. Layard, and R. Metcalfe. 2011. Measuring Subjective Well-being for Public Policy. Page Office for National Statistics.
- Dolan, P., T. Peasgood, and M. White. 2008. Do we really know what makes us happy? A review of the economic literature on the factors associated with subjective well-being. *Journal of Economic Psychology* 29:94–122.
- Doyal, L., and I. Gough. 1984. A theory of human needs. *Critical Social Policy* 4:6–38.
- Eger, R. J., and J. H. Maridal. 2015. A statistical meta-analysis of the wellbeing literature. *International Journal of Wellbeing* 5:45–74.
- Einstein, H. A. 1951. Bed-load function for sediment transportation in open channel flows. Pages 43–46 in H. C. H. Engle, R. Adams, L. R. Howson, E. W. H. Newhouse, G. A. E. Emerson, L. H. Tiffany, G. D. Stoddard, D. W. Morris, and

- A. M. Buswell, editors. Proceedings of the Conference on Water Resources, October 1-3, 1951.
- Elwell, T. L., D. López-Carr, S. Gelcich, and S. D. Gaines. 2020. The importance of cultural ecosystem services in natural resource-dependent communities: Implications for management. *Ecosystem Services* 44:101123.
- Epstein, G., J. Pittman, S. M. Alexander, S. Berdej, T. Dyck, U. Kreitmair, K. J. Raithwell, S. Villamayor-Tomas, J. Vogt, and D. Armitage. 2015. Institutional fit and the sustainability of social-ecological systems. *Current Opinion in Environmental Sustainability* 14:34–40.
- Evans, S., J. Moon, A. Bunker, and M. Green. 2015. Impacts of Bait Digging on the Gann: An Evidence Review. *Natural Resources Wales Evidence Report No: 81*.
- Fa, D. A., J. C. Finlayson, G. Finlayson, F. Giles-Pacheco, J. Rodríguez-Vidal, and J. M. Gutiérrez-López. 2016. Marine mollusc exploitation as evidenced by the Gorham's Cave (Gibraltar) excavations 1998–2005: The Middle–Upper Palaeolithic transition. *Quaternary International* 407:16–28.
- Fabian, M. 2020. The Coalescence of Being: A Model of the Self-Actualisation Process. *Journal of Happiness Studies* 21:1487–1508.
- FAO. 2019. Securing sustainable small-scale fisheries: sharing good practices from around the world. *FAO Fisheries and Aquaculture Technical Paper No. 644*. Rome.
- FAO UN. 2015. Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication. A report for the Food and Agriculture Organization of the United Nations.
- Fearnley, H., K. Cruickshanks, S. Lake, and D. Liley. 2013. The effects of bait harvesting on bird distribution and foraging behaviour in Poole Harbour SPA. Unpublished reports by Footprint Ecology for Natural England.
- Ferreira, J., S. Hawkins, and S. Jenkins. 2015. Physical and biological control of fucoid recruitment in range edge and range centre populations. *Marine Ecology Progress Series* 518:85–94.

- Field, A. 2018. *Discovering Statistics Using IBM SPSS Statistics*. Fifth edition. SAGE Publications Ltd.
- Fischer, A., and A. Eastwood. 2016. Coproduction of ecosystem services as human-nature interactions - An analytical framework. *Land Use Policy* 52:41–50.
- Fischer, L. K., and I. Kowarik. 2020. Connecting people to biodiversity in cities of tomorrow: Is urban foraging a powerful tool? *Ecological Indicators* 112:106087.
- Fleming, L. E., B. Maycock, M. P. White, and M. H. Depledge. 2019. Fostering human health through ocean sustainability in the 21st century. *People and Nature* 1:276–283.
- Floyd, F., and K. Widaman. 1995. Factor Analysis in the Development and Refinement of Clinical Assessment Instruments Article in *Psychological Assessment*.
- Fowler, S. L. 1999. Natura 2000: Guidelines for managing the collection of bait and other shoreline animals within UK European Marine Sites. English Nature (UK Marine SACs Project). Page English.
- Fredheim, L. H., and M. Khalaf. 2016. The significance of values: heritage value typologies re-examined. *International Journal of Heritage Studies* 22:466–481.
- Freudenberg, P., and R. Arlinghaus. 2009. Benefits and Constraints of Outdoor Recreation for People with Physical Disabilities: Inferences from Recreational Fishing. *Leisure Sciences* 32:55–71.
- Frey, S. E., and S. E. Dashtgard. 2012. Seaweed-assisted, benthic gravel transport by tidal currents. *Sedimentary Geology* 265–266:121–125.
- Furkon, M. N. Nessa, and R. Ambo-Rappe. 2019. Invertebrate Gleaning: Forgotten Fisheries. *IOP Conference Series: Earth and Environmental Science* 253:012029.
- Gallagher, C. 2004. CCTV and Human Rights: the Fish and the Bicycle? An Examination of *Peck V. United Kingdom* (2003) 36 E.H.R.R. 41. *Surveillance and Society* 2:270–29.

- García-Quijano, C. G., and J. J. Poggie. 2019. Coastal resource foraging, the culture of coastal livelihoods, and human well-being in Southeastern Puerto Rico: consensus, consonance, and some implications for coastal policy. *Maritime Studies* 19:53–65.
- García-Quijano, C. G., J. J. Poggie, A. Pitchon, and M. H. Del Pozo. 2015. Coastal resource foraging, life satisfaction, and well-being in southeastern Puerto Rico. *Journal of Anthropological Research* 71:145–167.
- Garden, C. J., and A. M. Smith. 2015. Voyages of seaweeds: The role of macroalgae in sediment transport. *Sedimentary Geology* 318:1–9.
- Garekae, H., and C. M. Shackleton. 2020. Urban foraging of wild plants in two medium-sized South African towns: People, perceptions and practices. *Urban Forestry and Urban Greening* 49:126581.
- Garrett, J. K., T. J. Clitherow, M. P. White, B. W. Wheeler, and L. E. Fleming. 2019. Coastal proximity and mental health among urban adults in England: The moderating effect of household income. *Health & Place*:102200.
- Gelcich, S., G. Edwards-Jones, and M. J. Kaiser. 2005. Importance of attitudinal differences among artisanal fishers toward co-management and conservation of marine resources. *Conservation Biology* 19:865–875.
- Gilbert, R. 1984. The movement of gravel by the alga *Fucus vesiculosus* (L.) on a arctic intertidal flat. *Journal of Sedimentary Petrology* 54:463–468.
- Glaser, M., P. Gorris, B. P. Ferreira, and A. Breckwoldt. 2018. Analysing Ecosystem User Perceptions of the Governance Interactions Surrounding a Brazilian Near Shore Coral Reef. *Sustainability* 10:1464.
- Goss-Custard, J. D., R. A. Stillman, A. D. West, R. W. G. Caldow, P. Triplet, S. E. A. le V dit Durell, and S. McGrorty. 2004. When enough is not enough: shorebirds and shellfishing. *Proceedings. Biological sciences / The Royal Society* 271:233–7.
- Gould, R. K., A. Adams, and L. Vivanco. 2020. Looking into the dragons of cultural ecosystem services. *Ecosystems and People* 16:257–272.

- Grantham, R., J. Lau, and D. Kleiber. 2020. Gleaning: beyond the subsistence narrative. *Maritime Studies*:1–16.
- Grieve, S. 1882. Note on the physical effects produced by the floating power of some of the family *Fucaceae* as observed at The Strand between Colonsay and Oronsay, August 25, 1980. *Transactions and Proceedings of the Botanical Society of Edinburgh* 14:lviii–lxii.
- Grivins, M. 2016. A comparative study of the legal and grey wild product supply chains. *Journal of Rural Studies* 45:66–75.
- Grivins, M. 2021. Are all foragers the same? Towards a classification of foragers. *Sociologia Ruralis*:soru.12335.
- Grivins, M., and T. Tisenkopfs. 2018. Benefitting from the global, protecting the local: The nested markets of wild product trade. *Journal of Rural Studies* 61:335–342.
- Grivins, M., T. Tisenkopfs, Z. Stojanovic, and B. Ristic. 2016. A Comparative Analysis of the Social Performance of Global and Local Berry Supply Chains. *Sustainability* 8:1–20.
- Hall, C. M. 2013. Why forage when you don't have to? Personal and cultural meaning in recreational foraging: A New Zealand study. *Journal of Heritage Tourism* 8:224–233.
- Hall, M. C., and R. Mitchell. 2000. "We are what we eat": Food, tourism and globalization. *Tourism, Culture & Communication* 2:29–37.
- Halpern, B. S., K. A. Selkoe, F. Micheli, and C. V. Kappel. 2007. Evaluating and ranking the vulnerability of global marine ecosystems to anthropogenic threats. *Conservation Biology* 21:1301–1315.
- Hambrey, J., and S. Evans. 2016. Aquaculture in England, Wales and Northern Ireland: an analysis of the economic contribution and value of the major sub-sectors and the most important farmed species. *Page Seafish*.
- Harper, S., M. Adshade, V. W. Y. Lam, D. Pauly, and U. R. Sumaila. 2020. Valuing invisible catches: Estimating the global contribution by women to small-scale marine capture fisheries production. *PLOS ONE* 15:e0228912.

- Hartill, B. W., M. Cryer, and M. A. Morrison. 2005. Estimates of biomass, sustainable yield, and harvest: Neither necessary nor sufficient for the management of non-commercial urban intertidal shellfish fisheries. *Fisheries Research* 71:209–222.
- Hawkins, S. J. 1999. Experimental ecology and coastal conservation : conflicts on rocky shores. *Aquatic Conservation* 9:565–572.
- Hicks, C. C., and J. E. Cinner. 2014. Social, institutional, and knowledge mechanisms mediate diverse Ecosystem service benefits from coral reefs. *Proceedings of the National Academy of Sciences of the United States of America* 111:17791–17796.
- Hicks, C. C., L. B. Crowder, N. A. Graham, J. N. Kittinger, and E. Le Cornu. 2016a. Social drivers forewarn of marine regime shifts. *Frontiers in Ecology and the Environment* 14:252–260.
- Hicks, C. C., A. Levine, A. Agrawal, Z. Basurto, S. J. Breslow, C. Carothers, S. Charnley, S. Coulthard, N. Dolsak, J. Donatuto, C. García-Quijano, M. B. Mascia, K. Norman, M. R. Poe, T. Satterfield, K. St. Martin, and P. S. Levin. 2016b. Engage key social concepts for sustainability. *Science* 352.
- Hill, J. M., and N. White. 2008. *Ascophyllum nodosum* . Knotted wrack. In Tyler-Walters H. and Hiscock K. (eds) *Marine Life Information Network: Biology and Sensitivity Key Information Reviews*, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 26-02-2.
- HLPE. 2020. Food Security and Nutrition. Building a global narrative towards 2030. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, Rome.
- Hockey, P. A. R. 1987. The Influence of Coastal Utilisation by Man on the presumed extinction of the Canarian Black Oystercatcher <i>Haematopus meadewaldoi</i> Bannerman. *Biological Conservation* 39:49–62.
- Hollenbeck, J. P., M. J. Olsen, and S. M. Haig. 2014. Using terrestrial laser scanning to support ecological research in the rocky intertidal zone. *Journal of Coastal Conservation* 18:701–714.

- Howarth, M., A. Griffiths, A. da Silva, and R. Green. 2020. Social prescribing: a 'natural' community-based solution. *British Journal of Community Nursing* 25:294–298.
- Howell, A. J., R. L. Dopko, H. A. Passmore, and K. Buro. 2011. Nature connectedness: Associations with well-being and mindfulness. *Personality and Individual Differences* 51:166–171.
- Hunt, S. E. 2005. "Free, Bold, Joyous": The love of seaweed in Margaret Gatty and other mid-Victorian writers. *Environment and History* 11:5–34.
- Hunt, W., and A. McManus. 2015. Recreational fishing supports health and wellbeing in Western Australia Principles and strategies for improving the prevention of cardio-metabolic diseases in indigenous populations View project Web-based Alcohol Brief-Intervention View project. Article in *Australian and New Zealand Journal of Public Health*.
- Husk, K., R. Lovell, and R. Garside. 2018, April 1. Prescribing gardening and conservation activities for health and wellbeing in older people. Elsevier Ireland Ltd.
- Ignelzi, M. 2000. Meaning-Making in the Learning and Teaching Process. *New Directions for Teaching and Learning* 2000:5–14.
- Innocenti, R. A., R. A. Feagin, and T. P. Huff. 2018. The role of *Sargassum* macroalgal wrack in reducing coastal erosion. *Estuarine, Coastal and Shelf Science* 214:82–88.
- IPCC. 2019. The Ocean and Cryosphere in a Changing Climate A Special Report of the Intergovernmental Panel on Climate Change K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.)).
- Jenkins, J. G. 1984. Cockles and mussels: Aspects of shellfish-gathering in Wales. National Museum of Wales.
- Jenkins, S. R., T. a. Norton, and S. J. Hawkins. 2004. Long term effects of *Ascophyllum nodosum* canopy removal on mid shore community structure. *Journal of the Marine Biology Association of the United Kingdom* 84:327–329.

- Jimenez, H., P. Dumas, D. Mouillot, L. Bigot, and J. Ferraris. 2016. Harvesting effects on functional structure and composition of tropical invertebrate assemblages. *ICES Journal of Marine Science* 73:420–428.
- JNCC. 2010. UK Priority Species data collation *Anotrichium barbatum* version 2 updated UK priority species pages. Version 2.
- Johnson, D. S. 2018. The values of small-scale fisheries. Pages 1–21 in D. S. Johnson, T. G. Acott, N. Stacey, and J. Urquhart, editors. *Social wellbeing and the values of small-scale fisheries*. MARE Publication Series. Springer International Publishing.
- de Jong, A., and P. Varley. 2018. Foraging tourism: critical moments in sustainable consumption. *Journal of Sustainable Tourism* 26:685–701.
- Kaplan, S. 1995. The restorative benefits of nature: Toward an integrative framework. *Journal of Environmental Psychology* 15:169–182.
- Kellert, S. R., and E. . Wilson, editors. 1993. *The Biophilia Hypothesis*. Island Press.
- Kelly, C. 2018. 'I Need the Sea and the Sea Needs Me' : Symbiotic coastal policy narratives for human wellbeing and sustainability in the UK. *Marine Policy*.
- Kelly, C., G. Ellis, and W. Flannery. 2019. Unravelling Persistent Problems to Transformative Marine Governance. *Frontiers in Marine Science* 6:213.
- Keough, M. J., and G. P. Quinn. 2000a. Legislative vs. Practical protection of an intertidal shoreline in southeastern Australia. *Ecological Applications* 10:871–881.
- Keough, M. J., and G. P. Quinn. 2000b. Legislative Vs. Practical Protection of an Intertidal Shoreline in Southeastern Australia. *Ecological Applications* 10:871–881.
- Klain, S. C., P. Olmsted, K. M. A. Chan, and T. Satterfield. 2017. Relational values resonate broadly and differently than intrinsic or instrumental values, or the New Ecological Paradigm. *PLoS ONE* 12.
- Krauss, S. E. 2005. *Research Paradigms and Meaning Making: A Primer*. The

Qualitative Report 10:758–770.

- Kruize, H., I. van Kamp, M. van den Berg, E. van Kempen, W. Wendel-Vos, A. Ruijsbroek, W. Swart, J. Maas, C. Gidlow, G. Smith, N. Ellis, G. Hurst, D. Masterson, M. Triguero-Mas, M. Cirach, R. Gražulevičienė, P. van den Hazel, and M. Nieuwenhuijsen. 2019. Exploring mechanisms underlying the relationship between the natural outdoor environment and health and well-being – Results from the PHENOTYPE project. *Environment International*:105173.
- Kudrass, H. R. 1974. Experimental study of nearshore transportation of pebbles with attached algae. *Marine Geology* 16:M9–M12.
- Kummu, M., H. De Moel, G. Salvucci, D. Viviroli, P. J. Ward, and O. Varis. 2016, March 3. Over the hills and further away from coast: Global geospatial patterns of human and environment over the 20th-21st centuries. Institute of Physics Publishing.
- Lau, J. T. F., N. C. Y. Yeung, L. W. H. Mui, H. Y. Tsui, and J. Gu. 2011. A Simple New Method to Triangulate Self-Reported Risk Behavior Data - The Bean Method. *Sexually Transmitted Diseases* 38:788–792.
- Lawton, E., E. Brymer, P. Clough, and A. Denovan. 2017. The Relationship between the Physical Activity Environment, Nature Relatedness, Anxiety, and the Psychological Well-being Benefits of Regular Exercisers. *Frontiers in Psychology* 8:1058.
- Liddiard, M., D. Gladwin, D. Wege, and A. Nelson-Smith. 1989. Impact of boulder-turning on sheltered sea shores. A contract report for the Nature Conservancy Council.
- Lindberg, D. R., J. A. Estes, and K. I. Warheit. 1998. Human Influences on Trophic Cascades Along Rocky Shores. *Ecological Applications* 8:880.
- Litt Woon, L. 2019. The Way Through the Woods. Page (B. Haveland, Ed.). Scribe.
- Liversage, K., and M. Chapman. 2018. Coastal ecological engineering and habitat restoration: incorporating biologically diverse boulder habitat. *Marine Ecology Progress Series* 593:173–185.

- Lovell, R., M. Depledge, and S. Maxwell. 2018. Health and the natural environment: A review of evidence, policy, practice and opportunities for the future.
- Łuczaj, Ł., A. Pieroni, J. Tardío, M. Pardo-De-Santayana, R. Sõukand, I. Svanberg, and R. Kalle. 2012, November 1. Wild food plant use in 21st century Europe: The disappearance of old traditions and the search for new cuisines involving wild edibles. Polish Botanical Society.
- Lyubomirsky, S., K. M. Sheldon, and D. Schkade. 2005. Pursuing happiness: The architecture of sustainable change. *Review of General Psychology* 9:111–131.
- MacKerron, G., and S. Mourato. 2013. Happiness is greater in natural environments. *Global Environmental Change* 23:992–1000.
- Madsen, J. D., P. A. Chambers, W. F. James, E. W. Koch, and D. F. Westlake. 2001. The interaction between water movement, sediment dynamics and submersed macrophytes. *Hydrobiologia* 444:71–84.
- Magee, C., M. Voyer, A. McIlgorm, and O. Li. 2018. Chasing the thrill or just passing the time? Trialing a new mixed methods approach to understanding heterogeneity amongst recreational fishers based on motivations. *Fisheries Research* 199:107–118.
- Martins, G. M., S. R. Jenkins, S. J. Hawkins, A. I. Neto, A. R. Medeiros, and R. C. Thompson. 2011. Illegal harvesting affects the success of fishing closure areas. *Journal of the Marine Biological Association of the United Kingdom* 91:929–937.
- Martins, G. M., R. C. Thompson, A. I. Neto, S. J. Hawkins, and S. R. Jenkins. 2010. Exploitation of intertidal grazers as a driver of community divergence. *Journal of Applied Ecology*.
- Maslow, A. H. 1943. A Theory of Human Motivation. *Psychological Review* 50.
- McAfee, A. 2017, May 16. Scotland's Love Affair With Seaweed. *The New York Times*.
- McKinnon, M. C., S. H. Cheng, S. Dupre, J. Edmond, R. Garside, L. Glew, M. B. Holland, E. Levine, Y. J. Masuda, D. C. Miller, I. Oliveira, J. Revenaz, D. Roe, S. Shamer, D. Wilkie, S. Wongbusarakum, and E. Woodhouse. 2016. What are the

- effects of nature conservation on human well-being? A systematic map of empirical evidence from developing countries. *Environmental Evidence* 5:8.
- McLain, R. J., M. R. Poe, L. S. Urgenson, D. J. Blahna, and L. P. Buttolph. 2017. Urban non-timber forest products stewardship practices among foragers in Seattle, Washington (USA). *Urban Forestry and Urban Greening* 28:36–42.
- McMahan, E. A. 2018. Happiness Comes Naturally: Engagement with Nature as a Route to Positive Subjective Well-Being. Page *in* E. Diener, S. Oishi, and L. Tay, editors. *Handbook of well-being*. Salt Lake City, UT: DEF Publishers. DOI:nobascholar.com This.
- McMahan, E. A., and D. Estes. 2015. The effect of contact with natural environments on positive and negative affect: A meta-analysis. *The Journal of Positive Psychology* 10:507–519.
- Mcphee, D. P., and G. A. Skilleter. 2002. Harvesting of intertidal animals for bait for use in a recreational fishing competition. *Proceedings of the Royal Society of Queensland* 110:93–101.
- McQuatters-Gollop, A., I. Mitchell, C. Vina-Herbon, J. Bedford, P. F. E. Addison, C. P. Lynam, P. N. Geetha, E. A. Vermeulan, K. Smit, D. T. I. Bayley, E. Morris-Webb, H. J. Niner, and S. A. Otto. 2019. From Science to Evidence – How Biodiversity Indicators Can Be Used for Effective Marine Conservation Policy and Management. *Frontiers in Marine Science* 6:109.
- Monkman, G., G. Cambie, K. Hyder, M. Armstrong, A. Roberts, and M. J. Kaiser. 2015. Socioeconomic and Spatial Review of Recreational Sea Angling in Wales. Fisheries and Conservation Report No. 52, Bangor University. pp. 176.
- Moon, K., D. A. Blackman, V. M. Adams, R. M. Colvin, F. Davila, M. C. Evans, S. R. Januchowski-Hartley, N. J. Bennett, H. Dickinson, C. Sandbrook, K. Sherren, F. A. V. St. John, L. van Kerkhoff, and C. Wyborn. 2019. Expanding the role of social science in conservation through an engagement with philosophy, methodology, and methods. *Methods in Ecology and Evolution* 10:294–302.
- Moreau, M., S. Siebert, A. Buerkert, and E. Schlecht. 2009. Use of a tri-axial accelerometer for automated recording and classification of goats' grazing

- behaviour. *Applied Animal Behaviour Science* 119:158–170.
- Moreno, C. A., J. P. Sutherland, and H. F. Jara. 1984. Man as a Predator in the Intertidal Zone of Southern Chile. *Oikos* 42:155.
- Morris, E., H. Goudge, R. Sharp, and D. . Brazier. 2012. Collection activity in the Menai Strait and pilot methods to assess frequency of boulder turning activity. Countryside Council for Wales Marine Monitoring Report No: 94.
- Moser, S. 2008. Personality: a new positionality? *Area* 40:383–392.
- Mrowicki, R. J., C. A. Maggs, and N. E. O'Connor. 2015. Consistent effects of consumer species loss across different habitats. *Oikos* 124:1555–1563.
- Mugel, O., P. Gurviez, and A. Decrop. 2019. Eudaimonia Around the Kitchen: A Hermeneutic Approach to Understanding Food Well-Being in Consumers' Lived Experiences. *Journal of Public Policy & Marketing* 38:280–295.
- Murray, F., and P. Tarrant. 2015. A social and economic impact assessment of cockle mortality in the Burry Inlet and Three Rivers cockle fisheries, South Wales UK.
- Nakamura, J., and M. Csikszentmihalyi. 2014. The concept of flow. Pages 239–263 *Flow and the Foundations of Positive Psychology: The Collected Works of Mihaly Csikszentmihalyi*. Springer Netherlands.
- Natural England. 2014. Seaweed Harvesting Natural England ' s Advice.
- Natural England. 2019. Monitor of Engagement with the Natural Environment - The national survey on people and the natural environment. Headline Report 2019 and ten years of survey from 2009-2019.
- Naylor, L. A., W. J. Stephenson, H. C. M. Smith, O. Way, J. Mendelssohn, and A. Cowley. 2016. Geomorphological control on boulder transport and coastal erosion before, during and after an extreme extra-tropical cyclone. *Earth Surface Processes and Landforms* 41:685–700.
- Neill, S. P., P. E. Robins, and I. Fairley. 2017. The impact of marine renewable energy extraction on sediment dynamics. Pages 279–304 *Marine Renewable*

Energy: Resource Characterization and Physical Effects. Springer International Publishing.

New Economics Foundation. 2011. Five Ways to Wellbeing New applications, new ways of thinking.

New Economics Foundation. 2012. Measuring Well-being A guide for practitioners.

Newing, H. 2011. Chapter 6. Qualitative interviews and focus groups. Pages 98–118 *in* H. Newing, editor. Conducting Research in Conservation. A Social Science Perspective. Routledge.

Ng Fat, L., S. Scholes, S. Boniface, J. Mindell, and S. Stewart-Brown. 2017. Evaluating and establishing national norms for mental wellbeing using the short Warwick–Edinburgh Mental Well-being Scale (SWEMWBS): findings from the Health Survey for England. *Quality of Life Research* 26:1129–1144.

Norris, M., and L. Lecavalier. 2010. Evaluating the use of exploratory factor analysis in developmental disability psychological research. *Journal of Autism and Developmental Disorders* 40:8–20.

NRW. 2016a. Zoned digging introduced at The Gann, Natural Resources Wales. <https://naturalresources.wales/about-us/news-and-events/news/zoned-digging-introduced-at-the-gann/?lang=en>.

NRW. 2016b. The State of Natural Resources Report (SoNaRR): Assessment of the Sustainable Management of Natural Resources. Chapter 5. Well-being in Wales. Natural Resources Wales Final Report Date.

NRW. 2018. Guidance note Detailed Guidance for Seaweed Harvesting-Hand Gathering.

Nuno, A., and F. A. V St John. 2014. How to ask sensitive questions in conservation: A review of specialized questioning techniques. *Biological Conservation* 189:5–15.

Nuttall, G. 2016. Encouraging positive interaction and preventing conflicts between marine stakeholders - Lessons and recommendations from the Celtic Seas. A report for the Celtic Seas Partnership.

- Nyman, M. 2019. Food, meaning-making and ontological uncertainty: Exploring 'urban foraging' and productive landscapes in London. *Geoforum* 99:170–180.
- O'Connor, B. P. 2000. SPSS and SAS programs for determining the number of components using parallel analysis and Velicer's MAP test. *Behavior Research Methods, Instrumentation, and Computers* 32:396–402.
- O'Connor, K. 2009. The secret history of "The weed of Hiraeth": Laverbread, identity and museums in Wales. *Journal of Museum Ethnography* 22:81–101.
- O'Connor, K. 2016. Imagining and Consuming the Coast: Anthropology, Archaeology, "Heritage" and "Conservation" on the Gower in South Wales. Pages 121–142 in M. Janowski and T. Ingold, editors. *Imagining Landscapes: Past, Present and Future*. Routledge. Taylor & Francis Group. London and New York.
- O'Connor, N. E., I. Donohue, T. P. Crowe, and M. C. Emmerson. 2011. Importance of consumers on exposed and sheltered rocky shores. *Marine Ecology Progress Series* 443:65–75.
- Oak, H. L. 1984. The Boulder Beach: A Fundamentally Distinct Sedimentary Assemblage. *Annals of the Association of American Geographers* 74:71–82.
- Odendaal, F. J., M. O. Bergh, and G. M. Branch. 1994. Socio-Economic Options for the Management of the Exploitation of Intertidal and Subtidal Resources. Pages 155–167 in W. . Siegfried, editor. *Rocky Shores: Exploitation in Chile and South Africa*. Springer, Berlin, Heidelberg.
- OED. 2021. "meaning, n.2". In the Oxford English Dictionary.
- Office for National Statistics. 2011. 2011 Wales Census Household Questionnaire Wales. www.census.gov.uk.
- Ohly, H., M. P. White, B. W. Wheeler, A. Bethel, O. C. Ukoumunne, V. Nikolaou, and R. Garside. 2016a. Attention Restoration Theory: A systematic review of the attention restoration potential of exposure to natural environments. *Journal of Toxicology and Environmental Health, Part B* 19:305–343.
- Ohly, H., M. P. White, B. W. Wheeler, A. Bethel, O. C. Ukoumunne, V. Nikolaou, and

- R. Garside. 2016b. Attention Restoration Theory: A systematic review of the attention restoration potential of exposure to natural environments. *Journal of Toxicology and Environmental Health, Part B* 19:305–343.
- Onset. 2013. HOBO® Pendant® G Data Logger (UA-004-64) White Paper Operating Principles.
- Oyanedel, R., S. Gelcich, and E. J. Milner-Gulland. 2020. Motivations for (non-)compliance with conservation rules by small-scale resource users. *Conservation Letters* 13:e12725.
- Perry, F., E. Morris, and S. Burton. 2014. Intertidal Species Collection in Wales : Impacts Review. An unpublished report to the Pembrokeshire Marine SAC Relevant Authorities Group.
- Pettijohn, F. J. 1957. *Sedimentary Rocks*. Harper and Bros., New York.
- Pitt, H. 2014. Therapeutic experiences of community gardens: Putting flow in its place. *Health and Place* 27:84–91.
- Poe, M. R., J. Donatuto, and T. Satterfield. 2016. “Sense of Place”: Human Wellbeing Considerations for Ecological Restoration in Puget Sound.
- Poe, M. R., J. Lecompte, R. McClain, and P. Hurley. 2014. Urban foraging and the relational ecologies of belonging. *Social & Cultural Geography* 15:901–919.
- Pollnac, R. B., and J. J. Poggie. 1988. The Structure of Job Satisfaction among New England Fishermen and Its Application to Fisheries Management Policy. *Page New Series*.
- Pollnac, R. B., and J. J. Poggie. 2006. Job Satisfaction in the Fishery in Two Southeast Alaskan Towns. *Source: Human Organization* 65:329–339.
- Pollnac, R. B., and J. J. Poggie. 2008. Happiness, Well-being and Psychocultural Adaptation to the Stresses Associated with Marine Fishing. *Page Human Ecology Review*.
- Pollnac, R. B., T. Seara, and L. L. Colburn. 2015. Aspects of Fishery Management, Job Satisfaction, and Well-Being among Commercial Fishermen in the

- Northeast Region of the United States. *Society & Natural Resources* 28:75–92.
- Ponsford, M. 2020, June 10. Foragers find a taste of nature amid London coronavirus lockdown. *Global Ideas*. Deutsche Welle.
- Pope, J. G., and C. T. Weber. 2019. A parable of compliance issues and their link to EBFM outcomes. *Fisheries Research* 211:51–58.
- Puri, R. . 2011. Chapter 5. Participant Observation. Pages 85–97 *in* H. Newing, editor. *Conducting Research in Conservation. A Social Science Perspective*. Routledge.
- Raymond-Yakoubian, J., B. Raymond-Yakoubian, and C. Moncrieff. 2017. The incorporation of traditional knowledge into Alaska federal fisheries management. *Marine Policy* 78:132–142.
- Redpath, S. M., J. Young, A. Evely, W. M. Adams, W. J. Sutherland, A. Whitehouse, A. Amar, R. A. Lambert, J. D. C. Linnell, A. Watt, and R. J. Gutiérrez. 2013. Understanding and managing conservation conflicts. *Trends in Ecology and Evolution* 28:100–109.
- Rendón, O. R., A. Garbutt, M. Skov, I. Möller, M. Alexander, R. Ballinger, K. Wyles, G. Smith, E. McKinley, J. Griffin, M. Thomas, K. Davidson, J. F. Pagès, S. Read, and N. Beaumont. 2019. A framework linking ecosystem services and human well-being: Saltmarsh as a case study. *People and Nature* 00:1–11.
- Richardson, M., J. Dobson, D. J. Abson, R. Lumber, A. Hunt, R. Young, and B. Moorhouse. 2020. Applying the pathways to nature connectedness at a societal scale: a leverage points perspective. *Ecosystems and People* 16:387–401.
- Rittel, H. W. ., and M. M. Webber. 1973. Dilemmas in a General Theory of Planning . *Policy Sciences* 4:155–169.
- Ryfield, F., D. Cabana, J. Brannigan, and T. Crowe. 2019. Conceptualizing ‘sense of place’ in cultural ecosystem services: A framework for interdisciplinary research. *Ecosystem Services* 36.
- Sachdeva, S., M. R. Emery, and P. T. Hurley. 2018. Depiction of Wild Food Foraging Practices in the Media: Impact of the Great Recession. *Society & Natural*

Resources 31:977–993.

Sardeshpande, M., and C. Shackleton. 2020. Urban foraging: Land management policy, perspectives, and potential. *PLOS ONE* 15:e0230693.

van der Schatte Olivier, A., L. Jones, L. LeVay, M. Christie, J. Wilson, and S. K. Malham. 2018. A global review of the ecosystem services provided by bivalve aquaculture. *Reviews in Aquaculture* 12:3–25.

Scheibling, R. E., N. E. Kelly, and B. G. Raymond. 2009. Physical disturbance and community organization on a subtidal cobble bed. *Journal of Experimental Marine Biology and Ecology* 368:94–100.

Schneider, B., G. Hoffmann, M. Falkenroth, and J. Grade. 2019. Tsunami and storm sediments in Oman: Characterizing extreme wave deposits using terrestrial laser scanning. *Journal of Coastal Conservation* 23:801–815.

Schuitmaker, T. J. 2012. Identifying and unravelling persistent problems. *Technological Forecasting and Social Change* 79:1021–1031.

Schutte, N. S., and J. M. Malouff. 2018. Mindfulness and connectedness to nature: A meta-analytic investigation. *Personality and Individual Differences* 127:10–14.

Scoones, I., M. Melnyk, and J. N. Pretty. 1992. *The Hidden Harvest: Wild Foods and Agricultural Systems ; a Literature Review and Annotated Bibliography. The Sustainable Agriculture Programme. International Institute for Environment and Development, London.*

Seara, T., R. B. Pollnac, and J. J. Poggie. 2017a. Changes in Job Satisfaction Through Time in Two Major New England Fishing Ports. *Journal of Happiness Studies* 18:1625–1640.

Seara, T., R. B. Pollnac, J. J. Poggie, C. Garcia-Quijano, I. Monnereau, and V. Ruiz. 2017b. Fishing as therapy: Impacts on job satisfaction and implications for fishery management. *Ocean and Coastal Management* 141:1–9.

Sen, A. 1999. *Development as freedom*. Page Oxford University Press.

Shanahan, D., T. Astell–Burt, E. Barber, E. Brymer, D. Cox, J. Dean, M. Depledge,

- R. Fuller, T. Hartig, K. Irvine, A. Jones, H. Kikillus, R. Lovell, R. Mitchell, J. Niemelä, M. Nieuwenhuijsen, J. Pretty, M. Townsend, Y. van Heezik, S. Warber, and K. Gaston. 2019. Nature–Based Interventions for Improving Health and Wellbeing: The Purpose, the People and the Outcomes. *Sports* 7:141.
- Shanahan, D. F., R. Bush, K. J. Gaston, B. B. Lin, J. Dean, E. Barber, and R. A. Fuller. 2016. Health Benefits from Nature Experiences Depend on Dose. *Scientific Reports* 6:28551.
- Sharpe, A. K., and M. J. Keough. 1998. An investigation of the indirect effects of intertidal shellfish collection. *Journal of Experimental Marine Biology and Ecology* 223:19–38.
- Shields, I. A. 1936. Application of similarity principles and turbulence research to bed-load movement. (Translated from German and available at <https://repository.tudelft.nl/islandora/object/uuid:a66ea380-ffa3-449b-b59f-38a35b2c6658>). California Institute of Technology, Pasadena, California.
- Siegfried, W. R. 1994. Rocky Shores: Exploitation in Chile and South Africa. Page (W. R. Siegfried, Ed.). Springer-Verlag, Berlin, Germany.
- Siegfried, W. R., P. A. R. Hockey, and A. A. Crowe. 1985. Exploitation and Conservation of Brown Mussel Stocks by Coastal People of Transkei. *Environmental Conservation* 12:303–307.
- Skubel, R. A., M. Shriver-Rice, and G. M. Maranto. 2019. Introducing relational values as a tool for shark conservation, science, and management. *Frontiers in Marine Science* 6:53.
- Smith, C. L., and P. M. Clay. 2010. Measuring Subjective and Objective Well-being: Analyses from Five Marine Commercial Fisheries. *Human Organization* 69:158–168.
- Smith, S. D. A. 2002. Kelp rafts in the Southern Ocean. *Global Ecology and Biogeography* 11:67–69.
- Soulsby, R. 1998. Dynamics of Marine Sands. Page Dynamics of Marine Sands. Thomas Telford Ltd.

- Sousa, W. P. 1979a. Disturbance in Marine Intertidal Boulder Fields : The Nonequilibrium Maintenance of Species Diversity. *Ecology* 60:1225–1239.
- Sousa, W. P. 1979b. Experimental Investigations of Disturbance and Ecological Succession in a Rocky Intertidal Algal Community. *Ecological Monographs* 49:227–254.
- Sousa, W. P. 1984. The role of disturbance in natural communities. *Ann. Rev. Ecol. Syst* 15:353–91.
- St John, F. A. V., G. Edwards-Jones, J. M. Gibbons, and J. P. G. Jones. 2010a. Testing novel methods for assessing rule breaking in conservation. *Biological Conservation* 143:1025–1030.
- St John, F. A. V., A. M. Keane, and E. J. Milner-Gulland. 2013. Effective conservation depends upon understanding human behaviour. Pages 344–361 *Key Topics in Conservation Biology 2*. John Wiley and Sons.
- St John, F. A. V, G. A. Edwards-Jones, and J. P. Jones. 2010b. Conservation and human behaviour: lessons from social psychology. *Wildlife Research* 37:658–667.
- Stålhammar, S., and E. Pedersen. 2017. Recreational cultural ecosystem services: How do people describe the value? *Ecosystem Services* 26:1–9.
- Stålhammar, S., and · Henrik Thorén. 2019. Three perspectives on relational values of nature 14:1201–1212.
- Stengel, D., and M. Dring. 1997. Morphology and in situ growth rates of plants of *Ascomphyllum nodosum* (Phaeophyta) from different shore levels and responses of plants to vertical transplantation. *European Journal of Phycology* 32:193–202.
- Stephenson, W. J., and A. Abazović. 2016. Measuring Coastal Boulder Movement Under Waves Using Tri-Axial Accelerometers. *Journal of Coastal Research* 75:607–611.
- Stephenson, W. J., and L. A. Naylor. 2011. Geological controls on boulder production in a rock coast setting: Insights from South Wales, UK. *Marine Geology* 283:12–24.

- Steven, A., K. Appeaning Addo, G. Llewellyn, V. Thanh Ca, I. Boateng, R. Bustamante, C. Doropoulos, C. Gillies, M. Hemer, P. Lopes, J. Kairo, M. Rahman, L. Aigrette Ravaoarinorotsihoarana, M. Saunders, U. Rashid Sumaila, F. Sidik, L. Teh, M. Vanderklift, and M. Vozzo. 2020. Coastal Development: Resilience, Restoration and Infrastructure Requirements. Washington, DC: World Resources Institute. www.oceanpanel.org/blue-papers/coastal-development-resilience-restoration-and-infrastructure-requirements.
- Stewart-Brown, S., and K. Janmohamed. 2008. Warwick-Edinburgh Mental Well-being Scale (WEMWBS) User Guide. current version available at <http://www.healthscotland.com/scotlands-health/population/Measuring-positive-mental-health.aspx>.
- Stewart-Brown, S., P. C. Samaraweera, F. Taggart, N.-B. Kandala, and S. Stranges. 2015. Socioeconomic gradients and mental health: implications for public health. *The British Journal of Psychiatry* 206:461–465.
- Stiglitz, J. E., A. Sen, and J.-P. Fitoussi. 2009. Report by the Commission on the Measurement of Economic Performance and Social Progress (Commissioned by President of the French Republic, Nicholas Sarkozy).
- Stranges, S., P. C. Samaraweera, F. Taggart, N. B. Kandala, and S. Stewart-Brown. 2014. Major health-related behaviours and mental well-being in the general population: The health survey for England. *BMJ Open* 4.
- Strong, J. A., M. J. Dring, and C. A. Maggs. 2006a. Colonisation and modification of soft substratum habitats by the invasive macroalga *Sargassum muticum*. *Marine Ecology Progress Series* 321:87–97.
- Strong, J. A., M. J. Dring, and C. A. Maggs. 2006b. Colonisation and modification of soft substratum habitats by the invasive macroalga *Sargassum muticum*. *Marine Ecology Progress Series* 321:87–97.
- Synk, C. M., B. F. Kim, C. A. Davis, J. Harding, V. Rogers, P. T. Hurley, M. R. Emery, and K. E. Nachman. 2017. Gathering Baltimore's bounty: Characterizing behaviors, motivations, and barriers of foragers in an urban ecosystem. *Urban Forestry & Urban Greening* 28:97–102.

- Teixeira, H., T. Berg, L. Uusitalo, K. Fürhaupter, A.-S. Heiskanen, K. Mazik, C. P. Lynam, S. Neville, J. G. Rodriguez, N. Papadopoulou, S. Moncheva, T. Churilova, O. Kryvenko, D. Krause-Jensen, A. Zaiko, H. Veríssimo, M. Pantazi, S. Carvalho, J. Patrício, M. C. Uyarra, and À. Borja. 2016. A Catalogue of Marine Biodiversity Indicators. *Frontiers in Marine Science* 3:207.
- Tennant, R., L. Hiller, R. Fishwick, S. Platt, S. Joseph, S. Weich, J. Parkinson, J. Secker, and S. Stewart-Brown. 2007. The Warwick-Edinburgh Mental Well-being Scale (WEMWBS): development and UK validation. *Health and Quality of Life Outcomes* 5:63.
- Thomas-Walters, L., A. Hinsley, D. Bergin, H. Doughty, S. Eppel, D. MacFarlane, W. Meijer, T. Ming Lee, J. Phelps, R. J. Smith, A. K. . Wan, and D. Verissimo. 2020. Motivations for the use and consumption of wildlife products. *SocArXiv Papers* October 26.
- Thompson, R. C., T. P. Crowe, and S. J. Hawkins. 2002. Rocky intertidal communities: Past environmental changes, present status and predictions for the next 25 years. *Environmental Conservation* 29:168–191.
- Thurstan, R. H., Z. Brittain, D. S. Jones, E. Cameron, J. Dearnaley, and A. Bellgrove. 2018. Aboriginal uses of seaweeds in temperate Australia : an archival assessment. *Journal of Applied Phycology*:1–12.
- Tilley, A., A. Burgos, A. Duarte, J. Dos, R. Lopes, H. Eriksson, and D. Mills. 2020. Contribution of women’s fisheries substantial, but overlooked, in Timor-Leste. *Ambio* 50:113–124.
- Tinlin-Mackenzie, A. R. 2018. Intertidal collection within the Berwickshire and North Northumberland Coast European Marine Site : Investigating the scale, locale, and ecological impacts of harvesting *Arenicola marina*, *Arenicola defodiens*, and *Littorina littorea* PhD Thesi.
- Tredinnick-Rowe, J., T. Taylor, and A. Tuohino. 2018. Public Health and Well-being Innovation in the Natural Environment Sector: Lessons from the UK and Finland. *European Journal of Environment and Public Health* 2:08.
- Tsaur, S.-H., Y.-W. Liang, and S.-C. Weng. 2014. Recreationist-environment fit and

- place attachment. *Journal of Environmental Psychology* 40:421–429.
- Tyler, H., C. Arnold, and W. Arnold. 2008. Sensitivity of Intertidal Benthic Habitats to Impacts Caused by Access to Fishing Grounds. Countryside Council for Wales Policy Research Report No. 08/13.
- Ulrich, R. S., R. F. Simons, B. D. Losito, E. Fiorito, M. A. Miles, and M. Zelson. 1991. Stress recovery during exposure to natural and urban environments. *Journal of Environmental Psychology* 11:201–230.
- UN. 2001. Millennium Ecosystem Assessment. Page United Nations.
- UN. 2010. UN Conference of Parties 10 Decision x/2. Strategic Plan for Biodiversity 2011-2020. Secretariat of the Convention on Biological Diversity.
- UN. 2015. THE 17 GOALS | Sustainable Development. <https://sdgs.un.org/goals>.
- Underwood, A. J. 1993. Exploitation of species on the rocky coast of New South Wales (Australia) and options for its management. *Ocean and Coastal Management* 20:41–62.
- Venerus, L. A., and P. V. Cedrola. 2017a. Review of marine recreational fisheries regulations in Argentina. *Marine Policy* 81:202–210.
- Venerus, L. A., and P. V Cedrola. 2017b. Review of marine recreational fisheries regulations in Argentina. *Marine Policy* 81:202–210.
- Wam, H. K., H. C. Pedersen, and O. Hjeljord. 2012. Balancing hunting regulations and hunter satisfaction: An integrated biosocioeconomic model to aid in sustainable management. *Ecological Economics* 79:89–96.
- Warner, S. L. 1965. Randomized Response: A Survey Technique for Eliminating Evasive Answer Bias. *Journal of the American Statistical Association* 60:63.
- Watson, G. 2014. Does local marine conservation work? A case study of bait collection in the UK. *Ocean Challenge* 20:35–41.
- Watson, G. J., P. Farrell, S. Stanton, and L. C. Skidmore. 2007. Effects of bait collection on *Nereis virens* populations and macrofaunal communities in the Solent, UK. *Journal of the Marine Biological Association of the UK* 87:703.

- Watson, G. J., J. M. Murray, M. Schaefer, and A. Bonner. 2015. Successful local marine conservation requires appropriate educational methods and adequate enforcement. *Marine Policy* 52:59–67.
- Watson, G. J., J. M. Murray, M. Schaefer, and A. Bonner. 2016. Bait worms: a valuable and important fishery with implications for fisheries and conservation management. *Fish and Fisheries*:1–15.
- Watson, R. T., A. Zakri, A. El-Beltagy, M. Finlayson, C. Galbraith, K. Leitner, M. A. Ramos, T. Rosswall, A. Steiner, F. Almeida, P. Barnard, G. Beltram, D. Blasco, A. Burgmans, E. Camac-Ramirez, A. Cropper, P. Dasgupta, J. María Figueres, C. Rica Fred Fortier, M. H. Hassan, J. Lash, W. Maathai, P. Maro, H. A. Mooney, M. Motovilova, M. Prasad, W. V Reid, H. Schacht, P. Johan Schei, A. Wenblad, X. Guanhua, and M. Yunus. 2005. Living beyond our means: Natural assets and human well-being. *Millenium Ecosytem Assessment*.
- Welsh Government. 2015. Well-being of Future Generations Act (Wales) 2015. The Essentials Available at <https://gov.wales/well-being-future-generations-act-essentials>.
- Welsh Government. 2021a. Intertidal fisheries Guidance & Legislation. <https://gov.wales/intertidal-fisheries>.
- Welsh Government. 2021b. Byelaw 16 (Shell fishery - Temporary Closure) of the Llanfairfechan and Penmaenmawr razor clam fisheries.
- Wentworth, C. K. 1922. A Scale of Grade and Class Terms for Clastic Sediments. *The Journal of Geology* 30:377–392.
- Wheeler, B. W., M. White, W. Stahl-Timmins, and M. H. Depledge. 2012. Does living by the coast improve health and wellbeing? *Health & Place* 18:1198–1201.
- White, M. P., I. Alcock, B. W. Wheeler, and M. H. Depledge. 2013a. Coastal proximity, health and well-being: Results from a longitudinal panel survey. *Health & Place* 23:97–103.
- White, M. P., and P. Dolan. 2009. Accounting for the Richness of Daily Activities. *Psychological Science* 20:1000–1008.

- White, M. P., L. R. Elliott, M. Gascon, B. Roberts, and L. E. Fleming. 2020. Blue space, health and well-being: A narrative overview and synthesis of potential benefits. *Environmental Research* 191:110169.
- White, M. P., S. Pahl, K. Ashbullby, S. Herbert, and M. H. Depledge. 2013b. Feelings of restoration from recent nature visits. *Journal of Environmental Psychology* 35:40–51.
- White, M. P., S. Pahl, B. W. Wheeler, M. H. Depledge, and L. E. Fleming. 2017. Natural environments and subjective wellbeing: Different types of exposure are associated with different aspects of wellbeing. *Health & Place* 45:77–84.
- White, M. P., B. W. Wheeler, S. Herbert, I. Alcock, and M. H. Depledge. 2014. Coastal proximity and physical activity: Is the coast an under-appreciated public health resource? *Preventive Medicine* 69:135–140.
- White, S. C. 2016. Introduction: The many faces of wellbeing. Pages 1–44 *Cultures of Wellbeing: Method, Place, Policy*. Palgrave Macmillan.
- White, S. C. 2017. Relational wellbeing: Re-centring the politics of happiness, policy and the self. *Policy and politics* 45:121–136.
- Whomersley, P., M. Huxham, S. Bolam, M. Schratzberger, J. Augley, and D. Ridland. 2010. Response of intertidal macrofauna to multiple disturbance types and intensities - An experimental approach. *Marine Environmental Research* 69:297–308.
- Wiersum, K. F., R. Singhal, and C. Benneker. 2004. Common property and collaborative forest management: Rural dynamics and evolution in community forestry regimes. *Forests Trees and Livelihoods* 14:281–293.
- Williams, R. 2005. Gologit2: A program for Generalised Logistic Regression/ Partial Proportional Odds Models for Ordinal Dependent Variables. *Stata Journal* 6:58–82.
- Williams, R. 2016. Understanding and interpreting generalized ordered logit models. *Journal of Mathematical Sociology* 40:7–20.
- Wright, B. 2015. Big Brother Watching Mother Nature: Conservation Drones and

Their International and Domestic Privacy Implications. *Vermont Journal of Environmental Law* 17.

Young, J. C., D. C. Rose, H. S. Mumby, F. Benitez-Capistros, C. J. Derrick, T. Finch, C. Garcia, C. Home, E. Marwaha, C. Morgans, S. Parkinson, J. Shah, K. A. Wilson, and N. Mukherjee. 2018. A methodological guide to using and reporting on interviews in conservation science research. *Methods in Ecology and Evolution* 9:10–19.

Zheng, R. Y., X. Zhu, and M. Tan. 2019. Miniature underwater animal tags and smart sensors for civil engineering applications. Pages 1–7 *ACM International Conference Proceeding Series*. Association for Computing Machinery, New York, NY, USA.

Živojinović, I., G. Weiss, M. Wilding, J. L. G. Wong, and A. Ludvig. 2020. Experiencing forest products – An innovation trend by rural entrepreneurs. *Land Use Policy* 94:104506.

APPENDICES

APPENDICES A:

Chapter 2

Appendix A.1: 'What does gathering mean to you?' survey: Questionnaire structure and rationale.

Research questions (RQ): i) what living resources are collected? ii) what are the motivations to collect? iii) who collects? iv) whether collecting CRs increases the well-being of CCR. C - Circumstantial predictors of well-being, grounded in sociodemographic or nature exposure literature / theory ; H - hypothetical predictor of well-being related to collection activities.

MWB= mental well-being; SWB = subjective WB; LS = life satisfaction; WW = Worthwhile; H = Happiness; Anx = Anxiety; OWB = other well-being measure

¹ Some response categories were collapsed for well-being analysis (See Appendix 2)

Section	Question	Response Type	Initial response categories / range in answers ¹	To answer RQ	Potential quant WB Predictor?	Reason for inclusion	References
0: Introductory questions	2 Gender	Binomial	Male / Female	iii)	Y	Known covariate effecting WEMWBS.	Ng Fat et al 2017 (gender can be an important covariate effecting MWB in some sociodemographic groups) Stewart-Brown et al 2015; Ng Fat 2017 (35-54 = more likely to suffer mental illness; older = higher MWB)
	3 What is the year of your birth?	Continuous (numerical)		iii) iv)	Y - C	Used to derive age a theoretical predictor of well-being.	
	4 Are you on holiday?	Binomial	Y / N	iii) iv)	Y - C	People on holiday probably more relaxed; people not on holiday may feel more rushed during survey.	
1: What is collected	5 Which animals, seaweeds or plants have you collected from the Welsh shoreline in the last 2 years (24months)? (all that apply)	Categorical (asked as an open question and coded live by administrator)	19 taxa available to administrator on device.	i) iv)	Y - H (total no of taxa)	Inform CCR community description? Does the number of taxa collected tell us anything about 'collector typology'? In terms of motivation or well-being.	
	6 Of these species which is the most important to you this year?	Categorical	Additional taxa entered as open responses and coded by analyst.	i)			
	7 Which is the 2nd most important to you this year?	Categorical		i)			
	8 Which is the 3rd most important to you this year?	Categorical		i)			

PhD: Understanding coastal resource collection in Wales

Research questions (RQ): i) what living resources are collected? ii) what are the motivations to collect? iii) who collects? iv) whether collecting CRs increases the well-being of CCR. C - Circumstantial predictors of well-being, grounded in sociodemographic or nature exposure literature / theory ; H - hypothetical predictor of well-being related to collection activities.
MWB= mental well-being; SWB = subjective WB; LS = life satisfaction; WW = Worthwhile; H = Happiness; Anx = Anxiety; OWB = other well-being measure

¹ Some response categories were collapsed for well-being analysis (See Appendix 2)

Section	Question	Response Type	Initial response categories / range in answers ¹	To answer RQ	Potential quant WB Predictor?	Reason for inclusion	References
2: Motivations to collect	9 Currently what is the main reason you collect the three species most important to you (these may be a different reason for each species)? (1, 2, 3)	Categorical (asked as an open question and coded live by administrator, after checking with respondent)		ii)		Understanding primary motivations to collect.	
	10 If this reason is different from when you started collecting, please tell me the main reason when you first started: (1, 2, 3)	Categorical (asked as an open question and coded live by administrator, after checking with respondent)		ii)		Understanding primary motivations to collect.	
	11 Thinking about other reasons that you collect all or any of your species, please tell me the how important the following statements are to you:	Ordinal		ii) iv)	Y - H	Understanding multiple motivations to collect.	See p3 of Hall 2013 for references (may also be useful for thematic analysis) – save money; folk food traditions, desire to live more sustainably / know where food comes from; healthier paleo-diet of
	Enjoy looking at species on beach (natural history interest) Visiting the beach and thought I'd have a look for angling bait Food for the table (personal consumption) I am foraging / I enjoy the challenge of finding my own food. It is fun. I like the feeling that I can provide food / practice survival skills. It's a serious activity for me. I find it a good form of stress-relief / escapism I enjoy the environment / fresh air To feel more connected to nature I enjoy the time alone on the beach I collect as a social activity with my friends / family I make a bit of money from it Research, field or citizen science Collection gives me reason to explore new beaches	Ordinal	(SHOWCARD) Where 0 is "This is never a reason I collect" and 10 is "I feel strongly that this is a reason I collect"	iiii) iv)	Y - H		

PhD: Understanding coastal resource collection in Wales

Research questions (RQ): i) what living resources are collected? ii) what are the motivations to collect? iii) who collects? iv) whether collecting CRs increases the well-being of CCR. C - Circumstantial predictors of well-being, grounded in sociodemographic or nature exposure literature / theory ; H - hypothetical predictor of well-being related to collection activities.

MWB= mental well-being; SWB = subjective WB; LS = life satisfaction; WW = Worthwhile; H = Happiness; Anx = Anxiety; OWB = other well-being measure

¹ Some response categories were collapsed for well-being analysis (See Appendix 2)

Section	Question	Response Type	Initial response categories / range in answers ¹	To answer RQ	Potential quant WB Predictor?	Reason for inclusion	References
3: Collecting behaviour	12 How long have you been collecting?	Categorical	Since I was a child (12 or under); Since my teenage years (13-17); Since early adulthood (18-23); As an adult (24-retirement); Since retiring (after leaving work)	iii)		Description of community.	
	13 (CollectWhen) Do you collect...?	Categorical	Through the year; In spring / summer only; In autumn / winter only.	iii)		Description of community.	
	14 Thinking about your collections at any time of year in the last 2 years (24months) how far do you normally travel to collect (record distance in one direction of travel only)?	Categorical	Less than 1 mile; 1 - 4.9 miles; 5 - 9.9 miles; 10 - 19.9 miles; 20 - 49.9 miles; Greater than 50 miles; n/a (eg: I'm on holiday and collecting is not the focus of my holiday)	iii)		Description of community.	
	15 (CollectFrom) Do you collect from...?	Categorical	the same beach every time; 2 - 4 beaches; 5 or more beaches	iii)		Description of community.	
	16 (CollectWhere) Over the past two years, have your collection activities been...?	Categorical	Restricted to Wales; Wales and elsewhere in the UK; Anywhere I go in the world; Other	iii)		Description of community.	
	17 (CollectToday) Choose the statement that best applies:	Categorical	TodayBefore_ collected before interview (today); CollAfter_ going collecting shortly; CollLater_ going collecting later today; Coll24_ collected within the last 24hrs; Coll7_ collected in the last 7 days; NoColl_ not collected in the past 7 days (and does not plan to today); WhilstColl_ questioning whilst collecting;	iv)	Y - H	H effect on affective well-being (H & Anx), which are known to be 'in the moment' feelings of well-being?	Lyubomsky et al 2005 (intentional / chosen activities +ve effect on H) Jeong et al 2020 (offwork activities +ve effect on WB, stress relief)
	18 (added question: Regularity) How would you describe your collection activities	Nominal	Weekly (at least once a week); Monthly (at least once a month); Ad Hoc (several times a year); Annual (I make one specific seashore collection trip per year)	iii)		Description of community	
	19 Please sum up what does collecting means to you in three words:	Open		iv) (qualitative analysis)		Aims to highlight most important meanings (or values) behind collection activities	

PhD: Understanding coastal resource collection in Wales

Research questions (RQ): i) what living resources are collected? ii) what are the motivations to collect? iii) who collects? iv) whether collecting CRs increases the well-being of CCR. C - Circumstantial predictors of well-being, grounded in sociodemographic or nature exposure literature / theory ; H - hypothetical predictor of well-being related to collection activities.

MWB= mental well-being; SWB = subjective WB; LS = life satisfaction; WW = Worthwhile; H = Happiness; Anx = Anxiety; OWB = other well-being measure

¹ Some response categories were collapsed for well-being analysis (See Appendix 2)

Section	Question	Response Type	Initial response categories / range in answers ¹	To answer RQ	Potential quant WB Predictor?	Reason for inclusion	References
3: Collecting behaviour	12 How long have you been collecting?	Categorical	Since I was a child (12 or under); Since my teenage years (13-17); Since early adulthood (18-23); As an adult (24-retirement); Since retiring (after leaving work)	iii)		Description of community.	
	13 (CollectWhen) Do you collect...?	Categorical	Through the year; In spring / summer only; In autumn / winter only.	iii)		Description of community.	
	14 Thinking about your collections at any time of year in the last 2 years (24months) how far do you normally travel to collect (record distance in one direction of travel only)?	Categorical	Less than 1 mile; 1 - 4.9 miles; 5 - 9.9 miles; 10 - 19.9 miles; 20 - 49.9 miles; Greater than 50 miles; n/a (eg: I'm on holiday and collecting is not the focus of my holiday)	iii)		Description of community.	
	15 (CollectFrom) Do you collect from...?	Categorical	the same beach every time; 2 - 4 beaches; 5 or more beaches	iii)		Description of community.	
	16 (CollectWhere) Over the past two years, have your collection activities been...?	Categorical	Restricted to Wales; Wales and elsewhere in the UK; Anywhere I go in the world; Other	iii)		Description of community.	
4: Health & Exercise	20 Compared to people of a similar age, do you consider your health status to be:	Ordinal	Very good; Good; Fair; Poor; Very poor	iv)	Y - T		Ng Fat et al 2017 (effects MWB)
	21 How many of these were days you were collecting?	Continuous (numerical)	0 - 7	iii)	Y - H?	H effect on affective well-being (H & Anx), so might be used as a predictor.	
	22 Thinking about exercise in relation to your collection activities, how strongly do you agree with the following statement? My activity level drops significantly in any seasons or periods when I am not collecting.	Ordinal	(SHOWCARD) 0 (not at all) -10 (completely)	i)		Description of community.	
5: Measuring well-being	23 Below are some statements about feelings and thoughts. Please choose the answer that best describes your experience of each over the last two weeks.					Response variable overall mental well-being.	Warwick - Edinburgh Mental well-being Scale © NHS Health Scotland, University of Warwick and University of Edinburgh, 2008, all rights reserved.
	I've been feeling optimistic about the future I've been feeling useful I've been feeling relaxed I've been feeling interested in other people I've had energy to spare I've been dealing with problems well I've been thinking clearly I've been feeling good about myself I've been feeling close to other people I've been feeling confident I've been able to make up my mind about things I've been feeling loved I've been interested in new things I've been feeling cheerful	Ordinal	(SHOWCARD) 1 (none of the time); 2 (rarely); 3 (some of the time); 4 (often); 5 (all of the time).	iv)		Response variable overall mental well-being (MWB).	

PhD: Understanding coastal resource collection in Wales

Research questions (RQ): i) what living resources are collected? ii) what are the motivations to collect? iii) who collects? iv) whether collecting CRs increases the well-being of CCR. C - Circumstantial predictors of well-being, grounded in sociodemographic or nature exposure literature / theory ; H - hypothetical predictor of well-being related to collection activities.

MWB= mental well-being; SWB = subjective WB; LS = life satisfaction; WW = Worthwhile; H = Happiness; Anx = Anxiety; OWB = other well-being measure

¹ Some response categories were collapsed for well-being analysis (See Appendix 2)

Section	Question	Response Type	Initial response categories / range in answers ¹	To answer RQ	Potential quant WB Predictor?	Reason for inclusion	References
	<p>24 Next I would like to ask you four questions about your feelings on particular aspects of your life. There are no right or wrong answers. For each of these questions I'd like you to give an answer on a scale of zero to 10, where zero is 'not at all' and 10 is 'completely'.</p> <p>Overall, how satisfied are you with your life nowadays?</p> <p>Overall, to what extent do you feel that the things you do in your life are worthwhile?</p> <p>Overall, how happy did you feel yesterday?</p> <p>Overall, how anxious did you feel yesterday? (note reverse scale)</p>					ONS4.	Office for National Statistics 2011
	25 Overall, how satisfied are you with your present	Ordinal	(SHOWCARDS) 0 (not at all X) -10 (completely X)	iv)	Y - T	Response variable LS. Response variable WW. Response variable H. Response variable Anx.	Pollnac et al 2015 (+ve effect on LS)
	27 How many leisure visits to the Welsh outdoors have you made in the last 4 weeks? By outdoors, we mean open spaces anywhere in the countryside or in towns and cities, including your local neighbourhood, paths, woodland, parks and farmland. This may include any visits to the beach for collection or otherwise. You may have made more than one visit each day	Continuous	(Numerical)	iv)	Y - T	Predictor of LS and H.	White 2017

PhD: Understanding coastal resource collection in Wales

Research questions (RQ): i) what living resources are collected? ii) what are the motivations to collect? iii) who collects? iv) whether collecting CRs increases the well-being of CCR. C - Circumstantial predictors of well-being, grounded in sociodemographic or nature exposure literature / theory ; H - hypothetical predictor of well-being related to collection activities.

MWB= mental well-being; SWB = subjective WB; LS = life satisfaction; WW = Worthwhile; H = Happiness; Anx = Anxiety; OWB = other well-being measure

¹ Some response categories were collapsed for well-being analysis (See Appendix 2)

Section	Question	Response Type	Initial response categories / range in answers ¹	To answer RQ	Potential quant WB Predictor?	Reason for inclusion	References
5: Sociodemographics	30 How would you describe your national identity?	Categorical	Welsh; English; Scottish; Northern Irish; British; Other (please specify); prefer not to say	iii) iv)	Y - T	May effect MWB and H.	
	31 What is your ethnic group? Choose one option that best describes your ethnic group or background:	Categorical	White British; White Gypsy or Irish Traveller; Asian: Indian; Asian: Pakistani; Asian: Bangladeshi; Asian: Chinese; Black African; Black Caribbean; Other / Mixed / Multiple ethnic group (please state); Don't know; Prefer not to say	iii) iv)	Y - T	Predictor of MWB.	Ng Fat et al 2017 (effects MWB)
	32 (Marital status) Are you...?	Categorical	Single (that is never married or never registered as in civil partnership); Married / living as a couple; Widowed ; Divorced / Separated	iii) iv)	Y - T	Predictor of MWB and H.	Stewart-Brown et al 2015 (married = lower mental illness)
	33 (Employment status) Are you currently (this week)	Categorical	A student; Working full time; Working part time; Retired; A Volunteer; Unemployed; Other (please specify)	iii) iv)	Y - T	Predictor of MWB.	Stewart-Brown et al 2015 (unemployed = more likely to suffer mental illness; retired = higher MWB)
	34 What is your full postcode: (this will be used to assess your distance from coast compared to other collectors, and not mapped or made available in any way) (if unwilling to answer postcode, then asked..)	Open	Converted to distance from nearest mean high water mark	iii) iv)	Y - T	Used to derive coastal proximity (0 = coastal; 1 = inland) as predictor of MWB and LS.	Wheeler et al. 2012, White et al. 2013b, 2014
	35 Do you live: <input type="checkbox"/> <input type="checkbox"/>	Categorical	less than 1mile from the coast; 1 - 6 miles from the coast; 6 – 10 miles; 11-20 miles; 21 or more miles from the coast	iii) iv)	Y - T	Used to derive coastal proximity (0 = coastal; 1 = inland) as predictor of MWB and LS.	Wheeler et al. 2012, White et al. 2013b, 2014
6: Summary information	37 Where was the respondent questioned?	Categorical	On the beach; at / in the van; indoors at a prearranged meeting site; via telephone; online			Acknowledge any bias from questionnaire delivery.	

Appendix A.2: Personal Information Sheet and Consents (available in English or Welsh for participants)

What does **gathering** from the seashore mean to you?

The aim of this survey is to speak with people collecting animals, plants and seaweeds from the Welsh seashore. I hope to document your stories and realise the true value of your activities. This information will contribute towards my PhD research, which aims to understand the personal benefits people get from collection activities in Wales.

I would like to know:

- what you collect;
- why you collect it;
- what collecting means to you personally (i.e. exercise, well-being, solitude, saves bait /food money)
- if you think your activity has a heritage or cultural value that should not be forgotten.

What I will NOT ask you is

- where or when you collect or
- how much money you earn from it.

If you don't like any of our questions, you can skip them. The questionnaire should take around 20 minutes.

Before you decide, it is important that you understand the purpose of this research and what it involves for you. We can talk now or with tea and cake after your collection.

*** INFORMATION SHEET - TO BE READ BEFORE COMPLETION ***

I recognise that for many people collecting has value beyond anything financial. 2018 is both the Welsh Year of the Sea and the European Year of Cultural Heritage, so my research is interested in any cultural or heritage value you place with your collection, as well as any health or well-being benefits you gain from it. My research hopes to provide evidence towards preserving these activities for future generations, whilst showing that our Welsh activities have value on the global stage.

You do not have to give any personal information to identify yourself, although if you are happy for me to contact you again to ask further questions, there is space for you to do so. Importantly, you will remain anonymous. Your data will be assigned a unique ID which will be kept separately to any contact details you have provided. Any names and contact information will be kept in encrypted files separate to the data you have provided for the duration of the project, used only by me to contact you in future.

The results of my work will be made publically available via scientific publications. I will not be sharing name, contact information or any locational detail with any other people or organisations. This questionnaire has been developed by a panel of academics and collectors and all questions have been scrutinized and approved by an independent Ethical Review Committee as part of Bangor University's Ethical Policy Framework.

Thank you for taking part

CONTACT ME

Liz Morris-Webb

harvestingtheseashore@bangor.ac.uk



PhD: Understanding coastal resource collection in Wales

GDPR statement

New data laws insist that I explain exactly how I will store and use your information after you give it to me. Please take time to understand this before participating.

In summary, any contact details will be processed and stored as follows:

- *Digital responses will be collected on password protected tablets, not connected to the internet in the field but downloaded to encrypted external hard-drives or laptops daily.*
- *Name and any unique identifying references will be dis-associated from the survey answers and stored in a 'link file'.*
- *The 'link file' containing names and contact info will be stored in a password protected file, in a separate folder away from the rest of the project files.*

In the field, you will be provided with an initial reference ID (RefID) along with a leaflet with the project contact details. You can use this ID to contact us to delete or discuss your data within 14 days of the initial contact. This reference ID (RefID) will be deleted 14 days after questioning to protect anonymity.

In order to undertake research on the well-being benefits of collection over time, a subsection of willing participants will be asked for your name, email and / or telephone number. At the time of data entry, your data will be assigned a new unique ID number that will be recorded on an electronic database. In order to protect your confidentiality and anonymity, the unique ID (UnqID) and your protected personal information (name and contact details) will be stored in a password protected, encrypted file in a separate place to the digital data to be analysed.

Postcodes are collected purely to assist accurately calculate how far you live from the coast, to help me define if you are part of a 'coastal community'. This will be calculated upon first opening of the digital data, categorised into 'distance from coast' and the postcode detail removed from the data set and stored along with your name and contact details as above. The data provided by participants will never be presented or stored geographically / spatially (on a map), so neither you nor your sites should be identifiable.

All personal protected information (stored in the encrypted file) will be deleted after publication of the project. All data gathered by this project will remain anonymous to anybody beyond the PhD researcher. As the stored quantitative digital data will be completely anonymised, it does not fall under the data privacy rules.

Voice recordings will be digitised to written form, and audio files destroyed upon publication. Voice recordings themselves will not be used in any publications or advertising. Your personal voice will not be heard by anyone beyond the project team.

If responding to some of the final questions of the survey, regarding personal identity, sense of place, culture and heritage it may be more difficult to maintain your anonymity. I will present any quotes as anonymous, unless you have checked the box where you are happy for your name and photograph to be presented with your opinions. This information will only be used in publicity of the importance of your gathering activity to your identity, culture or heritage. You will be provided another chance to opt in or out of these questions when you reach them.

If you have any complaints about the way this research study is being carried out, please contact me on the previous email address, or the University directly via Dr David Assinder, School Manager, School of Ocean Sciences, Bangor University, Menai Bridge, Anglesey, LL59 5AB.

Consent for face to face participation:

Research Project:

What does gathering from the seashore mean to you?

- ☐ I have read and understand the information sheet about the study (V1) and had opportunity to ask questions about the study

- ☐ I understand that for the study is completely voluntary and I can withdraw my answers up to 14 days after today using the ID provided to me on the leaflet that I've been given today

- ☐ I understand that all the information I give will be confidential and I will remain anonymous in all publications *(there are additional opportunities to be recognised and give your personal, quoted opinions or photos at the end of the survey if you would like to)*

- ☐ I agree to take part in this study

- ☐ I consent to the recording of some answers *(audio files will not be shared beyond the project supervision team, and will be deleted after the project is completed)*

Consent for telephone / skype participation:

Bangor University Research Project: Telephone Interview Permissions

What does [gathering from the seashore](#) mean to you?

☐ I have read and understand the attached information sheet about the study (V1) and had opportunity to ask questions about the study

☐ I understand that for the study is completely voluntary and I can withdraw my answers up to 14 days after today using either my name or the ID provided to me on the leaflet that I've been given today

☐ I understand that all the information I give will be confidential and I will remain anonymous in all publications *(unless you opt to be identified in the permissions below)*

☐ I agree to take part in this study

☐ I consent to the recording of some answers *(audio files will not be shared beyond the project supervision team, and will be deleted after the project is completed)*

Appendix A.3: 'What does gathering mean to you?' survey. Data analysis plan for each question.

Section	Question	Response Type	Initial response categories / range in answers	Collapsed response categories / codes for analysis	Used in ... Analysis
0: Introductory questions	2 Gender	Binomial	Male / Female	1 = male; 2 - female	GOLR
	3 What is the year of your birth?	Continuous (numerical)		age (continuous scale)	GOLR (age)
	4 Are you on holiday?	Binomial	Y / N		No
1: What is collected	5 Which animals, seaweeds or plants have you collected from the Welsh shoreline in the last 2 years (24months)? (all that apply)	Categorical (asked as an open question and coded live by administrator)	19 taxa available to administrator on device.	Total no of taxa collected (continuous)	GOLR
	6 Of these species which is the most important to you this year:	Categorical	Additional taxa entered as open responses and coded by analyst.		
	7 Which is the 2nd most important to you this year	Categorical			
	8 Which is the 3rd most important to you this year	Categorical			
2: Motivations to collect	9 Currently what is the main reason you collect the three species most important to you (these may be a different reason for each species): (1, 2, 3)	Categorical (asked as an open question and coded live by administrator, after checking with respondent)			
	10 If this reason is different from when you started collecting, please tell me the main reason when you first started: (1, 2, 3)	Categorical (asked as an open question and coded live by administrator, after checking with respondent)			
	11 Thinking about other reasons that you collect all or any of your species, please tell me the how important the following statements are to you:	Ordinal			
	Enjoy looking at species on beach (natural history interest)	Ordinal	(SHOWCARD) Where 0 is "This is never a reason I collect" and 10 is "I feel strongly that this is a reason I collect"	Collapsed scale: 1 = recoded from 0, never a reason 2 3 4 5 6 = recoded from 9 & 10, very important reason	EFA; GOLR (averaged into motivational domain 'intrigue')
	Visiting the beach and thought I'd have a look				EFA; GOLR (averaged into motivational domain 'intrigue')
	for angling bait				EFA; GOLR (as independent variable)
	Food for the table (personal consumption)				EFA; GOLR (as variable representative of food, challenge and life skills)
	I am foraging / I enjoy the challenge of finding my own food. It is fun.				not included (motivational domain 'challenge / life skills' - correlated with food)
	I like the feeling that I can provide food / practice survival skills. It's a serious activity for me.				not included (motivational domain 'challenge / life skills' - correlated with food)
	I find it a good form of stress-relief / escapism				GOLR (averaged into motivational domain 'connect')
	I enjoy the environment / fresh air				GOLR (averaged into motivational domain 'intrigue')
	To feel more connected to nature				GOLR (averaged into motivational domain 'connect')
	I enjoy the time alone on the beach				GOLR (averaged into motivational domain 'intrigue')
	I collect as a social activity with my friends / family				GOLR (averaged into motivational domain 'connect')
	I make a bit of money from it				EFA; GOLR (as independent variable)
	Research, field or citizen science				EFA; GOLR (as independent variable)
	Collection gives me reason to explore new beaches				GOLR (averaged into motivational domain 'intrigue')

PhD: Understanding coastal resource collection in Wales

Section	Question	Response Type	Initial response categories / range in answers	Collapsed response categories / codes for analysis	Used in ... Analysis
3: Collecting behaviour	12 How long have you been collecting?	Categorical	Since I was a child (12 or under); Since my teenage years (13-17); Since early adulthood (18-23); As an adult (24-retirement); Since retiring (after leaving work)		
	13 (CollectWhen) Do you collect:	Categorical	Through the year; In spring / summer only; In autumn / winter only.		
	14 Thinking about your collections at any time of year in the last 2 years (24months) how far do you normally travel to collect (record distance in one direction of travel only)?	Categorical	Less than 1 mile; 1 - 4.9 miles; 5 - 9.9 miles; 10 - 19.9 miles; 20 - 49.9 miles; Greater than 50 miles; n/a (eg: I'm on holiday and collecting is not the focus of my holiday)		
	15 (CollectFrom) Do you collect from:	Categorical	the same beach every time; 2 - 4 beaches; 5 or more beaches		
	16 (CollectWhere) Over the past two years, have your collection activities been:	Categorical	Restricted to Wales; Wales and elsewhere in the UK; Anywhere I go in the world; Other		
	17 (CollectToday) Choose the statement that best applies:	Categorical	TodayBefore_ collected before interview (today); CollAfter_ going collecting shortly; CollLater_ going collecting later today; Coll24_ collected within the last 24hrs; Coll7_ collected in the last 7 days; NoColl_ not collected in the past 7 days (and does not plan to today); WhilstColl_ questioning whilst collecting	Collected earlier today: 0 = no; 1 = yes	GOLR
	18 (added question: Regularity) How would you describe your collection activities	Nominal	Weekly (at least once a week); Monthly (at least once a month); Ad Hoc (several times a year); Annual (I make one specific seashore collection trip per year)		
	19 Please sum up what does collecting means to you in three words:	Open			Thematic analysis of words; content analysis of themes.

PhD: Understanding coastal resource collection in Wales

Section	Question	Response Type	Initial response categories / range in answers	Collapsed response categories / codes for analysis	Used in ... Analysis
4: Health & Exercise	20 Compared to people of a similar age, do you consider your health status to be:	Ordinal	Very good; Good; Fair; Poor; Very poor		
	21 How many of these were days you were collecting?	Continuous (numerical)	0 - 7		
	22 Thinking about exercise in relation to your collection activities, how strongly do you agree with the following statement?				
	My activity level drops significantly in any seasons or periods when I am not collecting.	Ordinal	(SHOWCARD) 0 (not at all) -10 (completely)		
5: Measuring well-being	23 Below are some statements about feelings and thoughts. Please choose the answer that best describes your experience of each over the last two weeks.				
	I've been feeling optimistic about the future	Ordinal	(SHOWCARD) 1 (none of the time); 2 (rarely); 3 (some of the time); 4 (often); 5 (all of the time).	Total score split into three WEMWBS categories: 1 = low (<41); 2 = medium (41-61); 3 = high (>62)	GOLR
	I've been feeling useful				
	I've been feeling relaxed				
	I've been feeling interested in other people				
	I've had energy to spare				
	I've been dealing with problems well				
	I've been thinking clearly				
	I've been feeling good about myself				
	I've been feeling close to other people				
	I've been feeling confident				
	I've been able to make up my mind about things				
	I've been feeling loved				
	I've been interested in new things				
	I've been feeling cheerful				
	24 Next I would like to ask you four questions about your feelings on particular aspects of your life. There are no right or wrong answers. For each of these questions I'd like you to give an answer on a scale of zero to 10, where zero is 'not at all' and 10 is 'completely'.				
	Overall, how satisfied are you with your life nowadays?	Ordinal	(SHOWCARDS) 0 (not at all X) -10 (completely X)	1 = low (ONS4 <7); 2 = medium (ONS4 7-9); 3 = high (ONS4 10)	GOLR
	Overall, to what extent do you feel that the things you do in your life are worthwhile?			1 = low (ONS4 <7); 2 = medium (ONS4 7-9); 3 = high (ONS4 10)	GOLR
	Overall, how happy did you feel yesterday?			1 = low (ONS4 <7); 2 = medium (ONS4 7-9); 3 = high (ONS4 10)	GOLR
	Overall, how anxious did you feel yesterday? (note reverse scale)			ONS4 Responses reversed so 0 = completely; 10 = not at all; 1 = low affective wellbeing / high anxiety (<6). 2 = medium affective wellbeing / medium anxiety (7-8); 3 = high affective wellbeing / low anxiety (>8);	GOLR

PhD: Understanding coastal resource collection in Wales

Section	Question	Response Type	Initial response categories / range in answers	Collapsed response categories / codes for analysis	Used in ... Analysis
	25 Overall, how satisfied are you with your present job?	Ordinal	(SHOWCARD) 0 (not at all X) - 10 (completely X)	1 = low (ONS <4); 2 = medium (4-9); 3 = high (10)	GOLR
	27 How many leisure visits to the Welsh outdoors have you made in the last 4 weeks? <i>By outdoors, we mean open spaces anywhere in the countryside or in towns and cities, including your local neighbourhood, paths, woodland, parks and farmland. This may include any visits to the beach for collection or otherwise. You may have made more than one visit each day</i>	Continuous (0-56)	(Numerical)	Compressed (response / 10): min = 0; max = 5.6	GOLR
5: Sociodemographics	28 How would you describe your national identity?	Categorical	Welsh; English; Scottish; Northern Irish; British; Other (please specify); prefer not to say		
	29 What is your ethnic group? Choose one option that best describes your ethnic group or background:	Categorical	White British; White Gypsy or Irish Traveller; Asian: Indian; Asian: Pakistani; Asian: Bangladeshi; Asian: Chinese; Black African; Black Caribbean; Other / Mixed / Multiple ethnic group (please state); Don't know; Prefer not to say		
	30 (Marital status) Are you:	Categorical	Single (that is never married or never registered as in civil partnership); Married / living as a couple; Widowed; Divorced / Separated	Collapsed scale: 1 = Single; 2 = Separated, divorced or widowed; 3 = Married / civil partnership	GOLR
	31 (Employment status) Are you currently (this week):	Categorical	A student; Working full time; Working part time; Retired; A Volunteer; Unemployed; Other (please specify)	Coded: 1 = Unemployed; 2 = Other; 3 = A student; 4 = working part time; 5 = working full time; 6 = retired.	GOLR
	32 What is your full postcode: (this will be used to assess your distance from coast compared to other collectors, and not mapped or made available in any way) ²³ (if unwilling to answer postcode, then asked..)	Open	Converted to distance from nearest mean high water mark	Collapsed to: 1 = Coastal (<=1km); 2 = Inland (>1km)	GOLR
	35 Do you live: ²⁴	Categorical	less than 1mile from the coast; 1 - 6 miles from the coast; 6 – 10 miles; 11-20 miles; 21 or more miles from the coast		
6: Summary information	37 Where was the respondent questionned?	Categorical	On the beach; at / in the van; indoors at a prearranged meeting site; via telephone; online		

Appendix A.4: 'What does gathering mean to you?' survey: Questionnaire responses used to characterise the collectors of coastal wild resources questioned in Wales, 2018-2019 (highlighting differences between face to face administration and online delivery, of total responses n=90).

Variable	Response category	All responses (n=90)		Face to face (n=49)		Survey method Online (n=41)		Difference in survey		
		n	%	n	%	n	%	Pearsons chi ²	df	P
Gender	Male	58	64.4%	42	85.7%	19	46.3%	0.18	0	<0.001**
	Female	26	28.9%	6	12.2%	20	48.8%			
	missing	6	6.7%	1	2.0%	2	4.9%			
Age		x = 47, SE = 2		x = 51, SE = 2		x = 44, SE = 2		6.95	6	0.325
	16-24	5	5.6%	2	4.1%	3	7.3%			
	25-34	18	20.0%	6	12.2%	12	29.3%			
	35-44	15	16.7%	7	14.3%	8	19.5%			
	45-54	14	15.6%	6	12.2%	8	19.5%			
	55-64	16	17.8%	12	24.5%	4	9.8%			
	65-74	9	10.0%	5	10.2%	4	9.8%			
	75+	3	3.3%	1	2.0%	2	4.9%			
	missing / skipped (data taken from year of birth provided by respondent)	10	11.1%	10	20.4%	0	0.0%			
On Holiday	Yes	8	8.9%	7	14.3%	1	2.4%	3.99	1	0.046*
	No	77	85.6%	41	83.7%	40	97.6%			
	missing	5	5.6%	1	2.0%	0	0.0%			
National_Identity	Welsh	32	35.6%	24	49.0%	12	29.3%	11.36	4	0.023*
	English	17	18.9%	5	10.2%	12	29.3%			
	Scottish	2	2.2%	0	0.0%	2	4.9%			
	Northern Irish	0	0.0%	0	0.0%	0	0.0%			
	British	25	27.8%	16	32.7%	9	22.0%			
	Other (Canadian, European, Irish, Italian, Malaysian)	9	10.0%	3	6.1%	6	14.6%			
	missing	5	5.6%	1	2.0%	0	0.0%			
Ethnic group	White British	75	83.3%	45	91.8%	34	82.9%	3.00	2	0.0223*
	Asian: Oriental	1	1.1%	0	0.0%	1	2.4%			
	Other (Canadian, Chinese British, Jewish, Mixed Asian white british, mixed white and Asian, New age traveller, White caucasian, White European)	9	10.0%	3	6.1%	6	14.6%			
	missing	5	5.6%	1	2.0%	0	0.0%			
Coastal Proximity (derived from postcode)	less than 1 mile from the coast	55	61.1%	28	57.1%	26	63.4%	8.51	4	0.075
	1 - 6 miles	20	22.2%	14	28.6%	6	14.6%			
	6 - 10 miles	3	3.3%	1	2.0%	3	7.3%			
	11 - 20 miles	4	4.4%	0	0.0%	4	9.8%			
	21 miles or more	3	3.3%	1	2.0%	2	4.9%			
	missing	5	5.6%	5	10.2%	0	0.0%			
Country of Residence	Wales	66	73.3%	40	81.6%	29	70.7%	3.22	3	0.359
	England	10	11.1%	5	10.2%	5	12.2%			
	Scotland	1	1.1%	0	0.0%	1	2.4%			
	Unknown	8	8.9%	3	6.1%	6	14.6%			
	missing	5	5.6%	1	2.0%	0	0.0%			
How long have you been collecting?	Since I was a child (12 or under)	36	40.0%	20	40.8%	19	46.3%	4.11	4	0.391
	Since my teenage years (13-17)	8	8.9%	7	14.3%	1	2.4%			
	Since early adulthood (18-23)	15	16.7%	7	14.3%	8	19.5%			
	As an adult (24-retirement)	23	25.6%	12	24.5%	11	26.8%			
	Since retiring (after leaving work)	3	3.3%	2	4.1%	2	4.9%			
	missing	5	5.6%	0	0.0%	0	0.0%			

PhD: Understanding coastal resource collection in Wales

Variable	Response category	All responses (n=90)		Survey method						
		n	%	Face to face (n=49)		Online (n=41)		Difference in survey		
				n	%	n	%	Pearsons chi ²	df	P
Do you collect	Throughout the year	74	82.2%	42	85.7%	35	85.4%	0.09	2	0.958
	In spring / summer only	7	7.8%	4	8.2%	4	9.8%			
	In autumn / winter only	4	4.4%	2	4.1%	2	4.9%			
	missing	5	5.6%	1	2.0%	0	0.0%			
Ave distance	Less than 1 mile	7	7.8%	2	4.1%	5	12.2%	9.85	6	0.131
	1- 4.9 miles	17	18.9%	11	22.4%	9	22.0%			
	5 - 9.9 miles	11	12.2%	8	16.3%	3	7.3%			
	10-10.9 miles	20	22.2%	13	26.5%	6	14.6%			
	20 - 49.9 miles	13	14.4%	7	14.3%	7	17.1%			
	Greater than 50 miles	13	14.4%	7	14.3%	7	17.1%			
	n/ a (eg I'm on holiday and this is not the reason I travelled)	4	4.4%	0	0.0%	4	9.8%			
	missing	5	5.6%	1	2.0%	0	0.0%			
Do you collect from:	The same beach every time	7	7.8%	3	6.1%	5	12.2%	1.27	2	0.530
	2 - 4 beaches	29	32.2%	16	32.7%	15	36.6%			
	5 or more beaches	49	54.4%	29	59.2%	21	51.2%			
	missing	5	5.6%	1	2.0%	0	0.0%			
Over the past two years, have you collection activities	Restricted to Wales	48	53.3%	29	59.2%	22	53.7%	1.50	3	0.683
	Wales and elsewhere in the UK	15	16.7%	9	18.4%	7	17.1%			
	Anywhere I've been in the world	20	22.2%	10	20.4%	10	24.4%			
	Other	1	1.1%	0	0.0%	1	2.4%			
	missing	6	6.7%	1	2.0%	1	2.4%			
Regularity (introduced part way through survey)	Weekly (at least once a week)	13	14.4%	11	22.4%	5	12.2%	16.64	3	0.001*
	Monthly (at least once a month)	16	17.8%	8	16.3%	8	19.5%			
	Ad Hoc (several times a year)	30	33.3%	4	8.2%	26	63.4%			
	Annually (I make one specific seashore collection trip per year)	2	2.2%	0	0.0%	2	4.9%			
	Unknown	24	26.7%							
	missing	29	32.2%	26	53.1%	0	0.0%			
How many days did you collect in the last week?	0	38	42.2%	x = 2, SE = 0		x = 1, SE = 0		21.53	7	0.003*
	1	16	17.8%							
	2	14	15.6%							
	3	6	6.7%							
	4	5	5.6%							
	5	1	1.1%							
	6	2	2.2%							
	7	2	2.2%							
	missing	6	6.7%							
Does your exercise reduce during periods when you're not collecting?	0: Not at all	33	36.7%	x = 5, SE = 1		x = 3, SE = 1		18.90	10	0.042*
	1	4	4.4%							
	2	2	2.2%							
	3	4	4.4%							
	4	2	2.2%							
	5	7	7.8%							
	6	6	6.7%							
	7	7	7.8%							
	8	5	5.6%							
	9	1	1.1%							
	10: Completely	12	13.3%							
	missing	7	7.8%							
Money compressed	1 - Not a reason	44	48.9%	9	18.4%	36	87.8%	43.134	5	<0.001
	2	3	3.3%	3	6.1%	0	0.0%			
	3	3	3.3%	3	6.1%	0	0.0%			
	4	13	14.4%	12	24.5%	2	4.9%			
	5	11	12.2%	11	22.4%	0	0.0%			
	6 - Very important reason	11	12.2%	9	18.4%	3	7.3%			
	missing	5	5.6%	2	4.1%	0	0.0%			

PhD: Understanding coastal resource collection in Wales

Variable	Response category	All responses (n=90)		Survey method						
				Face to face (n=49)		Online (n=41)		Difference in survey		
		n	%	n	%	n	%	Pearsons chi ²	df	P
Overall mental wellbeing								2.34	2	0.310
	Low	12	13.3%	6	12.2%	11	26.8%			
	Medium	60	66.7%	28	57.1%	24	58.5%			
	High	13	14.4%	10	20.4%	5	12.2%			
	missing	5	5.6%	5	10.2%	1	2.4%			
Life Satisfaction								2.35	2	0.309
	Low	20	22.2%	10	20.4%	10	24.4%			
	Medium	52	57.8%	26	53.1%	26	63.4%			
	High	17	18.9%	12	24.5%	5	12.2%			
	missing	1	1.1%	1	2.0%	0	0.0%			
Feelings of								2.04	2	0.360
	Low	14	15.6%	7	14.3%	7	17.1%			
	Medium	56	62.2%	28	57.1%	28	68.3%			
	High	19	21.1%	13	26.5%	6	14.6%			
	missing	1	1.1%	1	2.0%	0	0.0%			
Happiness yesterday								1.65	2	0.437
	Low	25	27.8%	13	26.5%	12	29.3%			
	Medium	41	45.6%	20	40.8%	21	51.2%			
	High	23	25.6%	15	30.6%	8	19.5%			
	missing	1	1.1%	1	2.0%	0	0.0%			
Anxiety yesterday								3.88	2	0.143
	Low	33	36.7%	17	34.7%	16	39.0%			
	Medium	26	28.9%	18	36.7%	8	19.5%			
	High	30	33.3%	13	26.5%	17	41.5%			
	missing	1	1.1%	1	2.0%	0	0.0%			

PhD: Understanding coastal resource collection in Wales

Appendix A.5: All marine and coastal taxa collected in Wales, recorded during 'What does gathering mean to you?' questionnaires, 2018-19.

Marine (M) or Terrestrial (T)	Taxa rank	Common name	Scientific taxa name	Phyla	% of participants collecting taxa	% of all taxa recorded	Accounted for (Cumulative) % of all taxa recorded	Most important for % of respondents	2nd most important for % of respondents ¹	3rd most important for % of respondents ¹
M	1	Mussel	<i>Mytilus edulis</i>	Mollusca	60	10	9	13.3	2.2	8.9
M	2	Cockle	<i>Cerastoderma edule</i>	Mollusca	42	7	16	10.0	10.0	4.4
M	3	Seaweed	<i>Any Algae</i>	Algae	39	7	21	1.1	2.2	2.2
M	4	Peeler / Shore / Green crab	<i>Carcinus maenas</i>	Crustacea	36	6	27	6.7	5.6	8.9
M	5	Prawns / Shrimp	<i>Caridea</i>	Crustacea	33	6	32	1.1	2.2	4.4
M	5	Razor shell / clam	<i>Pharidae</i>	Mollusca	33	6	37	1.1	4.4	10.0
M	7	Periwinkle	<i>Littorina littorea</i>	Mollusca	28	5	41	6.7	12.2	4.4
M	8	Lugworm / Blow lug	<i>Arenicola marina</i>	Annelida	27	5	45	8.9	7.8	3.3
T	8	Marsh samphire / glasswort	<i>Salicornia europaea</i>	Angiosperm	27	5	49	2.2	5.6	2.2
M	9	Other algae*		Algae	26	4	53	0.0	0.0	0.0
M	10	Limpets	<i>Patellidae</i>	Mollusca	19	3	56	1.1	2.2	1.1
M	11	Ragworm	<i>Hediste diversicolor</i> & <i>Perinereis cultrifera</i>	Annelida	17	3	59	4.4	3.3	1.1
M	11	Edible crab	<i>Cancer pagurus</i>	Crustacea	17	3	61	1.1	1.1	1.1
M	13	Laver	<i>Porphyra</i>	Algae	16	3	64	4.4	0.0	0.0
M	14	Velvet swimming / fiddler crab	<i>Necora puber</i>	Crustacea	13	2	66	0.0	1.1	0.0
M	15	Lobster	<i>Homarus gammarus</i>	Crustacea	12	2	68	4.4	1.1	2.2
M	15	Oyster	<i>Ostrea edulis</i>	Mollusca	12	2	69	1.1	0.0	0.0
M	17	Sea lettuce	<i>Ulva lactuca</i>	Algae	10	2	71	0.0	1.1	0.0
M	17	Hermit crab	<i>Paguridae</i>	Crustacea	10	2	72	1.1	0.0	1.1
M	18	Dulse	<i>Palmaria palmata</i>	Algae	9	2	74	0.0	0.0	2.2
M	18	Pepper dulse	<i>Osmundea</i>	Algae	9	2	75	3.3	1.1	0.0
M	18	Black lug	<i>Arenicola defodiens</i>	Annelida	9	2	76	3.3	0.0	0.0
T	18	Rock samphire	<i>Crithmum maritimum</i>	Angiosperm	9	2	78	0.0	0.0	0.0
T	18	Sea purslane	<i>Halimione portulacoides</i>	Angiosperm	9	2	79	0.0	0.0	0.0
M	23	Oarweed	<i>Laminaria digitata</i>	Algae	8	1	80	1.1	2.2	1.1
M	24	Gutweed	<i>Ulva intestinalis</i>	Algae	7	1	81	0.0	1.1	0.0
T	25	Sea beet / sea spinach	<i>Beta vulgaris maritima</i>	Angiosperm	6	1	82	1.1	1.1	2.2

PhD: Understanding coastal resource collection in Wales

Marine (M) or Terrestrial (T)	Taxa rank	Common name	Scientific taxa name	Phyla	% of participants collecting taxa	% of all taxa recorded	Accounted for (Cumulative) % of all taxa recorded	Most important for % of respondents	2nd most important for % of respondents ¹	3rd most important for % of respondents ¹
M	26	Bladder wrack	<i>Fucus vesiculosus</i>	Algae	4	1	83	3.3	0.0	0.0
M	26	Carrageen	<i>Chondrus crispus</i>	Algae	4	1	84	0.0	0.0	2.2
M	26	Sea spaghetti / Japanese Thong weed	<i>Himanthalia elongata</i>	Algae	4	1	84	0.0	0.0	0.0
M	26	Sugar kelp	<i>Saccharina latissima</i>	Algae	4	1	85	0.0	0.0	0.0
M	26	Spider crabs	<i>Maja brachydactyla</i>	Crustacea	4	1	86	1.1	2.2	1.1
M	31	Unspecific Seaweed		Algae	3	1	86	3.3	2.2	0.0
M	31	Wireweed	<i>Sargassum muticum</i>	Algae	3	1	87	0.0	0.0	0.0
M	31	Wracks	<i>Fucaceae</i>	Algae	3	1	87	0.0	0.0	1.1
M	31	Dogwhelks	<i>Nucella lapillus</i>	Mollusca	3	1	88	1.1	0.0	0.0
M	31	Nudibranchs	<i>Nudibranchia</i>	Mollusca	3	1	88	2.2	0.0	1.1
M	31	Whelk	<i>Buccinum undatum</i>	Mollusca	3	1	89	0.0	0.0	0.0
M	37	Channel wrack	<i>Pelvetia canaliculata</i>	Algae	2	0	89	0.0	0.0	0.0
M	37	Dumonts tubular weed	<i>Dumontia contorta</i>	Algae	2	0	89	0.0	0.0	0.0
M	37	Egg wrack	<i>Ascophyllum nodosum</i>	Algae	2	0	90	0.0	0.0	0.0
M	37	False Carrageen	<i>Mastocarpus stellatus</i>	Algae	2	0	90	0.0	0.0	0.0
M	37	Mermaid's pubes	<i>Vertebrata lanosa</i>	Algae	2	0	90	0.0	0.0	0.0
M	37	Serrated wrack	<i>Fucus serratus</i>	Algae	2	0	91	0.0	0.0	0.0
M	37	White ragworm / Catworm	<i>Nephtys hombergii</i>	Annelida	2	0	91	1.1	1.1	0.0
M	37	Any mollucs		Mollusca	2	0	91	0.0	0.0	0.0
M	37	Gaper shells	<i>Mya</i>	Mollusca	2	0	92	0.0	0.0	0.0
M	37	Grey winkles	<i>Gibbula</i>	Mollusca	2	0	92	0.0	0.0	0.0
M	37	Painted topshells	<i>Calliostoma zizyphinum</i>	Mollusca	2	0	92	0.0	0.0	0.0
M	37	Scallops	<i>Pecten maximus</i>	Mollusca	2	0	93	1.1	1.1	1.1
M	37	Surf clams	<i>Spisula</i>	Mollusca	2	0	93	0.0	0.0	0.0
M	37	Nemertean worms	<i>Nemertean</i>	Nemertean	2	0	93	0.0	0.0	0.0
M	37	Tunicates	<i>Tunicata</i>	Tunicata	2	0	94	0.0	1.1	0.0
M	37	Any intertidal species			2	0	94	1.1	1.1	0.0
T	37	Sea arrowgrass / sea coriander	<i>Triglochin maritima</i>	Angiosperm	2	0	94	0.0	0.0	0.0
T	37	Sea aster	<i>Aster tripolium</i>	Angiosperm	2	0	95	0.0	0.0	0.0
T	37	Sea buckthorn	<i>Hippophae rhamnoides</i>	Angiosperm	2	0	95	0.0	0.0	0.0
M	55	Plocamium	<i>Plocamium</i>	Algae	1	0	95	1.1	0.0	0.0
M	55	Sea noodles	<i>Gracilaria</i>	Algae	1	0	95	0.0	0.0	0.0
M	55	King ragworm	<i>Alitta virens</i>	Annelida	1	0	96	0.0	1.1	0.0
M	55	Bryozoa	<i>Bryozoa</i>	Bryozoa	1	0	96	0.0	0.0	0.0
M	55	Anemones	<i>Actiniidae</i>	Cnidarian	1	0	96	0.0	0.0	0.0

PhD: Understanding coastal resource collection in Wales

Marine (M) or Terrestrial (T)	Taxa rank	Common name	Scientific taxa name	Phyla	% of participants collecting taxa	% of all taxa recorded	Accounted for (Cumulative) % of all taxa recorded	Most important for % of respondents	2nd most important for % of respondents [!]	3rd most important for % of respondents [!]
M	55	Beadlet anemone	<i>Actinia equina</i>	Cnidarian	1	0	96	0.0	1.1	0.0
M	55	Hydroids	<i>Hydrozoa</i>	Cnidarian	1	0	96	0.0	0.0	1.1
M	55	Snakelocks anemone	<i>Anemonia viridis</i>	Cnidarian	1	0	96	1.1	0.0	0.0
M	55	Montagu crabs	<i>Xantho</i>	Crustacea	1	0	97	0.0	0.0	0.0
M	55	Chitons	<i>Polyplacophora</i>	Mollusca	1	0	97	0.0	1.1	0.0
M	55	Cowrie shells	<i>Trivia</i>	Mollusca	1	0	97	1.1	0.0	0.0
M	55	Pacific Oyster	<i>Crassostrea gigas</i>	Mollusca	1	0	97	1.1	0.0	0.0
M	55	Piddocks	<i>Pholadidae</i>	Mollusca	1	0	97	1.1	0.0	0.0
M	55	Slipper limpets	<i>Crepidula fornicata</i>	Mollusca	1	0	97	0.0	0.0	1.1
M	55	Thick lined top shell	<i>Phorcus lineatus</i>	Mollusca	1	0	98	0.0	0.0	0.0
M	55	Dogfish embryos	<i>Scyliorhinus</i>	Pisces	1	0	98	0.0	1.1	0.0
T	55	Alexanders	<i>Smyrniolum olusatrum</i>	Angiosperm	1	0	98	0.0	0.0	0.0
T	55	Bald mustard	<i>Alliaria petiolata</i>	Angiosperm	1	0	98	0.0	0.0	0.0
T	55	Dewberry	<i>Rubus caesius</i>	Angiosperm	1	0	98	0.0	0.0	0.0
T	55	Festuca maritima	<i>Festuca maritima</i>	Angiosperm	1	0	98	0.0	0.0	1.1
T	55	Good king henry	<i>Chenopodium bonus-henricus</i>	Angiosperm	1	0	99	0.0	0.0	0.0
T	55	Salt marsh grass	<i>Puccinella maritima</i>	Angiosperm	1	0	99	1.1	0.0	0.0
T	55	Sea lavender	<i>Limonium vulgare</i>	Angiosperm	1	0	99	0.0	0.0	0.0
T	55	Sea pink / Sea Thrift	<i>Armeria maritima</i>	Angiosperm	1	0	99	0.0	0.0	0.0
T	55	Sea plantain	<i>Plantago maritima</i>	Angiosperm	1	0	99	0.0	0.0	0.0
T	55	Sea rocket	<i>Cakile maritima</i>	Angiosperm	1	0	99	0.0	0.0	0.0
T	55	Sea sandwort	<i>Honckenya peploides</i>	Angiosperm	1	0	100	0.0	0.0	0.0
T	55	Wild brassicas	<i>Brassicaceae</i>	Angiosperm	1	0	100	0.0	0.0	0.0
T	55	Wild parsnips	<i>Pastinaca sativa</i> var. <i>sativa</i>	Angiosperm	1	0	100	0.0	0.0	0.0
M		Dabberlocks	<i>Alaria esculenta</i>	Algae	qual response elsewhere in questionnaire			0.0	1.1	0.0
M		Spiral wrack	<i>Fucus spiralis</i>	Algae	qual response elsewhere in questionnaire			0.0	0.0	0.0
M		All Barnacles		Crustacea	qual response elsewhere in questionnaire			0.0	0.0	1.1
M		Unknown Crab		Crustacea	qual response elsewhere in questionnaire			0.0	1.1	0.0
M		Gastropods		Mollusca	qual response elsewhere in questionnaire			0.0	0.0	0.0
T		Sea kale	<i>Crambe maritima</i>	Angiosperm	qual response elsewhere in questionnaire			0.0	0.0	1.1

* Had to be included as separate taxa as was different to All Algae, as respondent had listed all their known species of algae and this was an 'other' taxa rather than an 'all' or 'any' group

! Not all respondents had a second or third important taxa, so column totals less than 100% of responses

PhD: Understanding coastal resource collection in Wales

Appendix A.6: 'What does gathering mean to you?' Summary of predictors input into Generalised Ordered Logit Regression Models (gologit2) to assess theoretical (circumstantial and general practise) predictors of WEMWBS well-being (Model 1) compared to coastal collection predictors related to intertidal collection activity (Model 2). (Model 3 provided in main text).

Wellbeing summary of the collectors of coastal resources in Wales.

WELLBEING BY CATEGORY

	WEMWBS (derived from sum of 14 WEMWBS wellbeing statements)			Evaluative wellbeing (life satisfaction)			Evaluative, eudaemonic wellbeing (worthwhile)			Positive affective wellbeing (happiness)			Negative affective wellbeing (anxiety)		
N	85			89			89			89			89		
Mean	50.91														
SE	1.11														
Median				8			8			8			7		
StDev				2.2			2.1			2.4			2.9		
Category	sumWEMWBS	n	%	ONS4	n	%	ONS4	n	%	ONS4	n	%	ONS4	n	%
Low	<41	12	14.1	<7	20	22.5	<7	14	15.7	<7	25	28.1	<6	33	37.1
Medium	41-61	60	70.6	7-9	52	58.4	7-9	56	62.9	7-9	41	46.1	6-8	26	29.2
High	>62	13	15.3	10	17	19.1	10	19	21.3	10	23	25.8	>8	30	33.7

ONS4 LMH Categories - Median +/- 0.5 SD (rounded to nearest whole no)

PhD: Understanding coastal resource collection in Wales

Model	Variable	Code ^c	Response	All responses			Wellbeing category (based on total WEMWBS)						Differences between wellbeing groups			
				total WEMWBS range in WB category>			Low (1) 16-40		Medium (2) 41-61		High (3) 62-70					
				n	%	Valid %	n	Valid %	n	Valid %	n	Valid %	Fisher's Exact P ^a	Pearsons χ^2	df	P
GOLR Model 1. Theoretical (circumstantial / general practise)	Gender	1	Male	58	64.4%	69.0%	9	10.7%	40	47.6%	9	10.7%	0.934	0.242	2	0.886
		2	Female	26	28.9%	31.0%	3	3.6%	19	22.6%	4	4.8%				
		-99	missing	6	6.7%											
	Age		derived from year of birth, not category	85	94.4%	100.0%	12	14.1%	60	70.6%	13	15.3%	n/a			
		-99	missing	5	5.6%											
				x = 47, SE = 2				x = 40, SE = 3		x = 48, SE = 2		x = 47, SE = 4	R = 0.127, p = 0.123 ^p			
	Marital Status	1	Single (that is never married or registered as living in a civil partnership)	20	22.2%	23.5%	4	4.7%	15	17.6%	1	1.2%	0.163	5.673	4	0.225
		2	Separated, divorced or widowed	9	10.0%	10.6%	2	2.4%	4	4.7%	3	3.5%				
		3	Married / registered civil partnership	56	62.2%	65.9%	6	7.1%	41	48.2%	9	10.6%				
		-99	missing	5	5.6%											
	Employment Status	1	Unemployed	3	3.3%	3.5%	1	1.2%	2	2.4%	0	0.0%	0.217	14.349	10	0.158
		2	Other	6	6.7%	7.1%	3	3.5%	3	3.5%	0	0.0%				
		3	A student	7	7.8%	8.2%	2	2.4%	5	5.9%	0	0.0%				
		4	Working part time	10	11.1%	11.8%	2	0.0%	9	10.6%	1	1.2%				
		5	Working full time	46	51.1%	54.1%	5	5.9%	31	36.5%	10	11.8%				
		6	Retired	13	14.4%	15.3%	1	1.2%	10	11.8%	2	2.4%				
		-99	missing	5	5.6%											
	Job Satisfaction	1	Low	7	7.8%	9.2%	6	7.9%	0	0.0%	1	1.3%	<0.001**	44.710	4	<0.001**
		2	Medium	47	52.2%	61.8%	6	7.9%	39	51.3%	2	2.6%				
		3	High	22	24.4%	28.9%	0	0.0%	13	17.1%	9	11.8%				
		-99	n/a	3	3.3%											
		-99	missing	11	12.2%											
	General Health	1	Very Poor	1	1.1%	1.2%	1	1.2%	0	0.0%	0	0.0%	0.014*	21.408	8	0.006*
		2	Poor	1	1.1%	1.2%	1	1.2%	0	0.0%	0	0.0%				
		3	Fair	15	16.7%	17.9%	5	6.0%	9	10.7%	1	1.2%				
		4	Good	34	37.8%	40.5%	3	3.6%	27	32.1%	4	4.8%				
		5	Very good	33	36.7%	39.3%	2	2.4%	23	27.4%	8	9.5%				
		-99	missing	6	6.7%											
Leisure Days Outdoors (/10)			85	94.4%	100.0%	12	14.1%	60	70.6%	13	15.3%	n/a				
	-99	missing	5	5.6%												
			x = 16, SE = 1				x = 13, SE = 4		x = 17, SE = 2		x = 18, SE = 4	SR = 0.125, p = 0.253				
Residency (derived from postcode)	1	Coastal	55	61.1%	61.7%	9	11.1%	37	45.7%	4	4.9%	0.090	5.235	2	0.073	
	2	Inland	31	34.4%	38.3%	3	3.7%	20	24.7%	8	9.9%					
	-99	missing	4	4.4%												

Summary of wellbeing of collectors by WEMWBS group (n=89). Numbers are frequency (percent). p-Values taken from Chi squared analysis*

* X2 to determine the statistical significance of any difference in the distributions of the selected variables across categories of WEMWBS scores.

^p Pearson's R correlation for normal continuous variables

^{SR} Spearman's rho for non continuous normal

^c Predictor variables have been coded to reflect an anticipated positive correlation with mental wellbeing, as per the literature or our hypotheses. GOLRM seek a correlation between the coded predictors and responses.

! More than 20% of cells of all subtables have expected cell counts less than 5. Chi-square results may be invalid.

! The minimum expected cell count in all subtables is less than one. Chi-square results may be invalid.

PhD: Understanding coastal resource collection in Wales

Model	Variable	Code ^c	Response	All responses			Wellbeing category (based on total WEMWBS)						Differences between wellbeing groups			
				n	%	Valid %	Low (1) 16-40	Valid %	Medium (2) 41-61	Valid %	High (3) 62-70	Valid %	Fisher's Exact P	Pearson's χ^2	df	P
GOLR Model 2. Collection activity	No of species collected	-99	0-30 <i>missing</i>	85 5	94.4% 5.6%	100.0%	12	14.1%	60	70.6%	13	15.3%	n/a			
						$\chi^2 = 7, SE = 1$		$\chi^2 = 4, SE = 1$		$\chi^2 = 7, SE = 1$		$\chi^2 = 9, SE = 3$	$SR = 0.188, p = 0.084$			
	Collected today?	0 1 -99	Have not collected today Collected today <i>missing</i>	64 20 6	71.1% 22.2% 6.7%	76.2% 23.8%	10 2	11.9% 2.4%	45 14	53.6% 16.7%	9 4	10.7% 4.8%	0.729	0.685	2	0.710
	Reason: Bait	1 2 3 4 5 6 -99	1 - Not a reason 2 3 4 5 6 - Very important reason <i>missing</i>	50 4 4 5 3 18 6	55.6% 4.4% 4.4% 5.6% 3.3% 20.0% 6.7%	59.5% 4.8% 4.8% 6.0% 3.6% 21.4%	3 2 0 3 0 4	3.6% 2.4% 0.0% 3.6% 0.0% 4.8%	36 1 4 2 3 13	42.9% 1.2% 4.8% 2.4% 3.6% 15.5%	11 1 0 0 0 1	13.1% 1.2% 0.0% 0.0% 0.0% 1.2%	0.021*	22.425	10	0.013*
	Reason: Food	1 2 3 4 5 6 -99	1 - Not a reason 2 3 4 5 6 - Very important reason <i>missing</i>	27 4 4 6 8 36 5	30.0% 4.4% 4.4% 6.7% 8.9% 40.0% 5.6%	31.8% 4.7% 4.7% 7.1% 9.4% 42.4%	4 0 1 1 3 3	4.7% 0.0% 1.2% 1.2% 3.5% 3.5%	20 3 2 4 3 28	23.5% 3.5% 2.4% 4.7% 3.5% 32.9%	3 1 1 1 2 5	3.5% 1.2% 1.2% 1.2% 2.4% 5.9%	0.377	8.052	10	0.624
	Reason: Money	1 2 3 4 5 6 -99	1 - Not a reason 2 3 4 5 6 - Very important reason <i>missing</i>	44 3 3 13 11 11 5	48.9% 3.3% 3.3% 14.4% 12.2% 12.2% 5.6%	51.8% 3.5% 3.5% 15.3% 12.9% 12.9%	11 0 0 0 1 0	12.9% 0.0% 0.0% 0.0% 1.2% 0.0%	29 2 3 11 8 7	34.1% 2.4% 3.5% 12.9% 9.4% 8.2%	4 1 0 2 2 4	4.7% 1.2% 0.0% 2.4% 2.4% 4.7%	0.164	14.536	10	0.150
	Reason: Science	1 2 3 4 5 6 -99	1 - Not a reason 2 3 4 5 6 - Very important reason <i>missing</i>	44 2 0 6 7 24 7	48.9% 2.2% 0.0% 6.7% 7.8% 26.7% 7.8%	53.0% 2.4% 0.0% 7.2% 8.4% 28.9%	7 0 0 1 1 3	8.4% 0.0% 0.0% 1.2% 1.2% 3.6%	30 2 0 5 4 18	36.1% 2.4% 0.0% 6.0% 4.8% 21.7%	7 0 0 0 2 3	8.4% 0.0% 0.0% 0.0% 2.4% 3.6%	0.952	3.343	8	0.911
	Reason: Intrigue	1 2 3 4 5 6 -99	1 - Not a reason 2 3 4 5 6 - Very important reason <i>missing</i>	5 5 13 25 25 12 5	5.6% 5.6% 14.4% 27.8% 27.8% 13.3% 5.6%	5.9% 5.9% 15.3% 29.4% 29.4% 14.1%	1 0 3 3 5 0	1.2% 0.0% 3.5% 3.5% 5.9% 0.0%	3 5 10 18 13 11	3.5% 5.9% 11.8% 21.2% 15.3% 12.9%	1 0 0 4 7 1	1.2% 0.0% 0.0% 4.7% 8.2% 1.2%	0.236	12.559	10	0.249

PhD: Understanding coastal resource collection in Wales

				All responses			Wellbeing category (based on total WEMWBS)						Differences between wellbeing groups			
							Low (1)		Medium (2)		High (3)					
							16-40		41-61		62-70					
Model	Variable	Code ^c	Response	n	%	Valid %	n	Valid %	n	Valid %	n	Valid %	Fisher's Exact P ^a	Pearsons χ^2	df	P
	Reason: Connecting	1	1 - Not a reason	2	2.2%	2.4%	0	0.0%	2	2.4%	0	0.0%	0.069	17.735	10	0.060
		2	2	4	4.4%	4.8%	0	0.0%	3	3.6%	1	1.2%				
		3	3	9	10.0%	10.7%	1	1.2%	6	7.1%	2	2.4%				
		4	4	15	16.7%	17.9%	6	7.1%	8	9.5%	1	1.2%				
		5	5	26	28.9%	31.0%	3	3.6%	22	26.2%	1	1.2%				
		6	6 - Very important reason	28	31.1%	33.3%	2	2.4%	18	21.4%	8	9.5%				
		-99	missing	6	6.7%											
	Survey Method	1	Face to face	45	50.0%	52.9%	4	4.7%	33	38.8%	8	9.4%	0.323	2.340	2	0.310
		5	Online	40	44.4%	47.1%	8	9.4%	27	31.8%	5	5.9%				
		-99	missing	5	5.6%											

Summary of wellbeing of collectors by WEMWBS group (n=89). Numbers are frequency (percent). p-Values taken from Chi squared analysis*

* X2 to determine the statistical significance of any difference in the distributions of the selected variables across categories of WEMWBS scores.

^P Pearson's R correlation for normal continuous variables

^{SR} Spearman's rho for non continuous normal

^C Predictor variables have been coded to reflect an anticipated positive correlation with mental wellbeing, as per the literature or our hypotheses. GOLRM seek a correlation between the coded predictors and responses.

! More than 20% of cells of all subtables have expected cell counts less than 5. Chi-square results may be invalid.

! The minimum expected cell count in all subtables is less than one. Chi-square results may be invalid.

PhD: Understanding coastal resource collection in Wales

Appendix A.7: Meanings of collection activities to collectors collection of wild coastal resources in Wales, based on 88 respondent answers to 'sum up what collecting from the seashore mean to you in three words', 2018-19.

Meanings were thematically analysed using content analysis of the responses to 'sum up what collecting from the seashore means to you in three words'.

Theme	Codes grounded from thematic analysis		Total Responses	Occurance [!]	n Responses within wellbeing groups			% of responses within wellbeing groups (from total occurrence)		
		Comprising words from respondents*	n	%	Low WB	Medium WB	High WB	Low WB	Medium WB	High WB
Provisioning	Food	Food, Fresh	11	6	3	8	0	12	6	0
	Money	Money, business, livelihood, profit, vital for work	7	4	1	6	0	4	4	0
	Saving Money (bait or food)	Cheap, free, free bait, free food, free good food, saves money, saving money	7	4	0	7	0	0	5	0
	Science	Data, for study purposes, research, science	6	3	0	6	0	0	4	0
	Food (sustainable / conscientious)	Delicacy, low impact seafood, nourishment, quality	4	2	1	3	0	4	2	0
	Bait		1	1	0	1	0	0	1	0
Experiential	Enjoyment	Enjoyment, fun, fun experimenting food, hobby, pleasure, great day out	22	11	1	17	4	4	12	14
	Learning / Intrigue / Skills	Capability, fascinating, education, interesting, intricate, intrigue, knowledge, learning, skills	15	8	1	11	3	4	8	10
	Self-sufficiency	Being self-sufficient, self-reliance, efficient, local, natural, protection, self-sufficiency, useful, 'dinner during apocalypse'	12	6	2	10	0	8	7	0
	Societal independence / freedom	Freedom, independence, uncommercial	11	6	3	7	1	12	5	3
	Peace & relaxation	Peace & quiet, peaceful, peace, quiet, 'sea of tranquility', relaxation, relaxing,	9	5	2	6	1	8	4	3
	Rewarding / Satisfaction / Sense of Achievement	Pride, earned, rewarding, satisfaction, sense of achievement, hard work, satisfying	9	5	1	6	2	4	4	7
	Connection (with nature)	Nature, cooking outdoors, environmental connection, nature, wildlife	9	5	1	7	1	4	5	3
	Exercise	Better than lazy', active, exercise, fitness	9	5	1	7	1	4	5	3
	Fresh air / environment	Fresh air, being outdoors, environment, fresh air, just being outside, outdoors, scenery, coasts	8	4	1	6	1	4	4	3
	Adventure / thrill	Adventure, exciting, exhilaration, energised and treasure hunt	7	4	1	2	4	4	1	14
	Sustainability / Conservation		6	3	2	3	1	8	2	3
	Sport	Hunting, 'good days fishing', fishing, sporting	6	3	1	4	1	4	3	3
	Exploration		5	3	1	2	2	4	1	7
	Health	Health, human health	5	3	0	3	2	0	2	7
	Way of life	Lifestyle, part of life, way of life, a better life	5	3	0	4	1	0	3	3
	Connection (unspecified)	Connection / connecting, closeness, cooking outdoors	4	2	1	2	1	4	1	3
	Culture / Heritage		3	2	0	2	1	0	1	3
	Mental wellbeing	Critical psychological wellbeing', therapy, wellbeing	3	2	0	2	1	0	1	3
	Sense of place	Cynefin, home, place	3	2	0	2	1	0	1	3
	Connection (with others)	Socialising with friends, togetherness, wife	3	2	0	3	0	0	2	0
	Challenge		1	1	1	0	0	4	0	0
	Inspiration		1	1	0	1	0	0	1	0
	Stress-relief		1	1	0	1	0	0	1	0
			193	100	25	139	29	100	100	100

* where words are missing, codes are the words of respondents

! % occurrence is the frequency of the 'code' amidst total number words provided by respondents

APPENDICES B:

Chapter 3

Appendix B.1: Personal Information Sheet and Consents (available in English or Welsh for participants)

What does gathering from the seashore mean to you?

The aim of this survey is to speak with people collecting animals, plants and seaweeds from the Welsh seashore. I hope to document your stories and realise the true value of your activities. This information will contribute towards my PhD research, which aims to understand the personal benefits people get from collection activities in Wales.

I would like to know:

- what you collect;
- why you collect it;
- what collecting means to you personally (i.e. exercise, well-being, solitude, saves bait /food money)
- if you think your activity has a heritage or cultural value that should not be forgotten.

What I will NOT ask you is

- where or when you collect or
- how much money you earn from it.

If you don't like any of our questions, you can skip them. The questionnaire should take around 20 minutes.

Before you decide, it is important that you understand the purpose of this research and what it involves for you. We can talk now or with tea and cake after your collection.

*** INFORMATION SHEET - TO BE READ BEFORE COMPLETION ***

I recognise that for many people collecting has value beyond anything financial. 2018 is both the Welsh Year of the Sea and the European Year of Cultural Heritage, so my research is interested in any cultural or heritage value you place with your collection, as well as any health or well-being benefits you gain from it. My research hopes to provide evidence towards preserving these activities for future generations, whilst showing that our Welsh activities have value on the global stage.

You do not have to give any personal information to identify yourself, although if you are happy for me to contact you again to ask further questions, there is space for you to do so. Importantly, you will remain anonymous. Your data will be assigned a unique ID which will be kept separately to any contact details you have provided. Any names and contact information will be kept in encrypted files separate to the data you have provided for the duration of the project, used only by me to contact you in future.

The results of my work will be made publically available via scientific publications. I will not be sharing name, contact information or any locational detail with any other people or organisations. This questionnaire has been developed by a panel of academics and collectors and all questions have been scrutinized and approved by an independent Ethical Review Committee as part of Bangor University's Ethical Policy Framework.

Thank you for taking part

CONTACT ME

Liz Morris-Webb

harvestingtheseashore@bangor.ac.uk



PhD: Understanding coastal resource collection in Wales

GDPR statement

New data laws insist that I explain exactly how I will store and use your information after you give it to me. Please take time to understand this before participating.

In summary, any contact details will be processed and stored as follows:

- *Digital responses will be collected on password protected tablets, not connected to the internet in the field but downloaded to encrypted external hard-drives or laptops daily.*
- *Name and any unique identifying references will be dis-associated from the survey answers and stored in a 'link file'.*
- *The 'link file' containing names and contact info will be stored in a password protected file, in a separate folder away from the rest of the project files.*

In the field, you will be provided with an initial reference ID (RefID) along with a leaflet with the project contact details. You can use this ID to contact us to delete or discuss your data within 14 days of the initial contact. This reference ID (RefID) will be deleted 14 days after questioning to protect anonymity.

In order to undertake research on the well-being benefits of collection over time, a subsection of willing participants will be asked for your name, email and / or telephone number. At the time of data entry, your data will be assigned a new unique ID number that will be recorded on an electronic database. In order to protect your confidentiality and anonymity, the unique ID (UnqID) and your protected personal information (name and contact details) will be stored in a password protected, encrypted file in a separate place to the digital data to be analysed.

Postcodes are collected purely to assist accurately calculate how far you live from the coast, to help me define if you are part of a 'coastal community'. This will be calculated upon first opening of the digital data, categorised into 'distance from coast' and the postcode detail removed from the data set and stored along with your name and contact details as above. The data provided by participants will never be presented or stored geographically / spatially (on a map), so neither you nor your sites should be identifiable.

All personal protected information (stored in the encrypted file) will be deleted after publication of the project. All data gathered by this project will remain anonymous to anybody beyond the PhD researcher. As the stored quantitative digital data will be completely anonymised, it does not fall under the data privacy rules.

Voice recordings will be digitised to written form, and audio files destroyed upon publication. Voice recordings themselves will not be used in any publications or advertising. Your personal voice will not be heard by anyone beyond the project team.

If responding to some of the final questions of the survey, regarding personal identity, sense of place, culture and heritage it may be more difficult to maintain your anonymity. I will present any quotes as anonymous, unless you have checked the box where you are happy for your name and photograph to be presented with your opinions. This information will only be used in publicity of the importance of your gathering activity to your identity, culture or heritage. You will be provided another chance to opt in or out of these questions when you reach them.

If you have any complaints about the way this research study is being carried out, please contact me on the previous email address, or the University directly via Dr David Assinder, School Manager, School of Ocean Sciences, Bangor University, Menai Bridge, Anglesey, LL59 5AB.

Consent for face to face interview:

Research Project:

What does gathering from the seashore mean to you?

- ☐ I have read and understand the information sheet about the study (V1) and had opportunity to ask questions about the study

- ☐ I understand that for the study is completely voluntary and I can withdraw my answers up to 14 days after today using the ID provided to me on the leaflet that I've been given today

- ☐ I understand that all the information I give will be confidential and I will remain anonymous in all publications *(there are additional opportunities to be recognised and give your personal, quoted opinions or photos at the end of the survey if you would like to)*

- ☐ I agree to take part in this study

- ☐ I consent to the recording of some answers *(audio files will not be shared beyond the project supervision team, and will be deleted after the project is completed)*

Consent for telephone / skype interview:

Bangor University Research Project: Telephone Interview Permissions

What does [gathering from the seashore](#) mean to you?

☐ I have read and understand the attached information sheet about the study (V1) and had opportunity to ask questions about the study

☐ I understand that for the study is completely voluntary and I can withdraw my answers up to 14 days after today using either my name or the ID provided to me on the leaflet that I've been given today

☐ I understand that all the information I give will be confidential and I will remain anonymous in all publications *(unless you opt to be identified in the permissions below)*

☐ I agree to take part in this study

☐ I consent to the recording of some answers *(audio files will not be shared beyond the project supervision team, and will be deleted after the project is completed)*

Appendix B.2: Interview topic guide

Pre-amble:

- Ensure Personal Information Sheet has been provided and talked through with participant.
- Complete GDPR consents and request to record the interview for transcription.

Notes to interviewer:

- Provide unique reference to link to 'What does gathering from the seashore mean to you?' (WGM) questionnaire (if relevant): (to be destroyed after 14 days)
- Date
- Keep a printed copy of the interview questions for brief note taking, and to reflect on tone of interview as soon as possible after interview.
- Ensure silence between questions to enable enough time to think.
- Ask about unclear things. Repeat your understanding (it may prompt more discussion). If they mention something fleetingly then ask them more about it, probe the discussion but as a consequence of what they have initiated (eg: you mentioned X, would you like to tell me a bit more about X? Or what happened next? The consequences?). Especially if things were mentioned before the interview started.
- If they haven't done the WGM questionnaire, ask at the end if they would like to.

Questions:

If they have not completed the WGM questionnaire:

- i. Tell me a bit about your collection activities

If they have completed the WGM questionnaire, move straight to **(core questions in bold)**:

- 1. What does gathering from the seashore mean to you?**
- 2. Do you feel that collecting from the intertidal beach is part of your personal identity?**
- 3. Do you feel that collecting from the intertidal is part of your family or cultural heritage? Or your national identity?**
4. Do you have any stories, recipes or images that you would like to share with me? (I won't give your secrets away if you don't want to, but they make good talking points!)
5. Finally, thinking back on a recent bad weather day when you went out collecting (or a scorchingly hot one as we've had a lot of those recently). What made you get up off of the sofa and go out on the shore? How did you feel before you went, whilst you were there and when you got home?
6. Is there anything that we have missed in terms of have we missed anything important to you that you think now you have reflected of it?
7. Is there anything else you would like to talk about today relating to your collection activity?

PhD: Understanding coastal resource collection in Wales

Appendix B.3: Summary of themes

n = number of people theme present in (number of interviews in brackets)

Theme	Subtheme?	Description	Comprising the key codes.... (in order of prevalence by number of participants)	Pluralism and relationships between themes and subthemes	n	Number of quotes
1. Provisioning		Direct provision of collected taxa for food, money, or anything that can be utilised.	Money; Food; Science or natural history; Bait; Cosmetics; Health supplements / medicinal; other provisioning.	All other themes, especially Personal Identity	31 (30)	135
2. Nature connectedness		Collecting from the seashore offers a way of developing a greater closeness to nature; appreciating it and watching it change. Some use collecting activities to help others (especially children) develop a connection with nature. Environment and nature makes some feel somehow insignificant.	Connecting to nature	Health & Wellbeing	22 (19)	37
3. Health and Wellbeing		Mutiple physical and mental health values to coastal collection included physical exercies and fitness, and a plethora of mental health aspects including stress reduction, feelings of restoration, solitutde and escapism in terms of both the beach environment and the respite from a busy mind through 'getting into the flow' of picking. Commercial pickers also feel the stress of picking to order and the uncertainties related to stock depletion and poor management.	Mental health (anxiety, depression, restorative, helps with coping, gets out of the house, also stress related to commercialisation of collecting); Exercise and Fitness.	Personal Identity	30 (26)	133
	Enjoyment	The joy of the treasure hunt. Feelings of happiness, excitement and thrill of finding, collecting and preparing the harvest.	Enjoyment, excitement, thrill.	Health and Wellbeing (Social and Giving); Knowledge; Nostalgia	17 (15)	29
	Social and Giving	Connecting to people through their activities, on beaches or virtually, or as a talking point. Giving or sharing their harvest, knowledge or experiences is a large part of this social subtheme.	Connecting to people, giving and sharing.	Knowledge; Personal Identity (Heritage)	23 (19)	61

PhD: Understanding coastal resource collection in Wales

Theme	Subtheme?	Description	Comprising the key codes.... (in order of prevalence by number of participants)	Pluralism and relationships between themes and subthemes	n	Number of quotes
4 Personal Identity		Most collectors clearly linked their collecting activities as part of their identity, but the more subtle references that make up some aspects of personal identity have been separated into four clear constituent subthemes.			31 (29)	194
	The hunter-gatherer persona	Although some may not label themselves hunter-gatherers, the challenge and sense of achievement from finding and collecting, for food or money, and the sense of pride associated to it, is very important to this theme. Human instincts to collect include the practising of ancestral knowledge and survival skills, and maintaining their intrinsic right to collect from the seashore.	Challenge, satisfaction, reward and achievement; Pride and feelings of worthwhile; Being human; Survival skills; Right to collect.	Being Outside; Knowledge.	22 (20)	57
	Sense of place	Some collectors have 'found their place' through their activities, either geographically or in the people they have connected with. Some collector's 'place' was the emotion described as being most comfortable in themselves when undertaking their collecting activities.	Belonging or sense of place	Nature Connectness; Health and Wellbeing	14 (12)	21
	Heritage	Strong links to family hertiage, local traditions or cultural heritage.	Family heritage; Cultural identity or heritage; Local tradition.	Provisioning; Knowledge	20 (18)	45
	Way of life	Way of life' emerges through long and thick descriptions of collectors' lives.	Way of life	Health and Wellbeing; Provisioning	13 (11)	23
Personal Identity & Nature Connectedness	Being Outside	Being outside, invigorated by the weather or challenged by the environment, was a key feature of both Nature Connectedness and the Hunter-Gatherer Persona.	Being outside (invigorating in bad weather); , Working with the sea.	Self-actualisation; Sense of place; Nature connectedness	16 (15)	26

PhD: Understanding coastal resource collection in Wales

Theme	Subtheme?	Description	Comprising the key codes.... (in order of prevalence by number of participants)	Pluralism and relationships between themes and subthemes	n	Number of quotes
Personal Identity & Health and Wellbeing	Knowledge	Interest, intrigue, fascination, learning, knowledge of the environment and the species and practising learned skills are all key aspects of 'Knowledge', which contributes to both Health and Wellbeing and Personal Identity.	Interest Learning; Practising learned skills; Knowledge of target species; Intrigue or fascination.	Health and Wellbeing (Enjoyment and Social and Giving); Personal Identity (The Hunter-Gatherer Persona).	25 (23)	42
Personal Identity & Health and Wellbeing	Nostalgia	Nostalgia for childhood memories, ancestral 'ideals' and as a way of connecting to people of the past (deceased or absent). Links strongly to Knowledge, Personal Identity and Health and Wellbeing.	Nostalgia; Connecting to people in the past / deceased.	Health and Wellbeing (Enjoyment and Social and Giving); Personal Identity (Heritage); Knowledge	16 (15)	23
5. Sustainability Concerns		Sustainability concerns for both the target stocks and collection activities themselves were discussed in respect to every other theme, and might be considered a potential fear related to the loss of these values or meanings to the collector. Sustainability concerns were initially coded under six main codes; threats to heritage, or fear of losing traditions; threats to stock from pollution or poor management of declining stocks; threats to income; threats to knowledge or education; confusing or poor management processes (with a call for more transparency) and conflicts with other users. Many are underpinned by fears of loss due to changing society, environment or policies and management.	Threats to heritage (family, trade or traditions); Threats to stock; Confusing management, call for transparency); Threats to income; Threats to education or knowledge; Conflict with other users.	All other themes, particularly Provisioning and Personal Identity.	24 (21)	56

PhD: Understanding coastal resource collection in Wales

Appendix B.4: Full codebook including all codes and subcodes with quotes

n = number of interviews in which code was present; NQ = total number of times code appeared across interviews

Theme	Subtheme	Code: parent	Code: child	Description	Example Quotes (each example within each code are from different interviews)	n	NQ
Provisioning		Bait		Bait		3	4
Provisioning		Cosmetics incl soap		Cosmetics incl soap		2	3
Provisioning		Food		Any references which allude to their collection being for food. Comprising an aggregation of all child codes.		19	102
Provisioning		Food	Appreciation	Choosing to eat self sourced food to appreciate where food comes from		12	20
Provisioning		Food	Joy in and preparation to eat	Joy of collecting your own food, smelling it, tasting it, knowing where it comes from and preparing it. It's all part of the 'foraging process', but not directly the enjoyment of the act of foraging itself.		10	19
Provisioning		Food	Sustenance or Need	Some people have said that either now or in the past they have 'needed' food, or that they believe it provides sustenance. It is difficult to disentangle a 'need' compared to a 'choice' - I'm not sure whether it's possible so I've suggested that they may be merged up, But these should probably be teased apart if possible.		9	16
Provisioning		Food	Freedom from supermarkets	Freedom from supermarkets specifically (rather than survival skills), this may be a personal preference to prefer to 'buy local' or use local rather than buying processed food etc. Links to the FAO idea that provisioning can be for preference (rather than need) and provides necessary escape from society for some.		6	9

PhD: Understanding coastal resource collection in Wales

Theme	Subtheme	Code: parent	Code: child	Description	Example Quotes (each example within each code are from di n	NR
Provisioning		Health supplements Medicinal		Health supplements or medicinal - for use and or for sale.		2 7
Provisioning		Money		Any refernces which allude to their collection being for money. Comprising an aggregation of all child codes.		22 106
Provisioning		Money	Main income	Mentions that this is their main income or livelihood, or it has been.		13 33
Provisioning		Money	Alternative income	Collector has specifically mentioned that this is or has recently been an important 'second' or alternative income. This may be a choice 'second' occupation or a necessary one - it is again difficult to tell.		9 20
Provisioning		Money	Security in times of hardship	Specifically mentions that people are returning to collecting as a 'back up option', offering money where other jobs have been hard to come by.	<i>"I think everybody in Caernarfon collected [winkles] at one time. Everybody I see. They might go out of work for a few months and, you know, do the winkles. Just like a step forward towards another job. So it's something to fall on. So</i>	7 8
Provisioning		Money	Education Teaching	Teaching foraging, coastal survival, bush craft, etc for money.		6 15
Provisioning		Money	Career change	Career change into collecting for money. Usually this appears to be by choice, but not always (one specified that they fell into it after being on the dole and invited to pick cockles by some friends).		4 5
Provisioning		Money	Export industry	Mentions that they work in the export industry. This seems to really drive some people's ambition, or their pride?		4 7
Provisioning		Money	Need	References which specifically mention the financial need (rather than the reliance that comes with collecting being a main income).		2 2
Provisioning		Science or taxonomy		May be earning money, or providing data for research or citizen science		4 4

PhD: Understanding coastal resource collection in Wales

Theme	Subtheme	Code: parent	Code: child	Description	Example Quotes (each example within each code are from di n	NR
Provisioning		Other provisioning		Other instrumental / provisioning gain from collecting, such as arts and crafts, unspecified uses.		2 2
Nature Connectedness		Connecting to nature and environment		Many collectors mention their collecting activities in relation to nature: watching it, developing a greater closeness to it; appreciating it more; and that the environment and nature makes them feel somehow insignificant. Some people speak of foraging as a tool to help children develop a deep connection with nature.	<i>"It's understanding the way of the shore works, and the way the beaches work. It's understanding it all. You know, seeing nature, and working alongside nature. "</i> <i>"it gets me involved in nature and I have always been a fan of cooking as well, so kind of mix all those together. "</i> <i>" I think its er its very important you know for people to, to go out foraging because it gives us a link, it gives us a link with nature which is sort of lacking for a lot of people. "</i> <i>"It makes you feel part of everything, it makes you feel insignificant. I mean the weather is, is God to me if you have to pick a God or religion to me it's like mother nature and the weather. Everything I do and everything outside the whole wild thing is all about the weather and it, it basically. ... It shows how small and insignificant we are and how nature although we think we have mastered the environment, we have made all this stuff and we are the modern animal. "</i>	17 19
Nature Connectedness		Connecting to nature and environment	Appreciating, observing or learning the seasonal changes	Watching and observing the seasons passing; either as a close part of their collection (which crustaceans, fish, etc) or the surrounding environment.	<i>"I look forward to the seasons and what animals are about and what crustaceans are there or fish. But yeah, it's part of my identity and it gets me through the year. "</i> <i>"It's like, you are out there, and you don't know, you don't have to have er a car there with you because you know what birds are on the beach, so you know what time of year it is, you know what I mean. See the winter is coming you see the wigeon coming in you know the ducks and then come now this time of year they are all gathered together to go away. So, you know what I mean you know, you know the seasons like. I love it, I love going down in the morning never get tired of the view, never. "</i> <i>"There is just something really special about being out there, sitting on a rock and watching things. And seeing, because I've been seaweeding in the same places, it's interesting to see how things have changed on those particular beaches. "</i>	9 9

PhD: Understanding coastal resource collection in Wales

Theme	Subtheme	Code: parent	Code: child	Description	Example Quotes (each example within each code are from di n	NR
Health and wellbeing	Social and giving	Connecting with people (living)		Connecting with friends, family, colleagues, and clients. This is a 'living' code which connects people in the here and now. It could be through foraging with them, or enjoying the sharing of their feast, or enjoying teaching others. Cocklers in particular talk of the community and banter on the sands. People working in foraging businesses seem to talk of 'meeting spaces' and associations. Natural historians of facebook groups and citizen science projects.	<p>"So, we need a bit of alone time and space and that's becoming increasingly more difficult to find....Doing something without being a part of a crowd, something you are sharing together as a family having fun."</p> <p>"It's a family affair, the kids are there and the kids squealing, oh there's one popped up here, there's one popped up you know.....It was really, really great, good family quality time."</p> <p>"People are genuinely interested....You just end up talking about cockles.....We have such fun times and er we have always got a story to tell and we always know somebody who knew somebody who did it, who had a go at it. And um it's a way, it's an ice breaker and it's a way to get I mean it's just something isn't it, it's a bit different. What do you do?"</p> <p>"Normally I go there (a bushcraft festival) for a week or two weeks ... that's like 250 people just all living in the wood. And I love doing that, what I call an anarchistic point of view because I know that we don't actually need people to tell us what to do um. Yeah, well once we live outside the human zoo we don't but um. Its just really great, I just love how 250 people strangers can all live in a really small space and can all get along with no one in charge you know what I mean its brilliant...So, I go there, and I do foraging, fishing, survival, bush craft all sorts of stuff like."</p>	18 34

PhD: Understanding coastal resource collection in Wales

Theme	Subtheme	Code: parent	Code: child	Description	Example Quotes (each example within each code are from di n	NR
Health and wellbeing	Enjoyment	Enjoyment, excitement, thrill		Enjoyment can be so many things. Not just excitement and thrill, and often collectors can not put a specific description on it. It's just fun, or they just enjoy it.	<p>"I mean there's nothing more fun than being at the beach at super low tide and you have got this little razor clam squirting jets of water at you and you that you are trying to catch."</p> <p>"I do it because I enjoy it. And I enjoy it more because I have the knowledge of how, where and when to be able to do it."</p> <p>"its more about, to me it's more about like exploring and having fun with stuff...."</p> <p>"just totally considering how much fun I have from foraging and what it means to me, obviously it is part of my life... You know foraging is really and basically my, like my hobby, not my hobby my true love of the foraging turned into be a job so [laughing]....It's probably one of the best jobs I have ever had to be honest, it is nice to do the both with the other job I have people moan about the cockle picking, I, I just love it and as you said it's just getting paid for foraging."</p>	15 33
Health and wellbeing	Enjoyment	Enjoyment, excitement, thrill	Excitement Thrill	Specific mention of thrill of excitement, as a child or adult. The thrill of the find, or the excitement of the identification or the wonder at what you might find tomorrow.	<p>"I think for myself I feel, I feel the best when I am out foraging, I forget about everything and, and you know I probably get excited about finding stuff."</p> <p>"And it's just the pure excitement of playing around with the wildlife and the, and the sea."</p> <p>"We are proud that we have had an honest day's work, a hard day's work where you can lie down on the sofa in the night and say phew. Somehow you feel like excited about tomorrow to go and do it all again."</p> <p>"It's endorphins in your brain then is pumping....Because you have got this adrenaline"</p> <p>"But you always end up finding something and quite often it's the thing that you are not actually looking for that are more exciting part of it... Yeah, stumbling across something that you didn't image would ever be there...."</p>	7 12

PhD: Understanding coastal resource collection in Wales

Theme	Subtheme	Code: parent	Code: child	Description	Example Quotes (each example within each code are from di n	NR
Health and wellbeing		Exercise or Fitness		Any mention that collecting is benefiting their physical health, through exercise or fitness.	<p>"A natural workout." "And do things it's exercise, it's fresh air and that can only make you feel better. Because otherwise you are just sat in the house. "</p> <p>"someone described the work that we did before I got the machine as the brutal end of hard labour."</p> <p>"I think one of the great benefits of doing it is I don't have to go and worry about what exercise I am going to do at the end of every day and things like this because we get it at work. And you know when you look at the, how people are viewing what is a healthy lifestyle I think it's pretty much summed up in what we do.....you are actually manually grafting quite intensely for a tidal period which is three to four hours. So, you are probably doing quite an extended workout in that time and it's meant that I haven't had to go to the gym since I left university really."</p> <p>"Sounds daft when I go away I have put on a bit of weight before I go back on the cockles. ... I did check the scales, it was one of my duties I had to do is check the scales to make sure they are reading right. So, I would get on the scales every day, didn't matter what the weight was as long as the three scales read the same.... but I notice perhaps I would go from perhaps 110 kg down to 100 kg (when picking compared to when not picking)."</p> <p>"I have got my Fitbit to keep me going yeah.... I do about six, seven miles a day."</p>	10 19

PhD: Understanding coastal resource collection in Wales

Theme	Subtheme	Code: parent	Code: child	Description	Example Quotes (each example within each code are from di n	NR
Health and wellbeing	Social and giving	Giving or sharing		Could be time, knowledge, food, company, gifts. (Comprises the merged initial codes of 'connecting to people: giving' and 'knowledge: sharing knowledge, skills'). Dominated less by sharing catch, but more by mosly sharing knowledge and imparting skills and inspiration to people, both strangers and to 'the next generation'.	<i>"my ambition is, I haven't done it yet, but I will probably next summer is to go cockling um or musseling or both, winking maybe with the grandchildren and take a saucepan with me and make a little fire on the beach and boil them in seawater."</i> <i>See other quotes below for each subcode</i>	17 50
Health and wellbeing	Social and giving	Giving or sharing	Sharing knowledge, contributing to something bigger	eg sharing traditional knowledge with others, teaching coastal survival, or contributing records to i record, or to a citizen science project. Imparting skills and inspiration to people, both strangers and to 'the next generation'.	<i>"tradition is basically what I am about. So, survival and bush craft but it's also that sort of need to pass on knowledge to the next generation."</i> <i>" I almost feel like I'm telling you an untruth by saying it because it's so varied of where it has been, and I want to pass that onto the next generation. My next investment is to make a shop with a heritage centre there so that people can come in and learn about cockles and know what I have done, my father has done, my grandfather has done, my great grandfather has done, and I want to celebrate that. And not just us because everybody did it in this village and people continue to do it. And I want to celebrate what they do."</i> <i>"And I think that it's very important um that people er learn about nature when they are children. And I know that it's a fact that most of the people who are famous as naturalist for example David Attenborough and Chris Packham, people like this they always can tell you that they became fascinated by nature as children. And that, that fascination, that interest, that love of nature stays with them. And er that is something I think is vitally important to people you know to connect with nature as soon as you can in your life. And, and foraging goes, goes along with that but you know what I'm saying there is if you learn when you are a child what plants you can eat and what seafood you can catch at the beach. "</i> <i>"You know kids have stopped going out, you know there is no connection there is there any more they are all on their X boxes or this kind of thing or on their phones. Um, you know the younger generation I think foraging could be a massive thing just to get people back to the planet you know. You</i>	16 42

PhD: Understanding coastal resource collection in Wales

Theme	Subtheme	Code: parent	Code: child	Description	Example Quotes (each example within each code are from di n	NR
Health and wellbeing	Social and giving	Giving or sharing	Giving or sharing their collection	Could be products / stories / knowledge / practise, even time	<p><i>"We sometimes have whole dinners where everything has seaweeds in it, including the pudding. And they don't realise it, until you tell them "You've just been eating a load of seaweed off the beach". "</i></p> <p><i>"So, I had it in me from an early age for some reason to provide or supply food for the house and for myself as well, yeah."</i></p>	6 8
Health and wellbeing		Mental Health	Stress relief, restorative or suggestions of mindfulness	Stress relief, restorative or suggestions of mindfulness. Some collectors explicitly mention that they see the act of collecting as a 'mindful' activity, whilst others allude to it through their rich descriptions of the repetitive tasks, or getting into the 'zone' where they forget their other life stresses. Often they are mentioned together with discussions of anxiety or depression, but noth always.	<p><i>" it's really strange because you get into a rhythm, you get into a routine and all of a sudden, the movement of gathering cockles was you make that rake, you are moving, moving, moving.... So, before you know it you are on this treadmill and you are starting to get his competitiveness in yourself where you are trying to keep up with the water, keep up with the cockle flow, y.....and before you know it you are into this rhythm of pattern that's almost like a frenzy. "</i></p>	10 15

PhD: Understanding coastal resource collection in Wales

Theme	Subtheme	Code: parent	Code: child	Description	Example Quotes (each example within each code are from di n	NR
Health and wellbeing		Mental Health	Solitude Escapism	Mentions solitude or escapism collectors benefit from whilst collecting	<p>"solitude on a beach, yeah basically you can go out there on the beach and it's. It doesn't matter what the weather is it can be raining it can be blowing but I can still pick the cockles."</p> <p>"But when you leave the shore to pick cockles you are going into unknown territory where no other man wants to go [laughing]. Where people lose their lives, where it's that excitement that adrenaline and then your skills come into it. So, when you walk off the car park from a winkle pickers point of view you could trip over a stone, but you could be walking a dog. So, you are going into an environment where you feel you have got control of. And also, you are kind of excluded out onto the beaches because there's not holiday makers coming and asking you Mr Davis what are you doing? You don't see anybody"</p> <p>"You know, couldn't have a better office than being out there on your own, or only a couple of you out there on your own. It's freedom in it? "</p> <p>"And we are becoming increasingly overpopulated and, and there's so many crowds. And going to the beach collecting gets you away from that.So, we need a bit of alone time and space and that's becoming increasingly more difficult to find."</p> <p>"so there was no like media influence or anything like this and</p>	8 9

PhD: Understanding coastal resource collection in Wales

Theme	Subtheme	Code: parent	Code: child	Description	Example Quotes (each example within each code are from di n	NR
Health and wellbeing		Mental Health	Helps with coping	Collecting somehow helps with stress, bereavement or life circumstance (eg: one respondent mentions an alternative foraging based lifestyle to cope with his dyspraxia and dyslexia). Has been life changing, but seem to depend on the act of foraging to help them cope, rather than the 'idea of foraging' to rebel against society (akin to freedom or self actualisation?).	<p>"I don't know what I would do if where we were stopped tomorrow....In winter I'm just caged in really you know. ..Can't get out as much I do mind you know in spring, then it will be winter and then its just a complete cut off then just to get you know bloody accounts and stuff done and food safety stuff done... it's a nightmare...for foraging now but I get massive health benefits you know in the main season. But now this time of year (winter) obviously try and get out every day."</p> <p>"that was keeping him alive, that was keeping him alive that was, coming out there (cockle picking)..He didn't last long after that, he died when he was 90."</p> <p>"So you know I said about knowing how to provide my own shelter, fire, water and food that's massively beneficial for my mental health. I am not controlled by society, someone who was born in a lower class working family in an underprivileged background officially. You know I used to get all the meal tickets and stuff you know, I was the poor kid of the school um. Yeah, its massively beneficial for my mental health to know that I'm not bound by that connection that this modern world. Which I find really hard to live in as a now would be labelled autistic sort of dyspraxia um person.....And now they are labels as disabilities because they don't want us to think for ourselves, they don't want us to be random, they don't want us to be freely distracted. ... I used to really worry that like I am always going to be poor, what would I do when I am older and know what about if I have got nothing. And now"</p>	7 9

PhD: Understanding coastal resource collection in Wales

Theme	Subtheme	Code: parent	Code: child	Description	Example Quotes (each example within each code are from di n	NR
Health and wellbeing	Social and giving	Giving or sharing		Could be time, knowledge, food, company, gifts. (Comprises the merged initial codes of 'connecting to people: giving' and 'knowledge: sharing knowledge, skills'). Dominated less by sharing catch, but more by mosly sharing knowledge and imparting skills and inspiration to people, both strangers and to 'the next generation'.	<i>"my ambition is, I haven't done it yet, but I will probably next summer is to go cockling um or musseling or both, winking maybe with the grandchildren and take a saucepan with me and make a little fire on the beach and boil them in seawater."</i> <i>See other quotes below for each subcode</i>	17 50
Health and wellbeing	Social and giving	Giving or sharing	Sharing knowledge, contributing to something bigger	eg sharing traditional knowledge with others, teaching coastal survival, or contributing records to i record, or to a citizen science project. Imparting skills and inspiration to people, both strangers and to 'the next generation'.	<i>"tradition is basically what I am about. So, survival and bush craft but it's also that sort of need to pass on knowledge to the next generation."</i> <i>" I almost feel like I'm telling you an untruth by saying it because it's so varied of where it has been, and I want to pass that onto the next generation. My next investment is to make a shop with a heritage centre there so that people can come in and learn about cockles and know what I have done, my father has done, my grandfather has done, my great grandfather has done, and I want to celebrate that. And not just us because everybody did it in this village and people continue to do it. And I want to celebrate what they do."</i> <i>"And I think that it's very important um that people er learn about nature when they are children. And I know that it's a fact that most of the people who are famous as naturalist for example David Attenborough and Chris Packham, people like this they always can tell you that they became fascinated by nature as children. And that, that fascination, that interest, that love of nature stays with them. And er that is something I think is vitally important to people you know to connect with nature as soon as you can in your life. And, and foraging goes, goes along with that but you know what I'm saying there is if you learn when you are a child what plants you can eat and what seafood you can catch at the beach. "</i> <i>"You know kids have stopped going out, you know there is no connection there is there any more they are all on their X boxes or this kind of thing or on their phones. Um, you know the younger generation I think foraging could be a massive thing just to get people back to the planet you know. You</i>	16 42

PhD: Understanding coastal resource collection in Wales

Theme	Subtheme	Code: parent	Code: child	Description	Example Quotes (each example within each code are from di n	NR
Health and wellbeing		Mental Health	Anxiety or depression	Collector explicitly mentions anxiety or depression, and relates this to their collection activities.	<p>"it's proved er really good for my mental health over the years. So, um in general I track my, I track my mood er anxiety and mental welfare with, with an app. Um, and I have found that there is a big link between the days when I am at my best and least anxious um and least depressed er when are they are directly related to days when I am at my most active on the coastline. So, yeah, it's not just walking it's walking with a purpose um so either deliberately to take photos or to do picking."</p> <p>". I used to work in banking for 17yrs. And because of being micromanaged, etc. and various other aspects of what I did, it got on top of me. And it helped me a lot I believe. During my period of, when I was off sick, I'd go to the beach most days and carry out my own personal surveys, and things like that. I'd get out in the fresh air, spot the chuffs, and see the seals. And it was really uplifting. And, I uh, so I think that helped a lot. And I think, in the future, it could help lots of other people. I intend to, and I would I like to take people out voluntary. "</p>	5 6

PhD: Understanding coastal resource collection in Wales

Theme	Subtheme	Code: parent	Code: child	Description	Example Quotes (each example within each code are from di n	NR
Health and wellbeing		Mental Health	Life changing	Collector refers to collecting as a new hobby or even career that has changed their lives in some way.	<p>"Because the last few years I have gone through quite a traumatic time. I lost my husband four and a half years ago. He was only 53, er that was [exhale] that was very, very traumatic. Um, and er I consequently sort of sold up the family home, moved up to XX where my eldest son is with his children. Been looking after the kids for the last four and a half years. And now I am sort of, I have gone through that bereavement stage obviously that continues but I feel now it's my time to do something for me. And because [name] has introduced me to do this because we have become good friends. Um, er and it's like it's turned my life around, I know that sounds a bit dramatic, but it has [laughing]."</p> <p>"Six years ago, I ended up with some problems in my eye and I have had 10 operations on my eye and I have got permanent double vision and it's a pain in the bum etc etc. And my passion was squash, I played squash for 34 years and literally overnight I couldn't play squash again. And tried golf and various other things that didn't really do it er and this has replaced that passion that I had. Just be on the beach and the science side of it has replaced that passion that I had. So, that's fantastic.....It's, it's massive, massive, massive value yeah, even save your life value really, really is.... I ended up with severe depression. And it was a weird thing because I was always one of them people who used to say depression, there's no such thing, what complete and utter load of rubbish, pull yourself together get to work. And until it hits you don't understand and I don't think I am completely back to where I was, but I am a lot, lot nearer than I was. And his</p>	5 6

PhD: Understanding coastal resource collection in Wales

Theme	Subtheme	Code: parent	Code: child	Description	Example Quotes (each example within each code are from di n	NR
Health and wellbeing		Mental Health	Causes stress related to commercialisation	Usually commercial pickers, more often cockles. But also commercial foragers for restaurants. When the stock crashes and it's managed badly.... Inconsistently coded - if wanted go back to search commercial cockler transcripts.	<i>"But then since 2000 or well, it's all upside down and we thought then this mass mortality the government will go and sort this out. Now we are 19 years later, and we are still none the wiser. So, like you said the stress everything and that and I have seen, and we have all gone old haven't we and haven't noticed it. And none of us put anything away for our pension so [laughing] because you haven't earnt enough money to put money away for a pension, you know what I mean."</i> <i>"I did for a couple of years forage for a restaurant where they asked me to get specific things...And I found that incredibly stressful....To the point where I was not enjoying doing it."</i>	2 2
Health and wellbeing		Mental Health	Reason to get out of the house	Several people say that foraging gives them a reason to 'get out of the house'. Should this be coded 'boredom', or possibly a way of coping with loneliness? This could be related to many things, and as they usually haven't elaborated, I have coded as it appears.	<i>"But for me I think I used it initially as an excuse to get out of the house to get what at the time I thought was free food, which still is free food. But then you spend a lot of money [laughing] trying to buy ingredients to make it into something extra tasty."</i> <i>"it was absolutely hammering down and blowing a hooley and [laughing] it was a terrible day. But we still did it you know and its good to push yourself and get out there whatever the weather. And do things it's exercise, it's fresh air and that can only make you feel better. Because otherwise you are just sat in the house. "</i>	2 2

PhD: Understanding coastal resource collection in Wales

Theme	Subtheme	Code: parent	Code: child	Description	Example Quotes (each example within each code are from di n	NR
Personal Identity	The hunter-gatherer persona	Being human, human heritage, instinct, tradition or global heritage		Collectors often reflect on 'Being human, human heritage, instinct, tradition or global heritage', rather than collecting being something specific to local or national heritage. This includes connecting, or re-awakening, our ancestral knowledge; connecting with the past, the human spirit and life itself; and using our hunter-gatherer instincts.	<p><i>"You know, why not you would go down the beach at low tide and collect a meal so, whereas now everybody so conditioned to going to the supermarket it seems like an alien concept. Whereas for thousands and thousands of years that's what humans did was forage and hunt and gather. So, we are, I am just carrying on what normal humans do and everybody else has gone weird"</i></p> <p><i>"Gathering, I mean, it's foraging is the art of hunting with your hands it comes from the um French foray um. And its direct connection between actually just the tactile thing between touching your food and being able to smell it It's all about the sense, reengaging your senses, do you know what I mean? Trusting your senses So, I wouldn't teach you anything at all about wild, I am just helping you remember. Your body knows all of these plants even though you think you don't do you know what I mean, it's all programmed inside of us.it's reengaging um with my ancestral knowledge that's deep inside of us."</i></p> <p><i>"I think foraging is very important because it, its something that appeals if you like to the human spirit because its our link with when we were you know hunter gatherers long, long ago. That long, long ago used to be normal and it still is of course some indigenous people, people go out and collect stuff for the wild. But um, modern civilisation if you like you know we have lost that, we expect you just go along to the shop and you buy you know whatever you want from the shop. But if you can um, you can get people to see that they can also still go out er hunting, gathering then that is something different to them with their own way of life"</i></p>	8 31

PhD: Understanding coastal resource collection in Wales

Theme	Subtheme	Code: parent	Code: child	Description	Example Quotes (each example within each code are from di n	NR
Personal Identity	The hunter-gatherer persona	Being human, human heritage, instinct, tradition or global heritage	Survival skills	Some collectors feel strongly that they need to know how to live off the land, go 'off-grid', be able to disconnect from society or survive in a situation of 'anarchy', or simply if the shops closed tomorrow. This could also be a way of surviving 'cheaply' and living off the land, but also having occasional 'survival experiences' rather than making it a way of life.	<p>"I have always had an interest in living off the land as well that sort of um Robinson Crusoe style thing "</p> <p>"I suppose I have always done it, yeah always kind of done it, always cooked always been into the food. Always been into like freshness and um disconnecting from you know the bounds of society. Knowing that kind of I can be okay with nothing it is very liberating to know that you can um sort of engage with your own environment without feeling alien to it. It's quite important to me to have these self-sustainable skills so if the shops closed tomorrow I would actually benefit do you know what I mean? I suppose I would be king of the jungle, wouldn't I?"</p> <p>" it could be important as a survival skill you know, if you got stuck somewhere and you didn't know what you could eat and what you couldn't eat then you know its important to know that. Its important to know what you can, what you can eat. And er so, you know it is very important knowledge to have the plants that um we, we can use as food but also there's herbs."</p>	5 12
Personal Identity	The hunter-gatherer persona	Challenge, satisfaction, reward and achievement		Aggregated from two child codes.	"It's the joy of a treasure hunt."	13 23

PhD: Understanding coastal resource collection in Wales

Theme	Subtheme	Code: parent	Code: child	Description	Example Quotes (each example within each code are from di n	NR
Personal Identity	The hunter-gatherer persona	Challenge, satisfaction, reward and achievement	Satisfaction or Reward	Sense of satisfaction with their catch / haul. The 'treasure hunt feeling' of a reward seems to apply no matter what your catch is - from dinner to a massive sack of winkles or cockles. It's that feeling of reward and achievement that seems to count here.	<p><i>"But the satisfaction that people gain, I mean its not everybody is it? The hunting instinct is strong in some people, that used to be me when I was younger, that's gone. But the actual satisfaction of sitting down and eating a meal that's cost you nothing you know apart."</i></p> <p><i>"You know you see where everything comes from and you actually hand harvesting it. I think the whole process going from picking to cooking is really quite nice. You can, like I say you can pick something and 10 minutes later you can have it in your mouth on a dish er and oy know exactly where it's come from."</i></p> <p><i>"doesn't matter what I feel good or not I go on the winkles, and when I get home then I know that's something."</i></p>	10 15
Personal Identity	The hunter-gatherer persona	Challenge, satisfaction, reward and achievement	Challenge	Challenge seems different for different people. For some it's the challenge of picking, testing your knowledge and skills to find the thing you want most. For others its the challenge of cooking up whatever you find, and for others the challenge of processing and, or, selling your harvest. Cocklers claim that cockle picking is a very different challenge to winkle and laver picking, a much greater skill and a more challenging environment.	<p><i>"it's just an amazing er, it's an amazing hobby. And you know there's all different types of challenges involved in it and rewards."</i></p> <p><i>"You don't get the same satisfaction (with seaweed)... I think for me um [sigh] it's cockles was always our primary product and when people come in here they ask any cockles? I say no cockles today out of season, laver bread? They go okay then, it's not their first product so it's never been a priority in our sales pattern to have laver bread. anybody can do it really, it's not a skill involved. ... there's no reason why anybody couldn't go out there and pick a couple of buckets of seaweed. I challenge them to pick cockles and they couldn't....I think and even winkles, okay you might not get quite so much but I don't think everybody, like the kids go down the beach and pick winkles and they could fill the bottom of a bucket. But when they go to the sands and pick cockles it's very different."</i></p> <p><i>"But the best stories you have got to take with you Colin is on those challenging days, yeah? You will always remember those challenging days, you have been out on the sands for hundreds of days over your life however the ones you remember are the ones you shouldn't have gone, the days that it was probably the day you should have had a day off. But you went there, and you can say it because you went."</i></p>	5 8

PhD: Understanding coastal resource collection in Wales

Theme	Subtheme	Code: parent	Code: child	Description	Example Quotes (each example within each code are from di n	NR
Personal Identity	Heritage	Heritage	Family heritage	Mentions of strong family connections with collection.	<p>"I had a (cockling) license in um 1967 which was 51 years ago, um I am from, from Crofty myself and so I know, my family had um, my uncle, my mother had a license. And so, it's been in the family business for 60, 70 years maybe more than that. ... Yeah, you know I used to go out with my mother you know with the horse and cart, stand by the horse wherever it was. Because the horse would be standing on the sand for about two and a half three hours. And I used to go out with her, give her a hand you know."</p> <p>"Oh [pause] I suppose it goes back a long way for me into my childhood where I grew up in not this part of Wales but in an inland part of Wales in Breconshire. And um I was born not long after the war and my parents had moved from London to live in a very small place in the Black Mountains um. My father was Russian, so he was um an alien, he wasn't called up and my parents lived in this small place. My mother was a Londoner so they both came fresh to living in the country really and um my father was always interested in food of all, every kind um of every nationality. And he was interested in what could be foraged from the outdoors, because he was Russian he was part of the tradition of er collecting mushrooms in the forest every Autumn, this time of year um. It was, so it was kind of in the blood in a way, so he had been doing that um all his life really.....So, it's always come naturally to me to use what I can get for free out of doors whether it's apples or blackberries or um plants um. ...But then when I moved with my family to Pembrokeshire in 1994 um with two small children um that's when I started thinking about collecting the seaweed from the rocks. And then"</p>	12 28

PhD: Understanding coastal resource collection in Wales

Theme	Subtheme	Code: parent	Code: child	Description	Example Quotes (each example within each code are from di n	NR
Personal Identity	Heritage	Heritage	Cultural identity or heritage	Any mentions of cultural identity or heritage. This may not be Welsh specific, could be to their culture. In fact, most people who mention it do not associate Welsh culture so much with gathering, more other cultures.	<p><i>"Yeah, it seems funny sometimes with Wales and food you know. You have got all this mass of like amazing produce um and it just doesn't get taken any notice of really.He has just got a Michelin star but it's all in Japanese and that kind of stuff, and it's like it doesn't really sit well for me in Wales. You know it's like what I'm doing really is, is looking at the things we have got around us and bringing it into that modern phase you know....But as a, from a promotion thing you know somebody in Welsh government or business Wales should really be biting my hand off really you know."</i></p> <p><i>"it's partly my Russian heritage I suppose, partly the fact that my father was quite an unconventional man for his time."</i></p> <p><i>"(not talking about himself)...For me foraging and national identity I think it's kind of Eastern Europe. So, maybe Poland and Romania where they, you know they go out for days, weeks at a time and fill their cars with whatever they can find. And then spend the next week preserving them"</i></p>	8 13

PhD: Understanding coastal resource collection in Wales

Theme	Subtheme	Code: parent	Code: child	Description	Example Quotes (each example within each code are from different participants)	7	NR
Personal Identity	Heritage	Heritage	Local tradition	This code emerged from the idea that people in South Wales in particular were referring to cockle and laver picking as a local tradition, one that they largely want to keep alive, rather than part of Welsh culture as such.	<p>"I almost feel like I'm telling you an untruth by saying it because it's so varied of where it has been, and I want to pass that onto the next generation. My next investment is to make a shop with a heritage centre there so that people can come in and learn about cockles and know what I have done, my father has done, my grandfather has done, my great grandfather has done, and I want to celebrate that. And not just us because everybody did it in this village and people continue to do it. And I want to celebrate what they do."</p> <p>"From 1972. Before that laver bread was predominately made in South Gower. You know, and it um was processed then by, um, local market gardeners for the local markets in Swansea, Neath, Carmarthen, Port Talbot. And that is generally, to this day, where the laver bread market lies. Although it's not such a big market as it was years ago....It was. It was made to feed the copper industry, the tin industry, you know, in the South Wales area, you know, years ago. And the coal miners. It, you know, it was a working man's food. And a cheap working mans' food. For the time. "</p>	7	15
Personal Identity	The hunter-gatherer persona	Mental Health	Pride or feelings of worthwhile	Pride or feelings of worthwhile.	<p>"He takes pride in what he does and therefore he will wash the cockles cleanly, he will sieve out all the small ones, he will pick out all the shells. And to be that is a traditional gatherer."</p> <p>"It gives us um for me it's a sort of, you get a sense of self pride in you know to say I know what I can eat here, and I have collected this. And taking things back you have got yourself you know in some ways they always seem to taste a bit better because you got them if you know what I mean"</p> <p>"That was keeping him (Dad) alive, that was keeping him alive that was, coming out there.... He didn't last long after that (he stopped), he died when he was 90."</p>	7	15

PhD: Understanding coastal resource collection in Wales

Theme	Subtheme	Code: parent	Code: child	Description	Example Quotes (each example within each code are from di n	NR
Personal Identity		Personal identity		Any references which mention personal identity, or where it may emerge through descriptions of themselves, and particularly their interactions with others.	<i>See related subcodes for best quotes</i>	24 48
Personal Identity	Sense of place	Personal identity	Belonging or Sense of place	Few people actually directly mentioned belonging or sense of place. Often 'place' or 'belonging' to the geographical area, or just the beach or even activity itself, emerged through their descriptions of either being on the beach, and feeling connected to their local area through their activities, or having moved to the area and sensing place through their activities. Almost like they 'found their place' or were most comfortable through their activities.	<p><i>"[my wife] comes from Indonesia... she has been raised foraging. All of her life, medicinal... plants, food, spices, grown freely and, and that was, that's part of her make up. And then it comes to marsh samphire there's nobody like her gathering marsh samphire because she can squat with her bum an inch above the mud for an hour...she is really, really good at it."</i></p> <p><i>"It makes you feel part of everything, it makes you feel insignificant."</i></p> <p><i>"you realise that you know you could be like stood on the beach and you are gathering stuff and you just have this feeling of how insignificant we all really are. You know those beaches or whatever you are sitting on will never change the next probably couple of millions of years or thousands of years. And it hasn't changed for that you know for thousands of years either...It's that connection thing again where you, yeah it doesn't really matter what the weather is like really."</i></p> <p><i>"You see the old boys down after this like and they always come down...And they still come down to the ramp you know to have a chat don't they you know.... I think they miss being out there."</i></p> <p><i>"And then um moving to [place] I suddenly realised how much closer to the coast I was and that it kind of evoked that sort of childhood interest to learn more and rather than from a more of an adult perspective I suppose. So, it became finding out about plants and what you can do with them and, and relating that to the foraging that I was already kind of doing or was aware of as a child from woodland and grassland and everything else. So it was another opportunity, another</i></p>	12 21

PhD: Understanding coastal resource collection in Wales

Theme	Subtheme	Code: parent	Code: child	Description	Example Quotes (each example within each code are from di n	NR
Personal Identity	Way of life	Way of life		Often collectors specifically mention that foraging, collecting or picking is their way of life. Sometimes the 'way of life' emerges as important through much longer references and thick descriptions of their lives.	<p><i>"It's a way of life. It's understanding the way of the shore works, and the way the beaches work. It's understanding it all. You know, seeing nature, and working alongside nature. "</i></p> <p><i>"I guess that tradition that practice was already kind of embedded in the family that you know you did, you didn't waste anything. And if there were things um in the outdoors that could be used then you would. "</i></p> <p><i>"I needed to do something to get myself off the dole and that's opened the door. But obviously since then the gathering has become my way of life so."</i></p> <p><i>"Sometimes you are working in the early mornings, then you are working lunchtimes, late afternoons, early evenings so there's no actual fixed time. Initially that was quite difficult to get your head around you know you are working with cycles that nobody else works really unless you are in the fishing. Unless you actually work at the sea you are not going to work with those sorts of cycles. But over the years you start to get used to it and you start appreciating it. "</i></p> <p><i>"my parents, um, didn't want me to do it. They didn't want me to do it because of the life style commitment. It's a job that's, like, you know, 24/7. You know, it's a job like, that you're totally committed to."</i></p> <p><i>"it's my dream job, t's my dream [naame] because I never knew anything different from a young age. I was always wanting to do it, I was brought up to be expected to do it and as you know I will always invest in it. "</i></p>	11 23

PhD: Understanding coastal resource collection in Wales

Theme	Subtheme	Code: parent	Code: child	Description	Example Quotes (each example within each code are from di n	NR
Personal Identity & Nature Connectedness		Being outside		Being outside' was mentioned by many collectors, for many different reasons that some could not put their fingers on. For some, it was simply a reference to fresh air, exercise and mental health. Others made direct links to feeling more connected to nature, or ancestors. For others it was more about solitude and being out on the being making you feel who you 'are', that sense of being or place.	<p><i>"Collecting from the environment, to me it means, you're out in the open air"</i></p> <p><i>"When you leave the shore to pick cockles you are going into unknown territory where no other man wants to go [laughing]. Where people lose their lives, where it's that excitement that adrenaline and then your skills come into it. So, you are going into an environment where you feel you have got control of. And also, you are kind of excluded out onto the beaches because there's not holiday makers coming and asking you Mr X what are you doing? You don't see anybody.."</i></p> <p><i>"You know, couldn't have a better office than being out there on your own, or only a couple of you out there on your own. It's freedom in it? "</i></p> <p><i>"Just being outdoors... there's that feeling you get as well when you do the job that I do, and you 'ARE'. "</i></p> <p><i>"...knowing where your food comes from. Um, its just lovely to do it anyway Becausee you are outside, you are outdoors when you are doing it you know. With me with the food that I do it makes you feel more connected."</i></p>	10 13

PhD: Understanding coastal resource collection in Wales

Theme	Subtheme	Code: parent	Code: child	Description	Example Quotes (each example within each code are from di n	NR
Personal Identity & Nature Connectedness		Being outside	Invigorating in bad weather	When the weather is cold, rough and stormy there are suggestions of, extra challenge and making people feel 'better'. Also the fact that the weather is stormy seems to mean collectors are put 'in their place', crossing over with feelings of solitude and escapism.	<p>"I think you just obviously at the sea it's just changing all the time isn't it? It's just a different mood of the sea you know on those wet and wild days when no one is out at the beach you know. I am, more or less in, in fits of excitement ready to go down to see what I can find or to see if there's a big swell coming in. The fish are going to be there and it's, it doesn't get any more exciting and then you get soaked to the skin."</p> <p>"you're having a hammering from the elements. The rain, the storms and wind, everything like that. You couldn't have it better, could you? You know you have to carry that sack of seaweed up the cliffs. By the time you've got your sacks of seaweed back to the truck, the tide is full in. And by the time you're home the tides going out. You know. "</p> <p>"It's the challenge isn't it, it's like um when you look at the forecast last night and it said a yellow weather warning, 70 mph wind. You are thinking let's go and do that, let's get out there and go and battle it even if we don't earn much money we can say when we came in, phew we were out in that weather. We were there, we were men you know. When you are in the pub then you are talking you say well, I went out on that day oh, I didn't go it was too cold, oh we went out, we were the men, we were the challengers."</p> <p>".. it was absolutely hammering down and blowing a hooley and [laughing] it was a terrible day. But we still did it you know and its good to push yourself and get out there whatever the weather. And do things it's exercise, it's fresh air and that can only make you feel better. Because otherwise you are just sat in the house."</p>	7 10

PhD: Understanding coastal resource collection in Wales

Personal Identity & Nature Connectedness	Being outside	Personal identity	Working with the sea	Feels that working with the sea is part of them. Was originally coded under family heritage	<p><i>"I think it's just something you're born into. It's not just in your blood. It's in your own make up. It's something you've got to do. You know, when you're young and all that, you live close to the sea, you're fishing in the sea, you grow up by the sea. You work with the sea. And you enjoy it.. I do it because I enjoy it. And I enjoy it more because I have the knowledge of how, where and when to be able to do it. "</i></p> <p><i>"I think it's in your, I think it's in your genes I think...I have got a photograph of my boys when they were very young maybe three and four and they were on the sands and they picked a rake up, never touched the sands before. And just their posture of how they held a rake without me showing them and how they were bent gathering.And [name] said "my god, I have never seen that before in my life. Those kids have never been on the sands before and they have just taken the position of what we have been taught. " So, where does that come from isn't it, you know what I mean?"</i></p>	4	5
Personal Identity & Health and Wellbeing	Knowledge	Intrigue, learning, knowledge		This is personal knowledge (not shared knowledge). Merged initial codes of interest, learning, intruqe and fascination with knowledge (below)	See best of the 3 subcodes below	23	48
Personal Identity & Health and Wellbeing	Knowledge	Intrigue, learning, knowledge	Interest Learning	Mentions of self-learning, or learning from others, or general interest.	<p><i>"Apart from the collecting, you are surveying as well. So, you're evaluating what's there and what's not there, and you see what other people have taken. You're finding out about any pollution aspects. So yes, that's, I get a buzz out of it.....You never stop learning. No matter who you are, how many qualifications you've got. You never stop learning, especially on our coast"</i></p> <p><i>"I am still discovering things, I still discover things in the woods and the fields um. But I feel like I have got a lot more to learn about the coast still, and that's, and that's another you know a reason to keep doing it as well."</i></p> <p><i>"It's more like I don't know when you are gathering things you are learning more as well."</i></p> <p><i>"I go to the coast to see what there is to see and what there's to find."</i></p>	12	15

PhD: Understanding coastal resource collection in Wales

Theme	Subtheme	Code: parent	Code: child	Description	Example Quotes (each example within each code are from di n	NR
Personal Identity & Health and Wellbeing	Knowledge	Intrigue, learning, knowledge	Practising learned skills	This could be about practising our 'ancestral knowledge', or things taught by parents or forefathers, or learned academically and trained. Almost continuing traditions. This was originally coded under family heritage, but moved up to heritage. Could be under interest, learning and knowledge but its a 'practice' so more ritual than new learning, I think.	<p>"I was lucky to be taught by many a person what to do and how to do it...And they were taught by their forefathers and the skills which it probably is a skill than just to go the beach in some respect to gather.... But it's just, you know it's just nice to, an excuse to be at the beach as well."</p> <p>"The experience he's got of it is phenomenal. He can tell what beach a seaweed comes from by the colour of the sand by the colour of the sand that's washed out of the seaweed. And looking at the seaweed. And my mother then has the experience then of the process of it. Where she knows by the feel and the look, and how the laverbread is being processed, you know, it its gonna set. If it's good laver bread or, you know, not so good. If the gelatine content in it is strong or not. She is like the connoisseur of it, in all fairness.... He learned it from a guy, you know, that he was supplying. He bought laver bread off in Bishopston. And he taught him the ropes step by step, and in later years then, he bettered it. And like to this day, then, although there is a smaller market, we bettered the process and the way it's processed now to what it was before. "</p> <p>"When my father used to talk about things he'd picked, and things he'd done, and you were like 'Oh yeah,', but then you're absorbing it all the time, you're absorbing it, and then suddenly it all comes out when you're a bit older. So I'm hoping that they will as well, now, and that they will be brave with it and love it. "</p>	9 15

PhD: Understanding coastal resource collection in Wales

Theme	Subtheme	Code: parent	Code: child	Description	Example Quotes (each example within each code are from di n	NR
Personal Identity & Health and Wellbeing	Knowledge	Intrigue, learning, knowledge	Knowledge of target species	Expressions of passion and enthusiasm for their collection through their detailed knowledge about their target species, or the environment, rather than actively enjoying the process of learning, Almost enjoying the fact they have this knowledge, and often want to talk about it or test it by visiting the shore and checking they still have it.	<p>"It's having the kind of understanding of the ocean and then you kind of, I get to a beach and I just, I can read the beach literally do you know what I mean? I just look at the waves, the sea, the rocks, the sand, what plants there are all sort of I call it reading the beach."</p> <p>"I know the winkles they grow quite quick, they breed all year round they are not like cockles. With winkles they, they don't rear, so they grow every all year around not like cockles slow growing, winkles are quickly growing winkle.Each time we get a storm, strong winds the winkles start gathering together and come together....I know a lot about winkles, so that's all I have been doing anyway."</p> <p>"the other thing which I really, really love is sea beet and I collect that a lot routinely um from X estuary where it grows in great profusion. So, um my dentist is in X, so I never go to the dentist without going down to collect the sea beet as well um and it grows in as few other places but not everywhere. "</p>	8 10
Personal Identity & Health and Wellbeing	Knowledge	Intrigue, learning, knowledge	Intrigue or fascination	Intrigue or fascination with things living on the coast, which feeds indirectly into interest, learning and knowledge. Think these codes can be merged, but not sure if they are slightly different 'feelings' or 'meanings' yet.	<p>"I also still appreciate looking at all the taxonomic value of the things that you see while you are farming. It's not just a case of er yeah, here's some oysters, let's make some money. You are looking at, I look at all the other things that are in with the oysters or the extra organisms, fish, crabs er hydrozoans, bryozoans. And you, and seasonality changes so it's never, it's never the same every time you go down. Year to year there's always a subtle change, subtle differences. "</p> <p>"But yeah, it's just the fascination and the, it focuses the mind."</p> <p>"It's to me it's really exciting finding out what the name is of the nudibranch. Sometimes we have to get some help from the powers that be you know and find out, but it's great. "</p>	6 7

PhD: Understanding coastal resource collection in Wales

Theme	Subtheme	Code: parent	Code: child	Description	Example Quotes (each example within each code are from di n	NR
Personal Identity & Health and Wellbeing	Nostalgia	Nostalgia and connecting to the deceased		Foraging can bring back childhood memories, or links to family, friends or idolisms from the past. This could be deceased relatives that may feel closer through foraging. Merged from 'Connections with people; in past' and 'family heritage: nostalgia'.	<i>See below subcodes</i>	15 33
Personal Identity & Health and Wellbeing	Nostalgia	Nostalgia and connecting to the deceased	In past ie childhood or deceased	Specifically mentions memories of their childhood or recollecting stories of deceased family / friends whom collecting reminds them of.	<i>" initially my father was a botanist and so on. He had a seaweed collection, which I found after he died sadly. And it was all his background that got me into doing foraging altogether. So, on the seashore, picking the seaweed which we eat everyday."</i> <i>"It's been a personal thing to me, when I was a very young probably you know six or seven years old my grandad used to take me down the beach picking periwinkles and mussels and you know whatever was on the seashore. So, I think it's always been a part of my life. "</i> <i>"It's a connection, there's a connection with you with your, with your ancestors, a connection with he past."</i> <i>"my dad used to take the family out in the car so we would go to various places. And then again, I was in my element I think because all the fantastic, this is a great place to find things. And I would start finding things and I didn't know what, what they were I would look them up in my books. "</i>	12 15
Personal Identity & Health and Wellbeing	Nostalgia	Nostalgia and connecting to the deceased	Nostalgia	More generic nostalgia, possibly alluding to childhood without the connections to people element that 'in the past' provides.	<i>"You know when we were kids we were dragged to the beach every day and this had probably rubbed off from me just er wandering the beach instead of looking at an iPad. "</i> <i>" I told you I lived in [place], but I have also lived in [place] which was near to the seashore. We would collect whatever was edible and catch fish.. "</i> <i>"..initially I saw something, and it reminded me of happy times rock pooling with my dad when I was seven..."</i>	12 18

PhD: Understanding coastal resource collection in Wales

Theme	Subtheme	Code: parent	Code: child	Description	Example Quotes (each example within each code are from di n	NR
Sustainability concerns		Sustainability concerns		Could be related to sustainability concerns, pollution, weather. Not related to threatening lifestyle / income / etc as that is covered by individual 'feeling threatened' subcodes.	<p>Concerns for pollution / climate changes for stocks: "I don't know if it is because of the weather because it was a very, that very stormy winter um or whether it was because of pollution. But anyway, they have gone, they may come back um. "</p> <p>"You know when they talk about the, the um oyster indicatory in Mumbles, in Mumbles that went in the 1920s and it will be the cockle industry is gong exactly the same way you know. [Fighting to get the oysters back over there haven't they?]. But they say history doesn't repeat itself it has [laughing].....it can't do because the water is so polluted there still.you know he is having a bit of success, but I think the conditions aren't right there you know....when we talk about pollution now, pollution now is ten times different than it was 50 years ago. Because all you had going down the toilets then was probably bit of Domestos right, carbolic soap and human waste. Have a look what they have got going down there now [laughing] open a cupboard in the house and there's about 10 whatever's in there don't know what half the stuff is. If you were on anti-dependents or whatever they are taking that's all going down it."</p> <p>Concerns about lack of management: "Going back to licensing and things like that. Like, you know I would have got a license but NRW said we, we are taking such a small amount anyway we will sort you out with a license if Crown Estate were being a bit funny about it. But you know</p>	9 14

PhD: Understanding coastal resource collection in Wales

Theme	Subtheme	Code: parent	Code: child	Description	Example Quotes (each example within each code are from di n	NR
Sustainability concerns		Sustainability concerns	Threats to heritage (family, trade or tradition)	<p>Discussions relating to misperception of what they are doing and why, conflict, management or sustainability that may threaten the future of traditions.</p> <p>Key example too lengthy to quote, was for instance removal of being able to share / pass on your cockle license. It is felt that this is killing the family industry and local heritage. That and expressions of bad management ineffective in solving the cockle mortality issues.</p>	<p><i>"you know as I think the art of foraging is slowly dying to be honest, the true art of it.... just totally considering how much fun I have from foraging and what it means to me, obviously it is part of my life as I have just said. But yeah, there's many people who won't experience it in generations to come."</i></p> <p><i>"Well, you know that was, that, that was my life you know that was my [pause]. And I was self-employed I mean you weren't, you weren't actually, you wouldn't have said oh, you have got to do this, and you have got to do that. I could have said to my customer oh, listen now it's Christmas time I am having it off. I could have, but I thought you know fair enough I am not doing anything you know, dress the horse out, two hours. Back in, give him the cockles, he would boil them, take them to market the following day, hip hip hooray....But it's gone, it's gone....My mother and my uncle had a license as well."</i></p> <p><i>"I know there was another Oyster Man, but he seems to have faded away. Whether he was an older Oyster Man and has retired because a lot of us are you know older than I am um so. I understand that's what's happening in Scotland.... people are just retiring there's no one else, nobody wants to come in and take them over.....Because the other problem, the other issues that you have today which you never really had in the past is permits and licensing and requisites to attend courses to be able to do simple activities that you were. As soon as you go above the personal use it becomes a</i></p>	10 24

PhD: Understanding coastal resource collection in Wales

Theme	Subtheme	Code: parent	Code: child	Description	Example Quotes (each example within each code are from di n	NR
Sustainability concerns		Sustainability concerns	Threats to heritage (family, trade or tradition)	<p>Discussions relating to misperception of what they are doing and why, conflict, management or sustainability that may threaten the future of traditions.</p> <p>Key example too lengthy to quote, was for instance removal of being able to share / pass on your cockle license. It is felt that this is killing the family industry and local heritage. That and expressions of bad management ineffective in solving the cockle mortality issues.</p>	<p><i>"you know as I think the art of foraging is slowly dying to be honest, the true art of it.... just totally considering how much fun I have from foraging and what it means to me, obviously it is part of my life as I have just said. But yeah, there's many people who won't experience it in generations to come."</i></p> <p><i>"Well, you know that was, that, that was my life you know that was my [pause]. And I was self-employed I mean you weren't, you weren't actually, you wouldn't have said oh, you have got to do this, and you have got to do that. I could have said to my customer oh, listen now it's Christmas time I am having it off. I could have, but I thought you know fair enough I am not doing anything you know, dress the horse out, two hours. Back in, give him the cockles, he would boil them, take them to market the following day, hip hip hooray....But it's gone, it's gone....My mother and my uncle had a license as well."</i></p> <p><i>"I know there was another Oyster Man, but he seems to have faded away. Whether he was an older Oyster Man and has retired because a lot of us are you know older than I am um so. I understand that's what's happening in Scotland.... people are just retiring there's no one else, nobody wants to come in and take them over.....Because the other problem, the other issues that you have today which you never really had in the past is permits and licensing and requisites to attend courses to be able to do simple activities that you were. As soon as you go above the personal use it becomes a</i></p>	10 24

PhD: Understanding coastal resource collection in Wales

Theme	Subtheme	Code: parent	Code: child	Description	Example Quotes (each example within each code are from di n	NR
Sustainability concerns		Sustainability concerns	Threats to stock	Threat to the sustainability of the stock (may or may not have financial impact too).	<p>"I did for a couple of years forage for a restaurant where they asked me to get specific things.....it never felt quite right. And also, the amount you need that's always concerned me the sort of sustainability of it. I feel that one thing I definitely feel about the coast here is it feels fragile to me, you know it feels like something I really need to look after."</p> <p>"I could gather for restaurants but there's no way because you know obviously there's a little gap in the market it's not just that. Its I have become so in tune now with my surroundings and you see differences obviously and weather and everything plays a big part in. All that you are doing um within my business frame anyway, but you know like the restaurant world is saturated isn't it? It's just you know look at all the restaurants in London that are using wild and gathered stuff. There's a guy actually that gathers in I think he is from [place], but he gathers commercially um. And you know he has got guys going through the, the um you know the lanes and stuff at this time of year and they are gathering like bucket loads of primroses to sell to chefs in London. So, there's this knock-on effect there you know if you are gathering that many you know that many flowers that are important to the bees and the insects and then in turn the birds. You know on that scale it's not right really is it, it's not meant to be that way I don't feel."</p> <p>"They used to tell me stories of years ago about how, how it was done and how much population of stuff was in the seas</p>	7 14

PhD: Understanding coastal resource collection in Wales

Theme	Subtheme	Code: parent	Code: child	Description	Example Quotes (each example within each code are from di n	NR
Sustainability concerns		Sustainability concerns	Confusing management Call for transparency	Discussions related to either confusing or bad management, with a suggestion that collectors would prefer more transparent, or even better management.	<p><i>EXAMPLE OF CONFUSING MANAGEMENT: She tried, got some permissions verbally, but not as many as she should, and when you do get through to the right people they seem to lose interest? But impossible to figure out NRW permissions.</i></p> <p><i>"But then as long as people are doing things sustainably. I think that's what we have what they are trying to do with the foragers association it's all about making sure that even if people do just come out of the woodwork and start ding stuff that they are doing it in a sustainable manner and in a safe way and [laughing]. Yeah, permissions and things like that. I think for coastal it's been the most difficult. Because of the weird ownership of the coast. So, I don't know if that's going to be useful to people or not or whether they are happy in the fact that they have got their patch and they are not. But like I say I should have more permission than I do but I have an understanding locally that it could get me into trouble if somebody really decided to you know. ... I am happy to be open about that because I have genuinely tried to be legal if you like you know on, what's the word professional about it and contact the people I need to contact to ask permission to do what I'm doing. And it's almost impossible because um I have, I have two of the beaches that I forage human ownership if you like of it holds with a solicitor. You know and then all they are interested in is massive great big contracts that they want to charge you loads and loads of money to do. And then I'm like well, hang on a minute I probably don't make any money from doing this really. You know I am</i></p>	5 6

PhD: Understanding coastal resource collection in Wales

Theme	Subtheme	Code: parent	Code: child	Description	Example Quotes (each example within each code are from di n	NR
Sustainability concerns		Sustainability concerns	Threats to income	Discussions relating to misperception of what they are doing and why, conflict, management or sustainability that may threaten the future of the industry.	<p>"Like you say it's a way of life and you know and do the the people in power want it to carry on? Because it's up to them, we can't do any more with it. You know when they talk about the, the um oyster industry in Mumbles, in Mumbles that went in the 1920s and it will be the cockle industry is going exactly the same way you know. But they say history doesn't repeat itself it has [laughing]."</p> <p>"to be quite honest with you I don't, I think the um the bird people to be quite honest with you wouldn't mind us going. ...Pay us off then isn't it? Thank you very much....Still don't know what's killing the cockles 19 years later and I think with all the technology they have got everything they have got. They can't tell me what's killing the cockles, it could be this, it could be that, it might be that, it might be this. And nobody has done anything, nothing.....But, as I say er so, do the people in power, do they want this type of thing or not? You know what I mean and that's to go back to the er environment issues. Like you know you have got Natural Resources Wales who are supposed to be the environment er champion. And 19 years we haven't done anything, nothing, oh yeah, we have reports, but nothing has. How can I say nothing has been said this is what's killing the cockles? Inconclusive [laughing] that's the word they use...Its just a waste of time to be quite honest with you, they are not interested."</p> <p>"Yes, yeah well you know my, I had a (cockling) license in um 1967, which was 54 years ago, but I was from Gwylfa" </p>	4 14

PhD: Understanding coastal resource collection in Wales

Theme	Subtheme	Code: parent	Code: child	Description	Example Quotes (each example within each code are from di n	NR
Sustainability concerns		Sustainability concerns	Threats to education or knowledge	Discussions relating to misperception of what they are doing and why, conflict, management or sustainability that may affect the future of the industry.	Miscperception / misunderstanding / conflict: <i>"I think there is a huge educational need going on here. Someone did describe us as foragers, and that's part of the problem. We were educating people of the huge benefits of seaweed and what lay on the shore, and then people would go down, as they saw it, and collect. we have been regarded as part of the problem. I've never heard of education being part of a problem before, but it's something that has stuck in my mind. Stuck on my throat in fact. Because I don't regard us as part of the problem, because while we are showing people the goodness of these things in marine environment, we are actually telling people about sustainability, and conservation, looking after the environment, how the environment is inter-twined between the flora and the fauna, and how to we have to look after it. "</i>	3 4
Sustainability concerns		Sustainability concerns	Conflict with other users	Discussions about conflict with other users	<i>" very soon you had hundreds of people coming and it would become a sustainability issue. And they had to obviously they had to legislate in the end. But the funny thing was the people that were complaining the most hadn't set food over that bridge onto the beach 15 years. And these are the people that were complaining about other people coming there and making off with their cockles you know?"</i> <i>" to be quite honest with you I don't, I think the um the bird people to be quite honest with you wouldn't mind us going. And basically, half a dozen birds here, that's my feeling now"</i>	2 3

PhD: Understanding coastal resource collection in Wales

Appendix B.5: Coastal collector typologies

100% Codes: Meanings present in 100% of respondents within typology. 60% Codes: Meanings present in >60% of respondents within typology (listed in order of prevalence amongst people in type).

Typology	Summary	Good quotes	100% codes	60% codes
Foragers and Educators	Collecting for food but also shared knowledge, with many of them making income from foraging based education businesses. Their collection activities connect them to nature, people and cultural heritage which is important to them. Some have concerns over sustainability of their activities and lack of transparent regulation / management.	<p><i>"I think there's very kind of innate about foraging. When you are going out picking it just seems normal, it doesn't seem odd or obscure. You know you see where everything comes from and you actually hand harvesting it. I think the whole process going from picking to cooking is really quite nice. You can, pick something and 10 minutes later you can have it in your mouth on a dish .. and know exactly where it's come from. If you go to a site over and over again of course you then get used to the site and used to the seasons and used to where things will grow and how they should grow. And you become more, more accustomed don't your kind of, kind of linked to that site."</i> Participant 10</p> <p><i>"tradition is basically what I am about. So, survival and bush craft but it's also that sort of need to pass on knowledge to the next generation."</i> Participant X</p> <p><i>"(Kids) associate ice cream and fish and chips sea-sides, instead of seaweeds and all the animals that live there. So it's a matter of educating. And I think there is a huge educational need going on here. Someone did describe us as foragers, and that's part of the problem. And we have been regarded as part of the problem. I've never heard of education being part of a problem before, but it's something that has stuck in my mind. Stuck on my throat, in fact. Because I don't regard us as part of the problem, because while we are showing people the goodness of these things in marine environment, we are actually telling people about sustainability, and conservation, looking after the environment, how the environment is inter-twined between the flora and the fauna, and how to we have to look after it. I mean, that is the major thrust of what we do. "</i> Participant 13</p> <p><i>"Look at all the restaurants in London that are using wild and gathered stuff. There's a guy actually that gathers commercially. And you know he has got guys going through... and they are gathering like bucket loads ... So, there's this knock-on effect ... You know on that scale it's not right really is it? It's not meant to be that way I don't feel."</i> Participant 1.</p> <p><i>"I should have more permission than I do, but I have an understanding locally... it could get me into trouble ... I am happy to be open about that because I have genuinely tried to be legal if you like ... professional about it, and contact the people I need to contact to ask permission to do what I'm doing. And it's almost impossible ... "</i> Participant 10.</p>	Food	<p>Knowledge;</p> <p>Food Appreciation;</p> <p>Connecting to nature and environment;</p> <p>Connecting with people (living);</p> <p>Giving / Sharing; Cultural identity / heritage;</p> <p>Joy in preparation to eat;</p> <p>Money;</p> <p>Sustainability concerns</p>

PhD: Understanding coastal resource collection in Wales

Typology	Summary	Good quotes	100% codes	60% codes
Collecting for Mental Health	Unified by collecting for knowledge (primarily science and natural history interest) but foraging as a coping strategy for life, specifically dealing with anxiety, depression or bereavement.	<p><i>"I have had 10 operations ... My passion was [hobby], I played [hobby] for 34 years and literally overnight I couldn't play [hobby] again ... this has replaced that passion that I had. Just be on the beach and the science side of it has replaced that passion that I had ... It's, it's massive, massive, massive value yeah, even save your life value ... I ended up with severe depression ... And until it hits you don't understand ... I don't think I am completely back to where I was, but I am a lot, lot nearer than I was. And [collecting] has helped immensely with that." Participant 9.</i></p> <p><i>"It's exercise, it's fresh air and that can only make you feel better. Because otherwise you are just sat in the house. I mean I have gone through in past years because of um bereavement and things a lot of depression and stuff like that. I feel on top of the world now, and again that might sound a bit dramatic." Participant 6</i></p>	Personal Identity; Belonging & Sense of Place; Helps with coping; Knowledge; Anxiety / depression; Pride & Feelings of worthwhile; Stress relief / restoration / mindfulness; Collecting for science / natural history	Life changing; Connecting to nature / env; Being outside; Exercise / fitness; Giving / Sharing; Connecting to people (living); Nostalgia & connecting to the deceased.
Collecting for lifestyle	Collecting food for the table and as income, usually by lifestyle choice, rather than heritage ties. Their collection activities appear to feed their self-actualisation needs through establishing their Hunter-gatherer persona (challenge, survival skills, knowledge, having control over their lives and providing).	<p><i>"I orchestrate a lot of my activities throughout the year um doing that, er so there's, so I have, I have a kind of rough schedule of what I am going to be doing that year dictated by the season before I plan anything else." Participant X</i></p> <p><i>"You know I collect everything ... When there's a big tide, a low tide I go down [place] and I find these cockles that size you know? And I pick them up if I fancy them and take them home and cook them, eat them yeah. They are big ones you know. I just started on my own you know because I am always on the beach, always I have been fishing since I was you know 12 years old ... and all through the year I am, I am on the beach especially in winter I collect whatever comes up with the tide you know? It's amazing what you find on the beach, I have had buoys I have had on low water I get anchors, oars, all kinds of stuff you know ... I sell some of them you know because um I have got no boats now." Participant Y</i></p> <p><i>"When I could I would take them home and, but on the odd occasion where I was somewhere, and they had cockles and mussels and other shellfish. And I used to always have a line and a hook, and I would catch a fish. I didn't seem to have much trouble finding something to eat." Participant Z</i></p>	Personal Identity; Food; Money	Survival skills; Challenge / satisfaction / reward / achievement; Connecting with people (living); Giving / sharing; Knowledge; Bait; Food Appreciation

PhD: Understanding coastal resource collection in Wales

Typology	Summary	Good quotes	100% codes	60% codes
Collecting for life	Comprises commercial and informal collectors with extensive knowledge of their species, places and practises. They rely on their activities for their livelihoods and way of life, often embedded in family heritage, and have strong fears for the future of their industry related to stock depletion and perceptions of mismanagement.	<p><i>"I needed to do something to get myself off the dole and that's opened the door. But obviously since then the gathering has become my way of life ... sometimes you are working in the early mornings, then you are working lunchtimes, late afternoons, early evenings ... Unless you actually work at the sea you are not going to work with those sorts of cycles. But over the years you start to get used to it and you start appreciating it."</i> Participant 20.</p> <p><i>"You have got to do it [picking winkles], well, well we don't have to do it, but I love doing it, and dad used to love doing it."</i> Participant 12.</p> <p><i>"Our history is very, very deep... My earliest recollection of working in the industry was ... as a young kid just my dad going to work every day ... He would come home and tell you and your mum, because your mum was involved as well, my grandparents were involved ... It was a family environment, so I would come down to work here or play here as a kid, see them all doing what they are doing, take a ride out on the sands on the tractor... I want to pass that on to the next generation."</i> Participant 8.</p> <p><i>"people are just retiring there's no one else, nobody wants to come in and take them over ... Because the other issues that you have today which you never really had in the past is permits and licensing and requisites to attend courses to be able to do simple activities that you ... As soon as you go above the personal use it becomes a commercial activity which is now regulated."</i> Participant 20</p> <p><i>"I say, to the people in power, do they want this type of thing or not? You know what I mean? ... You have got Natural Resources Wales who are supposed to be the environment champion. 19 years [of mass mortalities of cockles] ... Nothing has been said this is what's killing the cockles. 'Inconclusive', [laughing] that's the word they use ... It's just a waste of time to be quite honest with you, they are not interested."</i> Participant 25.</p>	Personal Identity; Money	Knowledge; Enjoyment; Threats to Heritage; Main / Alternative income; Connecting to Nature & Env; Exercise / fitness;

APPENDICES C:

Chapter 4

Appendix C.1: Twelve hour field trial comparing ONSET Hobo Pendant G recording frequencies on fast mode (every 2 seconds) to normal mode (every 1 minute).

Initial 12 hr trial using different recording frequencies confirmed that recording at 1min intervals was good enough resolution to pick up movement of algal rocks, and some change in rock orientation.

	Fast recording mode	Normal recording mode
	2 Hz frequency (every 2 seconds)	0.016 Hz (every one minute)
Bare rocks (n)	19880	1321
1. Sum of calibrated acceleration (or sum of change in force across axes, g)	0	0
2. Movement on any acceleration axes	0.00%	0.00%
3. Movement on any tilt axes	43.95%	32.17%
4. Any movement on any accelerometer axes.	43.95%	32.17%
Algal rocks (n)	19881	1321
1. Sum of calibrated acceleration (or sum of change in force across axes, g)	0	7.43
2. Movement on any acceleration axes	0.00%	13.02%
3. Movement on any tilt axes	0.00%	18.62%
4. Any movement on any accelerometer axes.	0.00%	18.70%

Appendix C.2: Summary of marked and measured rocks used in experiments and their movement tracked on the shore over up to 31 days in October and November 2017.

Type	ID	Rock diameter, cm	Total weight kg	Ascophyllum MaxLength cm	AlgalVolume cm3	Algal Biomass DM g	Algal Loading (RatioAlgalRock vol)	Days tracked	Distance moved, m (after stepwise analysis of error)	No of data points	Part of accelerometer trial?	% Movement on acceleration axis	% Movement on tilt axis	% Movement on any axis
Bare	B01	38	15.2	0	0	0	0.00	30	0.09	2				
Bare	B02	33	9.6	0	0	0	0.00	30	0.00	3				
Bare	B03	32	7.9	0	0	0	0.00	15	0.00	2				
Bare	B04	29	6	0	0	0	0.00	30	0.11	2				
Bare	B05	36.5	11.2	0	0	0	0.00	31	0.07	2	7 days + 22hrs	26.22	19.37	19.38
Bare	B06	25.5	13.5	0	0	0	0.00	0	unable to conclude	1				
Bare	B07	30	10	0	0	0	0.00	30	0.55	5	7 days	7.42	19.38	19.38
Bare	B08	27	5.6	0	0	0	0.00	31	0.03	2				
Bare	B09	24	4.1	0	0	0	0.00	30	0.09	2	7 days + 22hrs	0.16	36.63	36.67
Bare	B10	24	3.2	0	0	0	0.00	31	0.22	2				
Bare	B11	29	5.5	0	0	0	0.00	30	0.23	4				
Bare	B12	24.5	4.8	0	0	0	0.00	0	unable to conclude	1				
Bare	B15	21.5	2.4	0	0	0	0.00	0	unable to conclude	1				
Bare	BL02	15	3.3	0	0	0	0.00	5	unable to conclude	3	7 days			
Bare	BL03	38	30.7	0	0	0	0.00	19	0.00	2				
Bare	BL04	24	4.7	0	0	0	0.00	19	0.05	2				
Bare	BL06	17	2	0	0	0	0.00	19	0.00	2				
Bare	BL07	35.5	23.6	0	0	0	0.00	19	0.00	2				
Bare	BL08	19	2.3	0	0	0	0.00	29	2.15	4				
Bare	G13	18	2.4	0	0	0	0.00	30	0.00	2				
Bare	G14	25	5.2	0	0	0	0.00	31	0.00	2				
Bare	W01	33	7.3	0	0	0	0.00	31	0.14	2	7 days	0.01	19.44	19.44
Bare	W02	19	2.5	0	0	0	0.00	19	0.00	2				
Bare	W03	17	1.9	0	0	0	0.00	31	0.00	3				
Bare	W04	37	16.3	0	0	0	0.00	29	0.05	2				
Bare	W06	22	3.3	0	0	0	0.00	31	0.06	2	7 days	0.03	18.16	18.16
Bare	W07	18	22	0	0	0	0.00	31	2.27	3				
Bare	W08	31.5	7.6	0	0	0	0.00	29	2.16	2				
Bare	W09	27.5	5.9	0	0	0	0.00	29	0.00	2				
Algal	T07	36	24	130	46930	356	3.88	29	0.00	2				
Algal	T06	35.5	12.3	95	38000	297	6.15	31	0.22	2	7 days	0.01	20.1	20.11
Algal	T15	27	11.6	84	40656	315	7.53	29	0.00	2				

PhD: Understanding coastal resource collection in Wales

Type	ID	Rock diameter, cm	Total weight kg	Ascophyllum MaxLength cm	AlgalVolume cm3	Algal Biomass DM g	Algal Loading (RatioAlgrock vol)	Days tracked	Distance moved, m (after stepwise analysis of error)	No of data points	Part of accelerometer trial?	% Movement on acceleration axis	% Movement on tilt axis	% Movement on any axis
Algal	T55	33	24.2	78	65598	475	7.54	0	unable to conclude	1				
Algal	T19	23	5	73	18688	161	8.10	29	0.85	2				
Algal	T01	31.5	7.5	73	42048	324	9.27	0	unable to conclude	1				
Algal	T22	28	16.8	101	73629	524	9.33	29	0.00	2				
Algal	T04	29.5	12.4	97	55872	413	9.80	29	0.00	2				
Algal	T12	26	5.4	109	39349	306	10.19	29	1.45	3				
Algal	T62	28	6.7	98	43218	331	10.89	30	0.08	2	Accelerometer ripped from rock	11.18	35.13	35.13
Algal	T64	15	3.7	72	18432	159	12.29	31	0.53	2	7 days	36.8	44.62	50.8
Algal	T14	33	11.2	107	72332	516	12.60	19	0.00	2				
Algal	T25	27	4.9	84	40656	315	14.63	29	9.83	2				
Algal	T47	22	8.5	120	63480	461	16.43	31	0.03	2	7 days + 22hrs	11.86	11.86	11.86
Algal	T50	22	8.6	102	79968	563	16.95	0	unable to conclude	1				
Algal	T43	24	9.8	116	72500	517	17.70	30	0.28	3				
Algal	T60	27	8.3	120	100920	688	22.12	30	0.00	2				
Algal	T03	16	1.8	84	21504	182	22.40	29	0.05	2				
Algal	T16	21	4.7	104	45864	349	26.00	30	0.00	3				
Algal	T18	25	13.3	119	107100	724	29.34	30	0.00	2				
Algal	T05	16	3.6	65	40625	314	29.73	21	0.06	2				
Algal	T41	24	7.8	113	95033	653	31.30	30	9.66	2	22 hrs			
Algal	T17	19	5.2	120	63480	461	35.73	29	0.21	2				
Algal	T59	19	8	101	79184	558	37.89	19	0.00	2				
Algal	T24	29	7.8	118	106200	719	38.15	9	0.00	2				
Algal	T09	25.5	6.5	160	158760	1016	40.49	31	0.36	2				
Algal	T02	20	3.3	125	84500	590	45.14	18	15.20	2				
Algal	T48	21	3.3	82	64288	467	46.86	0	unable to conclude	1				
Algal	T49	21	5.3	91	81900	575	49.06	19	2.92	2				
Algal	T23	26	7.4	118	99238	678	49.57	30	3.12	5	7 days	0.14	21.59	21.59
Algal	T39	22	2.9	108	57132	421	56.66	30	0.00	2				
Algal	T20	18	4.1	126	85176	594	57.94	0	unable to conclude	1				
Algal	T45	22	3.5	84	70644	506	60.21	9	3.73	2				
Algal	T13	22	6.7	122	95648	657	62.11	31	5.61	2	7 days	0.03	52.87	52.87
Algal	T10	35.5	15.5	140	309260	1803	86.25	18	0.00	2				
Algal	T11	14	3.3	96	69984	502	357.06	28	13.62	3				

PhD: Understanding coastal resource collection in Wales

Appendix C.3: Movement of loose intertidal bare rocks and rocks with large *Ascophyllum* (algal rocks) at different predicted tidal flows over spring tides, expressed as the percentage of logger observations (a time stamp) when movement occurred either on any accelerometer axis, any tilt axis or either / both of any accelerometer or tilt axis. November 2-8th, 2017.

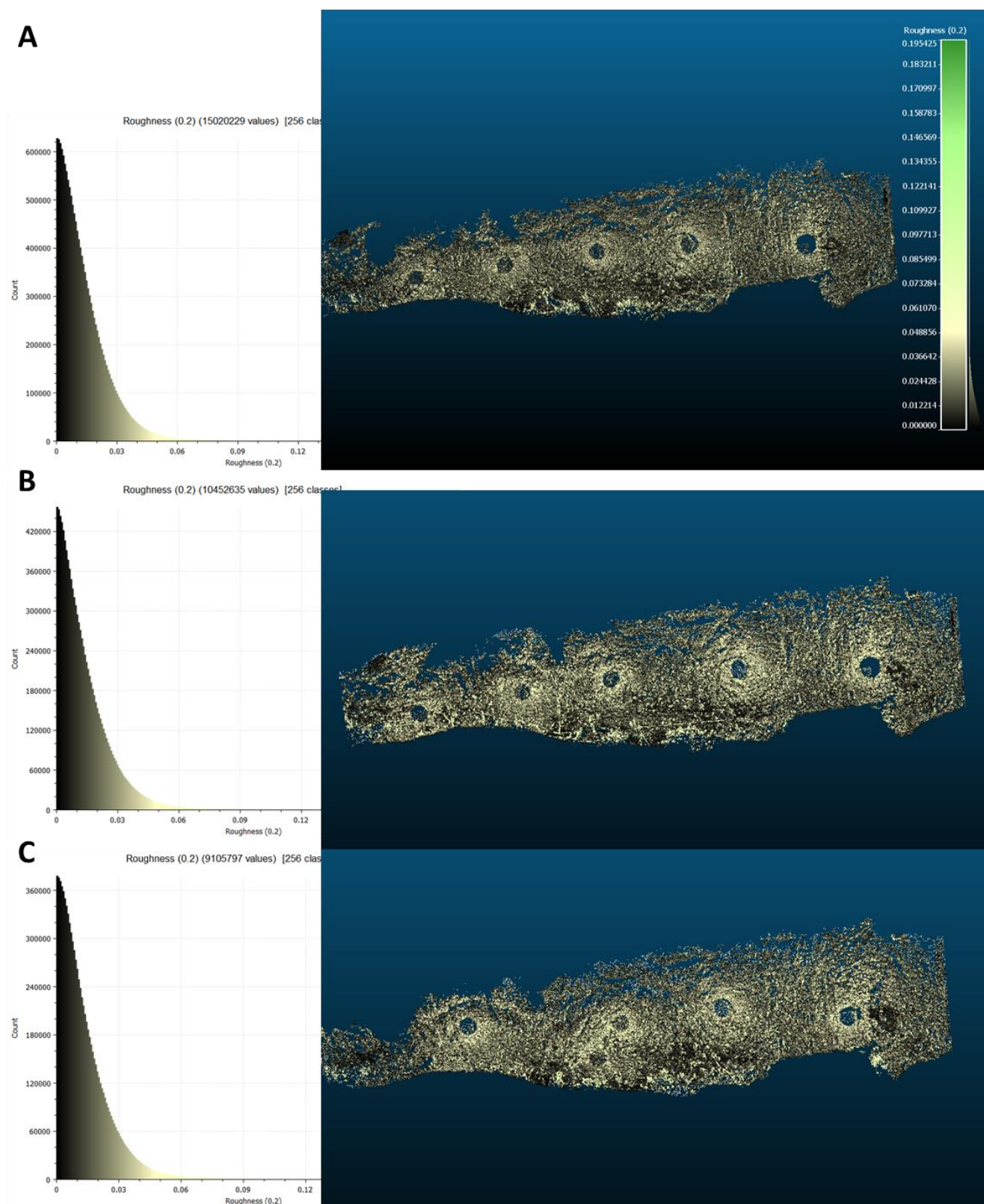
Any sign of movement on any axis was counted as a movement at low water (predicted tidal height <2m above chart datum), during weak flow (LW+/- 1hr), mid flow (LW+/-1-2hrs, HW+/-1=2hrs) or strong flow (LW+/-2-4hrs, HW+/-2-4hrs) using low water times from Belfield Software Tide Plotter, and the totals for all axes used to calculate percentage movement. Algal loading of rocks is calculated as field approximations of algal volume / ellipsoid rock volume.

Movement of algal rocks 2-8th Nov 2017. A mean of 27.90% of algal rock accelerometer readings showed any sign of movement (SE = 6.96%)																								
	T6				T62				T64				T47				T23				T13			
No of obs	8101				6601				8101				8101				8101				6601			
% of observations where any movement observed	20.11%				35.13%				50.79%				11.86%				21.59%				52.87%			
Total Change in g (indicative of accelerometer movement)	0.03				28.35				97.30				24.12				5.80				0.05			
Total weight (kg)	12.3				6.7				3.7				8.5				7.4				6.7			
Rock Diameter (cm)	35.5				28				15				22				26				22			
Rock Height (cm)	11				10.5				12				17				7				7.5			
Rock Circumference (cm)	95				81				50				62				66				56			
Rock volume (cm ³)	6183				3969				1500				3865				2002				1540			
Rock Shape	SA				A				SA				SA				A				SA			
Algal length (cm)	95				98				72				120				118				122			
Algal circumference (cm)	20				21				16				23				29				28			
Algal volume (cm ³)	38000				43218				18432				63480				99238				95648			
Algal biomass (DMg)	297				331				159				461				678				657			
Ratio of algae: rock (vol)	6.15				10.89				12.29				16.43				49.57				62.11			
Distance Moved (m)	0.22 (31 days)				0.08 (30 days)				0.53 (31 days)				0.03 (31 days)				3.12 (30 days)				5.61 (31days)			
	Total movem ent of Accelerometer meter (g)	% of accelerometer meter tensions	% of tilt observa tions	% of observa tions	Total movem ent of Accelerometer meter (g)	% of accelerometer meter tensions	% of tilt observa tions	% of observa tions	Total movem ent of Accelerometer meter (g)	% of accelerometer meter tensions	% of tilt observa tions	% of observa tions	Total movem ent of Accelerometer meter (g)	% of accelerometer meter tensions	% of tilt observa tions	% of observa tions	Total movem ent of Accelerometer meter (g)	% of accelerometer meter tensions	% of tilt observa tions	% of observa tions				
Movement assessed using predicted tidal data																								
0 No Movement	0.00	100.00%	79.90%	79.89%	0.00	82.82%	64.87%	64.87%	0.00	63.20%	55.38%	49.20%	0.00	88.14%	88.14%	88.14%	0.00	99.86%	78.41%	78.41%				
1 Moved at Low Water	0.00	0.00%	6.14%	6.14%	9.10	5.51%	10.82%	10.82%	28.10	10.53%	13.01%	14.31%	6.08	3.00%	3.00%	3.00%	0.00	0.00%	3.79%	3.79%				
2 Moved in Weak Flow	0.00	0.01%	3.28%	3.28%	4.00	2.42%	5.30%	5.30%	16.80	6.17%	7.49%	8.69%	6.45	3.16%	3.16%	3.16%	5.80	0.14%	6.88%	6.88%				
3 Moved in Mid Flow	0.03	0.00%	3.99%	4.00%	5.80	3.51%	7.57%	7.57%	20.63	7.88%	9.48%	10.96%	4.73	2.31%	2.31%	2.31%	0.00	0.00%	5.20%	5.20%				
4 Moved in Strong Flow	0.00	0.00%	6.69%	6.69%	9.45	5.73%	11.44%	11.44%	31.77	12.22%	14.64%	16.84%	6.88	3.39%	3.39%	3.39%	0.00	0.00%	5.73%	5.73%				

PhD: Understanding coastal resource collection in Wales

Movement of bare rocks 2-8th Nov 2017. A mean of 22.61% of bare rock accelerometer readings showed any sign of movement (SE = 3.52%)																				
	W6				B9				W01				B7				B5			
No of obs	6601				8101				8101				8101				6601			
% of observations where	18.16%				36.67%				19.44%				19.38%				19.38%			
Total Change in g (indicative of accelerometer movement)	0.10				2.15				0.10				15.03				53.10			
Rock weight (kg)	3.3				4.1				7.3				10				11.2			
Rock Diameter (cm)	22				22				33				30				36.5			
Rock Height (cm)	10				9.5				23				14				18			
Rock Circumference (cm)	59.5				62				77				76				80			
Rock volume (cm ³)	2182				2160				9741				5320				8760			
Rock Shape	SA				A				SA				A				A			
rock	0				0				0				0				0			
Distance Moved (m)	0.06				0.09				0.14				0.55				0.06			
	Total	% of	% of tilt	% of	Total	% of	% of tilt	% of	Total	% of	% of tilt	% of	Total	% of	% of tilt	% of	Total	% of	% of tilt	% of
	movem	accelero	observa	observa	movem	accelero	observa	observa	movem	accelero	observa	observa	movem	accelero	observa	observa	movem	accelero	observa	observa
Movement assessed using predicted tidal data																				
0 No Movement	0.00	99.97%	81.84%	81.84%	0.00	99.84%	63.37%	63.33%	0.00	99.99%	80.56%	80.56%	0.00	92.58%	80.62%	80.62%	0.00	73.78%	80.62%	80.62%
1 Moved at Low Water	0.00	0.00%	3.54%	3.54%	0.00	0.00%	8.37%	8.37%	0.00	0.00%	6.67%	6.67%	8.65	4.27%	10.02%	10.02%	10.30	6.16%	10.02%	10.02%
2 Moved in Weak Flow	0.10	0.03%	4.36%	4.36%	2.15	0.00%	8.13%	8.18%	0.00	0.00%	3.17%	3.17%	0.08	0.04%	0.67%	0.67%	12.48	8.11%	0.67%	0.67%
3 Moved in Mid Flow	0.00	0.00%	4.85%	4.85%	0.00	0.00%	8.96%	8.96%	0.00	0.00%	3.78%	3.78%	1.88	0.93%	2.68%	2.68%	13.90	5.09%	2.68%	2.68%
4 Moved in Strong Flow	0.00	0.00%	5.41%	5.41%	0.00	0.16%	11.16%	11.16%	0.10	0.01%	5.83%	5.83%	4.43	2.18%	6.01%	6.01%	16.43	6.86%	6.01%	6.01%

Appendix C.4: Laser scanned point clouds of Treborth intertidal boulder and bedrock shore, Menai Strait with histograms of topographical roughness. A = 02/11/2017, B = 08/11/2017; C=01/10/2019.



Appendix C.5: Change of topographical elevation in relation to eight monitored rocks with varying amounts of *Ascophyllum nodosum* (algal loading) on the rocky shore at Treborth, Menai Strait, between November 2nd and 8th, 2017. Change in elevation, extracted from Digital Elevation Maps derived from a terrestrial laser scanner,, is described in relation to the position of rock at the start of the survey (Nov 2nd) and at the end of the survey (Nov 8th), to test the feasibility of using DEM to detect the movement of rocks across the shore.

RockID	Rock Height (cm)	Algal Loading	Total Distance Moved Over 1month (m)	No Of Days Monitored Total	Change in elevation (m) within the area of proximal error around each rock start position after 6 days (since initial DEM)				Loss in elevation within 2cm Rock Height since start	Change in elevation (m) within the area of proximal error around each rock end position after 6 days (since initial DEM)				Gain in elevation within 2cm Rock Height at end of 6 days
					Mean	Min	Max	StDev		Mean	Min	Max	StDev	
B07	0.14	0	0.55	30	-0.01	-0.03	0.01	0.03		-0.03	-0.03	-0.03	0	
B09	0.095	0	0.09	30	-0.08	-0.08	-0.08	0	Evident on DEM	-0.02	-0.02	-0.02	0	
B11	0.12	0	0.23	30	-0.01	-0.02	0	0.01		-0.02	-0.02	-0.02	0	
W01	0.23	0	0.14	31	-0.11	-0.11	-0.11	0		-0.08	-0.14	-0.02	0.09	
T06	0.11	6.15	0.22	31	0.02	0.02	0.02	0		0	0	0	0	
T64	0.12	12.29	0.53	31	-0.02	-0.03	-0.01	0.01		-0.02	-0.02	-0.02	0	
T47	0.17	16.43	0.03	31	-0.04	-0.04	-0.04	0		-0.03	-0.03	-0.03	0	
T23	0.07	49.57	3.12	30	0	-0.08	0.06	0.02	Evident on DEM	0.07	0.07	0.07	0	Evident on DEM

Appendix C.6: Change of topographical elevation in relation to 38 monitored rocks with varying amounts of *Ascophyllum nodosum* (algal loading) on the rocky shore at Treborth, Menai Strait, between November 8th, 2017, and October 10th, 2019. Change in elevation, extracted from Digital Elevation Maps derived from a terrestrial laser scanner, is described in relation to the position of rock at the end of their tracking period (Nov 8th, 2017) and the measured change in elevation at the same point on October 10th, 2019, thus testing the feasibility of using DEM to detect the movement of rocks across the shore.

RockID	Rock Height (cm)	Algal Loading	Total Distance Moved Over 1month (m)		No Of Days Monitored Total	Change in elevation (m) within the area of proximal error around each rock start position between Nov 8th, 2017 and October 10th, 2019				Loss in elevation within 2cm rock height since start
						Mean	Min	Max	StDev	
B01	27	0	0.09		30	0.15		0.15	0.15	0.00
B02	13	0	0		30	-0.06	-0.07	-0.06		0.01
B04	17	0	0.11		30	-0.08	-0.08	-0.08		0.00
B05	18	0	0.07		31	-0.08	-0.08	-0.08		0.00
B06	22	0	n/a		0	-0.12	-0.12	-0.12		0.00
B07	14	0	0.55		30	0.00	0.00	0.00		0.00
B08	10	0	0.03		31	0.05	0.05	0.05		0.00
B09	9.5	0	0.09		30	0.01	0.01	0.01		0.00
B10	16	0	0.22		31	-0.11	-0.11	-0.11		0.00
B11	12	0	0.23		30	0.04	0.04	0.04		0.00
BL02	11	0	0		5	-0.09	-0.09	-0.09		0.00 Evidence of loss from DEM
BL03	17	0	0		19	-0.20	-0.20	-0.20		0.00
BL04	13	0	0.05		19	-0.04	-0.04	-0.04		0.00
BL06	10	0	0		19	-0.02	-0.02	-0.02		0.00
BL07	16	0	0		19	0.00	0.00	0.00		0.00
G13	8	0	0		30	0.03	0.00	0.05		0.04
G14	11.5	0	0		31	0.03	0.03	0.03		0.00
W01	23	0	0.14		31	-0.17	-0.17	-0.17		0.00
W03	9	0	0		31	0.01	0.01	0.01		0.00
W06	10	0	0.06		31		No DEM data			
W07	12	0	2.27		31	0.07	0.07	0.07		0.00
T06	11	6.15	0.22		31	0.04	0.04	0.04		0.00
T62	10.5	10.89	0.08		30	-0.07	-0.07	-0.07		0.00
T64	12	12.29	0.53		31	-0.05	-0.05	-0.05		0.00
T47	17	16.43	0.03		31	-0.06	-0.08	-0.04		0.03
T43	16	17.7	0.28		30		No DEM data			
T60	13	22.12	0		30	-0.01	-0.01	-0.01		0.00
T16	8	26	0		30	0.06	0.06	0.06		0.00 Evidence of loss from DEM
T18	12	29.34	0		30	-0.15	-0.15	-0.15		0.00
T05	12.5	29.73	0.06		21	-0.01	-0.01	-0.01		0.00
T41	11	31.3	9.66		30		No DEM data			
T59	12	37.89	0		19	-0.08	-0.08	-0.08		0.00
T09	15	40.49	0.36		31	-0.05	-0.05	-0.05		0.00
T48	7	46.86	n/a		0	0.02	-0.05	0.10		0.03
T49	9	49.06	2.92		19		No DEM data			
T23	7	49.57	3.12		30	-0.07	-0.07	-0.07		0.00 Evidence of loss from DEM
T39	5	56.66	0		30	-0.02	-0.02	-0.02		0.00
T13	7.5	62.11	5.61		31	-0.08	-0.08	-0.08		0.00 Evidence of loss from DEM