Fisheries & Conservation
Science, Bangor University

Cefas

Llywodraeth Cymru
Welsh Government

Socioeconomic and Spatial Review of Recreational Sea Angling in Wales

Graham Monkman, Talacre beach, North Wales

Authors: MONKMAN, G.[1], CAMBIÈ, G. [1], HYDER, K. [2], ARMSTRONG, M. [2], ROBERTS, A. [3], & KAISER, M.J [1].

[1]SCHOOL OF OCEAN SCIENCES, BANGOR UNIVERSITY, MENAI BRIDGE, LL59 5AB

[2]THE CENTRE FOR ENVIRONMENT, FISHERIES AND AQUACULTURE SCIENCE, PAKEFIELD ROAD, LOWESTOFT, NR33 0HT

[3]CARDIFF BUSINESS SCHOOL, CARDIFF UNIVERSITY, COLUM DRIVE, CARDIFF, CF10 3EU

Cite as: MONKMAN, G., CAMBIÈ, G., HYDER, K., ARMSTRONG, M., ROBERTS, A. & KAISER, M.J. (2015) Socioeconomic and Spatial Review of Sea Angling in Wales Fisheries and Conservation Report No. 52, Bangor University. pp. 176.

PRIFYSGOL
BANGOR
UNIVERSITY

Socioeconomic and Spatial Review of Recreational Sea Angling in Wales was commissioned by the Welsh Government under contract C167/2014/2015.

This document/publication is also available on the Bangor University's Fisheries and Conservation Science Group website at:

http://fisheries-conservation.bangor.ac.uk/wales/documents/52.pdf

a. ACKNOWLEDGEMENTS

Participant	Contribution
David Jones, Pembrokeshire Coastal Forum	Approving access to Pembrokeshire Wales Activity Mapping data and providing advice and guidance throughout.
Elizabeth Richardson, University of Edinburgh	For survey data collection and help in providing and interpreting her 2006 thesis derived data.
Geoff Campbell, Boatlaunch.co.uk	For taking the time to provide a list of slipways for Wales from his site boatlaunch.co.uk.
Henry Aron, Natural Resources Wales	FishMap Môn access, advice and guidance.
John Briggs, Natural Resources Wales	For advice and supply of the March 2015 final draft of the Marine Character Areas.
Malcolm Gilroy, Owner of Anglesey Bait Centre	For his time in discussing the recreational sea angling sector's strengths and weaknesses.
Philip Newman, Natural Resources Wales	Advice on sea angling in and around the Skomer Marine Conservation Zone.
Philip Rodgers, University of Lincoln	For invaluable feedback on the economic assessment.
Roger Cook, Welsh Federation of Sea Anglers	Advice on recreational sea angling in general, providing information on competitive angling, providing feedback, and contributing to the SWOT analysis with particular respect to the charter boat sector.
Rowland Sharp, Natural Resources Wales	Guidance on the North Wales Recreational Sea Angler Pilot Surveys and expert knowledge on the Welsh sea angling sector.

b. CONTENTS

N.B. Annexes are appended to the end of the hard copy reproduction of the main report.

c. ABBREVIATIONS

Abbreviation	Definition
CPI	Consumer Price Index
DCF	ICES' Data Collection Framework
EMFF	European Maritime and Fisheries Fund
FTE	Full Time Job Equivalent
GBDVS	Great Britain Day Visit Survey
HM Government	Her Majesty's Government
MCA	Marine Character Area(s)
MCAA	Marine and Coastal Access Act
MPS	Marine Policy Statement
NFSA	National Federation of Sea Anglers
nm	Nautical mile
NRW	Natural Resources Wales
ONS	Office of National Statistics
RSA	Recreational Sea Angling or Angler(s)
RSF	Recreational Sea Fishing or Fisher(s)
WFSA	Welsh Federation of Sea Anglers
WG	Welsh Government
WNMP	Welsh National Marine Plan

d. DEFINITIONS

Phrase	Definition
Aspirational species	Fish species an angler expresses a wish to catch, with little or no modification of angling method to catch the specified species.
Auxiliary expense	Non-consumable angler purchase not related to a single trip.
Creel survey	Catch and effort estimations using face to face interviews or observations on-site. Site can be actual fishing location or angler access points.
Day visit (day trip)	A single angling trip uninterrupted by sleep, with no purchase of accommodation facilities.
Overnight stay (overnight trip)	A trip where overnight accommodation was purchased for one or more nights.
Prestige species	Fish species to which is attached an elevated kudos in catching, owing to its size (e.g. tope), rarity (e.g. trigger fish) or difficulty in catching (e.g. the mullets).
Resident angler	An angler who lives in Wales.
Species hunter (or angler)	An angler engaged in the pursuit of specific, typically rare species, frequently as part of informal club competitions held over the duration of a year. Note that the pursuit of species, trophy fish, sport species and prestige species are not mutually exclusive for an individual angler or as an activity.
Sport species (sport or sporting fish)	Fish species valued for its fighting prowess (e.g. tope, bass and smooth hound).
Target species	Fish species an angler expresses a wish to catch and employs specialist methods to catch that species including geographic and temporal modifications to tactics.
Trophy fish	A fish of large size (formal definition is within the top quartile for weight within the sample distribution). This is usually restricted to sport and prestige species.
Visiting angler	An angler whose home residency is outside of Wales, but in the UK, unless otherwise specified.

e. LIST OF TABLES

f. LIST OF FIGURES

1. EXECUTIVE SUMMARY

The UK Marine Policy Statement (MPS) made in March 2011 was adopted by all administrations in the UK. On adoption of the MPS the Welsh Government was obliged to ensure that marine plans are prepared for the Welsh Marine Planning Region (HM Government 2009b). The Welsh National Marine Plan (WNMP) should emerge using an evidence base developed from a wide range of sources including existing plans, the plan area community, science advisors, statutory and other advisors, industry and other marine users (HM Government 2011). The present study is designed to inform the marine planning process by providing comprehensive insights into the distribution, extent and types of recreational sea angling (RSA) that occur in Wales such that these activities can be considered in the development of the WNMP.

RSA is an important activity with about 2% of the adult population participating in sea angling and 76,000 RSAs estimated in Wales in 2012 (Armstrong *et al.* 2013). The present study indicates that previous economic estimates did not account for the full economic value of RSA to the Welsh economy. RSA is an important activity for tourists with around 6% of all visitors engaging in sea angling (Visit Wales 2008). RSA also confers significant social benefits such as relaxation, exercise and environmental improvement (Armstrong *et al.* 2013). Opportunities to expand RSA have been identified to include better management of fishing packages and higher quality information on fishing, while threats included over-exploitation of the species targeted by RSAs.

Many definitions of recreational sea fishing (RSF) exist (EIFACC 2008, Pawson *et al.* 2008, ICES 2013). The ICES Working Group on Recreational Fisheries Surveys defined RSF as "the capture or attempted capture of living aquatic resources mainly for leisure and / or personal consumption, and covers active fishing methods including line, spear, and hand–gathering and passive fishing methods including nets, traps, pots, and set–lines" (ICES 2013). The Welsh RSF sector includes both active and passive fishing methods, but the extent of passive gear use is unclear. However, the focus of the report is to provide an economic and spatial review of sea angling in Wales, so an in depth treatment of the non-angling recreational sea fishery is excluded.

Sea angling provides significant social and community benefits, but understanding angling participation requires more qualitative approaches that assess the individual benefits from participation and the wider social and community benefits (Brown *et al.* 2010). Motivations for angling are not solely related to catching fish (Brown *et al.* 2013), with relaxation, experiencing nature, physical exercise, and a route for socialising or spending time with family also considered as important aspects of the activity (Armstrong *et al.* 2013a). Angling can build resilience to ill health and improve recovery from both physical and mental illness (McManus *et al.* 2011). The health and wellbeing benefits derived from angling are related to opportunities for relaxation, stress relief, physical activity and

access to the natural environment (Ormsby 2004). These secondary benefits are reviewed in the current report.

It is estimated that there were 76,000 sea anglers resident in Wales in 2012 (Armstrong *et al.* 2012). These Wales resident RSAs undertake ~340,000 trips per annum, split between 278,288 (82%) shore trips, 34,495 (10%) charters trips and 25,957 (8%) private boat trips. At a large spatial scale, the patterns of angling activity are strongly influenced by season, and the interaction of season with an area's visiting and resident sea angling population. In the summer months, anglers will fish as part of overnight stays in Wales, which will increase angling visitors to Anglesey and the Llŷn Peninsula, Ceredigion and Pembrokeshire. Increased day-length and species availability increase the level of angling activity in the summer which declines in the winter (lowest in February and March) most notably in remote venues.

There were 54 charter boats confirmed as operating across Wales, with some additional unquantified activity within 12 nautical miles of the Welsh coastline from ~12 boats operating from the northern ports of Devon and Somerset. The Welsh charter fleet was estimated to have undertaken 5,058 charter trips[1] year^{-1} in 2014, calculated using Richardson's (2006) average of ~77 boat angling days per boat per year. Applying metrics from Richardson (2006) to the 2015 list of charter vessels, the sector was running at 83% of total capacity based on angler occupancy per trip. It should be noted that many charter skippers may also be hired for other purposes such as wildlife viewing trips and survey work.

The report provides insights into the spatial distribution in catches of different species and highlights those species of greatest perceived value to RSA in Wales. Strong regional differences were apparent for some species such as rays and cod which were most prevalent in catches in South Wales. High value trophy species occurred around the entire Welsh coastline, e.g. bass, tope, rays. Deficiencies or omissions in other sources of data are highlighted, and problems with sampling to ensure adequate coverage of night angling are acknowledged.

In addition to using existing sources of information, the current study also undertook an independent on-line survey. The survey was designed to provide additional data pertinent to understanding sea angler activity across Wales relevant to the marine spatial planning process undertaken by the Welsh Government. Additional information was gathered to understand the investments that would enhance the RSA experience in Wales and to inform which issues (e.g. parking, access) were of highest priority. Potential conflicts with other stakeholder groups were also identified.

The use of bait is an important component and economic activity associated with RSA. Lug worms, common shore crab, sandeel and king rag worm were the most widely used baits according to the survey responses. It was beyond the scope of this study to map areas valued by RSA for bait collection,

[1] The term trip is largely interchangeable with boat day, despite a minority of boats possibly taking > 1 trip a day or running overnight trips to remote locations.

it is suggested that environmental niche mapping techniques, validated under expert knowledge, would provide a low cost method for assigning likelihoods to areas of importance. An overview of the environmental effects of bait collection is also provided.

RSA in Wales is well represented through membership of clubs. The Welsh Federation of Sea Anglers[2] is the governing body of RSA in Wales and is an umbrella organisation for sea angling clubs both within and outside of Wales. Although club coverage is good in the north and south of Wales, there are a lack of clubs registered in mid Wales which limits opportunities for appropriate representation of RSAs in this region.

Existing information about the economic characteristics of sea angling in Wales is sparse and it is often related to the angling activity in England. The economic importance of sea angling specific for the Welsh territory was derived to assess the specific cash flow that the activity generates in the country, but also to evaluate future opportunity for investments. The economic value of sea angling in Wales was determined by estimating the direct effects of the activity in Wales (total spending) and the indirect and induced effects, in terms of the economic impact on the angling related sectors, as well as the income and employment effects. The total annual expenditure of visiting sea anglers in Wales from one-day trips and overnight trips was estimated to be between £33.54 million and £45.12 million, with an average of £39.33 million. The total spending by Welsh sea anglers within Wales was estimated to be between £48.19 million and £125.96 million, with an average of £87.08 million. Each £1 million of net sea angler spending in Wales supported another £0.5 million of spending in the Welsh economy. The total employment directly created from sea angling spending was estimated as 1,706 FTEs representing ~0.13% of the total FTEs in Wales in 2007 (although a further 500 FTEs are probably supported indirectly).

The current analysis of the economic value of sea angling to the Welsh economy certainly highlights the considerable value of this sector to the Welsh economy. However, no comparably robust economic analysis has been undertaken for the value of the commercial fishing sector to the Welsh economy. This means that a meaningful comparison between the value of recreational and commercial sectors is not possible at this time.

A variety of data layers were generated that show the distribution of RSA activities around the Welsh coast that are suitable for the purpose of informing marine spatial planning. These data layers indicated the key areas for shore and afloat platform-based angling. A variety of different data sources were utilised based on other studies and innovative approaches developed in the present study. Taken together, these triangulated sources of information provide reliable indicators of those areas of the

[2] http://www.wfsa.org.uk/

Welsh coast that are most highly utilised by RSAs and are able to indicate patterns of use through different seasons.

Crynodeb Gweithredol

Cafodd Datganiad Polisi Morol y Deyrnas Unedig a wnaed ym mis Mawrth 2011 ei fabwysiadu gan holl weinyddiaethau'r Deyrnas Unedig. Wrth fabwysiadu'r Datganiad Polisi Morol bu'n rhaid i Lywodraeth Cymru sicrhau bod Cynlluniau Morol yn cael eu paratoi ar gyfer Rhanbarth Cynllunio Morol Cymru (Llywodraeth EM 2009b). Dylai Cynllun Morol Cymru (WNMP) gael ei lunio gan ddefnyddio sylfaen tystiolaeth a ddatblygwyd o amrywiaeth eang o ffynonellau gan gynnwys cynlluniau presennol, cymuned rhanbarth y cynllun, ymgynghorwyr gwyddonol, ymgynghorwyr statudol ac eraill, diwydiant a phobl eraill sy'n defnyddio'r môr (Llywodraeth EM 2011).

Bwriad yr astudiaeth bresennol yw rhoi sylfaen gwybodaeth i'r broses cynllunio morol trwy ddarparu gwybodaeth gynhwysfawr am ddosbarthiad genweirio môr hamdden yng Nghymru, faint ohono sy'n digwydd a'r gwahanol fathau, fel y gellir ystyried y gweithgareddau hyn wrth ddatblygu'r cynllun.

Mae genweirio môr hamdden yn weithgaredd pwysig gyda thua 2% o'r boblogaeth oedolion yn cymryd rhan, ac amcangyfrifir bod 76,000 o enweirwyr môr hamdden yng Nghymru yn 2012 (Armstrong *et al.* 2013). Mae'r astudiaeth bresennol yn dangos nad oedd yr amcangyfrifon economaidd blaenorol yn portreadu gwerth economaidd llawn genweirio môr hamdden i economi Cymru. Mae genweirio môr hamdden yn weithgaredd pwysig i dwristiaid gyda rhyw 6% o'r holl ymwelwyr yn cymryd rhan mewn genweirio môr (Visit Wales 2008). Mae genweirio môr hamdden hefyd yn cynnig manteision cymdeithasol sylweddol megis ymlacio, ymarfer a gwella'r amgylchedd (Armstrong *et al.* 2013). Nodwyd cyfleoedd i ehangu'r gweithgarwch hwn gan gynnwys rheoli pecynnau pysgota'n well a gwell ansawdd gwybodaeth am bysgota, tra oedd y bygythiadau yn cynnwys gorbysgota'r rhywogaethau a dargedwyd gan enweirwyr môr hamdden.

Ceir sawl diffiniad o enweirio môr hamdden (EIFACC 2008, Pawson *et al.* 2008, ICES 2013). Diffiniwyd Genweirio Môr Hamdden fel a ganlyn gan Weithgor ICES ar Arolygon Pysgodfeydd Hamdden "*the capture or attempted capture of living aquatic resources mainly for leisure and / or personal consumption, and covers active fishing methods including line, spear, and hand–gathering and passive fishing methods including nets, traps, pots, and set–lines*" (ICES 2013). Mae'r sector pysgota môr hamdden yng Nghymru yn cynnwys dulliau pysgota gweithredol a goddefol, ond nid yw'n glir faint o ddefnydd sydd o offer pysgota goddefol. Serch hynny, mae'r adroddiad yn canolbwyntio ar ddarparu adolygiad economaidd a gofodol o enweirio môr yng Nghymru, felly nid yw'r diwydiant pysgodfeydd môr hamdden ac eithrio genweirio môr yn cael ei drafod.

Mae genweirio môr yn darparu buddion cymdeithasol a chymunedol sylweddol, ond er mwyn deall sut a pham mae pobl yn cymryd rhan yn y gweithgaredd hwn, rhaid defnyddio dulliau mwy ansoddol sy'n asesu'r budd i'r unigolyn a'r budd cymdeithasol a chymunedol ehangach (Brown *et al.* 2010). Nid dal pysgod yw'r unig gymhelliant i gymryd rhan mewn genweirio hamdden (Brown *et al.* 2013). Mae

ymlacio, mwynhau natur, ymarfer corff a chyfle i gymdeithasu a threulio amser gyda'r teulu hefyd yn cael eu hystyried yn agweddau pwysig ar y gweithgaredd (Armstrong *et al.* 2013a). Gall genweirio alluogi pobl i wrthsefyll afiechyd a'u helpu i wella o salwch corfforol a meddyliol (McManus *et al.* 2011). Mae'r manteision iechyd a lles a ddaw o enweirio yn gysylltiedig â chyfleoedd i ymlacio, cael seibiant rhag straen, gweithgarwch corfforol a mynediad at yr amgylchedd naturiol (Ormsby 2004). Caiff y manteision eilaidd hyn eu hadolygu yn yr adroddiad cyfredol.

Amcangyfrifir bod 76,000 o enweirwyr yn byw yng Nghymru yn 2012 (Armstrong *et al.* 2012). Mae'r genweirwyr môr hamdden hyn sy'n byw yng Nghymru yn mynd ar ~340,000 o deithiau'r flwyddyn, a'r teithiau hyn wedi eu rhannu rhwng 278,288 (82%) o deithiau i lan y môr, 34,495 (10%) o deithiau mewn cychod wedi eu llogi ar y môr a 25,957 (8%) o deithiau mewn cychod preifat. Ar raddfa ofodol fawr, mae tymhorau'r flwyddyn yn cael effaith gref ar batrymau gweithgarwch genweirio, oherwydd mae gweithgarwch genweirio'r boblogaeth ymwelwyr a'r boblogaeth breswyl yn amrywio yn ôl y tymor. Ym misoedd yr haf, bydd genweirwyr yn dod i aros dros nos yng Nghymru i bysgota, ac oherwydd hyn bydd mwy ohonynt yn dod i Ynys Môn a Phenrhyn Llŷn, Ceredigion a Sir Benfro. Mae'r diwrnodau hirach a'r ffaith bod mwy o'r gwahanol rywogaethau ar gael yn golygu bod mwy o weithgarwch genweirio'n digwydd yn yr haf, a llai yn y gaeaf (mis Chwefror a mis Mawrth yw'r misoedd tawelaf), ac mae hyn yn fwyaf amlwg mewn lleoliadau anghysbell.

Cafwyd cadarnhad o 54 o gychod ar log oedd yn gweithredu ar draws Cymru, gyda ~12 o gychod ychwanegol yn gweithredu o borthladdoedd gogleddol Dyfnaint a Gwlad yr Haf ac yn dod o fewn 12 milltir forol i arfordir Cymru. Amcangyfrifwyd bod cychod ar log Cymru wedi gwneud 5,058 o deithiau[3] blwyddyn-1 yn 2014, a amcangyfrifwyd gan ddefnyddio cyfartaledd Richardson (2006) o ~77 o ddiwrnodau genweirio fesul cwch fesul blwyddyn. Os cymhwysir metreg Richardson (2006) i restr 2015 o gychod ar log, roedd y sector yn rhedeg ar 83% o'r capasiti llawn ar sail nifer y genweirwyr ar bob taith. Dylid nodi ei bod yn bosib bod llawer o feistri cychod yn cael eu cyflogi at ddibenion eraill hefyd megis teithiau gwylio bywyd gwyllt a gwaith arolwg.

Mae'r adroddiad yn ein helpu i ddeall dosbarthiadau gofodol dalfeydd gwahanol rywogaethau ac yn tynnu sylw at y rhywogaethau hynny y canfyddir eu bod o'r gwerth mwyaf i enweirwyr môr hamdden yng Nghymru. Gwelwyd gwahaniaethau mawr rhwng rhanbarthau yn achos rhai rhywogaethau megis cathod môr a phenfras oedd yn fwyaf cyffredin mewn dalfeydd yn ne Cymru. Cafwyd rhywogaethau gwerth uchel oddi ar holl arfordir Cymru e.e. draenogod môr, cŵn glas, cathod môr. Tynnir sylw at ddiffygion neu fylchau mewn data o ffynonellau eraill, a chydnabyddir problemau a gododd wrth samplo i sicrhau bod ystyriaeth ddigonol yn cael ei rhoi i enweirio nos.

3 Mae'r rhan fwyaf o'r teithiau hyn yn para diwrnod. Er hynny, mae'n bosib bod lleiafswm o'r cychod yn gwneud mwy nag un daith y diwrnod neu'n rhedeg teithiau dros nos i leoliadau anghysbell.

Yn ogystal â defnyddio ffynonellau gwybodaeth oedd eisoes yn bodoli, cynhaliwyd hefyd arolwg ar-lein annibynnol yn rhan o'r astudiaeth bresennol. Bwriad yr arolwg oedd darparu data ychwanegol oedd yn berthnasol i ddeall gweithgarwch genweirwyr môr ar draws Cymru, sy'n berthnasol i'r Broses Cynllunio Gofodol Morol y mae Llywodraeth Cymru ynglŷn â hi. Casglwyd gwybodaeth ychwanegol i ddeall y buddsoddiadau a fyddai'n hybu profiad genweirwyr môr hamdden yng Nghymru ac i weld pa faterion (e.e. parcio, mynediad) y dylid rhoi'r flaenoriaeth uchaf iddynt. Nodwyd gwrthdaro posib gyda grwpiau budd-ddeiliaid eraill.

Mae defnyddio abwyd yn elfen ac yn weithgaredd economaidd pwysig a gysylltir â genweirwyr môr hamdden. Llyngyren y traeth, cranc glas cyffredin, ac abwydyn gwyrdd oedd yr abwyd a ddefnyddid amlaf yn ôl yr ymateb i'r arolwg. Buasai mapio ardaloedd sy'n werthfawr i enweirwyr môr hamdden wrth gasglu abwyd y tu hwnt i gwmpas yr astudiaeth hon. Awgrymir y byddai technegau mapio arbenigol amgylcheddol, wedi eu dilysu trwy wybodaeth arbenigol, yn ddull rhad o nodi tebygolrwydd ardaloedd pwysig. Rhoddir trosolwg hefyd o effeithiau amgylcheddol casglu abwyd.

Mae cyfran dda o enweirwyr môr hamdden yng Nghymru yn aelodau clybiau. Ffederasiwn Genweirwyr Môr Cymru[4] yw corff llywodraethol genweirio môr hamdden Cymru ac mae'n gorff ymbarél i glybiau genweirio môr y tu fewn a'r tu allan i Gymru. Er bod nifer dda o glybiau yn y gogledd a'r de, mae prinder clybiau cofrestredig yn y canolbarth sy'n cyfyngu ar gyfleoedd i enweirwyr môr hamdden i gael cynrychiolaeth briodol yn y rhanbarth hwn.

Ychydig iawn o wybodaeth sydd am nodweddion economaidd genweirio môr yng Nghymru ac yn aml mae'n gysylltiedig â'r gweithgarwch genweirio yn Lloegr. Cyfrifwyd pwysigrwydd economaidd genweirio môr o fewn tiriogaeth Cymru er mwyn pennu'r llif arian y mae'r gweithgarwch yn ei greu yn y wlad, ond hefyd er mwyn gwerthuso cyfleoedd buddsoddi i'r dyfodol. Pennwyd gwerth economaidd genweirio môr hamdden yng Nghymru trwy amcangyfrif effeithiau uniongyrchol y gweithgarwch yng Nghymru (cyfanswm gwariant) a'r effeithiau anuniongyrchol, yn nhermau'r effaith economaidd ar y sectorau oedd yn gysylltiedig â genweirio, yn ogystal â'r effeithiau ar incwm a chyflogaeth. Amcangyfrifwyd bod cyfanswm gwariant blynyddol genweirwyr môr yng Nghymru wrth fynd ar deithiau diwrnod a theithiau dros nos rhwng £33.54 miliwn a £45.12 miliwn, gyda chyfartaledd o £39.33 miliwn. Amcangyfrifwyd bod cyfanswm gwariant genweirwyr môr o Gymru yn y wlad rhwng £48.19 miliwn a £125.96 miliwn, gyda chyfartaledd o £87.08 miliwn. Roedd pob £1 miliwn o wariant net gan enweirwyr môr yng Nghymru yn cefnogi £0.5 miliwn arall o wariant yn economi Cymru. Amcangyfrifwyd bod cyfanswm y gyflogaeth a grëwyd o wariant ar enweirio môr yn 1,706 CALl yn cynrychioli ~0.13% o'r cyfanswm CALl yng Nghymru yn 2007 (er bod 500 o CALl eraill fwy na thebyg yn cael eu cefnogi'n anuniongyrchol).

4 http://www.wfsa.org.uk/

Yn sicr mae'r dadansoddiad presennol o werth economaidd genweirio môr hamdden i economi Cymru yn amlygu gwerth sylweddol y sector hwn i economi Cymru. Ond ni chynhaliwyd dadansoddiad economaidd cadarn tebyg o werth y sector pysgota masnachol i economi Cymru. Golyga hyn na ellir gwneud cymhariaeth ystyrlon rhwng gwerth y sectorau hamdden a masnachol ar hyn o bryd.

Cynhyrchwyd amrywiaeth o haenau o ddata sy'n dangos dosbarthiad gweithgareddau genweirio môr hamdden o gwmpas arfordir Cymru sy'n addas at ddiben llywio cynllunio gofodol morol. Roedd yr haenau data hyn yn dangos lle'r oedd yr ardaloedd allweddol i enweirio ar lan y môr ac ar gychod. Defnyddiwyd amrywiaeth o wahanol ffynonellau data oedd yn seiliedig ar astudiaethau eraill a datblygwyd dulliau arloesol yn yr astudiaeth bresennol. Gyda'i gilydd mae'r ffynonellau gwybodaeth triongledig hyn yn rhoi dangosyddion dibynadwy o'r ardaloedd hynny ar arfordir Cymru a ddefnyddir fwyaf gan enweirwyr môr hamdden a gallant ddangos patrymau defnydd trwy'r gwahanol dymhorau.

2. OVERVIEW

2.1. Introduction

Recreational sea angling (RSA) is an important activity with 884,000 participants in England spending around £1.23B on their sport which supports 10,400 full time jobs (Armstrong *et al.* 2013). About 2% of the adult population participates in sea angling with around 76,000 RSAs estimated in Wales in 2012 (Armstrong *et al.* 2013). In 2000, it was estimated that RSAs in Wales had a value to the Welsh economy of over £28.7 million which supported 471 jobs (Nautilus Consultants Ltd. 2000). RSA is also an important activity for tourists with around 6% of all visitors engaging in sea angling (Visit Wales 2008). RSA also confers significant social benefits such as relaxation, exercise and environmental improvement (Armstrong *et al.* 2013). Opportunities to expand RSA have been identified to include better management of fishing packages and higher quality information on fishing, while threats included over-exploitation of the species targeted by RSAs (Nautilus Consultants Ltd. 2000). There are few examples that study the interactions between marine spatial planning and RSA, but see Milford Haven Port (Chambers *et al.* 2013). In addition, there is little information on the spatial activity of RSA at the scales required for marine spatial planning. The main aim of this report was to identify existing data (predominantly grey literature) and develop methods that produce robust and transparent maps that can be used for marine spatial planning and development of the sector.

The study was subdivided into three key tasks:

i. Identify and review all existing studies on RSA in the UK and data compiled on RSA websites to extract data for activity mapping, social benefits and economic value.
ii. Develop robust methods to extrapolate from existing data on activity and economic value to the highest resolution supported by data, and identify data collection strategies to improve the resolution of predictions.
iii. Identify opportunities for the development of RSA in Wales.

2.2. Policy Context

The Marine and Coastal Access Act 2009 (MCAA) (HM Government 2009a) provides the statutory basis for a new plan-led system for the UK marine environment. The purpose of marine planning under the MCAA is to help achieve sustainable development in the marine area. Welsh Ministers are the marine plan authority responsible for creating marine plans for both the inshore region (0 - 12 nautical miles) and offshore region (beyond 12 nautical miles) of Wales.

All four UK administrations adopted the UK Marine Policy Statement (MPS) in March 2011. On adoption of the MPS, the MCAA placed a duty on the Welsh Government to ensure that marine plans are prepared for the Welsh Marine Planning Region (HM Government 2009b). The Welsh National Marine Plan (WNMP) must conform to the MPS (HM Government 2011). The MPS states that: *"Marine plans will be based on a sound evidence base, as far as possible. This will identify issues to be addressed in the plan and inform plan development. The evidence base will be developed from a wide range of sources including existing plans, the plan area community, science advisors, statutory and other advisors, industry and other marine users*" (HM Government 2011).

The MPS also states that the process of marine planning will:

i. Achieve integration between different objectives.
ii. Recognise that the demand for use of our seas and the resulting pressures on them will continue to increase.
iii. Manage competing demands on the marine area, taking an ecosystem-based approach.
iv. Enable the co-existence of compatible activities wherever possible, and
v. Integrate with terrestrial planning.

The WNMP will build on the framework provided by the MPS to reflect the specific needs and interests of Wales. The WNMP will enable Welsh Government to plan for and guide the management of Welsh seas; integrating economic, social and environmental considerations and engaging with communities to help shape the future.

Once adopted the WNMP will support and guide marine authorisation and enforcement decisions. It will do this by:

i. Clarifying marine policy objectives and priorities.
ii. Directing and guiding decision makers and users of our seas.

The Welsh Government is committed to the UK vision for "*clean, healthy, safe, productive and biologically diverse oceans and seas*". In January 2009 the UK administrations published joint High Level Marine Objectives for achieving this vision (HM Government 2009c) which are based on the principles of:

i. Achieving a sustainable marine economy.
ii. Ensuring a strong, healthy and just society.
iii. Living within environmental limits.
iv. Promoting good governance.
v. Using sound science responsibly.

The Welsh Government has published the draft Vision and Objectives for the WNMP which builds upon that of the UK.

In July 2014, the European Parliament and the Council adopted Directive 2014/89/EU to create a common framework for maritime spatial planning in Europe (European Commission 2014). While each EU country will be free to plan its own maritime activities, local, regional and national planning in shared seas would be made more compatible through a set of minimum common requirements.

2.3. Definition of Sea Fishing and Angling in the Welsh Context

Many definitions of recreational sea fishing (RSF) exist (EIFACC 2008, Pawson *et al.* 2008, ICES 2013). The ICES Working Group on Recreational Fisheries Surveys defined RSF as "*the capture or attempted capture of living aquatic resources mainly for leisure and / or personal consumption, and covers active fishing methods including line, spear, and hand–gathering and passive fishing methods including nets, traps, pots, and set–lines*" (ICES 2013). Some definitions exclude subsistence fishing and fishing where the catch is sold or otherwise traded on export, domestic or black markets (EIFACC 2008, Pawson *et al.* 2008). Although the term "recreational fishing" is often used synonymously with angling (Pawson *et al.* 2008), the latter only covers fishing with hand lines, fishing rods and/or poles using baits and/or lures and only represents one part of recreational fishing (ICES 2013). Nevertheless, angling tends to be the dominant method used in most Welsh areas. The Welsh recreational sea fishing sector includes both active and passive fishing methods (NRW, WG Fisheries pers. comm.), but the extent of passive gear use is unclear. However, the focus of the report is to provide an economic and spatial review of sea angling in Wales, so an in depth treatment of the non-angling recreational sea fishery is excluded.

From a fisheries management perspective, definitions are only useful to categorise fishing activities in a way that ensures that all such activities and their catches can be defined and documented without overlap or gaps for the purposes of data collection, assessment, or legislation. For the purposes of this report, recreational sea angling in Wales is defined as ***"Any fishing for marine species primarily using rod and line or hand-held line where the purpose is recreation and not for the sale or trade of the catch"*** (Armstrong *et al.* 2013a).

2.4. Benefits of Sea Angling

Recreational sea angling (RSA) provides significant social and community benefits, but understanding angling participation requires more qualitative approaches that assess the individual benefits from participation and the wider social and community benefits (Brown *et al.* 2010). Motivations for angling are not solely related to catching fish (Brown *et al.* 2013), with relaxation, experiencing nature, physical exercise, and a route for socialising or spending time with family also considered as important aspects of the activity (Armstrong *et al.* 2013a). Similar social benefits have been found in many different cultures worldwide including the UK (Drew Associates 2004, Lawrence and Spurgeon 2007, Mawle and Peirson 2009, Brown 2012b, Armstrong *et al.* 2013a, Kenter *et al.* 2013), Australia (Frijlink and Lyle 2010, McManus *et al.* 2011), and USA (Gartner *et al.* 2002) and in both marine and freshwater angling (Brown 2012b, Brown *et al.* 2013).

There is a paucity of published studies on the social and community benefits of RSA. For example, a recent review of the health and wellbeing benefits associated with angling compiled 20,382 journal articles published since 2000 and found 131 related to angling, only 3 of which had a primary focus on health, wellbeing and angling (McManus *et al.* 2011). There are bodies of work that cover cultural attitudes to angling, but the literature relating natural environment to health issues, green spaces, and wellbeing have not focussed on angling, so there is need for study of social and community benefits of angling to help decision-makers to understand its wider societal role (Brown *et al.* 2010).

A broader review of published studies, grey literature, and stakeholder interviews found considerable health and well-being benefits were associated with angling. Anglers of any age can participate and enjoy the hobby which is a cost effective and healthy outdoor activity, has the potential to provide physical and mental health benefits, and impact on behaviour in young people (McManus *et al.* 2011). The latest assessment of the social benefits of sea angling was conducted in England in 2012 using online and face-to-face methods (Brown *et al.* 2013), and is probably the most relevant for Wales given the proximity of the two countries. There are a wide range of potential social and community benefits associated with RSA and these have been categorised into participation, social aspects, physical activity, health and wellbeing, environment, and local community (Brown *et al.* 2013), and are discussed in more detail below.

In the UK, anglers are predominantly white males of around 50 years old, but significant effort is being made to broaden the demographic profile of angling (Stark *et al.* 2012). The proportion of anglers with disabilities can be as high as 20% (Brown 2012a, Brown *et al.* 2013). Social and self-improvement benefits associated with angling can be high for participants with disabilities, so management actions targeted at this group are needed to maximise this potential health benefit (Freudenberg and Arlinghaus 2010). Motivation for going angling generally revolves around being outdoors, activity, relaxation, and spending time with friends and family, and surprisingly non-catch

motives can be as important as catch based motives for sea anglers (Brown *et al.* 2013). Understanding motivation is important when thinking about development of the angling sector (Stark *et al.* 2012).

Social aspects are very important to sea anglers who see it as a predominantly social activity that is done with friends or family (Brown *et al.* 2013) and important for social affiliation (Gartner *et al.* 2002). Sea angling is a way of mixing across all groups of society with around a third of anglers making friends and mixing with people from different backgrounds (Brown *et al.* 2013), and encourages interactions across age groups (Brown 2012b). Angling provides many development opportunities for young people that can raise attainment levels and divert young people from crime and antisocial behaviour, exampled by the initiatives *Get Hooked on Fishing* (Get Hooked on Fishing 2015) and *Angling for Youth Development* (AFYD 2015). Both GHoF and AFYD focus on freshwater angling, but similar programmes for sea angling could be developed in cooperation with and drawing on the expertise of, Wales centric sea angling organisations.

2.4.1. Health and Social Benefits

The importance of angling in increasing participation in sport and the associated benefits of physical activity have been identified (Lawrence and Spurgeon 2007, Brown *et al.* 2012c). Physical health and fitness is important to prevent obesity and is a strategic policy objective for most developing world countries including England, Wales, and Scotland. There is much additional anecdotal evidence of physical activity and angling, but little scientific evidence of actual activity levels exists. Moderate increases in cardiovascular strain have been found during fishing competitions with higher heart rates while landing fish (Chester University 2014). The long duration of angling activity means that, although the activity is low or moderate, it can account for significant total energy expenditure that is comparable to mountain biking (Pretty *et al.* 2007). Brown *et al.* (2013) asked sea anglers to rate their level of physical activity to which around 65% responded that their activity was moderate or high. This suggests that angling could be important in achieving targets to get adults to do at least three thirty minute sessions of physical exercise per week.

Angling can build resilience to ill health and improve recovery from both physical and mental illness (McManus *et al.* 2011). The health and wellbeing benefits derived from angling are related to opportunities for relaxation, stress relief, physical activity, and access to the natural environment (Ormsby 2004). Almost 70% of English respondents felt that sea angling played an important role in quality of life and contributed to their health and wellbeing though experiencing nature (Brown 2012b). In Australia, angling was seen to improve health and wellbeing particularly through stress relief and relaxation, but also through family bonding (McManus *et al.* 2011). Angling has also helped patients recover after breast surgery (Casting for Recovery 2015), stroke (e.g. angling days organised by the Stroke Association), and mental health problems (Brown *et al.* 2012c).

In summary, angling can bring significant social benefits and can be contribute to social welfare by bringing benefit to participants. The potential to develop angling to increase social benefits has been recognised and is central to the National Angling Strategy (Stark *et al.* 2012).

2.4.2. Environmental Benefits

Environmental benefits of angling are twofold: through engagement with conservation and raising environmental awareness, and as a gateway to access green spaces and connect with nature (Brown 2012b). Anglers make up an important interest group for a better and protected environment (Environment Agency 2006). They contribute to the natural environment through a broad variety of citizen science activities including fish tagging (Shark Alliance 2015) and fishery dependent monitoring (Environment Agency 2014). Around 17.5% of sea anglers in the England were involved in environmental improvement work with 51% of these participating in beach clean-ups (Brown *et al.* 2013). There are also campaigns to remove litter such as the Angling Trust's *Just Take 5* campaign (Angling Trust 2015) and anglers frequently report suspected illegal fishing activity and other events which may negatively impact the environments in which they fish (NRW, Welsh Government Fisheries Dept. pers. comm.).

2.4.3. Enhancement of Local Economies

Sea angling has a positive economic impact on income and employment in coastal communities by increasing visitor frequency (Brown 2012a) and it is an important part of local cultural heritage (Brown *et al.* 2013). Wales hosted approximately 65,000 overnight trips by resident and visiting sea anglers in 2013 (TNS Global 2014a), complemented by around 400,000 day trips (Simpson and Mawle 2010, TNS Global 2014b). Moreover sea angling follows seasonal patterns, partially determined by the availability of fish species, potentially bolstering visitor numbers outside of the spring and summer tourist season. In the UK, it is generally accepted that cod, coalfish and whiting shore angling peaks during the winter months.

2.5. Sea Angling in Fisheries Management

There is a growing awareness of the potential impacts of recreational sea angling on fish populations, hence there is a need to incorporate these effects into fisheries management (Cooke and Cowx 2006). Achieving this requires a body of evidence on fishing activities and catches compatible with what is available for the commercial fisheries on the same stocks. Estimating total recreational catches and effort is challenging especially where there is no licensing or registration scheme to identify the total population of recreational fishers and where there is a substantial tourist fishery. The most notable example of recreational fishery surveys is the USA Federal and State survey programme which has run since 1979 (NOAA 2015). This programme uses combination of two surveys to estimate total catches: the first to estimate participation rates and fishing effort, and a second that uses on-site surveys to collect data on catch per unit effort from fishers completing their fishing trips from the shore or boat. Other forms of surveys implemented in Australia, New Zealand, France and Netherlands combine nationwide population surveys to estimate fishing effort and randomly-selected respondents to log all their trips and catches in a diary (see ICES 2014a and earlier WGRFS reports). Europe lags behind countries such as the USA, Australia and New Zealand in monitoring recreational fisheries, but more recently recreational fishing has been included in the stock assessment of Baltic cod and European sea bass (ICES 2014a).

The recreational catch estimates for many USA species are included in the scientific assessments of the stocks, and attempts are made, where appropriate, to partition catch forecasts from the assessments into commercial and recreational components. Managing the recreational fishery to achieve the desired annual harvest typically involves technical measures such as changes in minimum landing sizes or slot sizes, bag limits, seasonal restrictions or other technical measures. Examples of such approaches include management of Atlantic striped bass (*Morone saxatilis*), for which recreational harvests are around two thirds of the total fishery harvests, and summer flounder (*Paralichthys dentatus*) where the annual quota is currently partitioned to 60% commercial and 40% recreational (ASFMC 2015). The use of technical measures to manage the catches of recreational fish species is similar to the approaches recently implemented for the European sea bass in the north-east Atlantic under EU council regulation 2015/523, such as an increase in the MLS to 42 cm (applied to all métiers) and a 3 bass bag limit for anglers.

The use of bag limits and minimum landing sizes or slot sizes for recreational fisheries management increases absolute release rates or size class specific release rates, with gear selectivity unchanged. In the USA in 2013, over 61% of recreationally caught marine fish were released alive (NOAA 2014). A recent study on European marine recreational fisheries by Ferter et al (2013) also revealed high release rates for many species. The Sea Angling 2012 project in England indicated that shore anglers released 75% of the fish caught and boat anglers around 50% (Armstrong *et al.* 2013a). A review of 274 published studies on post-release mortality on marine and freshwater fish caught by hook and line

showed that post-release mortality averaged about 18% (median 11%) but ranged from 0–95% depending multiple factors including species, hooking location (and associated bleed), temperature and handling time (Bartholomew and Bohnsack 2005). However, there are few direct estimates of post-release mortality of many sea angler targeted species in Europe, including the highly regarded recreational species, the European sea bass (see 3.3.1 and 3.3.2).

To date, there are few examples of the use of recreational fishery survey estimates in assessment and management of European marine stocks, despite the more widespread adoption of surveys as required under the EU Data Collection Framework (see below). The most notable example is that of Atlantic salmon, but there are also recent examples of use of recreational fishery catch data in assessments of European sea bass (ICES 2014b) and western Baltic cod (ICES 2014b). The total annual recreational removals of sea bass in England, France, Belgium and Netherlands during 2011–2013 was estimated at around 1,500t, equivalent to 25% of the total fish removals. There are many other marine fish species in Europe for which recreational catches may be locally or nationally significant and moving towards inclusion of recreational catch within these stocks will support fisheries management.

2.5.1. European Union Reporting Requirements

There exist legal requirements within the Common Fisheries Policy (CFP) for EU Member States to estimate and report catches of certain species and stocks taken by recreational fisheries. The first of these is the Council Regulation (EC) No 1224/2009 which specifies in Article 55 that Member States shall ensure that recreational fisheries on their territory and in Community waters are conducted in a manner compatible with the objectives and rules of the CFP, and shall monitor, on the basis of a sampling plan, the catches of stocks subject to recovery plans by recreational fisheries practised from vessels flying their flag and from third country vessels in waters under their sovereignty or jurisdiction. Fishing from the shore is excluded. The Council Regulation also mandates the European Council to submit these recreational fisheries to specific management measures such as fishing authorisations and catch declarations if an evaluation by the Scientific, Technical and Economic Committee for Fisheries (STECF) finds a significant recreational fishery impact.

The second, and main legal framework for collection of recreational fisheries data by EU Member States is currently the EU Data Collection Framework (DCF) (Council Regulation (EC) No 199/2008[5] and Commission Decision 2010/93/EU of 18 December 2009[6]) adopting a multiannual Community programme for the collection, management and use of data in the fisheries sector. Commission Decision 2010/93/EU provides a list of species and areas for which Member States are required to estimate recreational fishery catches, or in the first instance to carry out pilot studies to evaluate the

[5] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:060:0001:0012:EN:PDF
[6] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:041:0008:0071:EN:PDF

magnitude of catches. Wales falls within the North Atlantic area for implementation of DCF, and the species required are salmon, sea bass, sharks and eels (*Anguilla anguilla*). The term "sharks" is taken to cover all shark and ray species listed in Decision 2010/93/EU.

The DCF is being revised under a new EU Multi Annual Programme for data collection (EU-MAP). The basic regulation, which will replace the DCF Regulation 199/2008, is developed but the detailed data collection requirements are not included within the regulation and are still under development. It is expected that the new legal requirements, which are intended to have more flexibility to address end user needs, will continue to be specified in Commission Decision documents. The requirements for recreational fishery data collection may change from the current DCF, for example in relation to species coverage and frequency of surveys required.

Details of UK data collection schemes will be laid out in its Annual Work Plan for the European Maritime and Fisheries Fund (as described in Article 23 of the EMFF[7]) within the UK EMFF Operational Programme. The only recent UK surveys to estimate nation-wide recreational fishery catches were part of Sea Angling 2012 (Armstrong *et al.* 2013a), which included a population survey of sea angling participation and fishing effort, as part of a monthly Office of National Statistics Opinions survey covering the whole of Great Britain, and on-site and diary estimates of catches by shore, private boat and charter boat anglers in England only. This was included in the UK DCF programme, following on from some pilot studies carried out by the (then) Countryside Council of Wales and included in the DCF programme in earlier years.

[7] http://ec.europa.eu/fisheries/cfp/emff/index_en.htm

3. CHARACTERISTICS OF SEA ANGLERS AND SEA ANGLING IN WALES

3.1. Introduction to Sea Angling in Wales

Recreational sea angling (RSA) across Wales is spatially and temporally heterogeneous (Richardson 2006, Goudge *et al.* 2009, Goudge *et al.* 2010), this is unsurprising as the Welsh coast ranges over about 2740 km of highly variable shoreline. Fish are targeted from boats and the shore using a variety of methods, including lure fishing, presenting a bait under a float or free lined, ledgering a bait on the sea floor, and spear fishing. RSA occurs across a variety of coastal environments, from surf beaches, to high energy reef systems and offshore waters to over 100 m deep (Pearson 1968, Ladle and Vaughan 2003).

Wales is highly regarded as a venue for sea angling, noted in particular for its bass and other specialist experiences including blue shark, tope, and smooth hound sport angling. Wales' picturesque coastline and interior is a major factor in the value of the country as an outdoor activity holiday destination (Miller Research 2014) and there is a synergy between Wales' natural beauty and its sea angling opportunities, both for visiting and resident anglers.

It is estimated that there were 76,000 anglers resident in Wales in 2012 (Armstrong *et al.* 2012), or 7% of total angler numbers for England, Scotland and Wales. Applying this 0.07 proportion to SA2012's trip estimates and platform ratios suggests that Wales resident RSAs undertake ~340,000 trips per annum, split between 278,288 (82%) shore trips, 34,495 (10%) charters trips and 25,957 (8%) private boat trips however, these figures should be treated as approximations as there was uncertainty in the SA2012 effort estimates (see SA2012 annexes). Other historical surveys have estimated the participation by platform and these are given in Figure 3-1A & B however, SA2012 represents the best participation estimates to date (April 2015). Sea anglers' primarily targeted bass, cod, mackerel, pollack, rays and tope (section 3.3.1) however, there is some evidence that catches by number are predominantly of lesser spotted dogfish, mackerel, whiting and wrasse species (Goudge *et al.* 2010, Goudge and Morris 2011, Figure 3-7), though robust data for Wales are currently limited.

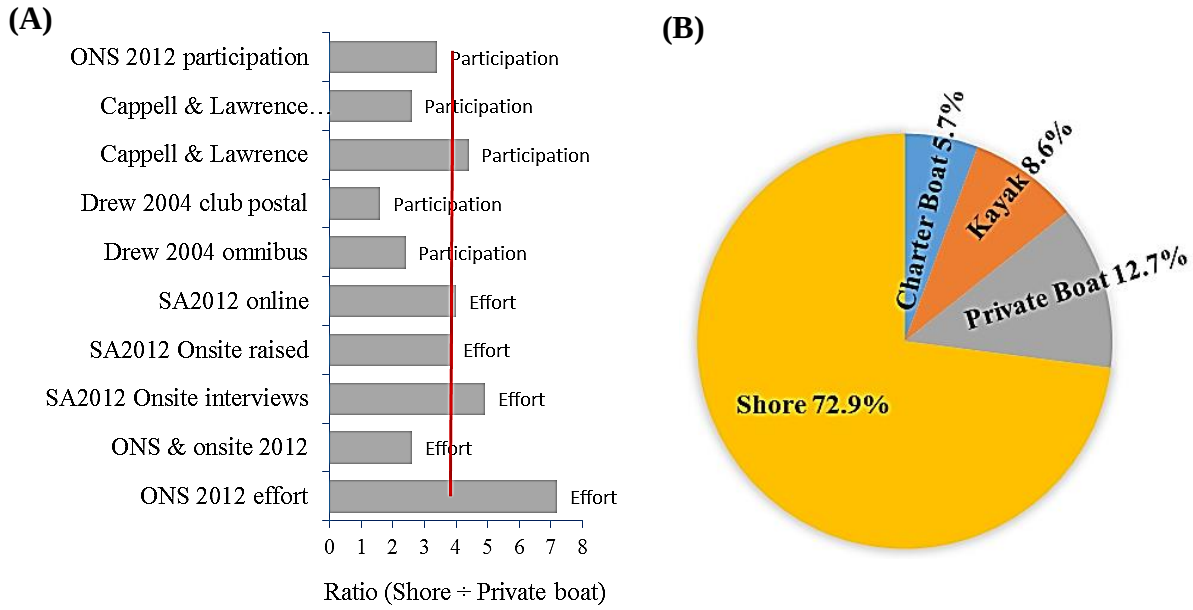


Figure 3-1. Ratio of shore angling to private boat angling across several surveys. (A), by effort measures (e.g. angler days per annum) and participation (e.g. number of anglers who primarily fish from the shore). Mean line ($\bar{x}$ = 3.7) in red. Adapted from Armstrong *et al.* (2012). (B) Mean participation estimates derived from This Survey (2015).

The majority of sea anglers are male (This Survey, 98%; Armstrong *et al.* (2013), 84%; Richardson (2006), 93.9%) and in the 46–55 age bracket (this Survey, 28%; Armstrong, 25%; Richardson 26%), and though all ages practice sea angling, participation is low in the under 25s (Brown 2012a, Armstrong *et al.* 2013a). Multiple studies found the best predictor of angling participation by those under 25 years of age was having another household member involved in the sport (Brown 2012a).

Angler avidity is important to measure in relation to survey data and comparison of avidity between surveys can indicate the presence of potential biases which may compromise estimated parameters (for example average trip durations). The stratified random ONS survey under Sea Angling 2012 (Armstrong *et al.* 2013) provides the best estimates of sea angler avidity, and would be expected to be transferable to sea anglers fishing in Wales. This Survey indicated that 64% of sea anglers fished between 1 and 14 days per year with only 12% fishing more than 35 days per year (Figure 3-2A). Figures for the survey undertaken as part of this report, and that of Richardson (2006) are also presented for comparison (Figure 3-2A and B respectively). It can be seen that our self-selecting survey was subject to over sampling of avid sea anglers which is important in the interpretation of This Survey's results.

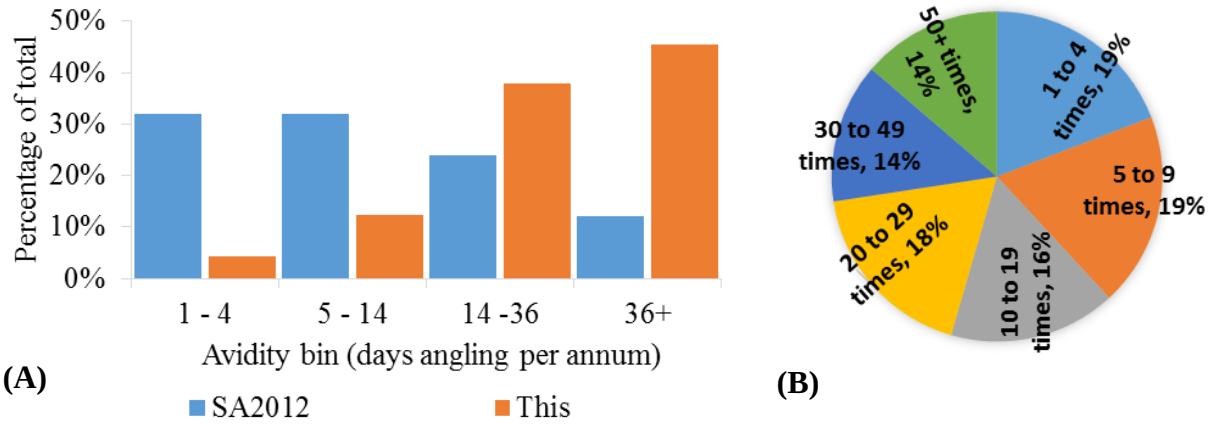


Figure 3-2. Angler avidity classes by sample proportion. (A) as percentage in frequency categories per annum from Sea Angling 2012 and This Survey (2015), similarly (B) from Richardson (2006). Note different avidity intervals between (A) and (B).

At a large spatial scale, the patterns of angling activity are strongly influenced by season, and the interaction of season with an area's visiting and resident angling population. Goudge *et al.* (2009, 2010) introduced the concept of different angler archetypes, based on similarity comparisons of questionnaire responses and expert knowledge, which for brevity can be summarised under the three categories: club and match (*competition*); regular and seasonal (*regular*), then casual and novice (*casual*). In the summer months, casual anglers will fish as part of overnight stays in Wales, which will increase angling visitors to Anglesey and the Llŷn Peninsula, Ceredigion and Pembrokeshire. In addition regular anglers, both residents and visitors, will undertake more overnight stays and increased day visits to more remote venues. This seasonal change in avidity can be attributed to longer daylight hours giving improved opportunities to fish venues, particularly rock marks, in favourable sea and weather conditions which increases trip viability.

The increased availability of species stimulates angler activity during summer, with Goudge *et al.* (2009) illustrating the affinity of the novice angler for mackerel (casual, 70% targeting; novice, 73% targeting) and the popularity of bass with more experienced anglers. Mackerel in particular are fished for from rock marks and piers/breakwaters, typically into deeper water (> 10 m) and high energy current systems. During such sessions, casual anglers will also catch wrasse, pollack and the occasional bass.

Regular and competition anglers may specialise to catch bass at suitable venues, but will also use specific methods to target other hard fighting prestige species from the shore, in particular tope, smooth hound, black bream and to a lesser extent mullet. Bull huss, conger, pollack and wrasse tend to be caught from rock marks, where the variety of species is conducive to keeping keen anglers occupied during long angling trips.

In spring, regular and competition anglers will start the season by pursuing thornback ray, plaice and flounder, these flatfish will be migrating inshore after breeding, and these species remain targets

throughout the summer. Most summer species continue to be resident into early November, including bass, though mackerel tend to leave Welsh shores in early October. From October, anglers' efforts will turn to cod, which are caught along with specimen bass particularly on storm beaches. Dabs and whiting will also be captured, though these are not as highly valued by sea anglers due to their ubiquity and small size. Coalfish also increase in catches from October onwards and these too will be targeted from beaches and rock marks by shore anglers, and over inshore reefs from private and charter boats.

Total activity tends to decrease into the winter months, in particular angling activity at the more remote venues will be curtailed, although localised effort can be high according to species availability and weather conditions. Expert knowledge indicates that activity minimums occur between February and March, but increase with the advent of the Easter holidays (see Figure 3-4 for example) and the promise of newly arriving bass following their post-spawning migration. The arrival of this top ranked sea angler prestige species coincides with the start of ecdysis in the male common shore crab (a bait species) through April and into May which marks the start of the new angling year for many RSAs.

Formal and informal club matches continue throughout the winter period (NRW and MES unpublished match cards; WFSA matches list, Appendix 10) and regular resident anglers will continue to fish, but effort will primarily be driven by day visits to venues generally closer to anglers' residencies. The significant reduction of effort across Wales in winter, but particularly the withdrawal of visiting anglers from vacation destinations in Pembrokeshire and Ceredigion are illustrated in Figure 3-3.

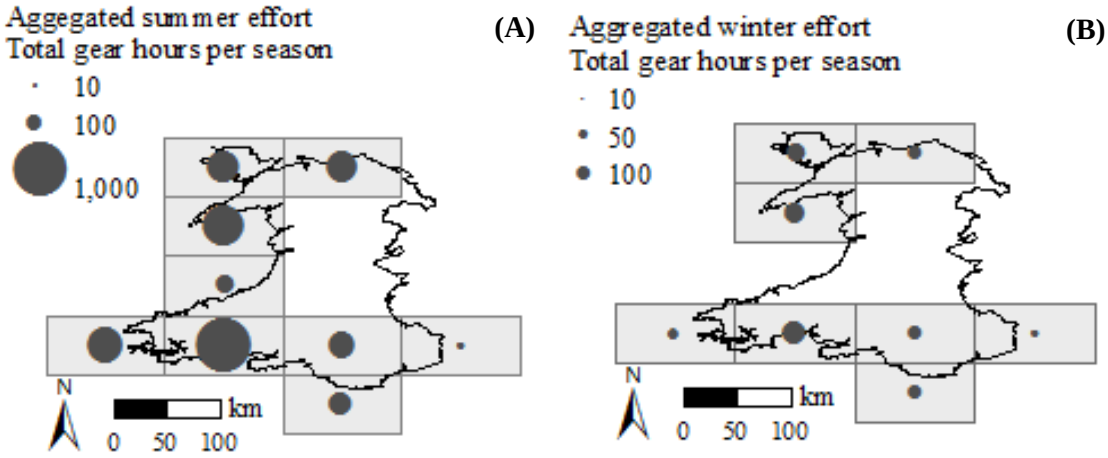


Figure 3-3.Distribution of angler effort from anglers who reported bass catches from heterogeneous data sources. Data aggregated by ICES rectangles reproduced from Monkman (2013). Note that effort is 'within sample' and not a population estimate.

It should be noted that these data may exaggerate the effect, as it is based on bass-centric angling activity nevertheless, it accords with seasonal overnight visitor patterns. The same data set was used to derive the effort trends illustrated in Figure 3-4. Seasonal effort reductions were also observed by Goudge *et al.* (2009, 2010).

(B)

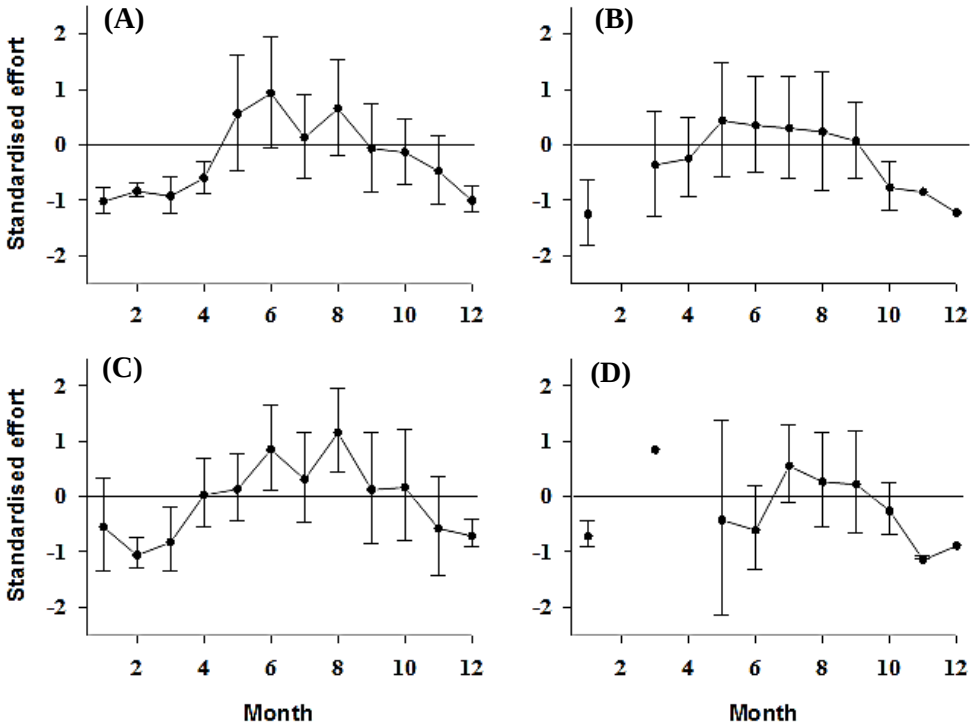


Figure 3-4. Graphs of monthly mean effort ±S.D. across years for private boat, shore and kayak anglers (combined) in North Wales (A), Mid Wales (B) and South Wales (C). (D) Charter boat activity for South Wales. Reproduced from Monkman (2013).

There were 54 charter boats confirmed as operating across Wales, with some additional unquantified activity within 12 nautical miles (nm) of Wales from approximately 12 boats operating from the northern ports of Devon and Somerset (section 5.4.4). The Welsh charter fleet was estimated to have undertaken 5058 charter trips[8] in 2014, calculated using Richardson's (2006) mean boat angling days stratified by distance license. Applying metrics from Richardson (2006) to the 2015 list of charter vessels, the sector was running at 83% of total capacity based on angler occupancy per trip. It should be noted that many charter skippers may also be hired for other purposes and Richardson's 2003–2004 survey data indicated that 84% ±21% S.D. (N = 50) of trips were angling related (*max*. = 100%, *min*. = 25%). Sightseeing (6.6%), diving (5.2%) and surveying (3.3%) were the major alternatives. Hence there existed in 2003–2004—and it may be assumed continues to exist—considerable elasticity in charter boat provision, subject to spatial variation according to available non-angling for-hire opportunities (for example, demand for sight-seeing tours would be low from some ports).

Charter boats across Wales have a distinct *modus operandi*, different markets may be targeted by different skippers according to boat capability, experience and locality; or employed by the same skipper according to weather, tides, season, fish availability, short term market demand and the day to day requests of customers. Drew (2004) classified activity as specialised wrecking, inshore ground and

[8] The term trip is largely interchangeable with boat day, despite a minority of boats possibly taking > 1 trip a day or running overnight trips to remote locations.

bait fishing, and inshore fishing/pleasure trips. Additional categories are pertinent and offshore ground and bait fishing and inshore reef fishing should be added to Drew's classifications.

Charter boats operating from the North Wales coastal resorts will primarily target mackerel, smooth hound, tope and rays during the summer, although they will switch to smaller species, such as the flatfishes, whiting and gurnard according to client experience, competency and preference. Some vessels will also target cod, pollack and conger eel on deep water wrecks, with those targeted by specialist charters tending to be outside the 12 nm limit to increase fish quantity and quality landed. During winter, fishing will be primarily for dabs and whiting, and some codling. Overall winter effort will be much reduced due to weather although some skippers relocate to the Mersey estuary, both for the better cod fishing and the increased boat days afforded by the shelter of the estuary itself from the prevailing south westerly winds.

Charter boats and private boats that operate from the Menai Strait and Anglesey have a wide variety of options and will pursue tope and smooth hound from May onwards, particularly from Holyhead and the Northern coast of the island. Spurdog have also been increasing in catches and the Holyhead Deeps is a favoured venue. Fishing over rough ground for pollack, wrasse and cod (among other species) is common from Puffin Island at the eastern tip of the island, where bass are also pursued, with suitable rough patches to be found right around to the south western end of the Llŷn Peninsular into Bardsey Sound, where black bream becomes increasingly common over patches of broken ground. Boat fishing throughout Cardigan Bay will be similar, and the reef systems (the Sarnau) extending into the bay are highly valued by kayak anglers, private boat and charter boat anglers alike for the bass, black bream, pollack and tope angling.

The far western reaches of Pembrokeshire have reduced boat activity (Appendix 30) and only a single boat was identified as operating in the waters around St. David's Head, primarily undertaking trips over wrecks and reefs. The remaining fishing is in the Bristol Channel and offshore. A small number of vessels (~10%) offer specialist shark fishing and have a nationwide reputation for this activity. There is increased targeting of bass in the Bristol Channel area both from charter boat and private boat (Monkman, 2013 and expert knowledge) and fishing for the target species above, as dictated by habitat availability.

3.2. General Method and Sources for this Chapter

The general characteristics of the recreational sea angling sector across Wales presented above were derived primarily from expert fisher knowledge, reviews of grey literature and scientific reports as detailed under sections 4.2, 5.2 and Appendix 1.

Species data derived from multiple sources required standardisation, with reductions in listed species achieved by the grouping of small species, such as gobies, smelts, tadpole fish etc. under 'mini species'. Species not commonly caught were grouped under the category rare, including for example the skates, angel shark, the shads and Atlantic bonito. Species which present difficulties in identification were also merged, hence the species groupings of rays, soles, mullets and breams. Merging was justified as the majority of anglers would not commonly express a wish to catch one species of sole or bream over another. Flatfish were frequently cited as a target species in multiple studies, these data were excluded from analysis along with the marlin reported in the 2003.

Both Richardson's (2006) sea angling questionnaire (Annex 2) and our online survey (This Survey) solicited anglers to rank the top three species they aspire to catch, where these data were aggregated by species (see for example Appendix 4 and Figure 3-6); the first, second and third ranked species frequencies were weighted by 1, 0.5 and 0.33 respectively.

3.2.1. This Report Survey – Purpose and Instrument

Recognising that there were no current Wales wide survey data which investigated sea angling quality metrics, a self-selecting, incentivised online survey was carried out between February and March 2015 using the Survey Monkey software as a service website (Finley 7/Jul/2013). This Survey (see Annex 1) was promoted through the channels specified below.

i. Sea angling magazine Sea Angler email-shot to anglers with a Wales postcode.
ii. Sea Angler magazine promotion on their facebook page.
iii. The online angling equipment retailer Veals distributed a promotional brochure in their parcels.
iv. Email shot to Welsh sea angling clubs requesting promotion to members
v. Publicised on online sea angling forums.

The survey was designed to provide additional data pertinent to understanding sea angler activity across Wales relevant to the marine spatial planning process undertaken by the Welsh Government. Additional information was gathered to understand the investments that would enhance the RSA experience in Wales and to inform which issues (e.g. parking, access) were of highest priority.

3.3. Review of Sea Angling Characteristics for Wales

3.3.1. Aspiration and Target Species

In a study by Richardson (2006) recreational sea anglers specified their top three target species while fishing on the specified platform (e.g. shore, kayak, charter boat). For anglers engaged in charter boat fishing on the day of interview, the top three targeted species (*N* = 431) were: bass, 86 (23%); tope, 62 (17%); and black bream 48 (13%). Comments made during interviews with charter skippers reiterated the importance of black bream and tope to their businesses, particularly around the Northern Llŷn and in Cardigan Bay. For anglers using private boats at interview (*N* = 171): bass (54, 32%); tope (24, 17%); and then pollack, whiting and mackerel (18, 11%) were the top ranked species. For shore angling interviewees the top ranked species (*N* = 555) were bass (194, 35%), cod (97, 17%) and mackerel (53, 10%). The complete species list is given in Appendix 3. Richardson's (2006) data represents the best by platform breakdown of target species for Wales however, the phrasing of the interview question (see Annex 2) means that it should not unequivocally be interpreted as "what species do you target while fishing on <a particular platform>".

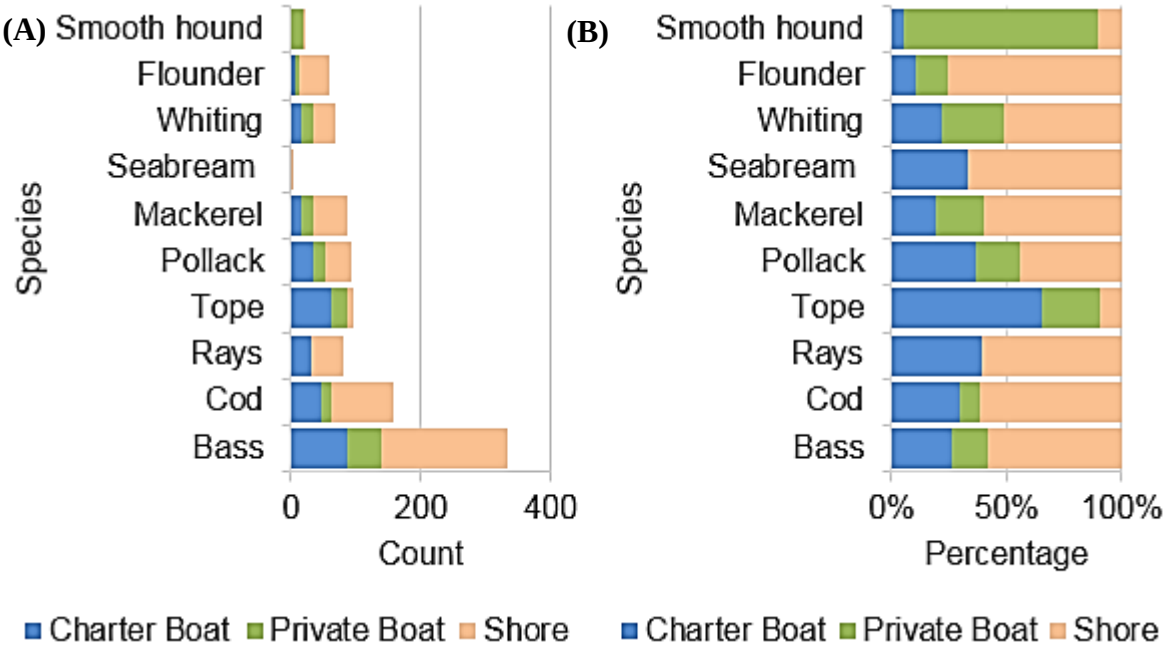


Figure 3-5. Top 10 target species for charter boat, private boat and shore anglers, data from Richardson (2006), as an absolute count (A) and a per species proportion by platform (B). Ray species; predominantly thornback ray, but includes blonde, spotted, small-eyed, cuckoo and undulate.

Other Wales specific studies have collected angler species preference data and it is useful to consider multiple sources due to the high sensitivity of angler responses to survey sampling methods (for example over sampling competitive matches will inflate recordings of dogfish and whiting responses). Appendix 4 summarises aspirational species across relevant studies including newly collected data (March 2015) as part of this study. Based on these data, bass was the most popular aspirational species

across angler surveys (31.6%), followed by cod (12.9%) and mackerel (7.9%), charter skippers ranked rays (10.2%) as the top preference species of their customers, followed by mackerel (7.9%) then pollack (8.8%). This result should be interpreted with caution as ambiguous question phrasing and a requirement for the skipper to specify five preference fish may have compromised accuracy. Nevertheless, it is unsurprising that bass are ranked 8th (6.5%) in the skipper list, as only ~36% target bass (Monkman 2013)—and then only seasonally—with gear hours dropping to as low as 11% of peak effort (Monkman 2013) in winter. Figure 3-6 contrasts the charter skipper customer preference (as reported by charter skippers) against amalgamated data from angler surveys, for species to which > 1% of anglers aspired to catch.

In general, surveys indicated that shore anglers target a greater variety of species, this observation is probably the result of a real effect, amplified by less avid or experienced anglers who are not specimen hunters optimistically answering, influenced by the interview situation.

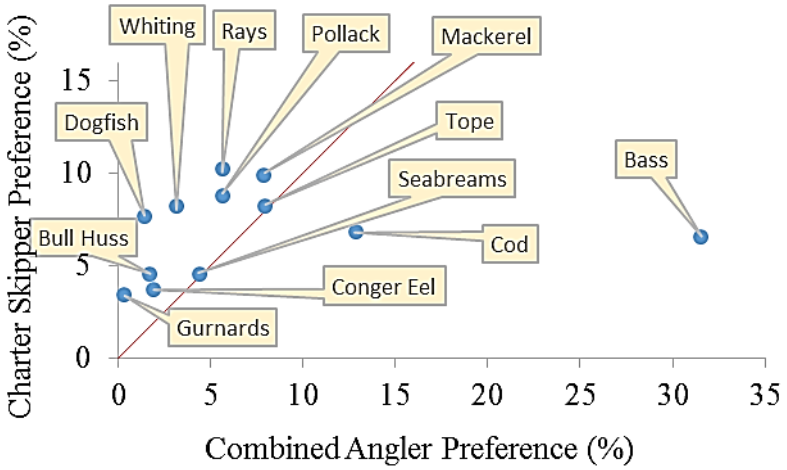


Figure 3-6. Charter skipper client preference plotted against combined angler preference for all species where preference proportion > 1%. Line shows where charter and angler preferences are the same. Based on amalgamated data from Richardson (2006), North Wales Recreational Sea Angler Pilot Surveys of Goudge *et al.* (2009, 2010) and This Survey.

Unfortunately, no surveys expressly sought to define the geospatial variation in target species, an overview for Wales was given by Drew (2004) and this is reproduced in Appendix 11. The list is not comprehensive, with surprising omissions. Bass and cod for example are not listed against the Menai Strait entry, despite these being key target species (seasonally dependent) for the area (expert knowledge). In addition, Drew's (2004) summary cannot hope to capture spatial variation at high resolution, where targeted species may vary within tens of metres of shoreline and from month to month.

Sea Angling 2012 found that 31% of shore anglers fish between 10pm and 6am (Hyder *et al.* 2013), yet it is likely that all survey methods under-sample shore based night fishing activity, owing to

operational considerations (e.g. safety). Such methodological nuances may underestimate target species rankings for particular species (e.g. cod and conger eel) and—under the assumption of increased catch rates at night—may also underestimate catch per unit effort.

3.3.2. Species Caught

Survey derived data on species caught by sea anglers fishing in Wales is severely limited, there exists no stratified random survey against which credible estimates can be made at either a fine spatial or national level. Available survey data for Wales is limited to the North Wales Recreational Sea Angler Pilot Survey (NWPS) of Goudge *et al.* (2009, 2010) and Richardson (2006). Richardson collated data from the magazine Sea Angler (SA) and the now defunct National Federation of Sea Anglers (NFSA), covering the years 1970–2004 (data filtered for 1990–2004 only).

Data from the NWPS and Richardson are tabulated in Appendix 5 however, the SA and NFSA data is angler submitted trophy data and will have considerable bias to prestige species. This bias will render the dataset unrepresentative of the relative proportions of species caught but provides a further indication of the species of generally higher value to anglers. Within the data, prestige bias explains the low proportion of mackerel (boat, 1.0%; shore, 1.1%) and dogfish (boat, 3.5%; shore, 1.4%) trophy reports, and supports the high value sea anglers assign to tope, rays, pollack, conger eel, bull huss and bass. These listed species are notable because of their maximum attainable sizes which range between ~5 kg to in excess of 50 kg for conger and it is notable that tope, rays, conger eel and bull huss have high release rates (see for example, Armstrong, 2012).

Appendix 5 tabulated data is summarised and presented graphically in Appendix 6, of particular note is the contrast between the frequencies calculated from Goudge *et al.* (2009, 2010) in which data were collected by direct observation and in-situ angler self-recording, whereas other sources are entirely self-selecting. The NWPS data presented high mackerel (20%), whiting (49%) and wrasse species (16.3%) catches, and undoubtedly gives a better representation of prosecuted species for shore anglers in North Wales. Unfortunately the survey was subject to accepted biases as a pilot assessment which sought in general to maximise angler-surveyor encounters (Rowland Sharp, NRW, pers. comm.). This approach would tend to under sample anglers in pursuit of prestige species, trophy fish and species hunters, who more frequently fish at remote or inaccessible venues, over certain tides and times of the year and under particular weather conditions.

Recognising that the data presented has no unbiased sources for charter boat prosecuted species, Sea Angling 2012 (SA2012) charter boat skipper derived survey data (Hargreaves *et al.* 2013) are presented in Figure 3-7. It is notable that mackerel (28%), whiting (14%) and dogfish (11%) are the top three species reported as caught in this SA2012 survey, and that the seabreams (5%) and bass (3%) are poorly represented in catches, similarly for tope (0.6%), which fall below the 1% cut-off point chosen

for the plot. It is possible that such a low figure for tope may not be representative of the Wales charter sector at a higher spatial resolution, which anecdotally relies somewhat on its tope catches (as reported by some charter skippers), particularly in Cardigan Bay.

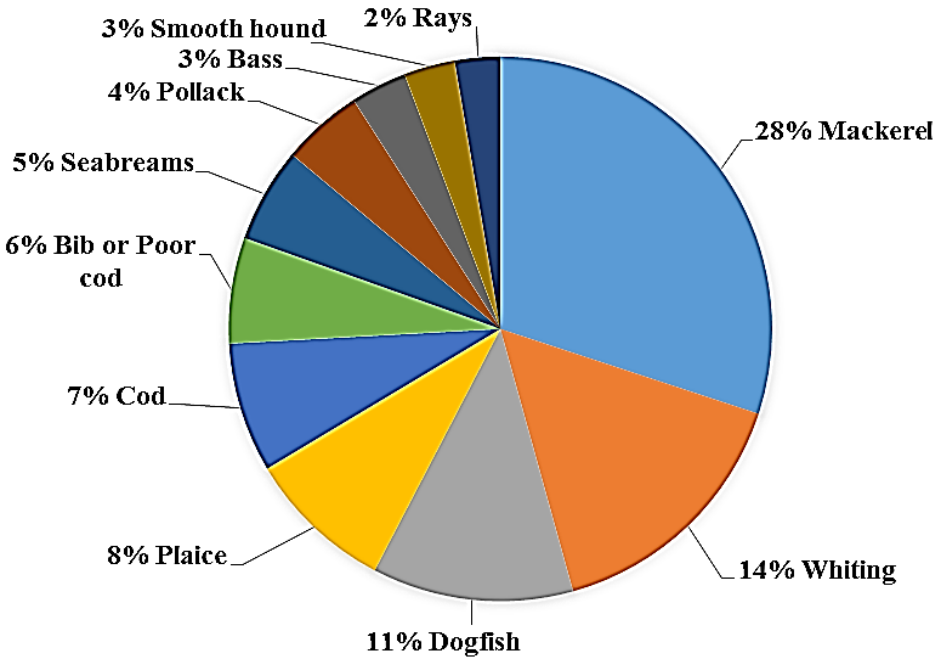


Figure 3-7. Charter boat caught species proportions for England, derived from Sea Angling 2012 charter boat surveys (Hargreaves *et al.* 2013). Total fish caught during survey work were 54,209.

3.3.2.1. Spatial Catches

Spatial data on catches for Wales are severely limited and the only spatially referenced dataset available with reasonable sample numbers were Richardson's (2006) Sea Angling magazine (SA) collated data. This SA data contained 964 separate capture records of 28 species (some of which are amalgamated categories, e.g. rare, sea breams and soles) but a significant proportion of records could not be differentiated by platform (charter boat, private boat and shore) and were data sparse for the angler aspirational species; mackerel, pollack, sea breams and tope. Bass, cod and rays were better represented (bass, n = 255, 26%; cod, n = 179, 19%; rays, n = 125, 13%) and the proportion of catches of these species by Marine Character Area (MCA) are presented in Appendix 7.

The spatial distribution of bass, cod and ray species catches are given in Figure 3-8 which visually adds weight to the general trend of increased catches of all species in the South Wales area. Cod landings in particular were much higher for South Wales in this historical Sea Angler data set. However, these data were undoubtedly subject to substantial biases and since data were recorded (1972–2003) expert knowledge would suggest that there have probably been substantial temporal fluctuations in species catch trends. Expert knowledge suggested for example that the Bristol Channel recreational cod and ray fishery has experienced a decline over time. Other biases which could have

had a significant influence on the displayed results include trophy catch reporting bias, no standardisation of effort across the coverage extent, methodological nuances in data collection and transcription, and changes in angler behaviour. The omission of recorded bass catches from the Tremadog Dwyryd Estuary area is also surprising and probably unrepresentative. Other potential sources of data that could be used include social media and the North Wales Recreational Sea Angler Pilot Surveys, but these were not available for use in this study.

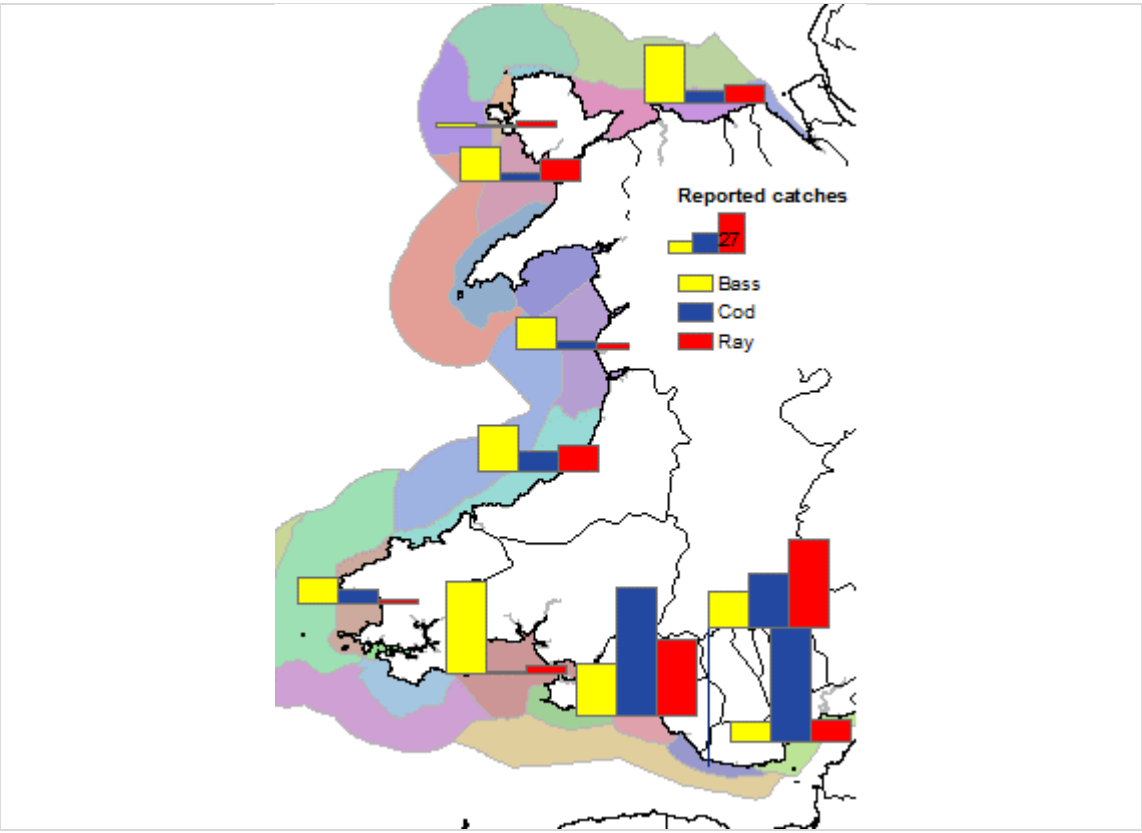


Figure 3-8. Catch frequencies of the 3 most frequently caught species (bass, cod and rays) by Marine Character Area from Richardson's (2006) Sea Angler magazine transcribed data for the period 1972–2003. These data are likely subject to a large degree of prestige bias and temporal changes in species distributions.

3.3.2.2. Release Rates and Post Release Mortality

Recreational sea anglers (RSA) frequently release the fish they catch (termed catch and release, C&R) with release rates dependent on many factors, including species, fish size, post-capture and pre-capture fish health, previously retained catch quantities, harvest control rules; ability and facility to store, process and transport; and angler outlook. Released fish also have different survival rates, with bleeding—strongly correlated to hooking location—a key survival predictor, along with other factors such as size, species handling time and water temperature (see review Bartholomew and Bohnsack, 2005). Both angler release rates and post-release mortality rates need to be quantified to minimise error in any national RSA estimates of RSA induced fish mortality.

Survivorship rates of European marine fish species following C&R is scant, with recent peer reviewed research only available for cod (Weltersbach and Strehlow 2013) though research is ongoing. More data is available on release rates, with Sea Angling 2012 (SA2012) providing a by species breakdown, which should arguably be representative of release rates in Wales. Richardson (2006) and the North Wales RSA Pilot Surveys (NWPS) of Goudge *et al.* (2009, 2010) provide species amalgamated catch rates. Goudge also collected by species release rates with an 'at release' survivorship estimate based on fish responsiveness, however these data were not made available.

Studies have shown that release rates are high in general (Table 3-1) and the unexpectedly low releases during the onsite observations of the NWPS (summer, 31%; winter, 31%) may be indicative of recall bias in the other surveys. Although it is more likely that NWPS recorded release rates were reduced under data aggregation by the elevated summer mackerel catches. It is also probable that match observations and self-recording errors and biases affected both summer and winter release estimates and these effects are expected to be of greater magnitude than recall biases in the Richardson (2006) and SA2012 surveys. In support, high release rates have also been recorded across multiple western European marine recreational fisheries according to the review of Ferter *et al.* (2013).

Afloat platform anglers in general had lower release rates than shore anglers (Table 3-1, Figure 3-9 and Figure 3-10). Likely explanations are fish size (*size effect*), intrinsic factors affecting survival rates (e.g. depth, gear used), transport, processing facilities and invested effort—the cost and time invested in boat angling increases the desire of a material return (*investment effect*). The higher afloat platform release rates for mackerel could be attributed to a *surplus effect*, and the marked difference in release rates for rays (afloat, 23%; shore 100%) should be treated with caution as recorded capture numbers were low. The difference in releases of wrasse species was unexpected (afloat, 51%; shore, 97%), this could be attributed to increased charter captures by novice anglers, or *investment* and *size effects* as outlined above. Average release rates for all species in SA2012 were 76% for shore and 51% for private and charter boats.

Table 3-1. Sea Angling 2012 release rates for important caught and target species in Wales for shore and afloat platforms (Armstrong and Hyder 2013b).

Species	Shore (%)	Afloat (%)	Species	Shore (%)	Afloat (%)
Bass	82	57	Rays[a]	100	23
Cod	56	27	Tope[a]	100	ND[1]
Dogfish	88	91	Whiting	87	66
Mackerel	9	28	Wrasse	97	51
Pollack	79	65			

[a]Small sample size; [1]No data

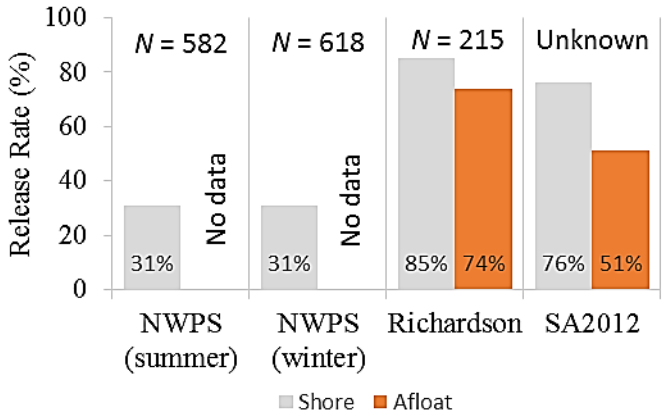


Figure 3-9. Release rates for all speciesfor shore (grey) and afloat (red) platforms across four surveys; NWPS, North Wales recreational sea angler pilot surveys for summer and winter; Richardson, Richardson (2006); SA2012, Sea Angling 2012 (Armstrong and Hyder 2013). Sample numbers (*N*) for NWPS was number of observed fish; for Richardson, the sampling unit was survey participant.

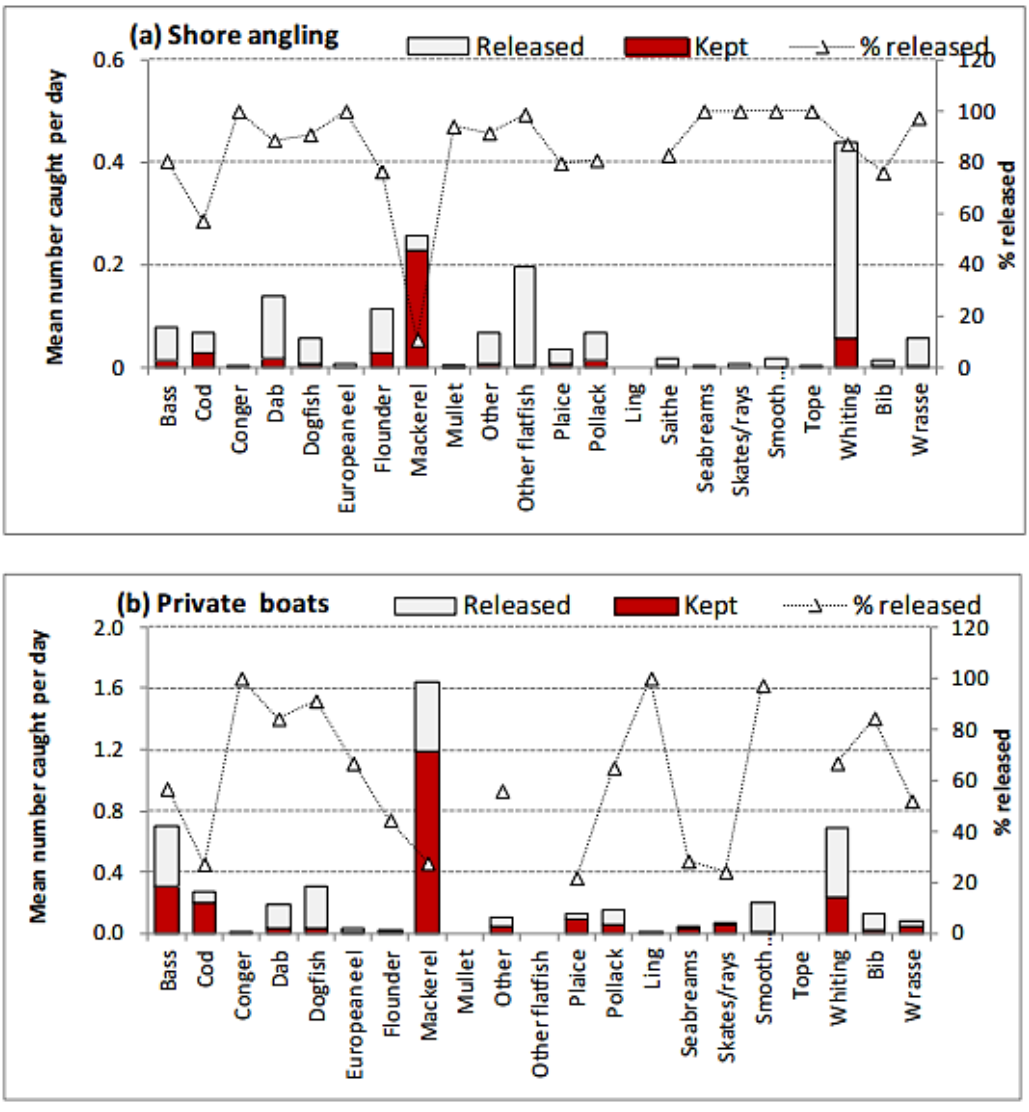


Figure 3-10. Sea Angling 2012 mean catch per unit effort by species (numbers caught per angler per day) for (a) shore angling and (b) private and rental boat angling. Triangles show percent releases. Reproduced from Armstrong and Hyder (2013).

There exists no specific assessment of C&R for Wales, in lieu of this, future estimates of RSA induced fish mortality could use the SA2012 C&R release rates which were incorporated into the SA2012 total estimates of bass and cod biomass removals for England. Aside from the not unreasonable implicit assumption that release rates for England are a good estimator of release rates in Wales, there were accepted limitations in the SA2012 as documented in the SA2012 reports. Sample sizes were particularly low for private and charter boat platforms and were generally low for some species (for example tope, Figure 3-10). Also measures of released fish were flagged as possibly subject to a high degree of uncertainty (Armstrong *et al.* 2013). Stock demographics are highly likely to influence release rates, yet little evidence is available on the relationship between the two. Further uncertainty is introduced through the poor understanding of post release mortality and sub-lethal effects, which remain largely uninvestigated for bass and European quota species, with the exception of cod (Weltersbach and Strehlow 2013, Ferter *et al.* 2014). Despite these issues inclusion of release rates—even those subject to bias—would undoubtedly improve RSA induced fish mortality estimates as part of any future national assessment of Welsh sea angling.

3.3.3. Bait Use and Bait Collection Activity

Bait[9] is an important component of recreational sea angling (RSA), with the majority of anglers still using a bait as their primary angling method (Figure 3-11A), though the increase in retailers offering specialist lure angling equipment and expert knowledge indicates an increasing popularity in fishing with artificials, particularly for predatory fish like bass.

Many anglers purchase bait for their fishing activities and bait costs were a major day expenditure. Sea Angling 2012 attributed bait as the highest expenditure at 11.4% of the total (Figure 3-11B) (Brown *et al.* 2013). Bait collection is an integral part of the hobby for many sea anglers, with 50% participating in bait gathering (56% from Brown *et al.* 2012, 50% from Richardson, 2006) and despite no formal treatment, it is conjectured that well-being enhancements are comparable to that of angling (see section 2.4). The significant amount of time and effort invested in bait collected in combination with the high population participation rates in RSA makes the consideration of sea angler bait collection—and that of commercial bait collectors—important in the context of marine spatial planning.

[9] Unless otherwise referenced, assertions made are primarily derived from expert and fisher knowledge sources and the authors' experience.

(A)

Fishing method	SHORE	BOAT
angling with bait	84%	48%
angling with lure/fly/jig	9%	26%
angling with mix of bait and lures	7%	26%
non-angling gears	0%	0%
mix of angling and non angling gears	0.1%	0.5%

(B)

Category	Annual Spend £m	Percentage of total spend
Trip spend		
Accommodation	107.8	8.7
Food and drink	135.1	11.0
Bait	140.1	11.4
Other fishing equipment	44.1	3.6
Car parking	18.9	1.5
Pier/harbour/launch fees	17.0	1.4
Charter boat/ boat hire	115.1	9.3
Boat fuel	34.7	2.8
Public transport	5.7	0.5
Other spending (incl. car fuel etc)	54.1	4.4

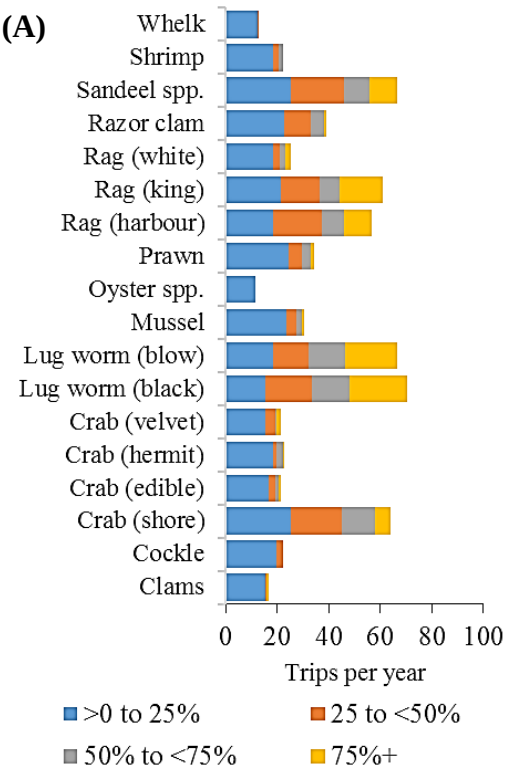
(C)

Bin	n	%
None	332	50.0
1 to 4	141	21.2
5 to 9	60	9.0
10 to 19	59	8.9
20 to 29	28	4.2
30+	44	6.6

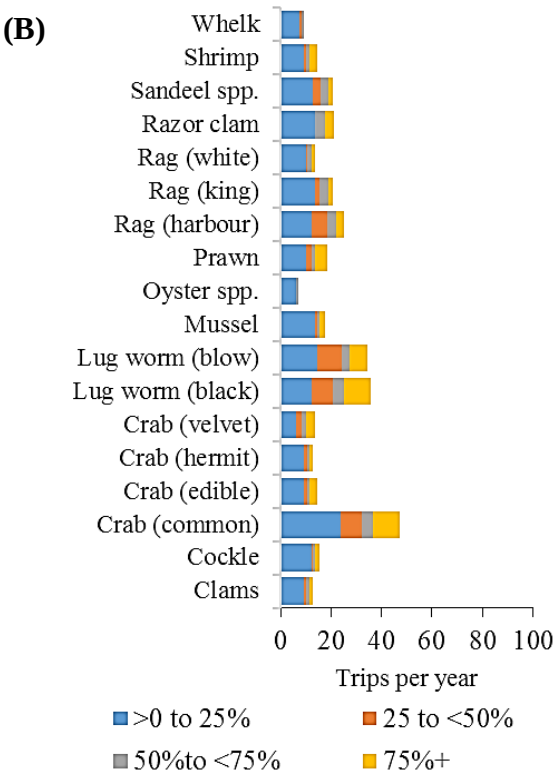
Figure 3-11. Fishing method proportions, spend and bait collection participation; (A) Fishing methods of primary respondents in Sea Angling 2012 (England coverage). (B) Day expenditures. Reproduced from Armstrong *et al.* (2013). (C) Percent respondent bait collection participation in Wales for the year 2003 from Richardson (2006), n is sample number, bin is categorical activity days year^{-1}.

RSAs collect a wide variety of baits, dependent on season, availability and intended target fish species. Collection methods vary but are primarily dictated by target bait species, collector preference, substrate and season. Different methods will have different efficiencies (and therefore target species mortality rates) and most notably, different environmental impacts; hence it is important to understand which species are valued by anglers and the methods employed to collect said species. Appendix 8 lists common baits used by anglers when fishing in Wales and section 3.3.3.1 gives a basic description of the major bait species.

(A)



(B)



(C)

Species	Collection Ratio
Clams	0.77
Crab (shore)	0.74
Whelk	0.71
Cockle	0.69
Crab (edible)	0.68
Shrimp	0.66
Crab (velvet)	0.64
Oyster spp.	0.60
Mussel	0.58
Crab (hermit)	0.57
Razor clam	0.55
Rag (white)	0.54
Prawn	0.53
Lug worm (blow)	0.52
Lug worm (black)	0.51
Rag (harbour)	0.45
Rag (king)	0.34
Sandeel spp.	0.31

Figure 3-12. Bait species usage proportions; (A) Number of trips per year summed by percentage use frequency categories in which the bait species was used in 2014, and (B) in which the bait species was collected by the respondents for angling trips in Wales in 2014 (*N* = 131). Table (C) is the total respondents who collected a bait (in any percent frequency category) divided by the total number of respondents who did not collect the species in Wales in 2014. See Appendix 8 for the binomial species names. These data from This Survey as detailed in section 3.2.1.

It is important to qualify that some baits which were traditionally provided by local collectors are now imported (e.g. lugworm) and/or farmed in the case of the king rag (*Alitta virens)*, with the exception of sandeel (which are only occasionally collected by RSAs). Angler preferences of bait use and collection derived from This Survey appear in Appendix 8 and provide an indication of favoured baits and those which tend to be purchased or collected.

Lug worms, common shore crab, sandeel and king rag worm were the most widely used baits according to survey response, Figure 3-12 shows that lug worms, sandeel and king rag tend to be purchased whereas the common shore crab tends to be collected. There is also a general trend that less common baits tend to be hand gathered, this is probably attributable to the baits' unavailability at tackle shops. Purchases of shellfish, squid and even soft shelled crab are made from 'traditional' UK and Asian supermarkets, though the extent of this market is currently unquantified.

It was beyond the scope of this study to map areas valued by RSA for bait collection, it is suggested that environmental niche mapping techniques, validated under expert knowledge, would provide a low cost method for assigning likelihoods to areas of importance.

3.3.3.1. Collection Methods and Impacts

3.3.3.1.1. Lug worms

Lug worms are abundant on Welsh beaches, where they have a high affinity for fine and muddy sands, but are largely absent in muds, coarse sand and gravel (see Longbottom, 1970). There are two species, *Arenicola defodiens* (black lug worm) and *Arenicola marina* (blow lug worm). Both are highly valued by sea anglers for their ability to catch most species of fish and widespread availability, particularly of blow lug which can be found at the mid tide level, as opposed to the black lug which tend to be at the spring low tide mark. Black lug are both larger and more robust, which makes them conducive to preservation by, for example, freezing, hence black lug are more highly valued than blow lug. Black lug is also commercially exploited and it is possible that over exploitation has reduced abundance at small spatial scales.

Traditionally both species were dug with a fork or spade, blow lug in particular were trench dug when densely distributed and these digging activities negatively impact resident fauna, though this is highly dependent on activity level and the benthos[10]. An alternative method, which has grown in popularity, primarily due to the reduced effort required, is to use a bait pump, which is particularly effective in the extraction of black lugworm and much reduces the volume of sediment excavated (see Figure 3-13).

[10] See http://www.ukmarinesac.org.uk/activities/bait-collection/bc19.htm for a review of the bait collection scientific literature.

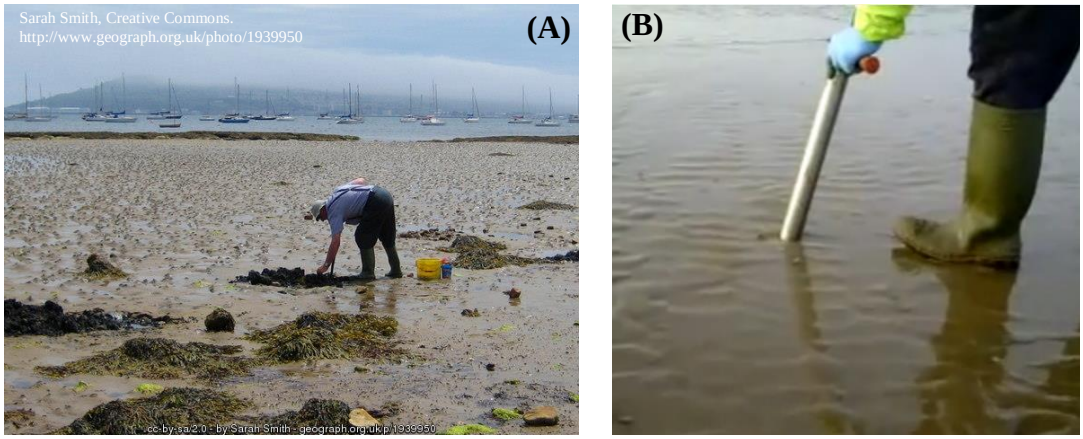


Figure 3-13. Collecting lugworm, (A) digging blow lug worm, and (B) pumping black lug worm using a bait pump.

3.3.3.1.2. Prawn and shrimp

Prawns species, primarily *Palaemon serratus*, are used as live bait for predatory species such as bass and pollack or ledgered dead for a variety of species. The popularity of prawn and shrimp is limited (Appendix 8; 34% used, 18% collected) probably due to its highly patchy distribution at fine spatial levels (see for example Grenfell 2013), fluctuations in seasonal availability (Rodriguez 1972) and difficulties in transport and storage. *P. serratus* are associated with sublittoral and mid to low level rocky shores and have a preference for sheltered waters (Rodriguez 1972). Prawns are captured for recreational use by netting with a hand net in rock pools and areas with high macroalgal coverage. Drop nets and dedicated traps may also be employed. Though no formal scientific literature is presented here, prosecution is suspected to be low and to have minimal effect on local habitats. For further information on *Palaemon serratus* pertinent to Wales see Grenfell (2013)[11].

The brown shrimp, *Crangon crangon* inhabits the muddy and sandy substrates of the shallow subtidal and sublittoral[12]. The use of brown shrimp by RSAs is similar to that of *P. serratus*, though it is less valued as a live bait due to its smaller average size (expert knowledge) (Appendix 8; 22% used, 15% collected). Brown shrimp is captured for bait using a push net, is widely available and impacts of collection by anglers are likely to be negligible due to low levels of collection activity.

3.3.3.1.3. Rag worms

Each of the three species of rag worm collected for bait are dug with spade or fork, though each species inhabits different substrate types. The primary bait species is the king rag (*Alitta virens*) which is extensively farmed for supply to tackle shops (Appendix 8; 61% used, 21% collected), they inhabit littoral and sublittoral mixed muddy sandy gravels, and are highly valued as a bait, for their wide appeal to many species, but in particular for bass and float fished for wrasse and pollack (expert

[11] http://fisheries-conservation.bangor.ac.uk/wales/documents/27_000.pdf
[12] http://www.marlin.ac.uk/lzspeciesreview.php?speciesid=3078

knowledge). The general availability of farmed worm has probably reduced the importance of rag worm beds and digging activity is probably significantly less than that for lug worm, though exploitation in the past has been high and may have been unsustainable (Coates 1983, Olive 1993).

Of the other species, the white rag worms (*Nephtys caeca* and *Nephtys hombergii*) are very highly prized. They are found in the littoral and sublittoral zones in sandy sediments but despite their high perceived value to sea anglers, their utilisation as a bait is below that of the lug worms and king rag (Appendix 8; 26% used, 14% collected). Lower angler usage levels are attributed to the difficulty in locating and storing them (expert knowledge). The harbour rag worm is very wide spread, preferring estuarine muddy sediments. Its level of exploitation was unexpectedly high according to This Survey (Appendix 8; 56% used, 25% collected). This high exploitation may be explained by confusion with other species by respondents as expert knowledge suggests that actual exploitation is low. The harbour rag may be opportunistically harvested while collecting other bait species or hand gathering.

3.3.3.1.4. Sandeel

Lesser and greater sandeel are a popular bait (Appendix 8; 66% used, 21% collected) where they are primarily purchased frozen from tackle shops. When dead, sandeel are ledgered for a wide variety of species and are particularly popular when targeting the rays in combination with squid. They are very highly valued as live bait in particular for bass, primarily from boat platforms where a live well will be installed to keep them alive for the duration of the fishing trip, they are occasionally used by shore and kayak anglers (expert knowledge). The high usages will primarily be from anglers using frozen sand eel nevertheless, some tackle shops and other retailers supply live sandeel when in season—between June and around late September—and these will almost certainly be captured locally and can be an important part of the business model of some RSA service providers.

Sandeel inhabit shallow waters over sandy substrates and will bury into the sand as an anti-predator strategy[13]. They are not commonly harvested by sea anglers for bait (expert knowledge) owing to the specialist equipment required to catch them and to keep them alive. Anglers typically harvest them from the shore with a seine net, or, probably more frequently, using a towed net from a boat, where they will frequently be captured and kept in a live well for same day use. An alternative method is to use a sandeel rake, but this method has largely been superseded with the availability of cheap nylon netting.

Benthic habitats are unlikely to sustain damage from harvesting, due to the light fishing gear used and the high mobility of the sediments affected. The mesh size of sandeel nets will be small (< 1 cm) and their capture will undoubtedly be associated with a bycatch, however the netting activity of sea

[13] http://www.marlin.ac.uk/speciesinformation.php?speciesID=2480

anglers is thought to be minimal and detailed research on RSA prosecution levels and associated impacts is probably unnecessary unless specific local concerns are expressed.

3.3.3.1.5. Shellfish

Of all the shellfish, *Ensis* species were the most commonly collected and used as bait (Appendix 8; 39% used, 21% collected). *Ensis* spp. are valued by sea anglers and local extirpation by hand gathering or other methods for commercial sale, or grey marketeering may negatively impact sea anglers. Levels of exploitation and the effects of harvesting of other bivalve species and molluscs (e.g. the common whelk) in Wales by RSAs are not known, though is minimal and primarily opportunistic in nature (for example whelk may be encountered at the spring low tide mark while collecting *Ensis*.).

3.3.3.1.6. Shore, velvet, hermit and edible crabs

Crabs are highly valued as a bait and are used for many species, but in particular bass, smooth hound and autumn cod. Crabs are collected for use during ecdysis; they are known as peelers just prior to moulting and soft crab (softies) after moulting, but while their exoskeleton has not completed hardening. Crab species habitat affinities are widely research and won't be dealt with here. Velvet and edible crabs will generally be opportunistically harvested while gathering shore crabs, as both velvets and edibles tend to be found near the spring low water mark. The shore crab was the most widely harvested bait (Appendix 8; 64% used, 47% collected), this may be attributable to the ease in which they can be kept, their ubiquity on the shore line and their reputation as an excellent bait in particular for bass, cod, flounder and smooth hound.

Shore crab are also captured with refuge traps, with anglers and professional bait collectors laying crab shelters around the mid shore line. A variety of shelters are used; typically car tyres, roofing tiles or half pipe guttering. Crabs approaching ecdysis seek refuge within shelters laid on the shore where they are then collected. Traps are laid in places of low tidal and wave energy and are typically associated with muddy substrates, and they may be used year on year and become highly valued by local sea anglers particularly during early spring and autumn where the densities of moulting crabs across the shore are low.

Removals of crab can have negative impacts, in particular rock turning which can be extensive (Johnson 1984), crab shelters could reduce this activity but there has been no assessment of its impact on Welsh venues. In broader terms detrimental impacts have not been strongly evidenced but could be primarily associated with 'footfall' involved in regular shelter checking in high activity areas[14]. Certainly the popularity of crab as an angling bait would mean restrictions on crab trapping and collection could be expected to negatively impact sea anglers and commercial bait collectors.

[14] http://www.ukmarinesac.org.uk/activities/bait-collection/bc2_6.htm

3.3.4. Angling Location Preferences

Survey respondents (N = 136) ranked 12 different shore location types according to their preference (Figure 3-14A), surf beaches were the most popular within the sample, followed by sheltered beach. Least popular were kayak, and power station outfalls and promenades. The low ranking of kayak and power station outfall location types was undoubtedly attributable in part to the availability of these platforms, with there being limited warm water power station outfalls across Wales and only 7.8% of anglers participating in kayak angling according to This Survey (noting a likely avidity bias towards the kayak platform).

Venue types which elicited the strongest ranking polarization (Figure 3-14B) were the afloat platforms, indicating that anglers who accept the additional costs of these methods—which tend to have higher CPUE (Richardson 2006, Armstrong *et al.* 2013a)—hold a strong preference for them. Anglers who do not choose to fish afloat express the lowest preference for afloat platforms. The polarization scores of Figure 3-14B suggest that sea anglers **on average** are ambivalent to estuarine creek systems, and piers and breakwaters, though individuals may still highly value such areas for their particular unique qualities (for example estuarine creek systems can be particularly productive for thick lipped grey mullet). In totality, these results are almost certainly subject to a large avidity bias (see Figure 3-2A) and in terms of Goudge's classification (Goudge *et al.* 2010, Goudge and Morris 2011) casual and novice anglers were under represented in the sample hence the preference ranking of easy access venues (e.g. promenades) may be under-ranked when compared to the location ranking in the angling population as a whole.

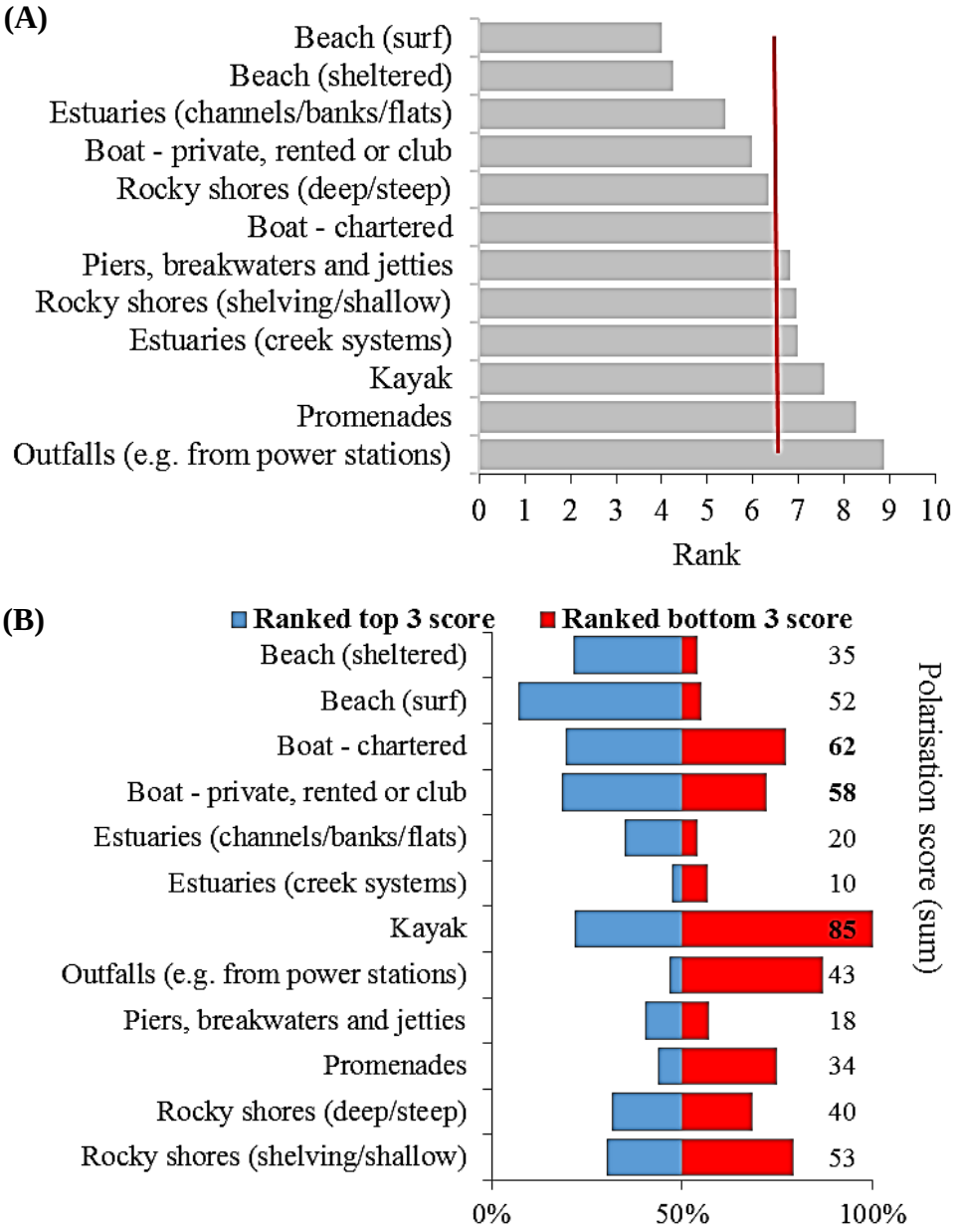


Figure 3-14. Angler venue type preferences. (A) Weighted ranking of venue types by preference (**lower is better**), red line is the mean ($\bar{x}$ = 6.5). (B) Blue bars: sum of top 3 ranked venue types (1st weight = 1, 2nd weight = 0.5, 3rd weight = 0.$\overline{3}$); red bars: sum of weighted bottom 3 ranked venue types. Polarisation score is the sum of the top and bottom 3 ranked values, interpretable as venue types which illicit a stronger response (both positive and negative) to venue type. Highest three polarisation scores are bolded. *N* = 136.

3.3.5. Other Recreational Fishing Methods Used by Anglers

The primary focus of this study is recreational sea angling, however other methods are employed by the recreational sector to catch fish in Welsh waters. It is important to be aware of the extent and impacts of these methods under marine spatial planning and to track temporal changes in activity levels to determine if increased assessment effort would be justified. Some methods may also be perceived as potentially conflicting with commercial fisheries, as exampled by crab and lobster hobby potting.

There exists no published survey data on the activities for Wales which specifically identifies recreational fishing activities which do not use rod and line despite the concerns of such activity (in particular gill netting) among sea anglers[15]. This Survey included a question to indicate the relative usage levels of such methods by respondents (N = 139). Results are given in Figure 3-15A, with potting accounting for the greatest activity among surveyed anglers, totaling 18% involved in some form of potting activity during 2014. Hobby potting was frequently reported as an area of conflict by commercials (Pantin *et al.* 2015) and is briefly discussed in section 3.3.6.1.

Sea Angling 2012 (SA2012) (Hargreaves 2012) also enquired if anglers used alternative gears and for comparison these results are summarised in Figure 3-15B. There are considerable differences between This Survey and the SA2012 survey nevertheless, both surveys indicate that non-rod and line fishing may occur at significant levels. In light of a probable increased efficiency (catch per person per unit time) of fish targeted extractive methods (e.g. netting) and the expected lower release rates in comparison to RSA then further assessment would appear justified.

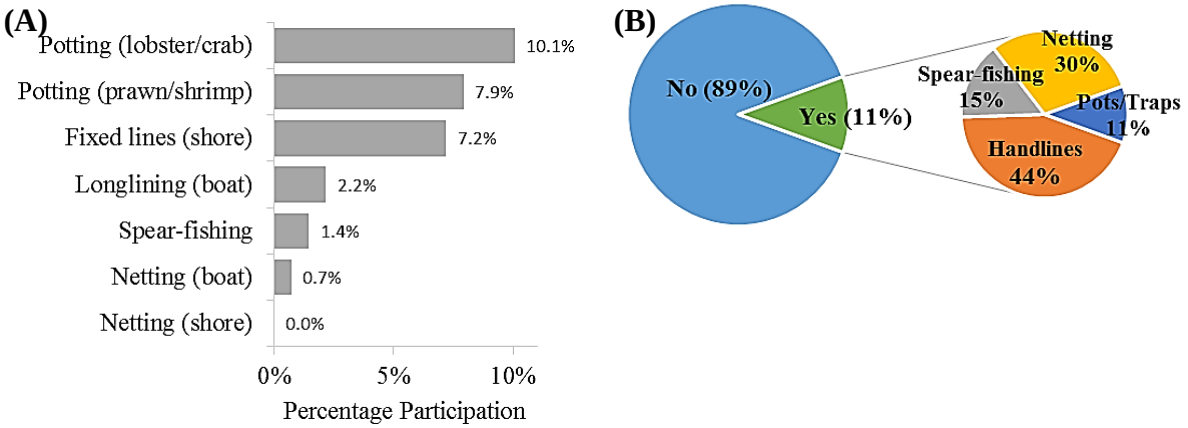


Figure 3-15. Other recreational fishing methods. (A) Percentage of This Survey respondents (N = 139) participating in the specified recreational sea fishing activity and (B) percentage of sea anglers participating in non-rod and line sea fishing according to question *Do you use any gear other than rod and line*? (N = 256), reproduced from Hargreaves (2012).

It is important to emphasize that it would be incorrect to undertake a population expansion from This Survey sample data and the participation proportions are likely subject to an avidity bias (Figure 3-2), with keen anglers probably engaging more frequently in other recreational sea fishing activities. The apparent differences between the SA2012 results and This Survey—as exampled by potting and netting activity levels—are likely caused by multiple factors, not least different survey target populations. This confirms that further detailed work is required to fully elucidate non-rod and line recreational sea fishing activity. It is also notable that the two surveys only include anglers who use alternative gears, excluding non-angling sea fishers, who as dedicated fishers would be expected to have increased absolute effort and CPUE.

[15] For example. http://www.fishingandforagingwales.co.uk/blog/, http://www.thenationalmulletclub.org/netting.htm, http://www.ukbass.com/wp/wp-content/uploads/2013/04/news6.pdf

3.3.6. Interactions with Other Users

Recreational sea angling (RSA) is one of many activities which share resource and space within the marine environment yet little information is available on how different marine users and usages interact with RSAs within a common geospatial and temporal space. This Survey (See Annex 1, Q20 – Q31) asked anglers to rate other marine activities for *what positively or negatively affected their fishing* (see Figure 3-16).

Recreational fishermen using methods besides rod and line (e.g. netting) and *Commercial fishing with nets* elicited the largest total response at 23% with 86% of these responses negative. Both *other recreational fishers* and *commercial fishing with nets* relate to other marine users capturing fish. Aquaculture and commercial shipping elicited the lowest total number of responses at 6.1% and 5.3% respectively. Wildlife and aesthetics produced the largest positive proportions, with 9.9% of total responses, 84.6% of which were strongly or weakly positive.

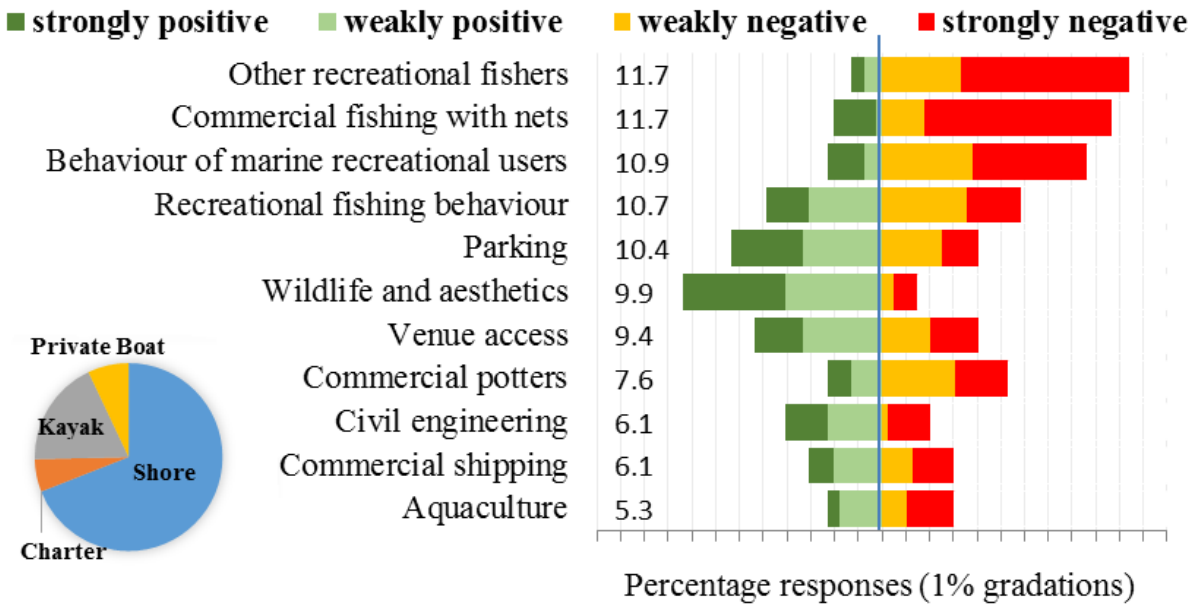


Figure 3-16. Likert scale response proportions to the question "*what positively or negatively affected [your] fishing*" by categories of interaction entities (N = 71). Categories were predefined on the questionnaire, for display, the category *Recreational fishermen using methods besides rod and line (e.g. netting)* was truncated to *Other recreational fishers*. Inset pie chart gives platform proportions specified by respondent to which the question applied. *Other recreational fishers* excludes recreational rod and line catch, for example gill netting and spearfishing. Vertical axis figures gives the total category response percentage (all positive and negative responses within the category).

In addition to the predefined categories, respondents were also able to provide an open ended response, these were collated and are produced verbatim in Annex II. Categorised open ended responses—following removal of extraneous words—were input into Wordle (Feinberg 2015). Figure 3-17 is the resulting word cloud for all responses and additional word clouds segregated by response category (e.g. other recreational fishers) are reproduced in Appendix 9. Though word clouds are open to interpretation with the inherent loss of context of the original words, several unambiguous key

words, indicative of perceived conflicts, are apparent, in particular; access, commercial [fishing], jetskis, litter, netting and parking. These factors though potentially important may not directly decrease effort however, these initial results may warrant a more rigorous treatment.

The frequency of some words may be associated with their appearance in the survey category and question phrases however, jetskis, powerboats, trawlers, litter, undersized and illegal (Figure 3-17) did not appear in the questionnaire. Also of note is that bass appeared in 4 of 7 (57%) word clouds and was the only species to feature, once again highlighting the elevated value of bass in the collective consciousness of the recreational sea angler.

Figure 3-17. Word cloud of all open ended responses to This Survey question *what positively or negatively affected [respondents] fishing* at a maximum of 3 respondent specified Welsh locations. Word cloud produced using Wordle (Feinberg 2015).

3.3.6.1. Conflicts of Interest with the Commercial Sector

Other work by Bangor University's Fisheries and Conservation team (Pantin *et al.* 2015) used a survey questionnaire approach to—among other aims—determine the conflicts experienced by commercial fishers in Wales. The questionnaire did not use the term recreational and/or angling, but potential pertinent categories with some degree of overlap with RSA activities were hobby fishers, hobby potters, illegal fishers, pleasure and tourism boaters, and sea fishers targeting the same species.

Pertinent data from Pantin *et al.* (2015) are presented in Figure 3-18. The largest reported conflict was with sea fishers targeting the same species as the commercial interviewee (interviewees using static gears, 34%; interviewees using mobile gears, 25%), although the proportion directly attributable to RSA cannot be made. Hobby potting (which some RSAs engage in, see section 3.3.5) was the second highest area of conflict. In addition the categories hobby fishers and illegal fishers are likely to have a degree of overlap with the hobby potting category and commercial fishers complained about a lack of enforcement of hobby potting regulations (Pantin *et al.* 2015). It is important to note that the extent of hobby potting practiced during angling trips remains unassessed as a proportion of all such

activity but in general terms the commercial potters interviewed indicated that hobby potting has increased over the last 5 years (Pantin *et al.* 2015).

According to Pantin *et al.* (2015), commercial fishers' conflicts with recreational boaters—some of which would be expected to be anglers—were mainly recorded as interference with static gears (anchoring on buoys and moving gears) and simply being a mechanical obstruction to the commercial fishers' activities.

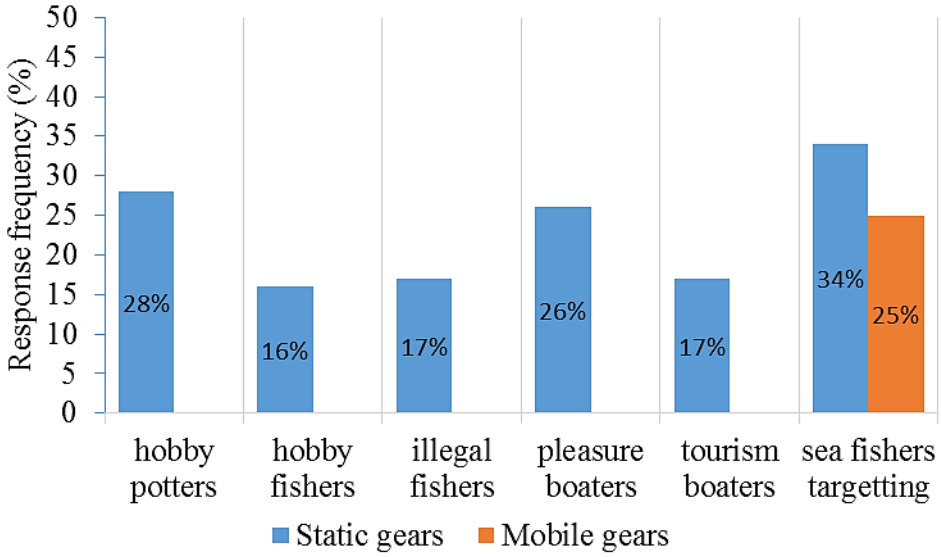


Figure 3-18. Percentage conflict frequency—by respondent nominated areas—of potential sea angler related activity. Note that non-relevant categories have been omitted for clarity, hence total percentage ≠ 100%. Sea fishers targeting = sea fishers targeting the same species as the survey respondent. Static and mobile gears refers to the fishing method of the respondent and not that of the conflicting activity.

3.3.7. Sea Angling Organisations

The distribution of clubs identified in this study is given in Figure 3-19. Established sea angling clubs dominate in South Wales with 38 (81%) of the total, with 9 (19%) in Mid and North Wales. It is difficult to estimate the quality of coverage although the relative proportions are assumed to be representative.

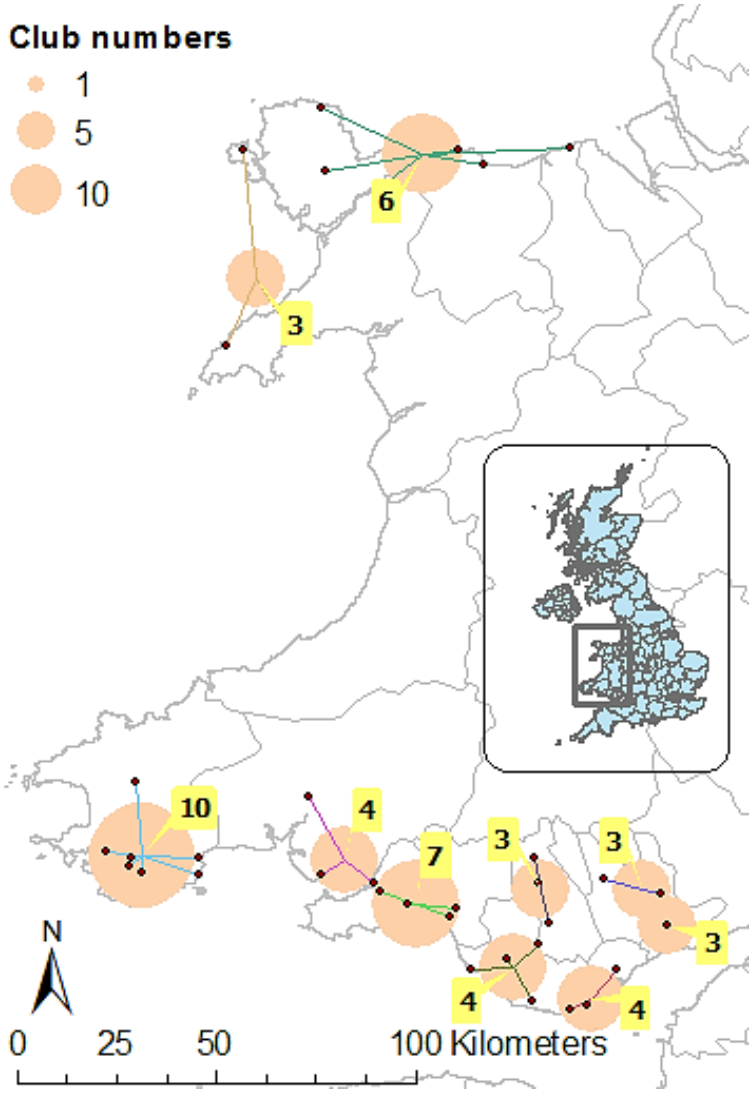


Figure 3-19. Distribution of sea angling clubs, dots are locations. Locations clustered (circles) using k-means procedure and club count labelled at cluster centroid.

The Welsh Federation of Sea Anglers[16] is the governing body of RSA in Wales and is an umbrella organisation for sea angling clubs both within and outside of Wales. It was formed in 1955 and seeks to provide a unified voice to lobby for the sport, its members and affiliated clubs. The WFSA has 37 Welsh club and 19 English club affiliates (May 2015) and it is instrumental in the organisation of matches at local, national and international levels. Appendix 10 details anticipated match participant numbers (Roger Cook, FSA pers. comm.), which totals 2,440 competitors taking part in matches across Wales in 2015. Mean participation rates per match based on the WFSA provided list is 60 anglers.

Clubs frequently organise matches independently, although all matches offer one or more prizes for fulfilling certain winning criteria. In the past, matches were based on fish weights taken at the end of the event. As a consequence, fish meeting the match's minimum landing size criteria were frequently

[16] http://www.wfsa.org.uk/

returned dead or unlikely to recover. Over the last decade there has been a decrease in the popularity of this match format and in 2015 almost all matches are catch and measure, with fish being release after a length measurement has been recorded and witnessed.

4. ECONOMIC ASSESSMENT OF SEA ANGLING IN WALES

4.1. Introduction

Existing information about the economic characteristics of sea angling in Wales is sparse and it is often related to the angling activity in England. The economic importance of sea angling specific for the Welsh territory is therefore needed, not only to assess the specific cash flow that the activity generates in the region, but also to evaluate future opportunity for investments.

The aim of this economic study is to determine the economic value of recreational sea angling (RSA) in Wales by estimating the direct effects of the activity in Wales (total spend) and the indirect and induced effects, in terms of the economic impact on the angling related sectors, as well as income and employment effects.

4.2. Review of Economic Assessments

Multiple studies have tried to estimate the economic impact of activities associated with marine and coastal resource usage in Wales (National Trust 2006, Chambers *et al.* 2013, TNS Global 2014a, TNS Global 2014b) but few have focused on the economics of recreational sea angling activity. The following studies have sought to assess the economic impact of angler expenditure in the UK.

The Nautilus Consultant study (2000) estimated that commercial and recreational fisheries contributed over £100 million annually to the Welsh economy and provided the equivalent of full-time employment for 1,600 people. Sea angling activity was sub-divided into shore, charter and private boat, and the year into three seasons (winter, spring and summer) and was estimated to generate a turnover of £28.7 million and full-time employment for 471 people. Nautilus (2000) estimated participation of 12,000 local-resident anglers and 28,000 visiting anglers. These estimates were based on the direct effect only and would have been greater if the analysis had been extended to include indirect and induced effects.

Drew Associates (2004) estimated that resident sea anglers in England and Wales undertook 12.7 million days of activity and spent a total of £538 million. The total spend by sea anglers was estimated to support 18,889 jobs and £71 million in income to suppliers. These estimates were based on the direct effect only and would have been greater if the analysis had been extended to include indirect and induced effects.

Simpson and Mawle (2005) undertook a study of public attitudes to angling in England and Wales to assess the levels of participation in freshwater and sea angling. Omnibus surveys were used to estimate participation rates in the population. For sea angling, they reported that 7% of the population of England and Wales had sea-fished in the two years preceding the study. Based on this picture, the

number of people aged 12 and over who had been sea angling was estimated to have been around three million.

A second Nautilus Consultant study (Cappell and Lawrence 2005) examined the economic contribution of sea angling in the South West of England. The study estimated that sea angling generated £165 million of expenditure within the region each year. Out of this amount, £110 million was from resident anglers (estimated to be 240,900 people) and £55 million from visitors, who spent 750,000 days sea angling in the region.

Radford *et al.* (2009) published a second study focused on recreational sea angling activity in Scotland. The study reported numbers of local and visiting anglers by type (shore, private and charter boats) and angler expenditure, and estimated the economic impact of sea angling to regional incomes and employment. The study estimated that sea angling supported 3,148 full time job equivalents (FTEs) and £69.67 million annually of Scottish household income in the form of wages, self-employment income, rents and profits. They concluded that a cessation of sea angling would lead to a net loss of at least 1,675 FTEs and annual income loss of £37 million.

A recent assessment on the value of the seven SACs in Wales for recreational activity (diving and sea angling) (Kenter *et al.* 2013) showed that these areas supported an annual recreational value of £68–122 million and generated a one-off non-use value of £66–129 million. Anglers in particular made an estimated 2.0–3.7 million visits to Welsh marine SACs, thus providing useful data for future marine protected area designation in Wales. These results, although characterized by considerable uncertainty due to the small sample size, demonstrated the economic benefits of conservation.

Finally, the most recent comprehensive study on RSA in England has been published in 2013 and provided a picture of the economic activity associated with RSA residents of England (Armstrong *et al.* 2013a). The analysis revealed a pattern of direct spending activity by sea anglers as well as how this spending supported other activity in England through supply chain and household income effects (Brown *et al.* 2013). Total resident sea angler spending in England was estimated to be £1.23 billion, a value that fell to £831 million once account was taken of imports and taxes. This £831 million of spending was estimated to directly support some 10,400 FTE jobs and almost £360 million of gross value added (GVA). When indirect and induced effects were accounted for, the £831 million of direct sea angler spending supported a total of £2.1 billion of total spending, over 23,600 jobs and almost £980 million of GVA.

4.3. Methods

4.3.1. Data Collection

Original data on anglers' expenditures were collected by Bangor University as part of a PhD research project during 2003 and 2004 (Richardson 2006). Although these data are currently published in the form of a PhD thesis, it represents a unique source of information on sea angling activity in Wales. Information on angler expenditure was collected through a questionnaire scheme (Annex 2– Richardson Angler Questionnaire). The questionnaire asked respondents to describe the frequency, nature and location of their angling activities, expenses on their most recent trip (e.g. food, transport) and on items not related to single trips (auxiliary expenses hereafter, e.g. magazine subscriptions, equipment, boat storage), and personal details such as gender, age, hometown and household income. The questionnaire, also supported by the Welsh Federation of Sea Anglers (WFSA), was either distributed by the main researcher or was distributed accompanied by an explanatory note through angling clubs throughout Wales. To increase the sample size, the questionnaire was also web-based, allowing respondents to answer the questions online. The data on angling expenditures were collected by Richardson (2006) during 2003–2004.

4.3.2. Data Analysis

4.3.2.1. Inflation adjustment

Angler expenditures disaggregated by expenditure type were extracted from the survey data conducted during 2003 and 2004. Ten main categories of angler expenditures were identified: angling equipment, boat, travel, bait, charter fees, food and drink, magazines and books, competition fees, membership fees and accommodation. Each category included one or more items, according to the interview scheme (Appendix 12).

Interviewees estimated their own expenditures at the category level and not at the item level. For a correct assessment of the inflation of each category, the relative importance of each item was first estimated. For the category "boat costs", which includes four items (maintenance, fuel, insurance, storage and launching fees), the relative importance of each item was estimated on the basis of data collected on small scale commercial vessels using rod and line in Wales (Cambiè *et al.*, unpublished data). For the categories "travel," "food and drink" and "magazine/books" the relative importance of each item was arbitrarily estimated. In particular, for the "travel" category, the fuel was assumed to be the most important item, covering 80% of the total expenses, while car rental and parking were considered to have the same importance (10% each). Conversely, for the categories "food and drink" and "magazines and books", the relative items were assumed to have the same importance.

The inflation of each item over the 10-year period (2003-2013) was calculated by using the relative Consumer Price Index (CPI) and represented the percentage change in the index of 2013 compared to the value recorded in 2003. A weighted average of the inflation rate for each items was then calculated to estimate the inflation per category (Appendix 2).

For "bait" and "charter fees", a different approach was used to estimate the relative inflation, as these categories were not represented in the CPI tables. For the category "bait," the inflation was estimated by comparing the price of ten different types of bait (blow lugworm, black lugworm, razor clam, mussel, crab, squid, mackerel, sand eel and rag worm) purchased by Bangor University for research purposes over the last ten years. Finally, for "charter fee" we collected information on the current price of a trip from ten charter boats around Wales (representing ~20% of the entire population of charter vessels in Wales) and calculated the inflation by comparing the average price per hour obtained with the price per hour estimated from the interviews in 2003 (Appendix 12, Table B).

4.3.2.2. Bias correction

In accordance with Brown *et al.* (2013), a disaggregated grossing up process was designed to overcome the expected issues of bias in the survey data. The results were expected to be highly skewed towards the keenest and active sea anglers in Wales, with their angling related expenditures higher than that of the average angler. This inherent bias was overcome by splitting the survey data by two key angler characteristics: frequency of angling and age. Three frequency categories were used: occasional (up to 12 days per year fishing), regular (13 – 35 days per year fishing) and frequent (more than 36 days per year fishing). Five different age categories were used: aged 16–24, 25–44, 45–54, 55–64 and 65–74. Under sixteens were excluded. Survey results were split into 15 different groups. The average profiles, in terms of spending by category (e.g. bait, angling equipment, trip, etc.), were then derived for each of these groups. Once these average profiles had been derived, each group was then grossed up to the total population of each group as estimated by the ONS survey (Brown *et al.* 2013). The grossed up total was therefore weighted to the target population of the ONS survey.

4.3.2.3. Expenditure estimation of visiting (non-resident) sea anglers

Out of the 687 anglers interviewed during 2003–2004 (Richardson 2006), 668 anglers indicated their area of origin; 364 (54.5%) were from Wales, 300 (44.9%) were from England, two (0.3%) were from Scotland and two (0.3%) were from overseas. When considering the expenditures of UK (domestic) sea anglers to the Welsh economy, data from resident ("Welsh sea anglers") and visiting ("other UK sea anglers") were analysed separately. It was assumed that visiting sea anglers made part of their expenditures outside Wales, therefore, their annual costs of angling equipment, boat expenditures (e.g. storage), magazines/books, membership fees and other annual costs were not taken into account. The

contribution of angling related tourism activity from visiting sea anglers to the Welsh economy was then estimated for both overnight stays and one day trips.

Of the visiting sea anglers, 47.2% (n = 142) were on an overnight trip when interviewed, with an average of 3.4 nights per trip. To estimate the cost of the accommodation, sea anglers that spent nights over at family and friends' houses were not taken into account. A 95% confidence interval for each mean expenditure (mean ±1.96 standard errors) was also provided. The expenditures during an average overnight trip were first estimated and the corresponding inflation was then applied. These estimates were then multiplied by the total number of overnight trips from tourist holidays in Wales (domestic holidays) involving sea angling, estimated from the Great Britain Tourism Survey (GBTS) in 2013.

52.8% (n = 159) of the visiting sea anglers interviewed were on a day trip. The related expenditures were first estimated and then inflation was applied. A 95% confidence interval for each mean expenditure (mean ± 1.96 standard errors) was also provided. From the Great Britain Day Visit Survey (GBDVS) in 2013 we estimated that in Wales, 1 million day trip visits[17] were angling related and 36.4% of the anglers on these trips came from outside Wales. Sea angling represented 40% of the total angling activity (sea angling + coarse fishing + game fishing) (Simpson and Mawle 2010) and this percentage was then applied to the 364,000 one day visits, for a total of 145,600 one day visits from visiting sea anglers. The total expenditures estimated were then multiplied by the 145,600 one day angling related trips that came from outside Wales.

4.3.2.4. Expenditure estimation of resident sea anglers

Average annual expenditures on food and drink, travel, bait, boat costs, charter fees, competition fees, membership fees, angling equipment, magazines and books and other general costs were calculated by angling category from the interview data. Respondents were asked to estimate the proportion of their spending inside Wales and this proportion was thus applied to their expenditures, which were then adjusted for inflation. For each expenditure, the weighted average over the 15 categories described in section 4.3.2.2 was estimated by using the ONS proportion and the associated 95% confidence interval was also estimated. The total amount of expenditures were then estimated by multiplying the annual value of each item by the total population of sea anglers in Wales, estimated as 76,000 people by Armstrong *et al.* (2013).

To estimate the total spending on "accommodation", a different approach was used, as most of the respondents did not declare the total annual number of their overnight trips. From the questionnaire, the cost of accommodation for one night was first estimated and adjusted for inflation. This value was then

[17] Figure based on the rounded data published in the Great Britain Day Visits Survey ((TNS Global 2014b)

multiplied by the total number of angling related nights spent by Welsh anglers obtained from the GBTS in 2013.

4.4. Results

4.4.1. Expenditure of Visiting (Non-resident) Sea Anglers

According to the frequency categories of Sea Angling 2012 (occasional ≤ 12 days/year, regular 13–35 days/year, and frequent ≥ 36 days/year), 51.3% of visiting sea anglers were occasional, 34.2% were regular and 14.4% were frequent. The average expenditures of a visiting sea angler for an average overnight trip length of 3.4 nights is reported in Table 4-1.

Table 4-1. Mean expenditures of overnight visiting sea anglers (±95% confidence intervals, CI). Average overnight trip length was 3.4 nights. Other costs refer to all costs different from the previous items. The inflation for this general category was calculated as the average inflation from all the previous categories.

Category	Mean expenditure	Category	Mean expenditure
Accommodation	£111.2 (± 28.0 CI)	Food and drink	£111.7 (± 25.0 CI)
Bait	£60.8 (± 22.1 CI)	Other costs*	£70.7 (± 37.5 CI)
Charter fees	£34.8 (± 12.0 CI)	Private boat	£18.5 (± 9.2 CI)
Competition fees	£30.0 (± 12.2 CI)	Travel	£107.7 (± 32.8 CI)

For a visiting sea angler, the total average expenditure for an average overnight trip length of 3.4 nights was estimated as £542.3 (± 98.5 CI). From the Great Britain Tourism Survey (GBTS) in 2013, out of the 6.09M million trips related to holidays in Wales, 1.07% were angling related. As the proportion of visiting (non-Wales resident) domestic tourists was 77%, the total estimated number of angling related trips from visiting tourists during 2013 was 50,231. Therefore, the total amount of spending in Wales by visiting sea anglers during overnight trips in 2013 was £27.24 (± 4.95 CI) million. The average angling related expenditures from visiting sea anglers during one day trips are shown in Table 4-2.

Table 4-2. Average expenditures of a visiting sea angler during a one day trip (±95% confidence intervals, CI). Other costs refer to all costs different from the previous items. The inflation for this general category was calculated as the average inflation from all the previous categories)

Category	Mean expenditure	Category	Mean Expenditure
Bait	£10.3 (± 1.5 CI)	Other costs*	£1.5 (± 0.8 CI)
Charter fees	£23.4 (± 3.8 CI)	Private boat	£3.4 (± 1.7 CI)
Competition fees	£2.1 (± 1.5 CI)	Travel	£28.5 (± 2.8 CI)
Food and drink	£14.2 (± 1.7 CI)		

For a visiting sea angler, the total average expenditure for an average one day trip was estimated as £83.00 (± 5.80 CI). From the Great Britain Day Visit Survey (GBDVS) in 2013, 145,600 daily sea angling related visits from non-residents were derived for 2013. Therefore, the total amount of spending in Wales by visiting sea anglers during one day trips in 2013 was £12.08 (± 0.84 CI) million. Due to the different nature between overnight trips and one day trips, their relative expenditures differed not only in absolute terms, but also by the relative proportions (Figure 4-1). The total

expenditures of visiting sea anglers in Wales from one day trips and overnight trips has been estimated between £33.54M and £45.12M, with an average of £39.33M.

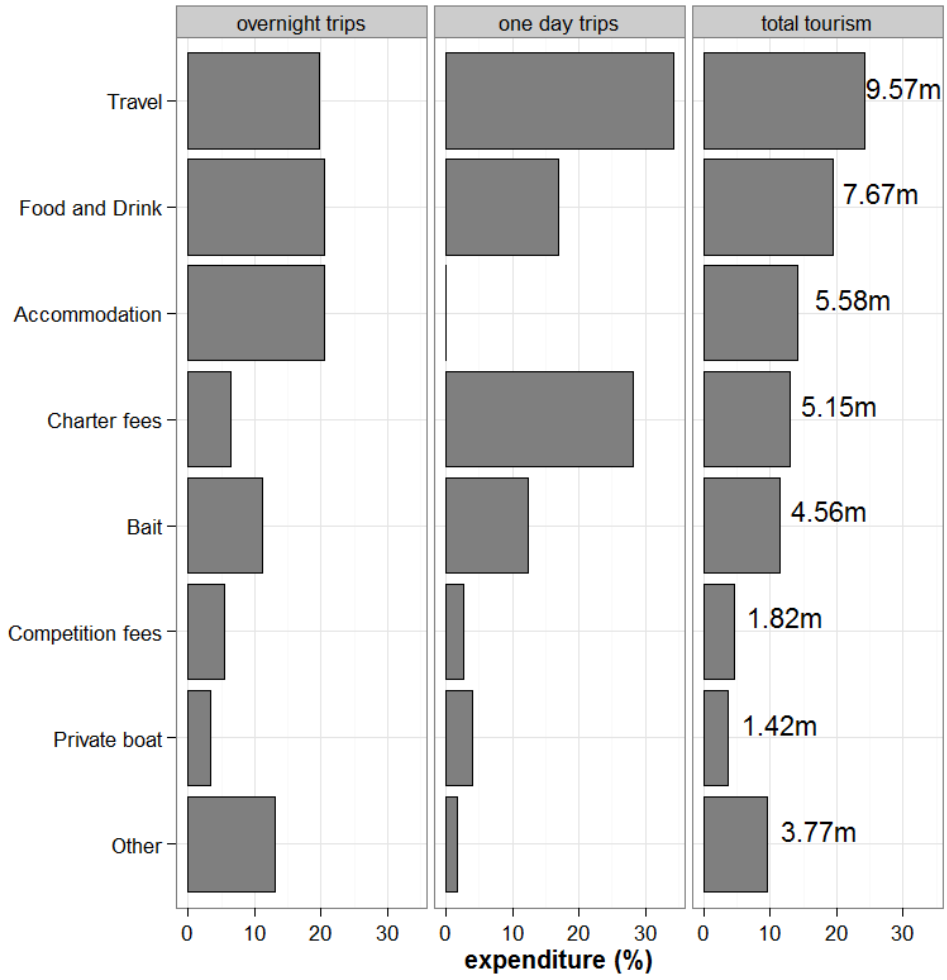


Figure 4-1. Expenditure composition for the different angling related trips of visiting UK sea anglers in 2013.

4.4.2. Expenditure of Resident Sea Anglers

Out of the 364 sea anglers interviewed that reside in Wales, 356 provided their age and the number of annual fishing days. On average, 90% of the expenditures of local anglers were declared to be made in Wales. The expenditure profile for each of the 15 categories described in the methodology (see section 2.2.2) was estimated and it was revealed that the expenditures for occasional anglers were approximately a third and an eighth of those of regular anglers and frequent anglers respectively (Table 4-3).

Table 4-3. Average annual expenditures (£) in Wales by angler category and the sums of the averages of all categories (angling frequencies and age). Data derived from Richardson's (2006) questionnaire survey.

	Occasional	Regular	Frequent	All frequencies
aged 16 to 24	362.7	681.0	2,168.9	3,212.6
aged 25 to 44	395.4	1,733.6	3,856.5	5,985.5
aged 45 to 54	762.0	1,787.3	3,960.9	6,510.2
aged 55 to 64	442.8	1,745.5	2,762.4	4,950.8
aged 65 to 74	436.4	1,924.5	3,123.7	5,484.7
All ages	2,399.3	7,871.9	15,872.5	26,143.7

As the proportions of sea anglers interviewed by category differed from the ONS survey (Brown *et al.* 2013) (Table 4-4), the average spending profile of each category was weighted to the ONS population.

Table 4-4. Proportion of sea anglers interviewed by category.

	Occasional		Regular		Frequent		All frequencies	
	Bangor survey	ONS	Bangor survey	ONS	Bangor survey	ONS	Bangor survey	ONS
aged 16 to 24	0.6	6.9	0.8	2.2	3.1	3.0	4.5	12.0
aged 25 to 44	7.3	24.3	25.6	5.8	23.0	1.8	55.9	32.0
aged 45 to 54	4.5	18.7	8.4	6.4	9.8	4.2	22.8	29.2
aged 55 to 64	0.8	8.7	7.6	7.4	5.1	0.9	13.5	17.0
aged 65 to 74	0.3	6.7	2.2	1.6	0.8	1.4	3.4	9.8
All ages	13.5	65.3	44.6	23.4	41.8	11.3	100.0	100.0

The average expenditures estimated for the whole population of Welsh RSAs in Wales (76,000 anglers) is represented in Figure 4-2. For Welsh sea anglers, the most expensive items were private boat and angling equipment and total spending was estimated to be between £48.19M and £125.96M, with mean of £87.08M.

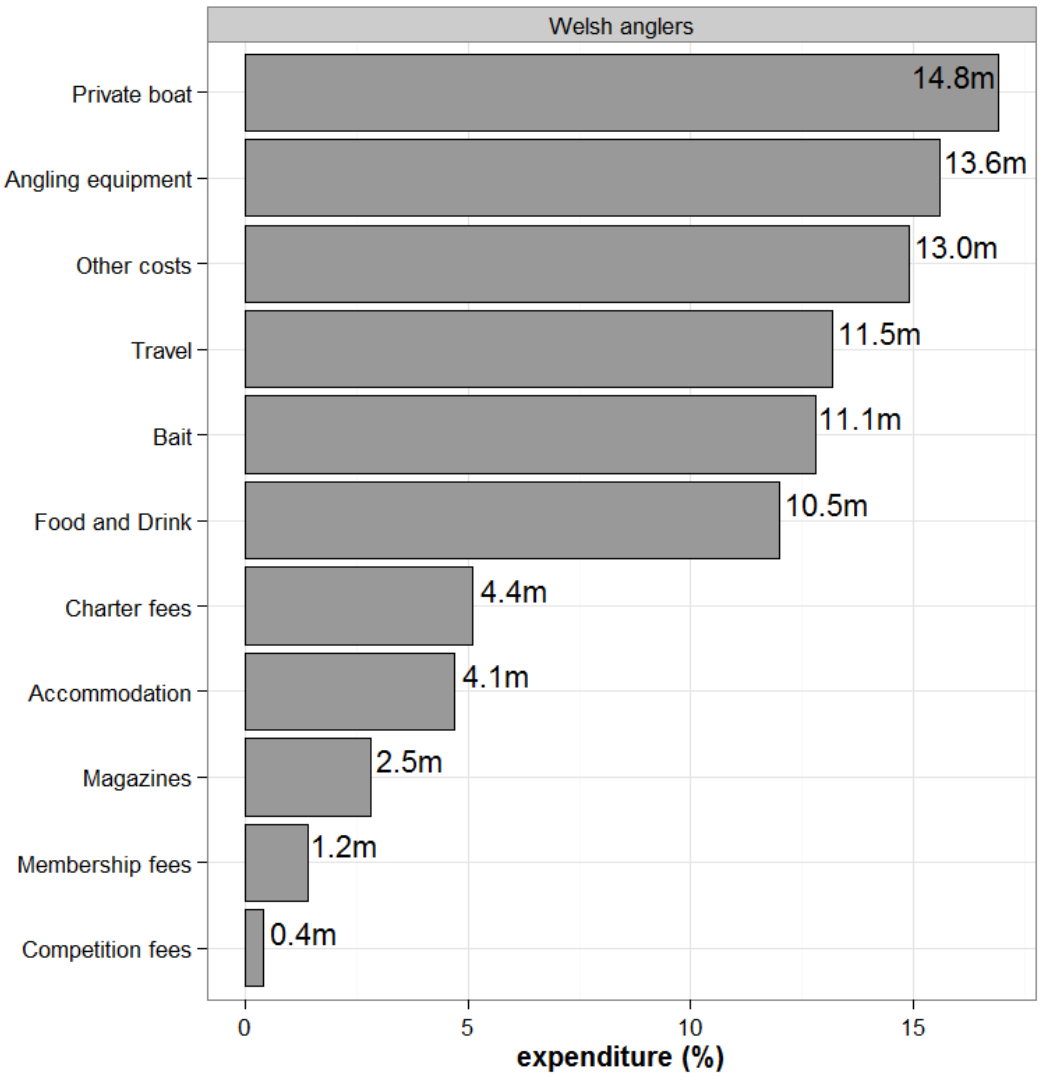


Figure 4-2. Expenditure composition for the Welsh anglers in 2013.

Considering all expenditures made in Wales by visiting and resident anglers, we estimated a total expenditure between £71.17 million and £182.06 million, with a mean of £126.61 million (Figure 4-3).

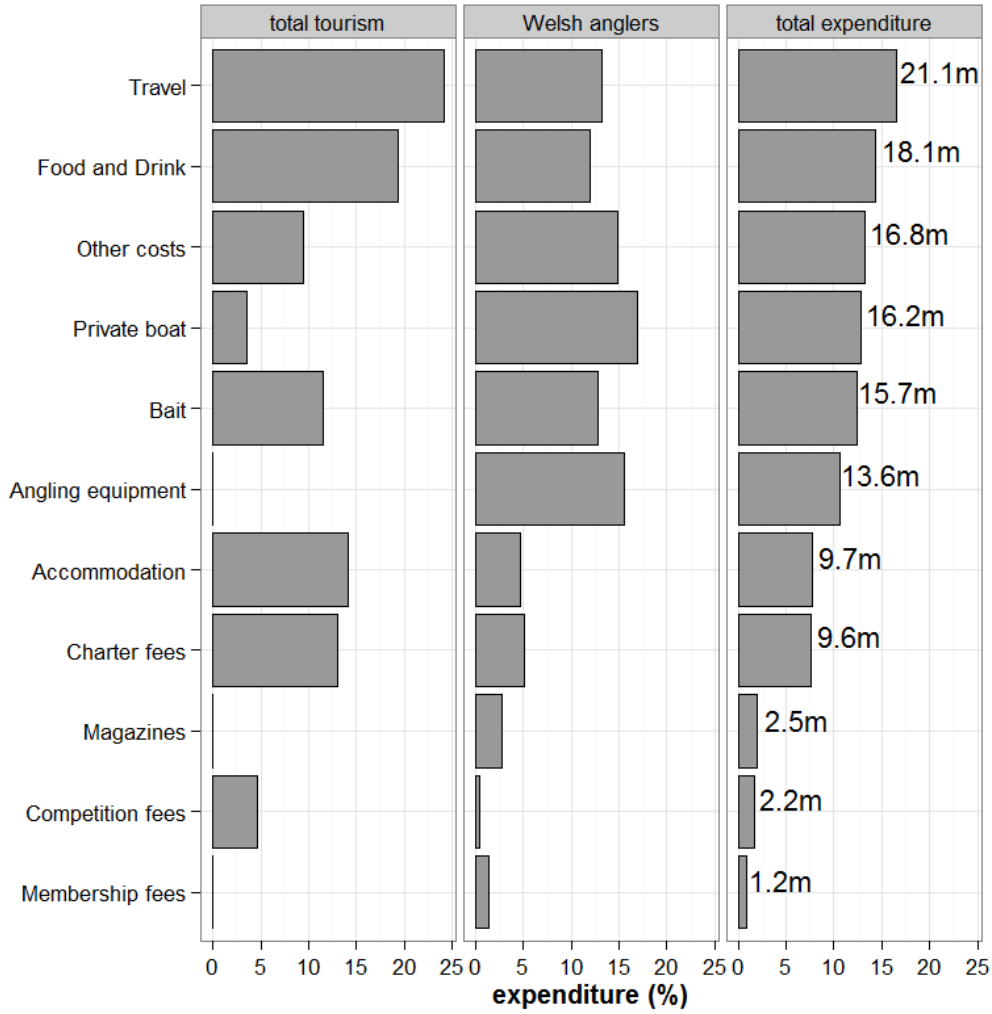


Figure 4-3. Estimation of the total angling related expenditure in Wales during 2013.

4.4.3. Input-Output Analysis

After being disaggregated, the spending breakdown shown in Figure 4-3 was allocated to industry groups corresponding to those for which the multipliers were estimated in 2007 (Jones *et al.* 2007) (Table 4-5). Table 4-5 also shows that the average annual spending of £126.61M decreased to £77.09M after accounting for imports and taxes, which represented around 40% of the total gross spending.

Table 4-5. Distribution of sea angler spending by industry groups.

Industry Group	**Selected items**	**Spend £m**
Agriculture, fishing, forestry	Bait	10.37
Food, drink and tobacco	Selected food and drink	4.53
Textiles and clothing	Clothing	0.56
Wood products, paper and publishing	Magazines	0.37
Oil processing, chemicals and pharmaceutical	Fuel	4.9
Machinery	Boat	2.55
Furniture and other manufacturing	Angling equipment	0.39
Wholesale and retail	Bait, selected food and drink, angling equipment, boat maintenance, fuel, other costs	20.42
Hotels, bars and restaurants	Selected food and drink, accommodation	16.85
Transport	Travel, selected charter fees	8.57
Recreation	Competition fees	2.20
Other public and private services	Selected charter fees, membership fees	5.39
Total		**77.09**
Import		16.72
Fuel tax		20.18
VAT		12.63
Total overall spend		**126.61**

The £77.09M of net direct spending in sea angling activity supported an average of £115.97M of total spending once indirect and induced effects were taken into account (Table 4-6). This also means that each £1M of net sea angler spending in Wales supported another £0.5m of spending in the Welsh economy.

Table 4-6. Economic impact of sea angling on the Welsh economy.

Industry Group	Output multiplier (Type II)	Spending £m	
		Initial	Final
Agriculture, fishing, forestry	1.54	10.37	15.96
Food, drink and tobacco	1.59	4.53	7.21
Textiles and clothing	1.38	0.56	0.78
Wood products, paper and publishing	1.39	0.37	0.52
Oil processing, chemicals and pharmaceutical	1.27	4.9	6.22
Machinery	1.4	2.55	3.57
Furniture and other manufacturing	1.4	0.39	0.55
Wholesale and retail	1.5	20.42	30.62
Hotels, bars and restaurants	1.54	16.85	25.94
Transport	1.53	8.57	13.11
Recreation	1.53	2.20	3.36
Other public and private services	1.51	5.39	8.13
Total		**77.09**	**115.97**

The total employment directly created from sea angling spending was estimated as 1,706 FTEs (Table 4-7), representing 0.13% of the total FTEs in Wales in 2007. As explained in the methodology, employment multipliers have not been used in this study due to the uncertainty related to these multipliers. Therefore 1,706 FTEs only represent the direct jobs created; however, it is reasonable to expect at least an additional 500 FTEs related to the indirect and induced effects.

Table 4-7. Full time job equivalents (FTE) and output per employee for each type of industry in Wales and output at basic price and FTEs generated from sea angling spending in Wales.

Industry	FTEs	Output (£) per employee (000s)	Outputs at basic price (£) from angling spending	FTEs from angling spending
Agriculture, forestry and fishing	37,400	37.57	10.37	275.91
All manufacturing	162,100	194.85	13.31	68.29
Wholesale and retail	212,200	40.44	20.42	504.83
Hotels, bars and restaurants	92,500	28.38	16.85	593.52
Transport	49,300	74.13	8.57	115.61
Recreation	35,000	39.86	2.20	55.10
Other public and private services	33,700	58.23	5.39	92.54
Total	1,352,900		77.09	**1,706**

4.4.4. Uncertainty in the Estimates

The picture provided above corresponded to the average value of sea anglers' expenditure and the related indirect and induced effects. However, there is uncertainty related to these estimates as demonstrated by the 95% confidence interval of Tables 4-1 and 4-2. These variations in the estimates are mainly due to the differences in the amount of spending between the 15 groups, defined from the combination age-angling frequency, for which the angling spending was derived. Therefore, considering this variation in the data, we estimated that the average net spending of £77.09M might have ranged between £43.56M and £110.61M. Consequently, the cash flow generated by the angling activity in the whole economy and estimated by applying type II multipliers might have been anything between £65.62M and £166.33M. The FTEs could also have ranged between 975 and 2,436 FTEs directly supported by RSA expenditure (see Table 4-8).

Table 4-8. Full time job equivalents (FTE) and output for Wales generated from angling expenditure (Millions). Direct spend is the figure generated without import tax, fuel and VAT. Total spend is the output generated by the direct spend taking account of type II multipliers.

Category	Average	95% Confidence Interval
Direct spend	£77.09M	£43.56M - £110.61M.
Total spend	£115.97M	£65.62M - £166.33M
FTEs supported (direct spend)	1,706	975 - 2,436

4.5. Discussion

The present study provides a comprehensive picture of the economic impact of recreational sea angling (RSA) in Wales by considering the contribution from both resident and visiting RSAs, thus including the important impact of sea angling related tourism activity in Wales. Moreover, the cash flow generated by the activity has been estimated not only in terms of direct effects, but also as indirect and induced effects on the whole economy, which represents a considerable advance on previous studies (e.g. Nautilus Consultants 200, Drew Associates 2004). We estimated an average gross spending of £126.61M from visiting and resident RSAs in Wales. This value is about a tenth of the gross spending estimated for England by slightly under one tenth of the angling population (Brown *et al.* 2013), which appears reasonable due to the differences in the respective populations and territorial variation.

In our analysis, taxes have not been included for the estimation of the indirect and induced effects and therefore this is only a partial estimate of the likely total tax take relating to RSA activity. The government will spend taxes derived from sea angling expenditure to support various economic activities, and thus the extent of the sea angling impacts will depend on how such taxes are spent.

Sea angling expenditure estimated for 2013 supported different industries, in particular "wholesale and retail", "hotels, bar and restaurants", "agriculture, fishing and forestry" and "transport". The employment directly created by sea angling expenditure for these industries represented 87% of the total employment created by this recreational activity. Our analysis thus showed the importance of RSA activity for key sectors in Wales and that the possible consequences of restrictions to this activity need to be taken into account for the Welsh economic context as a whole.

The current analysis of the economic value of RSA to the Welsh economy represents the most comprehensive and therefore most representative analysis undertaken to date and certainly highlights the considerable value of this sector to the Welsh economy. However, no comparably robust economic analysis has been undertaken for the value of the commercial fishing sector to the Welsh economy and hence comparison of the values of RSA published in this report should not be used to evaluate the relative economic contributions of RSA and commercial finfish fisheries sectors. This highlights the urgent need for robust economic analysis to be undertaken for the commercial sectors such that objective comparisons with the RSA sector can be made.

4.5.1. Limitations

Apart from the uncertainty in the estimates related to differences in the amount of spending between the 15 different groups of sea anglers additional limitations need to be stressed:

1. The depreciation of boats was not included in the direct spending, due to a lack of information on the cost of the private boats. This could lead to a small underestimation of the total spending by RSAs.
2. Expenditure of visiting sea anglers in Wales only referred to food and drink, bait, travel and accommodation while annual costs on private boat, angling equipment, magazines, membership fees and other annual costs were not taken into account. This also represented an approximation. Future studies should consider the relative proportion of spending inside and outside Wales for each item.
3. We assumed that the import proportion on goods and services used by sea anglers were the same in Wales as England, so the same rate was applied as in Sea Angling 2012 (Brown *et al.* 2013). However, it is possible that the proportion of goods and services imported into Wales was higher than in England. In this case a higher "leakage" outside the Welsh economy may be associated with sea angling expenditure. Future research based on consultations with industry representatives and information on imports for selected goods and services from the Office for National Statistics should be provided for Wales.
4. The I-O framework used for this study referred to the Welsh economy of 2007. FTEs also referred to 2007 to estimate the output per employee. For this reason the indirect and induced effects generated by sea angling expenditure could be slightly different from these estimates. Updated I-O tables should be provided in the future or inflation should be applied to have a better updated picture.
5. No adjustment for the FTEs that are necessary to reach the consistency when various industry groups are aggregated, has been taken into account, which could have caused some bias in the estimate of the FTEs created by RSA expenditure.

Despite the limitations, the picture provided on the economic impact of sea angling spending in Wales represents the best estimate produced from the available data. As this study provided a value of sea angling spending and the related impact on the Welsh economy, it is our opinion that changes in this value should be measured for assessing the impact of policy for cost-benefit purposes. However, additional approaches could be used in the future, including the assessing of the marginal value associated with the increase of the number of fishing trips (willingness to pay for each additional trip). This aspect is associated with the assumption that, as the number of trips per angler increases, the marginal value of each additional trip is worth less than the previous one. The estimates of this relation (number of trips vs. trip cost) is essential to understand the economic consequences of a set of management options.

In the future from this picture, which should be interpreted as a general trend and not a precise value, scientists and economists should derive an estimate of the marginal values for assessing the impact of a

policy for cost-benefit purposes (e.g. potential improvement in fishing experience). It has been estimated that a complete cessation of sea angling in Scotland would result in a loss of over 50% of the current FTEs and incomes (Radford *et al.* 2009). This loss can be considered the marginal value of sea angling in the region and its estimate is important for cost-benefit analysis.

5. SPATIAL REVIEW OF RECREATIONAL SEA ANGLING ACROSS WALES

5.1. Introduction

To date, there has been no randomised (bias minimising) survey of recreational sea angling (RSA) activity for Wales, with previous surveys deriving activity estimates from a combination of systematic observations, self-selecting questionnaires, expert and fisher knowledge, and interpolation from surveys targeting different angler populations. The execution of randomised surveys of RSA in Wales is complicated by several factors. Firstly, the Welsh shoreline and coastal waters are highly variable and many areas targeted by sea anglers are remote and difficult to access, yet have many access routes (for example St. David's Head in South Wales). Secondly, there is a large population of visiting RSAs, particularly in the summer months and during public holidays. Finally, there are no sea angler licensing or registration schemes to provide a formal sampling frame from which a randomised sample of resident and visiting sea anglers can be drawn.

Traditional survey assessments of effort/catch and expenditure have tended to focus on activities at the national or regional levels (Nautilus Consultants Ltd. 2000, Drew Associates 2004, Armstrong *et al.* 2013) and lack the sample numbers to produce high resolution angler-effort distribution maps (CEFAS, pers. comm.). The increased focus on marine management (section 2.2) has inspired several regional, Wales relevant projects which have recorded sea angling activity. These and other 'grey literature' sources of data were utilised and are summarised in section 5.2.

5.2. Review of Assessments

5.2.1. Richardson (2006)

Richardson (also see section 4.2) used a largely self-selecting questionnaire based survey instrument to collect data in 2003–2004 from recreational sea anglers (RSA) angling in Wales across the three platforms: charter boat, private boat and shore (questionnaire in Annex 2). The thesis also incorporated a census of charter boat skippers operating from ports in Wales, primarily collected by face to face questionnaire interviews (questionnaire in Annex 3), with interviewees specifying the spatial extents of their activities using a map. Richardson (2006) made no new estimates of effort. Her economic assessment estimated angler numbers for Wales from stratification transfer and expansion using the RSGB Omnibus Survey of 2003 (TNS 2003). Richardson collected target species data, but no recordings of catch by species were made.

An extensive proportion of Richardson's thesis dealt with the commercial sector. During 2003–2004 interviews were held with near census like coverage of the Welsh population of charter boat operators. Interviews sought to collect standard operational metrics and also included the highly pertinent capture of charter operators' spatial activity. Survey responses were collected during face to face interviews and angling locations were qualified using marine hydrographic maps.

5.2.2. FishMap Môn

The FishMap Môn project (Aron *et al.* 2014) piloted methods in the collection of fishing activity data covering Anglesey and the surrounding coastline (Figure 5-1). The activities of commercial fishers, charter boat skippers and recreational shore and private boat sea anglers were investigated. Face to face interviews were used for charter boats skippers, with an accompanying admiralty chart for interviewees to spatially reference their activity. 26 of the 28 skippers (93%) in the project area participated.

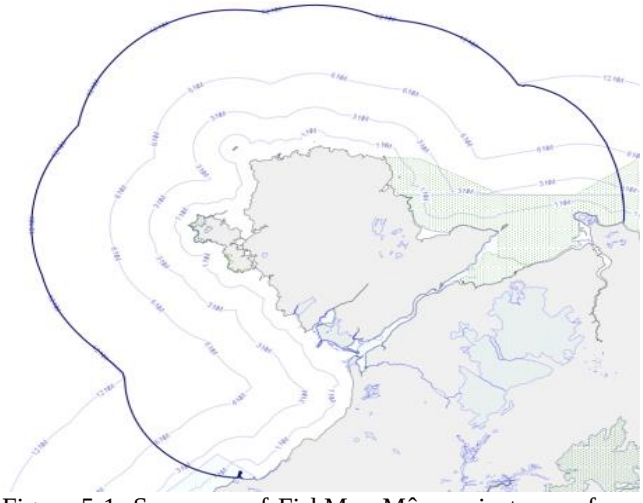


Figure 5-1. Summary of FishMap Môn project area, from Aron *et al.* (2014).

Private boat anglers were surveyed using a postal questionnaire. Shore sea angling used a creel survey approach with surveyors targeting sites previously selected under expert knowledge. Site selection was non-random and precise selection criteria unclear. Data were aggregated to 1 km^2 cells for the purpose of reporting and data anonymisation. The FishMap Môn questionnaire included

sections relating to anglers' species preference and angler value responses with respect to their fishing experiences and locations. Unfortunately these data were not made available for this study.

5.2.3. Pembrokeshire Wales Activity Mapping

The Pembrokeshire Wales Activity Mapping (WAM) programme is an ongoing multi-partner collaboration which seeks to understand and map marine recreational activities and their economic value across Pembrokeshire (Wales Activity Mapping Project 2014). Of primary relevance to this report was the assessment of RSA activities within the study area (Figure 5-2). Data were primarily derived from regional experts involved in marine related activities (e.g. harbour masters, wardens and beach managers) where daily activity levels were marked on a map, typically during face to face interviews. Further desktop research and telephone interviews also contributed to the collated dataset. The study classified the coverage quality and data quality, on a linear scale ranked between one and five; detailed methods are available in Chambers *et al.* (2013). The study covered all marine based recreational activity, so angler specific activity assessments were beyond the study's scope.

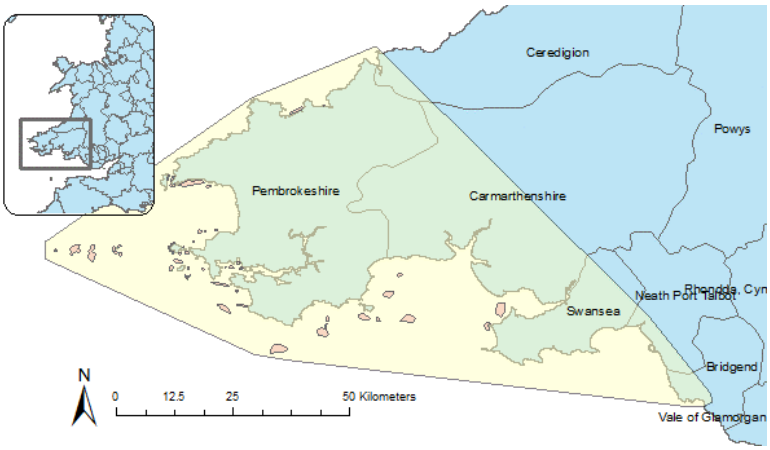


Figure 5-2. Summary of GIS coverage of the Pembrokeshire Wales Activity Mapping project.

5.2.4. North Wales Recreational Sea Angler Pilot Surveys

Spatial effort data were collected during the North Wales Recreational Sea Angler Pilot Surveys (NWPS) of winter 2007/8 and summer 2008 (Goudge *et al.* 2009, Goudge *et al.* 2010) for North Wales (Figure 5-3). Angling sites were identified through expert knowledge, and discussion with sea anglers and entities involved in the sector. Sites were then sampled using a semi-quota site allocation approach. Survey unit sampling employed a mixture of creel interviews,

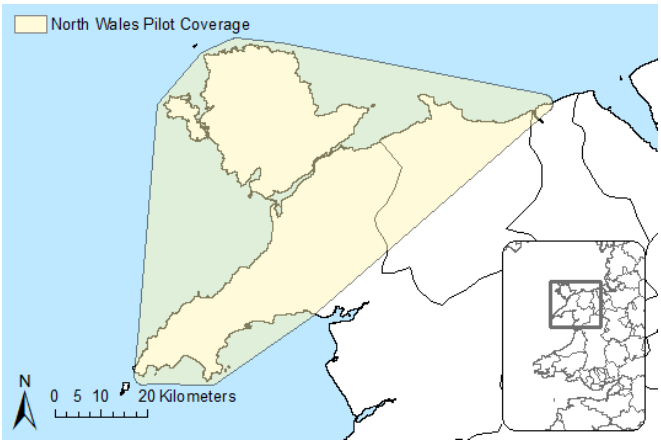


Figure 5-3. Summary GIS coverage of the North Wales Pilot Surveys.

observations of sea angler activity by survey personnel, and paper based angler self-recording, primarily to gather data on catch and effort. Species preference data were recorded on the questionnaire but were not made available for this report.

5.2.5. CEFAS Port Census

CEFAS carried out a port census around the coasts of England and Wales (Pickett 1990), covering different ports and areas in successive years (Figure 5-4). Surveyors visited ports and harbours and other coastal areas and in consultation with Marine Management Organisation field staff and fishers, identified boats catching bass. The port census largely involved the classification of commercial boats by métier but included a category for recreational boats using rod and line gears. Counts of recreational boats for the extent of the census survey (1985–2012) were recorded by port or a between–port length of coast. Not all ports and areas were visited every year, hence data from the last valid survey were frequently carried forward to produce yearly count estimates of boats prosecuting bass.

Figure 5-4. Welsh ports covered in the CEFAS port census survey.

5.2.6. Grey Literature and Alternative Sources

Several sources of spatially referenced, fisher knowledge based data exists. These datasets, including online records of sea angler fishing locations and Wales specific sea angling guides provide point data only. Nevertheless, they do give an indication of where sea angler effort will tend to be concentrated, not least because the information is within the public domain. In addition, records of Wales-specific sea angler catches, recorded in the publication *Sea Angler* and another catch data set submitted by the now defunct National Federation of Sea Anglers were collated by Richardson (2006) during 2003–2004.

5.3. Methods

5.3.1. General

Studies of potential relevance to the spatial extent of recreational sea angling (RSA) in Wales were identified from a review of the overarching list (Appendix 1) and were assessed for suitability according to their geospatial and temporal coverage and resolution, data availability and pertinence. Custodians were contacted to obtain use permission and raw data where necessary and possible. The studies of particular relevance have been summarised in sections 4.2 and 5.2.

5.3.1.1. Assigning Confidence to Contributing Survey Data

In contrast to the economic assessment, the spatial analysis drew on heterogeneous data sources of varying density measures and data recording methodologies (e.g. collection method, spatial resolution). These differed both between and within studies and necessitated a systematic quality grading of the information used, allowing an overall interpretation of confidence in the spatial analysis to be made and data deficient areas to be identified.

The confidence classification appears in Table 5-1, and follows similar classification systems as exampled by Vanstaen and Silva (2010) and the FishMap Môn project (Aron *et al.* 2014). Confidence classifications were applied to all relevant spatial data extents to create a confidence layer at the resolution of the source data. Confidence layers were then overlayed and the maximum confidence value assigned to co-occurring 25 km^2 cells. This lower resolution was chosen for ease of visual interpretation.

The confidence layer created should be interpreted as an assessment of the accuracy of recorded RSA activity at the spatial level of the data as provided. The FishMap Môn and Pembrokeshire Wales Activity Mapping project (WAM) had within-assessment confidence gradings for georeferenced data. For presentation clarity these intra-study variations in confidence were ignored however, the data are publicly available should further analysis be necessary.

For charter boat and private boat data coverages, no confidence mapping was produced. For charter boats, the coverage derived from Richardson's (2006) survey comprehensively covered Wales and scored 8 for the entire extent. For private boats the FishMap Môn private boat effort values were not obtained as a GIS layer and the method of inferring effort outside of FishMap Môn and WAM survey did not provide a survey derived description of the spatial distribution of effort. Nevertheless, both the FishMap Môn and the WAM shore confidences (Appendix 19) are closely comparable to the private boat surveys and would be representative of the private boat survey work.

Table 5-1. Multiplicative data confidence level matrix for quantifying spatial data quality during GIS mapping.

		Place or venue name	**Map recorded**	**GPS tracked**
		1	***2***	***4***
Expert knowledge or mined data	***1***	**1**	**2**	**4**
Offsite survey	***2***	**2**	**4**	**8**
Creel or intercept survey	***4***	**4**	**8**	**16**

5.3.1.2. Amalgamation of inter-study spatial layers

To produce a single amalgamated map of our current Wales wide understanding of the distribution of recreational sea angler effort for shore, the separate geospatial layers were normalised (Evans *et al.* 2014). The normalisation process used here preserved the distribution of the original intensity values but altered all values so they fall between 0 and 1. All normalised layers were merged, preserving the cell values for layers with the highest confidence score. Where a zero value or no-data value were present in the highest confidence scoring cell, the value for the cell was set to the value from the cell from the layer with the next lowest confidence score.

Data were not amalgamated for charter boats, and private boats. The charter boat coverage based on Richardson's (2006) data is comprehensive. Unfortunately the private boat angling spatial distribution of effort was severely limited, hence the port location data—overlayed with the other coverages—provided the best overview of the concentrations of boats by storage and launch locations.

5.3.1.3. Geoprocessing, general methods

All data where place or venue names were used required georeferencing. To achieve this, a list of all place names within 3 km of the Wales coast were compiled using the Ordnance Survey gazetteer for the UK (Ordnance Survey 2015). To these locations, all UK Hydrographic Office named sea features were added (United Kingdom Hydrographic Office 2013). During data manipulation further colloquial names were included as identified from sources.

Where necessary, all conversions between British National Grid and WGS84 used the OSGB 1936 WGS 1984 Petroleum transformation. Some geoprocessing tasks were performed with ETGeo Wizards (ET Spatial Technologies 2014) and Geospatial Modelling Environment 0.7.2 RC2 (Beyer 2015).

5.3.1.3.1. Boat activity unit area aggregation

It was frequently necessary to aggregate polygon data with embedded effort measures to polygon grids (e.g. 10 km by 10 km cells) or the newly drafted Marine Character Areas (Appendix 2), the general approach standardised effort ***by area*** (km^2) then split activity attributed polygons by their intersection with the aggregate layer polygons (e.g. 100 km^2 cells). Total effort was then rescaled to the cells intersecting the split polygons by multiplying the unit area effort and the new area to give total absolute effort for the area, which, as dictated by data presentation requirements, could then be expressed as an activity measure per unit area. Caveats of this standardisation method are discussed for specific data sources where necessary (e.g. CEFAS Boat Census data). Unless separately qualified, map pictorials used a Jenks classifier (Jenks 1967), this attempts to minimise the total error designated within classes. The area of shore abounding cells were adjusted by subtracting the encroaching land area from the total cell area prior to any area based standardisations.

5.3.1.3.2. Shore activity aggregation

Standardisation of shore activity for aggregated reporting (e.g. by 100 km^2 cells) was similar to boat activity (5.3.1.3.1), but used activity units (e.g. angler days per annum) divided by the ***high water shore length*** (Seazone 2014) within the bounding cells. Shore length was deemed to be more indicative of '*available opportunities to fish*' than grid area, and high water shore length more appropriate than low water length. Low water lengths would be inflated by uncovering—and shore angler inaccessible—sandbanks for example.

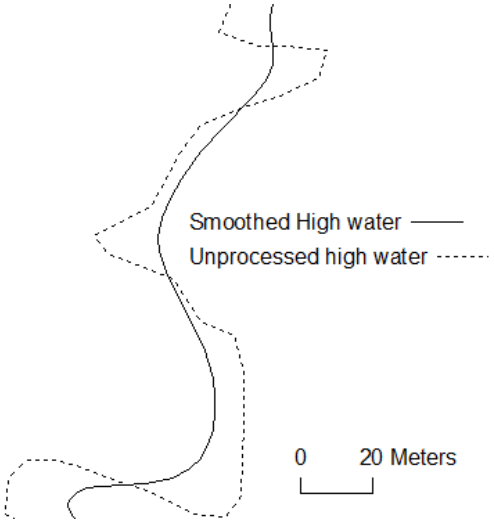


Figure 5-5. Effect of applying polynomial approximation with exponential kernel smoothing (100 m tolerance) to high water polyline.

To provide a degree of control for variations in the topological complexity of the coastline in the standardisation, a polynomial approximation with exponential kernel (PAEK) smoothing with 100 metre tolerance was applied. The output was reviewed for locations known to the authors, to validate the removal of 'meso level' shore features and Figure 5-5 illustrates smoothing of < 20 m features, while preserving > 20 m features.

5.3.2. Shore

Primary sources of data on shore sea angling were derived from Pembrokeshire Wales Activity Mapping project, FishMap Môn and the North Wales Recreational Sea Angler Pilot Surveys. Each of these surveys estimated effort at a spatial level, under traditional survey protocols. Effort standardisation followed that outlined in section 5.3.1.2., further data source specific detail is given below. Venue point data were mined from online sources and grey literature, these were georeferenced prior to mapping as outlined in section 5.3.1.2.

5.3.2.1. FishMap Môn

Survey details on FishMap Môn were given under section 5.2.2. The extent of the shore data are given in Figure 5-6. Data provided were already standardised for effort (termed intensity) however this was by an area measurement and not shore length. Unfortunately without the raw data it was impossible to accurately refactor intensity calculations by kilometre of shoreline without the possibility of introducing errors. As an example, the Holyhead Breakwater area had two separate cells containing a figure of around 3000 angler visits year^{-1}. This is a sensible approach for visually communicating effort to stakeholders across this location, however it would inflate total intensity under shore length standardisation. In particular, it introduces difficulties where cells intersect a very small area of coastline, greatly inflating apparent intensity. Nevertheless, for data aggregation by Marine Character Areas (MCA), intensities were standardised by smoothed high water shore length, this was possible as

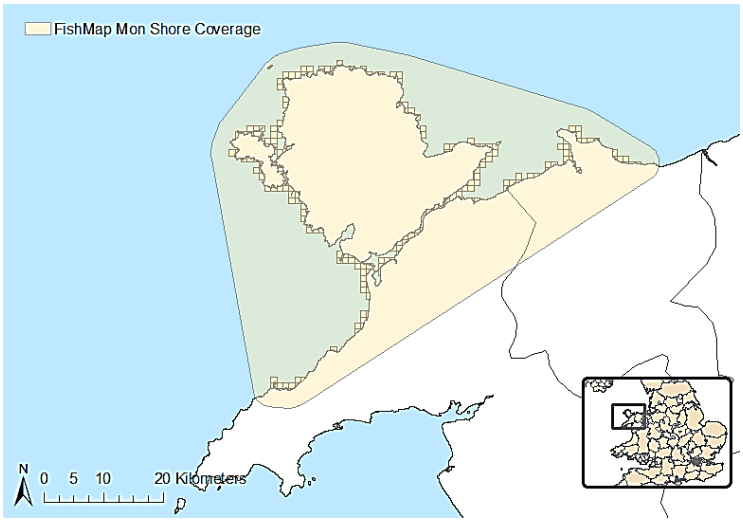
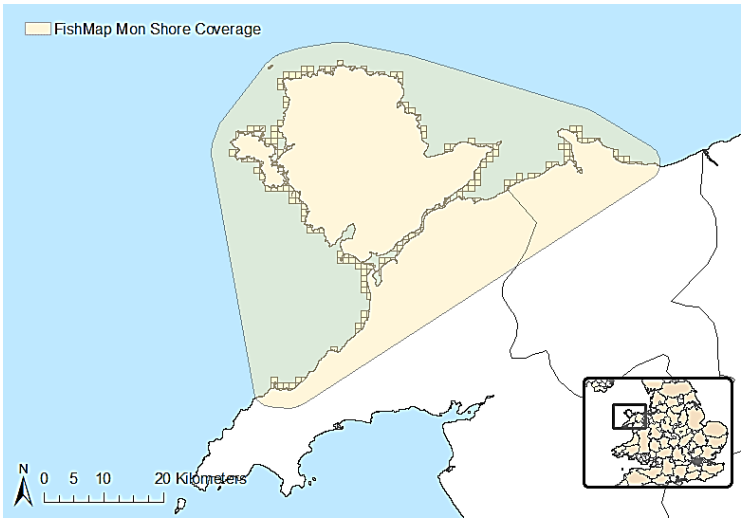


Figure 5-6. FishMap Môn shore survey extent.

angler numbers by MCA location can be summed and then divided by the total MCA shore length.



5.3.2.2. Pembrokeshire Wales Activity Mapping Project

Unfortunately platform stratified data were not provided for the Pembrokeshire Wales Activity Mapping (WAM) recreational sea angling effort data, however geospatial locations recorded by WAM were accurately mapped, hence polygons within 20 metres of the mean low water mark under Seazone (2014) were selected as shore angling activities. All other activities were assigned as private boat following personal communication with the WAM project team who were able to confirm that almost all non-shore polygons were attributable to private boat effort. Locations designated as representing shore activity were reviewed post-processing and platform allocation corrections made where appropriate.

Georeferenced data encoding activity and confidence for the data were provided by the WAM group. The total number of participant days per annum were estimated using the method of Chambers *et al.* (2014). In summary, WAM recorded effort parameter ranges for each mapped site as illustrated in Figure 5-7. Notional angler numbers per day per site (henceforth referred to as 'effort') were derived by calculating the product of the factors ***x*** and ***y*** for each 'seasonal' partition (Table 5-2), then summing across partitions after applying the weighting factor **z** (Table 5-2) to achieve the per annum estimate. Effort standardisation according to section 5.3.1.3.2 was carried out, aggregating to 100 km^2 cells.

Site	USAGESCALE	EASTERHOLS	EARLYSUMMER	SUMMERHOLS	AUTUMN	WINTER
Site 1	0-25	f	f	f	i	i
Site 2	0-25	i	f	f	i	i

Figure 5-7. Pembrokeshire Wales Activity Mapping with example survey site records (Jones 2015). Table 5-2 fully details the illustrated table coding.

Table 5-2. The 3 effort parameters recorded at each site for the Pembrokeshire Wales Activity Mapping project. These were the participant numbers at the location on a 'moderately busy' day and the bands of the number of days per month subject to 'moderately busy' visitor numbers, with the assigned weighting factor. To reflect fluctuations in site visits during key holiday periods, the site days per month was assessed for the annual periods as specified (e.g. Easter holidays). The length proportion factor is the proportion of these period days over a year. Further detail is available in Chambers *et al.* (2014).

Anglers/boats at site on a 'moderately busy' day (USAGESCALE)		Notional site days per month (EASTERHOLS etc.)		'Seasonal' day length (EASTERHOLS etc.)		Seasonal day length proportion **Factor *z***
Number	Mid-Point **Factor *x***	Number	**Factor *y***	Easter holidays	14 days	0.038 (14÷365)
0 - 25	12.5	28+ (**d**aily)	1.00	Late spring/early summer	91 days	0.249 (91÷365)
26 - 50	38.0	9-27 (**f**requent)	0.30	Summer holidays	62 days	0.170 (62÷365)
51 - 100	75.5	0-8 (**i**nfrequent)	0.05	Autumn	91 days	0.249 (91÷365)
101 - 200	150.5			Winter	107 days	0.293 (107÷365)

5.3.2.3. Recreational Sea Angling North Wales Pilot Surveys

The Recreational Sea Angling North Wales Pilot Surveys covering summer and winter 2007—2008 (NWPS) were reviewed and the survey locations extracted from the report along with the corresponding angler number observed by surveyors at the survey locations. Visited survey locations were determined prior to execution of the sampling plan based on expert knowledge to, in general, maximise the probability of encountering anglers (Rowland Sharp, NRW, pers. comm.). Number of anglers by venue were summed and divided by the visit number then mapped under ArcMap 10 (ESRI 2010). These survey locations were also included in the Wales wide shore angler venues dataset, as detailed under section 5.3.2.4.

5.3.2.4. Point Mapping of Shore Angling Locations

In the absence of a comprehensive survey coverage across all of Wales, shore angling venues (map points) were derived from multiple sources, including social media (forums, community shared Google Maps layers and dedicated web sites), Pembrokeshire Wales Activity Mapping (WAM) data (see section 5.2.3), Recreational Sea Angling North Wales Pilot Surveys (NWPS), sea angling books (see Appendix 1), Richardson's (2006) Sea Angler Records to 2003 and her surveys, and the locations published in Monkman's (2013) thesis. The centroids of the WAM polygon data were used in these methods.

It should be noted that these data sources are heterogeneous; NWPS, sea angling books and social media sources recorded the occurrence of unique venues (within a particular source) which were recommended as a sea angling venue. Richardson's (2006) Sea Angler magazine and survey data, and Monkman's (2013) data represent a proxy for effort—a venue may appear multiple times in each data set. WAM data were also an effort measure with sufficient resolution to warrant a separate treatment under section 5.3.2.2 nevertheless, it was treated as a unique venue occurrence for the purposes of point mapping.

Georeferencing locations was a major task, and the methodology used is detailed under section 5.3.1.2. Two methods were used to process point data (note that standardisation by shore length was unnecessary as the algorithm is spatially aware) as follows:

5.3.2.4.1. Unweighted kernel density

Kernel density (Silverman 1988, ESRI 2015)—without weighting for the number of sources contributing to points within an area—was calculated across all points with output cell size of 100 m and a search radius of 5 km. Outputs provided a graphical presentation of relative point densities which equate to shore angling venue numbers per km^2 derived from the venue sample sources, with an element of venue use frequency introduced from the Sea Angler data of Richardson (2006) and

Monkman's 2013 data. Hence it should be noted that these effort proxy datasets may produce multiple points for an individual venue.

5.3.2.4.2. Coverage weighted scoring

Point densities will be dependent on the number of spatial coverages (e.g. Richardson's Sea Angler data and the Pembrokeshire WAM data) incident within our area units (1 km^2 shore abounding cells). There were 17 separate coverages (representing 17 separate data sources) —with total coverage numbers ranging between 8 and 14 across Wales. Therefore a standard scoring method accounting for the variation in coverage number and shore length was required (Equation 1). In Equation 1, coverages are the total number of coverages in a 1 km^2 cell. Points are the number of points from distinct coverages in a cell (if a coverage has multiple points falling within the cell, this is counted as a single point, so *points* never exceeds 17 and *points* ≤ *coverages* in a given cell). Shore length is the smoothed high water shore length in kilometres (see section 5.3.1.3.2 for smoothing method).

$$Score = 0.5^{(coverages - points)} \Big/ 0.5^{points} \cdot shore\ length \qquad \text{Equation 1}$$

Outliers were set a ceiling value of mean + 2 standard deviations (score = 16.82), this was 0.01% of scored (none zero) 1 km^2 cells. Presentation outputs were prepared in ArcMap 10 (ESRI 2010) using geometric mean classes.

Cluster and hotspot analyses were undertaken for scores, these are spatial statistical techniques which apply significance testing to spatial data. Unfortunately the inherently sparse nature of the dataset (being restricted to a narrow coastal band) yielded few statistically significant spatial areas and so there will be no further discussion of cluster and hotspot analyses.

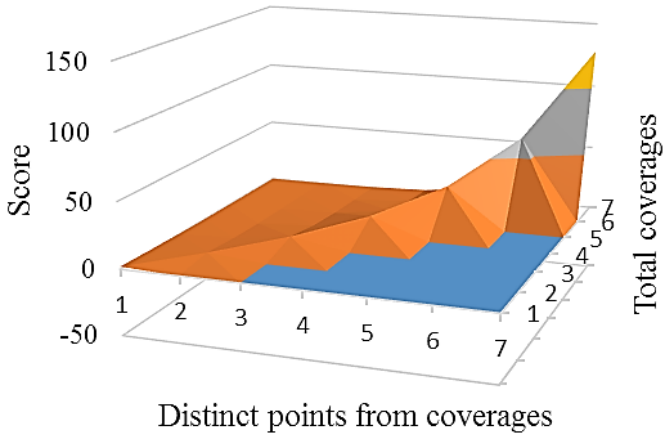


Figure 5-8. Scoring values distribution matrix for 7 separate data sources, the maximum coverage possible was 17, meaning there were 17 different data sources which could possibly have had a point within the area's 1 km^2 cell(s). Blue represents an impossible score— the number of coverage points cannot exceed the total number of coverages.

5.3.3. Private Boats

Powered private boats—with the exception of inflatables—require specialised launch facilities. A minimum requirement is road access and larger boats require a slipway, though sports utility vehicles make the launch of smaller powered boats possible from obstruction free firm sandy beaches, provided there is road access right onto the beach.

For convenience, boat owners also use moorings, marinas and harbour facilities that enable quick launching and safe storage during the months of more frequent fishing activity. We assumed that the selection of such moorings is partially dependent on distance to favoured fishing grounds and so slipways and boat mooring facilities were identified as detailed below.

K-means clustering (N = 23) on the slipway location spatial coordinates was carried out using the package Geospatial Modelling Environment (Beyer 2015), with 23 chosen as a numeric factor of the total number of slipways identified. K-means clustering attempts to minimise within cluster variation (based on Euclidean distance measures) of cluster members from the cluster centroid. This method was chosen to simplify the graphical presentation of the data and also enables the viewer to visually interpret the spatial density of the slipways across Wales and in this instance does not represent sites which share some set of common characteristics, aside from their spatial distribution.

5.3.3.1. Slipway Identification

Slipway locations were collated and cross validated using two primary sources; Google Earth satellite imagery (Google 2013) and boatlaunch.co.uk (Campbell 2015). Campbell (2015) classified slipways as ¼ tidal, ½ tidal, ¾ tidal, all of the tidal range, no ramp and non-tidal. Classifications reflect the availability of the physical slipway ramp according to tide height, beyond which anglers launching a boat need to venture onto the beach substrate, hence a ¼ tidal slipway becomes dry for approximately ¾ of the tidal cycle. Launch quality tends to be correlated with the ramp extent, so a full tidal ramp is typically of better quality and generally subject to a higher number of launches per unit time than ¼ tidal ramps – through there will be exceptions dictated by ramp seasonal availability and launch costs for example.

The classification non-tidal meant that launching is inside a locked water area. No ramp means that no ramp is available, typical of beach launches where no obstructions prevent a vehicle trailing the boat to the water's edge. This study attempted to exclude slipways which were inaccessible for launching from review under Google Earth in addition to the inclusion and user review process of Campbell's (2015) boatlaunch.co.uk website, though undoubtedly there will be some small number of inaccessible slipways included.

5.3.3.2. Harbours, Marinas and Near Shore Boat Storage Facilities

In addition to slipways, boats will also launch from temporary and permanent boat storage locations (e.g. harbours). The location of these services are expected to be highly correlated with boat angler activity. Longer term storage facilities may also tend to host larger recreational sea angling vessels, capable of elevating average activity levels because of factors such as comfort, distance range, carrying capacity and improved performance in inclement sea conditions.

To ascertain the distribution and estimate the capacity of boat storage facilities Google Earth (GE) (Google 2013) was used to visually identify and polygonise sites. Although Seazone (2014) includes layers which define these structures, identifying them under GE allowed there usages to be verified.

Sites were classified during the GE identification process into harbour moorings, marinas, moorings and storage. Harbour moorings are simply moorings protected by a man made harbour. Storage covers a wider variety of facilities, all of which are out of the water, but near the shore for easy launching (near-shore storage hereafter). Near-shore storage includes overnight areas associated with holiday and launch facilities (e.g. combinations of caravan and camp sites, assisted launch and slipways) and boat yards.

Manipulation of the created GE polygons was carried out under ArcMap 10 (ESRI 2010) allowing per facility calculation of area. Unfortunately area was not a suitable proxy of facility capacity with large variations in mooring densities for example. Hence the maximum capacities of identified facilities were estimated (rounding to the nearest 5) from Google Earth from satellite imagery captured between May and August 2009. For marinas, maximum capacity extraction was a relatively easy task as boat bays are clearly visible. For moorings, satellite image quality and resolution were usually sufficient to identify mooring buoys which were counted, though a small degree of error is anticipated due to difficulty in determining if a mooring buoy is permanent for example

Following collation of facilities, 10 of each classification (marina, harbour marina etc.) were randomly selected to estimate the proportion of boats by their probable primary activity. Assigned classifications were angling, commercial, sailing and other (e.g. powerboats), a combination of Google Street View and Google Earth associated photographs were reviewed by the primary author, and the number of boats for each category, to a ‘distance’ in the photograph where identification could be unambiguously made recorded. As the aim was to produce estimates of the proportion of probable angling boats, multiple photographs and Google Street View perspectives were reviewed when available to improve accuracy, it is of note that Google Street View, GE satellite imagery and GE photographs are collected at different times and from different sources. Where insufficient photographic data were available for a site, another site was randomly selected until the quota of 10 samples was met. Bias corrected and accelerated bootstrapping (N = 1000) of sample data were used to estimate means, confidence intervals and standard errors.

Sample means of likely angler boat proportions were applied to the population of facility capacity estimates and the area of these estimates to produce upper bounded estimates of capacity and capacity densities by facility. Confidence intervals estimated under bootstrapping above were applied to give statistical bounds to pertinent upper limit estimates of mean boat density. It should be noted that boats will frequently travel more than 10 km to reach fishing grounds (authors' experience, expert opinion), particularly where tide assists exploration and weather conditions are favourable, or where launch locations are a considerable distance from favoured fishing grounds (e.g. the Milford Haven estuary system).

5.3.3.2.1. Randomised spatial density mapping of private boats from capacity estimates

To indicate relative spatial effort and assist in its visualisation, the upper bound capacity estimates of angling boats at each storage location were converted to points and then randomly dispersed within a circular polygon of radius 10 km intersecting with the sea (i.e. points could not be dispersed onto land). To illustrate by example, Figure 5-9 shows a marina and moorings with an estimated upper limit of angling boat numbers of 28 for each. Two circles, of radius 10 km were created with centroids at the marina and mooring point location with areas intersecting land excluded. 28 points were then randomly dispersed within each 10 km radius circle. The point kernel densities (Silverman 1988, ESRI 2015) were then interpolated across all 'virtual' dispersed boat points across Wales to enhance visualisation of relative densities. Parameters for kernel density interpolation were an output cell size of 200 m and search radius of 1000 m. It is ***important to note*** that the locations of points were randomised, hence repeating the dispersion would change the point locations within the 10 km radius circle. Nevertheless, virtual boat densities are invariant within the circle areas and these relative densities could be assumed to be representative at areas of approximately $0.5 \times \pi r^2$ $(r = 10\ km)$, where 0.5 assumes that 50% of the circle intercepts land. A significant assumption is that the majority of private boat angling activity occurs with a 10 km radius of launch sites (expert opinion) and non-boat storage associated slipway launches are excluded. Facility utilisation by boat anglers will vary by numerous predictors, for example location, type and season nevertheless, informal contact with a small sample of marina operators confirmed that it is not unusual for facilities to operate at full occupancy.

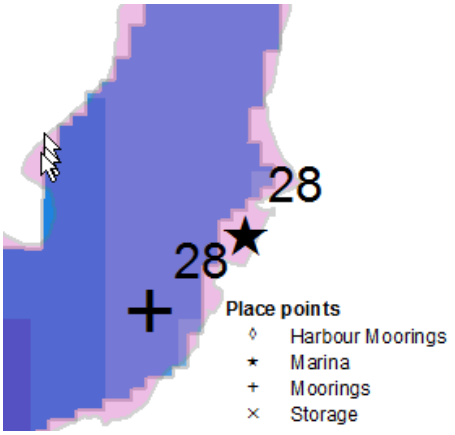


Figure 5-9. Marina and moorings at Y Felinheli on the Menai Strait, North Wales with theoretical maximum estimated angling boat capacity.

5.3.3.3. Pembrokeshire Wales Activity Mapping Project

Pembrokeshire Wales Activity Mapping (WAM) data recorded both shore and boat platform activity (see sections 5.2.3 and 5.3.2.2).The classification of activity was implicit in the spatial location (see section 5.3.2.2 for qualification), but personal communication with the WAM team confirmed that shore and boat site classification were valid. WAM data did not explicitly categorise boat activity into charter or private boat platforms, however personal communication confirmed that boat activity was "*in the main*" attributable to private boats, with a proportional increase of charter boat activity at some locations, particularly around Tenby and similar port areas, attributed to short duration casual charter trips in summer. All boat data from WAM is presented as private boat activity which introduces—an assumed minor—relative overestimate of activity around port areas as qualified.

5.3.3.4. CEFAS Boat Census

Port name and code and the number of boats identified in the recreational rod and line métier were extracted for the last year of the data set (2012). Where a port had not been surveyed in 2012 then the data from the last valid survey were carried forward and used. The port locations were identified and mapped using georeferenced layers previously compiled for this report. In some instances a stretch of coastline between two ports was recorded as the survey area in the collated data.

Unfortunately no distinction between charter boats and private boats were made in the recorded data however, the majority of boats were private vessels, as determined by the magnitude of the numbers recorded against the known level of charter boats prosecuting bass across Wales (Monkman 2013). All rod and line métier boats were therefore counted as private boats involved in recreational sea angling.

There was no recording of angling areas or boat operational distance. Hence to produce a boat density measure per spatial distance unit, the smoothed mean high water polyline (see Figure 5-5) was segmented with the segment mid points at the port location, or the segment was equal to the coastline specified where a stretch of coastline between two ports was recorded. Where there was a large distance between ports then a value judgement was made as to how far to extend the segment, but in general this segment extent was set to be of the same length as that between the current and previous port. It is accepted that some subjective interpretation was inevitable during this process. Segment distances were calculated and the boat number was divided by the corresponding segment distance to get a boat number km^{-1} coastline. 25 km^2 cells (5 km by 5 km) intersecting coastal polylines were assigned the boat number km^{-1} value for the purpose of data visualisation.

5.3.4. Charter Boats

Unfortunately no register of charter boats exists for United Kingdom operators, so the details of operating charters boat were derived from data previously compiled by Richardson (2006) and Monkman (2013). Compiled lists were then updated against online charter boat registers, social media, and World Wide Web search. Completed lists were sent to the Welsh Federation of Sea Anglers for validation. The number of operating boats by port location were mapped and displayed, including English ports abounding the Bristol Channel where current online information indicated that berthed charter boats probably operate in Welsh waters.

5.3.4.1. Richardson (2006) – Operational metrics

Charter boat details (e.g. carrying capacity and operating distance) were gathered from online sources and the study of Richardson (2006) with mapping operations executed in ArcMap 10 (ESRI 2010). Imputation of means was used for Richardson derived metric calculations (e.g. mean anglers per trip and days at sea) as necessary.

Estimates form the current fleet used stratification transfer of key metrics (e.g. mean days at sea) from Richardson (2006), based on the vessel operating distance license (20, 60 nautical miles and '*missing*'). This mean stratification improved estimation accuracy and was deemed worthwhile following examination of the F-statistic after group comparison. Furthermore, metrics calculated from Richardson are not Welsh charter boat population estimates but effectively calculated from the (near) whole population in 2006 (94% coverage estimated) and standard deviations should be interpreted as an indicator of data variability within the fleet.

In the calculation of confidence intervals (CI) it was assumed that 80% of the charter fleet remained the same from 2004 to 2015. Conversely this means that 20% of boats in the current population are newly sampled from a notional charter boat population represented by Richardson's original survey. As charter boat or skipper names went largely unrecorded by Richardson, the 20% figure was chosen following informal interviews with operators during 2013 (Monkman, 2013) and because of the numerical stability of the fleet over the last decade (Drew, 2004; Richardson, 2006; Monkman, 2013; This Report). In direct terms, CIs were simply scaled by 0.2 to make the adjustment outlined, hence should a more precise estimate of charter operator turnover rates become available then CI can be rescaled by applying a proportional factor.

5.3.4.1.1. Spatial Mapping

Operating ports from sources referenced in 5.3.4 were georeferenced according to 5.3.1.2. Richardson's (2006) data contained spatially referenced charter boat activity data in useable format which was cross referenced with skipper survey responses. A metric for boat days km^{-2} $year^{-1}$ was calculated from these responses by calculating the product of days at sea and proportion of time

employed in charter fishing per annum. Where figures were omitted from the survey data, calculated means across all respondents were substituted (imputed). Where multiple activity extents intersected, boat days km^{-2} $year^{-1}$ were summed.

5.3.4.2. FishMap Môn

Details on FishMap Môn were given under sections 5.2 and 5.3.2.1. The spatial coverage for charter boats—as provided by skippers under interview—is given in Figure 5-10. No connectivity between operating grounds and ports were available. Processing methods followed that of section 5.3.1.2. FishMap Môn data were expressed as normalised effort ha^{-2} $week^{-1}$ and aggregated spatial data provided at a 1 km^2 resolution.

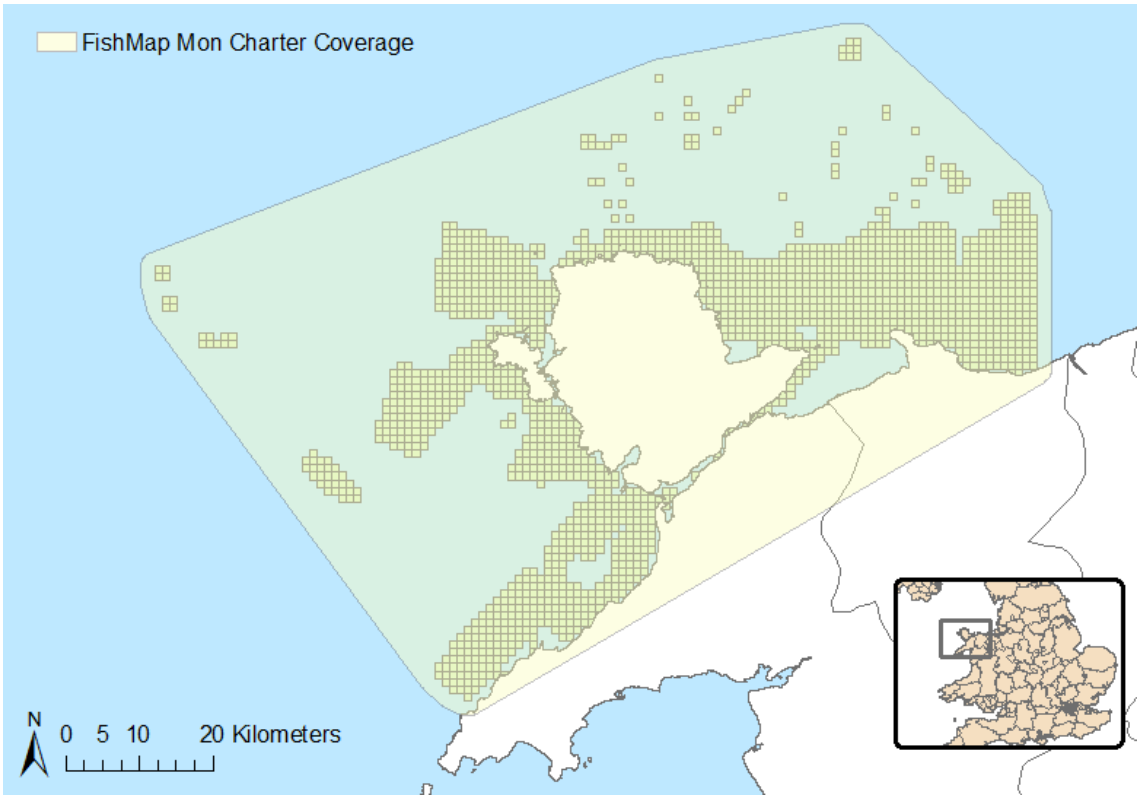


Figure 5-10. FishMap Môn charter boat coverage summary (yellow overlay). Underlayed 1 km^2 squares give specific extent. Data from Aron *et al.* (2014).

5.3.5. Sea Angling Organisations

A list of Wales based angling clubs was drawn up from WFSA records, social media, Monkman (2013), and individual details passed on by fisher experts. Data were manipulated in ArcMap 10 and k-means clustering (N = 10) was used to simplify graphical representation using the package Geospatial Modelling Environment (Beyer 2015).

5.4. Results

When viewing and interpreting activity data it is critical to appreciate that **effort measures have not been expanded to the population of visiting and resident sea anglers,** they indicate relative intensity within the individual study's sample only.

5.4.1. Shore, Charter and Private Boat Activity Metrics

Few studies have attempted to put estimates on sea angling metrics for Wales; Nautilus (2000) estimated there were a total of 41,010 visiting and resident anglers in 2000 (Table 5-3), however the figures are highly questionable, in particular estimates for charter boats appear inflated, while shore angler numbers are low. In addition the Office of National Statistics (ONS) survey of Sea Angling 2012 (SA2012) (Armstrong *et al.* 2013), estimated a total of 76,000 (7%) Wales resident anglers who participated in some form of sea angling, from a total UK sea angler population of 1.085m, almost twice that of Nautilus and unlikely to be attributable to temporal participation rate fluctuations (Figure 5-11).

Table 5-3. Estimates of total angler numbers and mean days spent angling per angler per year from Nautilus (2000).

Platform	Angling days per angler per yr^{-1}		Angler numbers	
	resident	visiting	resident	visiting
Shore	50	20	3,443	5,353
Charter boat	10	10	8,352	22,289
Private boat	50	20	381	1,192

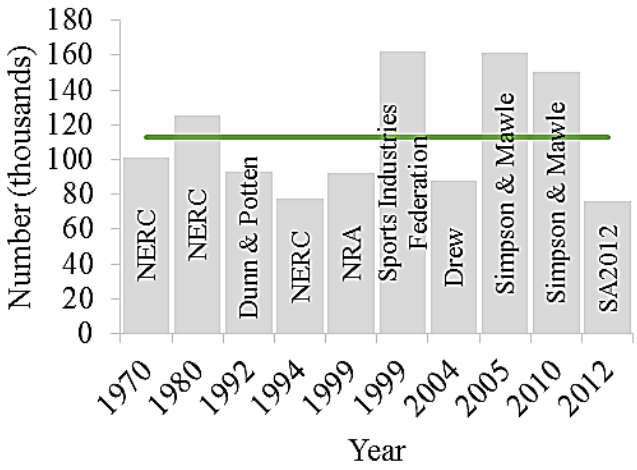


Figure 5-11. Population estimates of sea anglers resident in Wales with mean line.

Historical survey derived estimates of the total number of sea anglers resident in Wales are presented in Figure 5-11 and give a grand mean ±S.D. of 112,676 ±34,212 34 (*Min.* = 76,000, *Max.* = 162,400). Caution in making inferences on these historical data is advised due to the temporal and methodological breadth of these assessments. Despite this, the figures are surprisingly concordant (CV[18] = 30%), but lack of technical detail (for example test statistics) rendered a rigorous meta-analysis intractable.

The ONS based SA2012 figures represent the current and most rigorous estimate of those presented. Total angling days per annum (p.a.) for England and Wales from the SA2012 ONS survey were estimated at 3.975M for shore, 0.493M for private boat and 0.371M for charter boat. Applying a *pro*

[18] Coefficient of variance

rata proportion for population estimates of Welsh anglers from SA2012, gives trip days year^{-1} estimates of 278,288, 34,495 and 25,957 for shore, charter and private boat platforms respectively. These figures are probably an underestimate with more anglers entering Wales from England than Welsh residents leaving Wales to fish on the English coast.

Metrics for charter boats are considered in more detail below, as Richardson's data provides near census like coverage of the small population of charter boats operating in Wales in 2003–2004 (numbers in 2015 remain similar). Sampled shore anglers took 19.9 trips per year against the 12.4 of private boat anglers however, private boat anglers spent longer on the water (Table 5-4). Response variation was higher for private boat trip durations and different question interpretations may have meant that total boat time and actual angling time were reported by different respondents. The results agreed broadly with SA2012's ONS estimates which put platform aggregated trip durations at 6 hours. The Sea Angling 2012 per survey method and platform stratification details are reproduced in Table 5-5 and compared graphically in Figure 5-12. It is noted that the SA2012 online catch survey oversampled club anglers and as a self-selecting survey may have been particularly influenced by avidity bias (Hyder *et al.* 2013). The SA2012 online survey had higher estimates of angling days year^{-1} and daily trip durations than the other surveys.

Table 5-4. Average fishing days per year per angler and average trip durations (hours) by platform from Richardson (2006).

Platform	**Mean ±S.D.**	***N***
Shore trip numbers year^{-1}	19.9 ±15.7	558
Private boat trips year^{-1}	12.4 ±12.4	227
Shore trip length (hours)	5.4 ±2.9	278
Private boat trip length (hours)	7.2 ±6.8	64

Table 5-5. Average fishing days per year by platform from Sea Angling 2012 (calculated by multiplying the 3 monthly averages in brackets by 4) and hours fished in an angling day across survey methods. Reproduced from Hyder *et al.* (2013).

Platform	**Survey**	**Hours fished in one day**	**Angling days year^{-1}**
Shore	ONS	5.6	23.2 (5.8)
	On-site	4.7	16.4 (4.1)
	Online catch	5.9	53.6 (13.4)
Private boat	ONS	4.4	9.6 (2.4)
	On-site	5.1	17.2 (4.3)
	Online catch	6.2	34.0 (8.5)
Charter boat	ONS	5.9	6.0 (1.5)
	On-site	7.8	14.4 (3.6)
	Online catch	7.0	

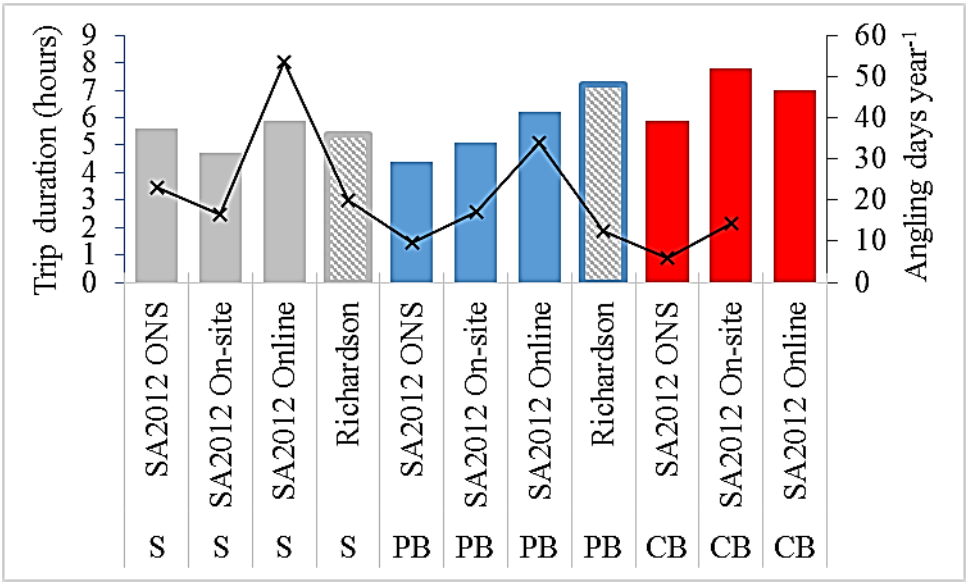


Figure 5-12. Angling days per annum and hours fished in a day from Sea Angling 2012. (Hyder *et al.* 2013) and Richardson (2006). SA2012 ONS was the Office of National Statistics omnibus survey, SA2012 On-site were creel style angler interviews and the online survey was a self-selecting online questionnaire. S = Shore, PB = Private boat, CB = charter boat.

Sixty charter vessels were identified as operating across Wales however, the absence of an official registration scheme means the actual figure could be larger. Coverage was thought to be good, with the results matching closely with the 56 charter operators identified by Richardson (2006) and Monkman (2013).

The current charter fleet has an estimated carrying capacity of 640 anglers when substituting the mean capacity of 10.5 anglers per boat for the two operators with no capacity data. The distribution of capacities are given in Figure 5-13A, and maximum operating distances—dictated by a compulsory license scheme—appear in Figure 5-13B. Data for the English charters presented in Figure 5-22B are not given, as no data on their durations within the Welsh 12 nm limit were available.

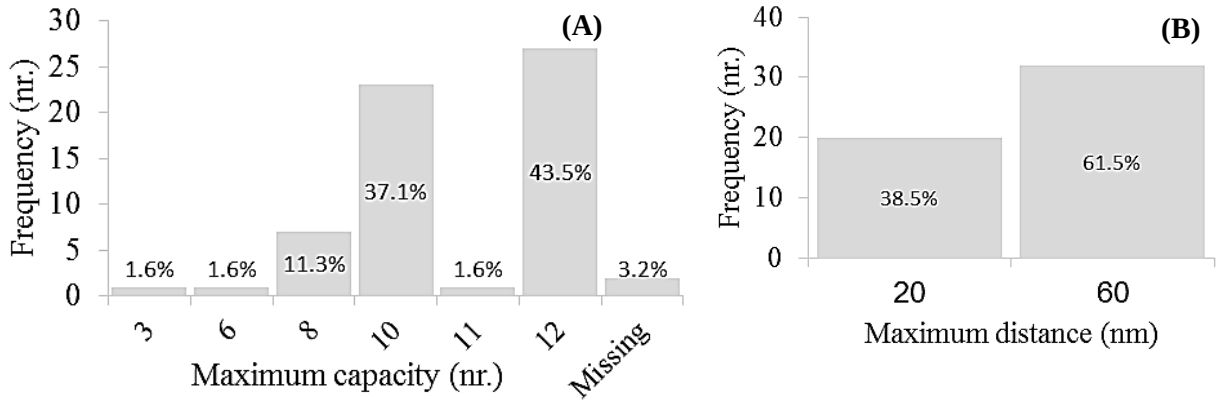


Figure 5-13. Charter boat metrics (A) Distribution of licensed passenger capacities and (B) the operating distance licenses (nautical miles) for all identified charter boats (March 2015).

Richardson (2006) collected boat days at sea per year for all charter activities; proportion of sea angling boat days per year, mean anglers per trip, and mean angling trip durations during 51 interviews of 56 (91%) charter skippers. In 2003/4 the charter fleet was estimated to be at 77% capacity, when comparing the licensed capacity with estimates of anglers per trip. It is accepted that there are limitations in this estimate. The number of charter boats operating for each month is given in Figure 5-14, this highlights the peak activity between May and October, although a significant percentage continue to operate through the winter months. Detailed metrics, giving averages across sampled vessels calculated from Richardson (2006) appear in Table 5-6. Mean trip durations are notably higher than durations reported by angler surveys undoubtedly due to different interpretations of questions relating to angling time and angling trip durations.

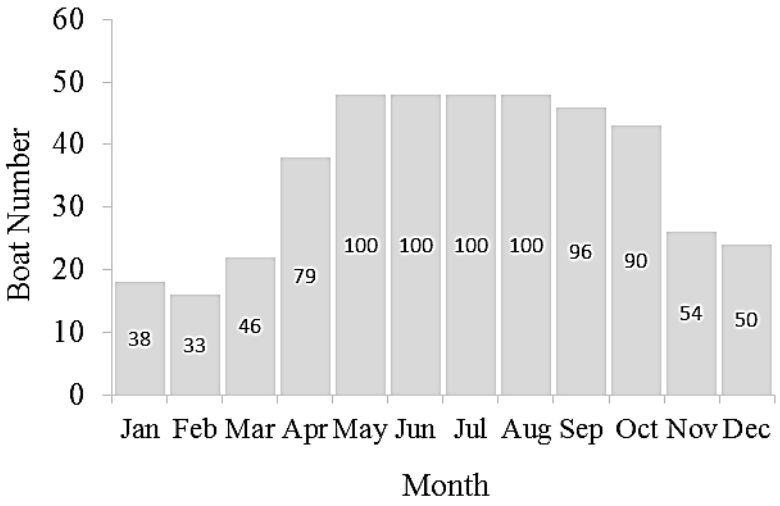


Figure 5-14. Number of charter boats operating per month (*N* = 48). Numbers within the bars are the percentage of charter boats operating in the given month.

Table 5-6. Key operating metrics of charter boats by their operating license category (missing indicates license data were not provided). Data calculated from unpublished charter boat survey in 2003/2004 (Richardson 2006). Gear hours year^{-1} may differ from the product of *days at sea* and *anglers onboard* as skippers did not always complete both answers. S.D. = standard deviation.

Missing Distance License				
Measure	*N*	Minimum	Maximum	Mean ±S.D.
Angling days at sea	29	10	342	76.7 ±65.26
Gear hours year^{-1}	28	162	16758	5634 ±4243.8
Distance (km)	27	3.2	80.5	15.9 ±14.3
Mean trip duration (hr)	29	1	48	9.3 ±7.93
Anglers onboard	28	4.5	12	8.3 ±1.94
Capacity	7	47%	100%	70% ±0.2
Distance License = 20 nautical miles				
Angling days at sea year^{-1}	4	25	200	94.3 ±78.91
Gear hours year^{-1}	4	2000	12800	6681 ±5030.5
Distance (km)	4	11.3	16.1	14.1 ±2.41
Mean trip duration (hr)	4	8	9	8.5 ±0.58
Anglers onboard	4	8	10	8.8 ±0.96
Capacity	3	75%	100%	0.85 ±0.13
Distance License = 60 nautical miles				
Angling days at sea	15	13.5	145.5	78.64 ±39.59
Gear hours year^{-1}	15	1440	11640	5987 ±3352.3
Distance (km)	16	4.8	43.5	16.6 ±8.96
Mean trip duration (hr)	16	5	11	8.7 ±1.70
Anglers onboard	16	6.5	10	8.7 ±1.08
Capacity	12	67%	100%	79% ±0.1

Metrics for the current fleet were calculate by applying data from Table 5-6 with license capacity data from the current charter fleet. Inter-year variation in boat days year^{-1}, dictated by weather, would be a substantial source of inter-year variation. A total effort of 5,058 boat days year^{-1} were estimated, providing 43,835 angler trip events. Armstrong *et al.* (2013) estimated England charter days per annum at 105,872 (skipper questionnaire) and 370,825 (ONS), putting the Wales estimate at 29% and 11% of the respective England estimates for 2012.

Table 5-7. Charter boat metrics of the 2015 fleet, imputed from Richardson's (2006) metrics using stratification transfer by charter boat operating distance license. *Boat angling days year^{-1}* is the number of days the boat undertakes angling activity per year. *Gear hours year^{-1}* is the total rod hours in the year (the product of *angling days year* and *anglers on board*); *total is angler capacity year^{-1}* is the sum of all charter boats licensed capacity; *angler days year^{-1}* is the product of *anglers on board* and *boat days year^{-1}*. Confidence intervals were based on Richardson's (2006) charter data, following normality and homoscedasticity testing, and under an assumption that 80% of the active boats remain unchanged since 2003/4, i.e. 20% of boat have been 'redrawn' from the original notional target population of Richardson's charter boat survey.

Parameter	**20 nm**	**60 nm**	**Missing**	**All**
Boat days year^{-1}	1,697 95% *CIs* [1,419 - 1,976]	2,516 95% *CIs* [2,388 - 2,645]	844 95% *CIs* [791 - 896]	5,058 95% *CIs* [4,966 - 5,149]
Gear hours year^{-1}	120,258 95% *CIs* [102,510 - 138,006]	191,584 95% *CIs* [180,730 - 202,438]	61,974 95% *CIs* [58,516 - 65,432]	373,816 95% *CIs* [367,404 - 380,228]
Total angler capacity year^{-1}.	16,504 95% *CIs* [13,798 - 19,210]	27,603 95% *CIs* [26,199 - 29,007]	8,701 95% *CIs* [8,162 - 9,240]	52,808 95% *CIs* [51,878 - 53,738]
Angler days year^{-1}	14,940 95% *CIs* [14,620 - 15,260]	21,888 95% *CIs* [21,619 - 22,157]	7,007 95% *CIs* [6,886 - 7,128]	43,835 95% *CIs* [43,693 - 43,977]

Metrics for 2015	**Mean ±*S.D.* (*N* = 18)**	**Mean ±*S.D.* (*N* = 32)**	**Mean ±*S.D.* (*N* = 11)**
Capacity	9.7 ±2.4	11.0 ±1.2	10.3 ±1.4
Anglers onboard	9.0 ±0.0	9.0 ±0.1	8.0 ±0.0

5.4.2. Shore: Spatial Review

5.4.2.1. FishMap Môn

The survey conducted creel style face to face interviews in 2011 across 43 sites eligible for survey selection divided approximately proportionately across 7 regions. Sites were selected under expert knowledge. It should be noted that these data are **not** standardised by shore length but by area.

Total angler days across the survey coverage were 39,077 or 11% of all angler days spent across Wales, under the estimated figure of 340,000 days. Shore fishing intensity levels ranged between 0 and 17.3 anglers km^{-2} $week^{-1}$. Across the coverage this is ~90 angler trips km^{-2} $year^{-1}$ within the sample. Turning to angler numbers, the maximum recorded per annum was 2,977 at Holyhead Breakwater, mean ±S.D. anglers per cell per year was 177 ±330, though the precise spatial significance of this figure is difficult to interpret without detail on the original mapping methods.

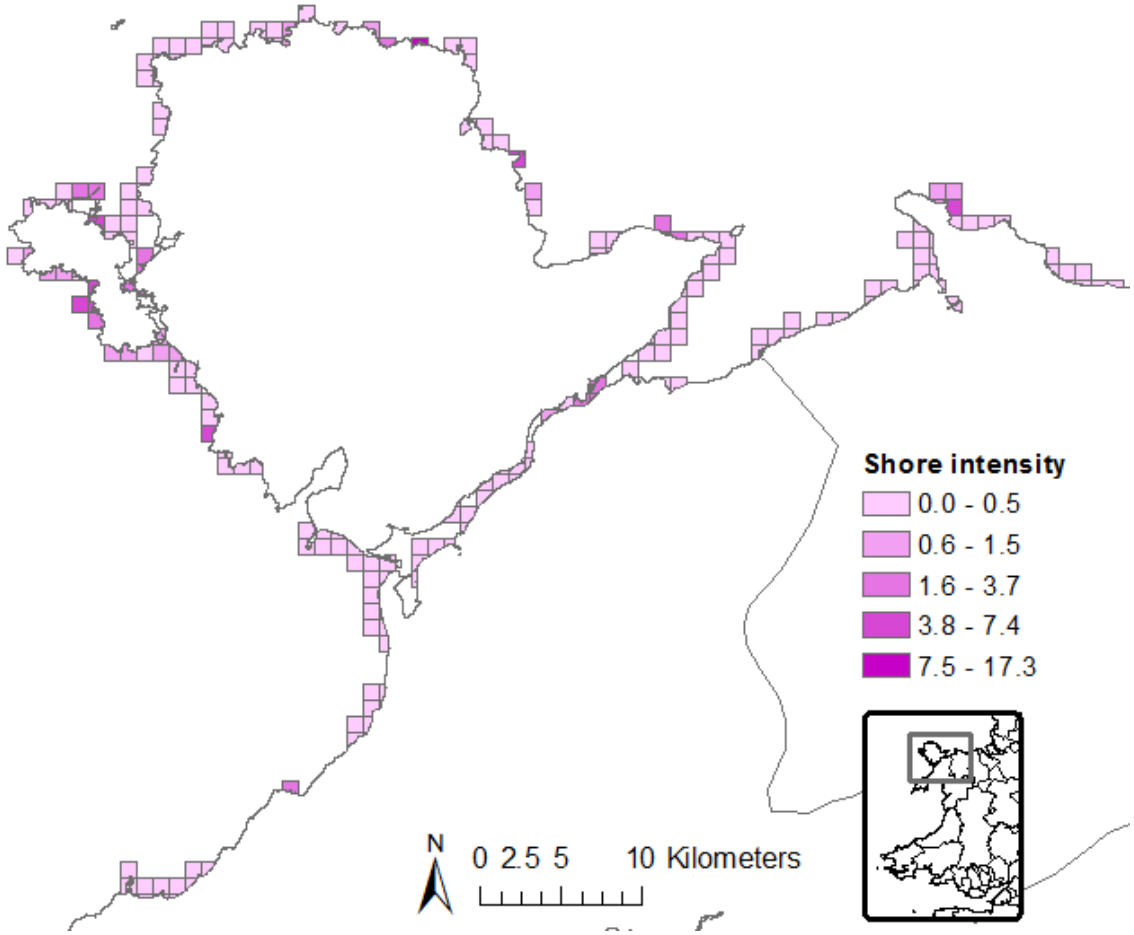


Figure 5-15. FishMap Môn derived shore recreational sea angling intensity (visits km^{-2} $week^{-1}$) for Anglesey and the surrounding area (Aron *et al.* 2014).

When angler numbers are spatially associated with their Marine Character Area (MCA), the Holyhead Bay and Skerries MCA was subject to the highest intensity with 139 angler trips km^{-1} $year^{-1}$ (Table 5-8). This is highly likely to be caused by Holyhead Breakwater which falls within Holyhead Bay and had four times the number of visits per year of Tŷ Croes, the next lowest area.

As noted in the table, intensity was calculated by standardising angler number by the total high water shore length of the MCA which will deflate totals where the FishMap Môn coverage was partial, i.e. Colwyn Bay and Rhyl Flats, and Llŷn and Bardsey Island. Additionally, the mean values by MCA in Table 5-8 do not account for within-sample areas with zero recorded activity omitted from the FishMap Môn spatial data. Omissions of these within-sample zero activity areas will have little effect on the minimum, maximum and total results presented in the table.

Table 5-8. Relative within sample shore angling effort (angler trips km^{-1} $year^{-1}$) and absolute numbers by Marine Character Area (MCA) (Appendix 2). Effort was calculated by standardising angler number by the total high water shore length of the MCA. This will deflate totals where the FishMap Môn coverage was partial, i.e. Colwyn Bay and Rhyl Flats, and Llŷn and Bardsey Island. Coloured cells highlight top 3 total values by measure. The number of 1 km^2 cells within the MCA area is *N*. Min = minimum, Max = maximum.

MCA	Measure	Mean	Min.	Max.	Total
Caernarfon Bay (*n* = 50)	Intensity	1.60 ±2.19	0.02	13.95	80 (14%)
	Numbers	181 ±248	2	1582	9,047 (23%)
Colwyn Bay and Rhyl Flats (*n* = 12)	Intensity	5.22 ±1.53	0.42	5.80	63 (11%)
	Nr.	262 ±77	21	291	3,144 (8%)
Holy Island West and Penrhos Bay (*n* = 9)	Intensity	8.03 ±6.99	0.51	22.01	72 (13%)
	Nr.	283 ±246	18	775	2,545 (7%)
Holyhead Bay and The Skerries (*n* = 25)	Intensity	5.56 ±15.17	0.11	55.81	139 (25%)
	Nr.	297 ±809	6	2977	7,419 (19%)
Llŷn and Bardsey Island (*n* = 24)	Intensity	0.28 ±0.58	0.04	2.28	4 (1%)
	Nr.	24.9 ±51.8	4	203	348 (1%)
Menai Strait (*n* = 30)	Intensity	0.83 ±0.75	0.03	2.22	25 (5%)
	Nr.	64.8 ±58.9	2	174	1,945 (5%)
North Anglesey Coastal Waters (*n* = 18)	Intensity	4.65 ±6.96	0.11	30.59	84 (15%)
	Nr.	166 ±249	4	1,094	2,996 (8%)
Red Wharf and Conwy Bays (*n* = 60)	Intensity	1.40 ±1.46	0.01	3.78	84 (15%)
	Nr.	188 ±195	2	506	11,275 (29%)

5.4.2.2. Pembrokeshire Wales Activity Mapping Project

Sea angler intensity standardised by smoothed high water shore length (numbers day^{-1} km^{-1}) according to Pembrokeshire Wales Activity Mapping (WAM) data are given in Figure 5-16. Total

effort from sampled data was 3,212 angler days[19] $year^{-1}$ representing 1.2% of the 278,288 total angler days a year estimated for Wales. This strongly suggests that the WAM data represents a small sample of shore angler intensity in the region, with total estimates for the relevant MCAs summing to ~25% of Wales wide effort under This Report's spatial shore effort estimates by MCA (Table 5-10). Maximum and minimum intensities by 100 km^2 cells were 0.07 and 11.78 numbers km^{-1} $year^{-1}$ with mean ±S.D. of 2.14 ±3.02. Mean absolute effort ±S.D. was 97 ±214 days $year^{-1}$ with a maximum of 1,215 days $year^{-1}$.

The original WAM data set provided no data for eastern Swansea Bay and the Port Talbot area, despite these areas being recognised as a popular location for shore angling according to social media and other online sources however, it is recognised that the WAM project was not dedicated to recreational sea angling assessments, but all forms of recreational activity and associated economic impacts.

[19] The Pembrokeshire Wales Activity Mapping project recorded number of people present in a day, angler days then is equivalent to angling day trip.

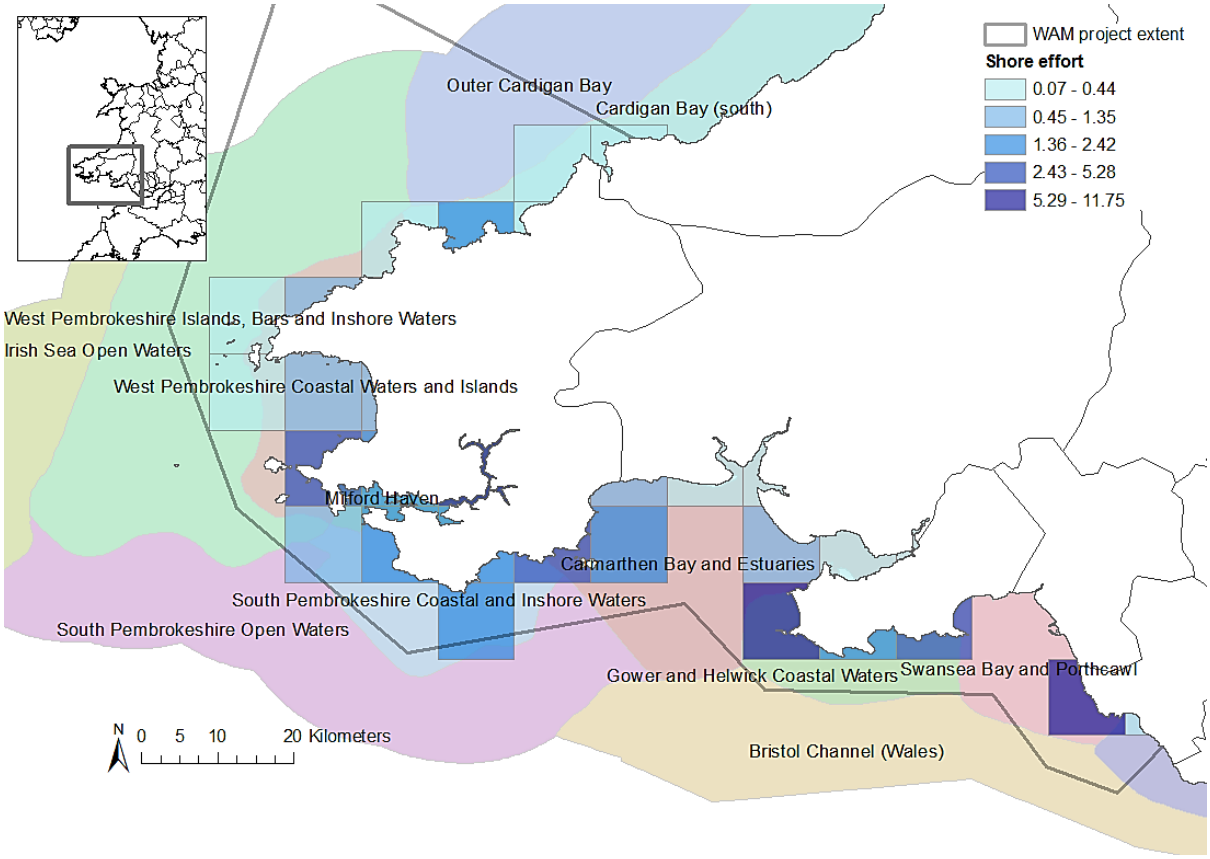


Figure 5-16. Pembrokeshire Wales Activity Mapping derived shore angler effort aggregated to 100 km^2 cells and standardised by within-grid high water shore length. Units are sea angler numbers per kilometre of coast line per year. Interpret shore areas with no bounding grids as no data. Marine Character Areas are underlayed.

5.4.2.3. Recreational Sea Angling North Wales Pilot Surveys

The two North Wales Recreational Sea Angler Pilot Survey Projects (NWPS), covering summer and winter 2007–2008 visited a total of 33 venues across North Wales, primarily based on their anticipated popularity. Some recorded visits were also made based on their convenience within a daily sampling itinerary despite an expectation under expert opinion that there would be little or no angling activity. Data were recorded for matches during the pilot however, these results were omitted from this report as the inclusion of angler numbers derived from matches would conflate effort. Average angler numbers by venue are presented in Figure 5-17.

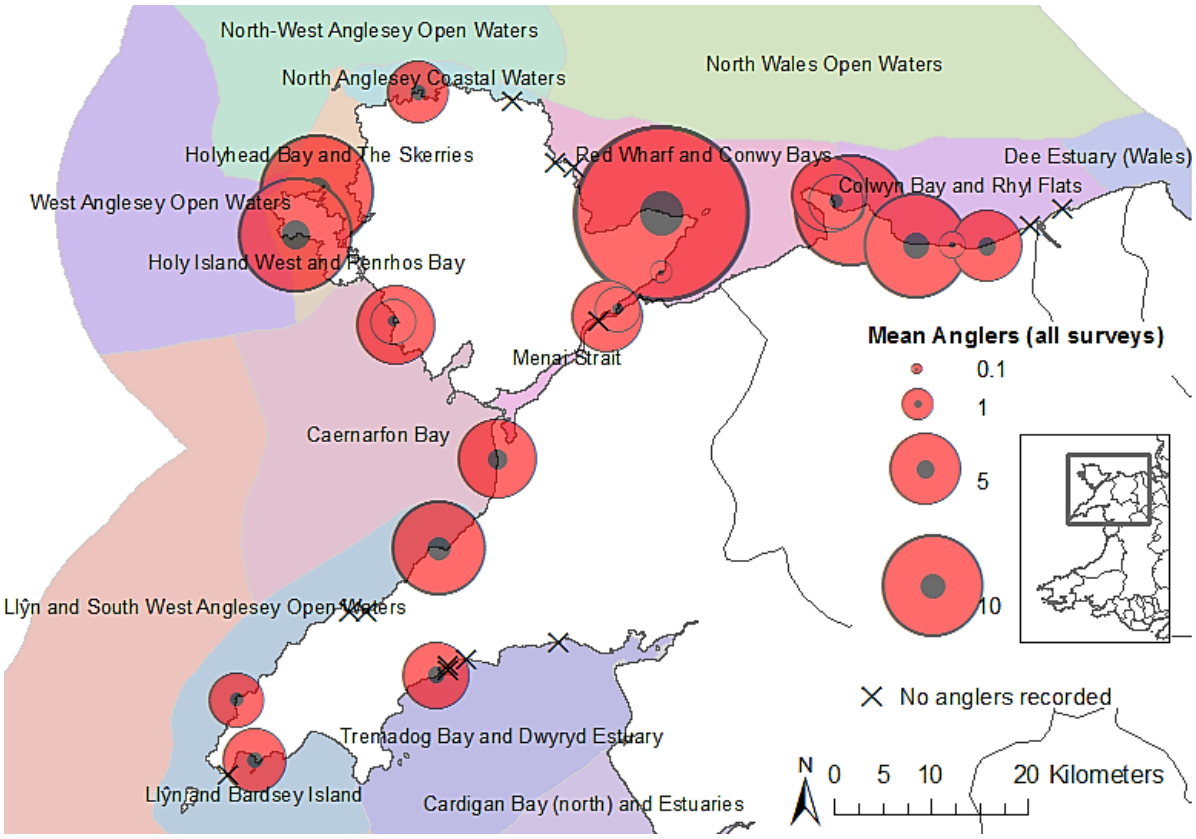


Figure 5-17. Recreational Sea Angling North Wales Pilot Survey average angler numbers by survey location aggregated across Winter and Summer surveys (Goudge *et al.* 2010, Goudge and Morris 2011). Crosses show locations visited which had no anglers present. Marine Character Areas underlayed and labelled.

The raison d'etre of NWPS introduces large biases into the results (Rowland Sharp, NRW pers. comm.) hence activity levels should be interpreted with great care. Nevertheless, the relative activity levels displayed—in particular for high activity areas—can tentatively be interpreted as correlated with general high activity at these venues under the venue selection criteria to maximise the number of sea angler encounters.

The absence of anglers at a recorded venue and the extensive coastal stretches not surveyed, does not mean these areas are not valued or used by RSAs. Variations in the seasonal patterns of species' distributions and the effects on weather, tides and long term species' availability will all affect a venue's popularity and value. As an example, the Cymyran Bay area is absent from Figure 5-17, probably because of the difficulty in approaching the area nevertheless, it is popular for bass and coalfish, and is particular valued by some anglers for small eyed ray (*Raja microocellata*) which is targeted by species hunters on specific tides over a few months of the year.

5.4.2.4. Point Mapping of Sea Shore Angler Locations

In total there were 2,700 venue instances (with duplication) appearing in 17 distinct data sources (Table 5-9), though there will be some duplication between sources with Richardson's (2006) Sea Angler magazine transcribed data contributing the largest number of locations at 36% of the total.

Table 5-9. Number of sea angling shore venues across Wales by the source type from which they were derived (N = 2700).

Source Type	Sub–source number	Venue count
Social media	9	742 (27%)
Published books	3	257 (10%)
North Wales Pilot Surveys Summer and Winter	N/A	97 (4%)
Monkman's (2013) thesis	N/A	136 (5%)
Richardson's (2006) Sea Angler magazine compiled data	N/A	966 (36%)
Richardson's (2006) surveys	N/A	298 (11%)
Pembrokeshire Wales Activity Mapping	N/A	204 (8%)

When venue location counts were aggregated by Marine Character Area (MCA)—omitting area standardisation—MCAs covering the Bristol Channel and South Wales areas were numerically dominant (Table 5-10) with Swansea Bay and Porth Cawl (9.2%), Severn Estuary (8.6%) and Carmarthen Bay and Estuaries (7.8%) ranked highest. This is a generally observed pattern with the North and Mid Wales coastal areas tending to have fewer venues according to the sources sampled and could be attributable to, for example, the generally higher population densities of South Wales and accessibility to angling locations. The exception is the Colwyn Bay and Rhyl Flats MCA, with second highest ranking of shore venues per kilometre of smoothed high water shore length.

Table 5-10. Absolute venue numbers and venue numbers standardised by smoothed high water shore length by Marine Character Area (MCA) across Wales (N = 2,700) derived from heterogeneous data sources. Top 3 MCAs by absolute count, approximate smoothed high water shore length and venues per kilometre smoothed high shore length are greyed.

Marine Character Area	Venue count	Shore length (km)	Venues per km
Caernarfon Bay	123 (4.6%)	119	1.0
Cardigan Bay (north) and Estuaries	120 (4.4%)	187	0.6
Cardigan Bay (south)	181 (6.7%)	165	1.1
Carmarthen Bay and Estuaries	210 (7.8%)	484	0.4
Colwyn Bay and Rhyl Flats	150 (5.6%)	50	3.0
Dee Estuary (Wales)	48 (1.8%)	23	2.0
Glamorgan Coastal Waters and Nash Sands	186 (6.9%)	42	4.5
Gower and Helwick Coastal Waters	140 (5.2%)	49	2.8
Holy Island West and Penrhos Bay	65 (2.4%)	37	1.8
Holyhead Bay and The Skerries	49 (1.8%)	55	0.9
Llŷn and Bardsey Island	133 (4.9%)	89	1.5
Menai Strait	149 (5.5%)	80	1.9
Milford Haven	99 (3.7%)	199	0.5
North Anglesey Coastal Waters	73 (2.7%)	36	2.0
Red Wharf and Conwy Bays	121 (4.5%)	136	0.9
Severn Estuary (Wales)	231 (8.6%)	103	2.2
South Pembrokeshire Coastal and Inshore Waters	66 (2.4%)	50	1.3
Swansea Bay and Porthcawl	248 (9.2%)	92	2.7
Tremadog Bay and Dwyryd Estuary	136 (5.0%)	133	1.0
West Pembrokeshire Coastal Waters and Islands	172 (6.4%)	162	1.1

5.4.2.4.1. Unweighted kernel density

Kernel densities for North and Mid Wales, and South Wales are presented in Appendix 13 and Appendix 14 respectively, the ubiquity of shore based RSA venues across extended sections of coastline is noticeable. Data also aligns with expert knowledge, with high density areas concurring with the expectations of the primary author for North Wales locations.

The heterogeneous nature of the data sources and the processing methodology employed will weight venue densities to the effort point sources of Richardson (2006) and Monkman (2013) (see section 5.3.2.4). Though this may be viewed as a methodological benefit, the largest single contributing dataset was Richardson's (2006) Sea Angler compiled data which was taken over the period 1990–2003. Despite the age of these data, it would be reasonable to assume that the majority of venues still remain popular although the Sea Angler data probably underestimates the importance of venues favoured by casual anglers. However, the results do not appear to be unduly affected by this mechanism.

5.4.2.4.2. Coverage weighted scoring

Scorings are unitless and are an indication of the relative weighted densities of venue location frequencies within the 17 data sources from which locations were collated. The geospatial distribution of scores in 1 km^2 cells for North, Mid and South Wales are presented in Appendix 15 and Appendix 16. Table 5-11 summarises scores according to Marine Character Area. The high ranking of the Dee Estuary area is attributable to the small length of coastline and the presence of 3 popular and widely known shore angling marks (Greenfield, Mostyn and Talacre) along this stretch.

Weighted scoring should be less subject to bias from the selection of data source coverages both used and available, though arguably, the availability of such sources could indicate increased popularity at large spatial scales. A degree of bias will still be present—though to a smaller degree owing to the geometric scoring (Figure 5-8)—arising from Richardson's (2006) Sea Angler magazine transcribed data, which would appear to display a bias towards RSA activity in South Wales.

No-data should not be interpreted as zero angling activity, the data used were historical and not the result of any randomised survey design. Where activity levels are non-zero, despite the severe data limitations, these did agree well with expectations under the expert knowledge of the author's for the North Wales region and also appear to have good agreement with the FishMap Môn recorded levels of activity.

Table 5-11. Intensity scores, (high tide shore length standardised) for intersecting 1 km^2 cells (*N*) by Marine Character Areas (MCA). Scores measure relative venue density by shore length within the collated data. Max is the maximum scored cell within the area. Sum is the sum of all scores–an absolute indicator of venue numbers. Mean is the cell scores average–a comparative measure of activity which standardises cells in the MCA. Mean % is the mean intensity score by MCA expressed as a percentage of the mean total. Note that score is unitless when not standardised by high tide shore length. Top 3 cells by column are greyed.

Marine Character Area	*N*	Max	Sum	Mean	Mean %
Caernarfon Bay	78	3.7	5.3	0.07 ±0.42	1%
Cardigan Bay (north) & Estuaries	135	0.7	2.0	0.02 ±0.08	0%
Cardigan Bay (south)	162	8.0	11.3	0.07 ±0.63	1%
Carmarthen Bay and Estuaries	222	16.8	37.7	0.17 ±1.38	3%
Colwyn Bay and Rhyl Flats	48	15.8	18.7	0.39 ±2.28	7%
Dee Estuary (Wales)	26	16.8	19.7	0.76 ±3.29	14%
Glamorgan Coastal & Nash Sands	43	3.1	13.2	0.31 ±0.67	6%
Gower and Helwick Coastal	51	6.5	10.9	0.21 ±0.96	4%
Holy Island West & Penrhos Bay	25	2.2	4.1	0.17 ±0.50	3%
Holyhead Bay & The Skerries	37	0.4	0.5	0.01 ±0.06	0%
Llŷn and Bardsey Island	104	15.6	31.8	0.31 ±1.94	6%
Menai Strait	68	5.3	7.0	0.10 ±0.65	2%
Milford Haven	138	16.8	18.5	0.13 ±1.43	3%
North Anglesey Coastal Waters	36	11.8	24.8	0.69 ±2.50	13%
Red Wharf & Conwy Bays	124	16.8	19.0	0.15 ±1.51	3%
Severn Estuary (Wales)	93	14.2	61.2	0.66 ±2.17	12%
South Pembs Coastal & Inshore	49	5.4	8.7	0.18 ±0.84	3%
Swansea Bay and Porthcawl	67	16.8	46.6	0.70 ±3.03	13%
Tremadog Bay & Dwyryd Estuary	95	5.6	6.2	0.07 ±0.58	1%
West Pembs Coastal Waters & Islands	144	10.9	15.5	0.11 ±0.93	2

5.4.2.5. Summary scored shore angling coverage and confidence

The 3 data layers were merged following normalisation of the 3 different effort and intensity measures of recreational sea angling shore activity. 1 km^2 cells of the data layer with the highest confidence were retained. Presented scores are effectively unitless, but are intended to provide an indication of intensity comparable across the whole Wales coverage. Results are presented in Appendix 17 for North Wales and Appendix 18 for South Wales. Although the results are largely apparent from the presented maps, increased activity appeared to be polarised towards the North Wales coast and Anglesey, and South Wales. Activity appeared lower in Mid Wales, with the exception of some localised high activity areas concentrated around the larger towns on the Southern Llŷn and Mid Wales. It is unfortunate that data were insufficient to elucidate the spatial fluctuations in seasonal angling patterns.

Only two surveys were available which assessed the spatial distribution of effort, remaining activity scores were based largely on venue point data. The confidence levels assigned to these sources and the extent of their coverages appear in Appendix 19.

5.4.3. Private Boats: Spatial Review

5.4.3.1. FishMap Môn

The survey had 27 respondents from 210 surveys distributed to private boat owners at intercept points and through the recreational potting permit holders address list. The number of recreational sea angler (RSA) fishing vessels operating in the vicinity of Anglesey is given in Figure 5-18. Although not explicitly expressed from the source (Natural Resources Wales 2015) it is assumed that this a summed frequency count of the 27 respondents marked angling areas. The project also expressed the results as a measure of fishing intensity (people ha^{-1} $week^{-1}$), which was then standardised to a ranking between 1 and 3, cells with a non-zero value in Figure 5-18 were assigned a ranking of 1, the lowest level of activity.

Reviewing the results, they concord with expert expectations despite the low response rate however, the absence of any RSA boat angling in Conwy Bay and estuary is surprising and undoubtedly a consequence of the small sample size and probably bias arising from sampling methods. It is also notable that these results are purely within-sample. Reasonably, no population expansion was undertaken. Unfortunately a spatial layer was not obtained to complete a more detailed analysis on the FishMap Môn private boat data.

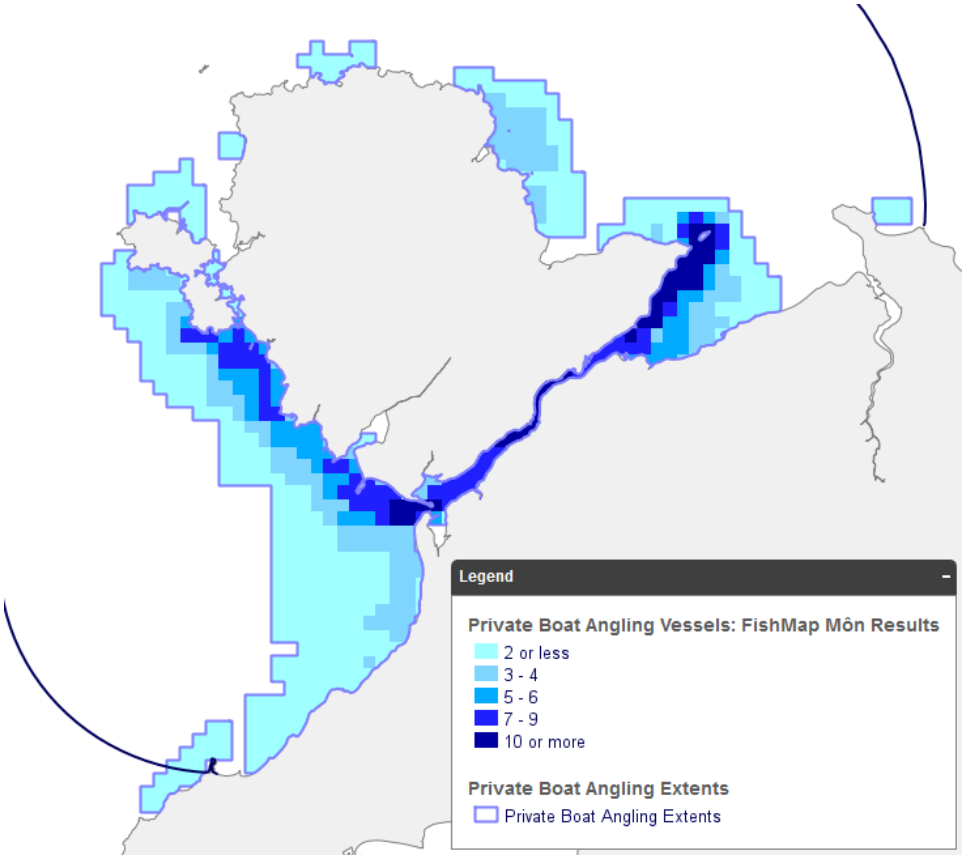


Figure 5-18. FishMap Môn private boat recreational sea angling intensity ("number of fishing vessels"). Reproduced from the FishMap Môn mapping portal (Aron *et al.* 2014, Natural Resources Wales 2015).

5.4.3.2. Slipways

Slipway provision across Wales is extensive with a variety of slipway services provision models and launch services. Slipways can be public (unrestricted or restricted public access) or private (open access, overnight accommodation associated, club/membership scheme or strictly private). During the summer months local authorities will frequently collect fees from people wishing to launch boats however, such facilities are also used by kayak anglers who can frequently use these at no charge (primary author's experience and expert knowledge).

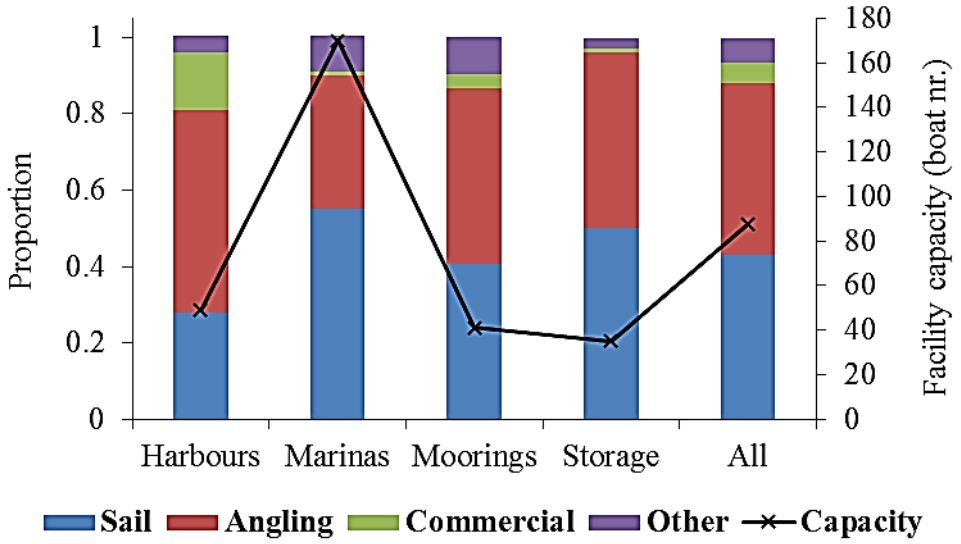
Slipways and assisted launching/recovery services—typically a suitably equipped tractor—are frequently offered together where slipway access does not extend to the low water mark and such services may be offered in association with boat yards who may also provide bait (e.g. live sandeel). There are also a significant number of slipways and launch services associated with camping and caravanning sites, a proxy indicator of the value that some tourists place on the synergy between the holiday experience and sea angling as provision of such facilities would incur a not insignificant cost to the owners of the camping and/or caravanning site.

Across Wales 134 slipways were identified and these are tabulated in Appendix 20 and mapped in Appendix 21. Non-tidal and slipways extending over the full tidal range can—in general terms—be interpreted as an indicator of quality and hence a likely proxy for higher activity levels., though this interpretation may be confounded by other vehicular based water sports (e.g. jetskis and sailing). The greatest densities were in South Wales, particularly around the major ports and harbours (for example Milford Haven and Carmarthen Bay). By Marine Character Area (MCAs listed in Appendix 2), the top 3 by slip count were Carmarthen Bay and Estuaries (11%), Milford Haven (10%) and Cardigan Bay and Severn Estuary at 9%. In North Wales Menai Strait had the highest number of slipways (5%). The geographic locations and the slipways occurrence by MCA is presented in Appendix 21. Further survey work could be undertaken, based on the slipway access locations and classifications presented, to assess relative levels of slipway utilisation by private boat and kayak anglers and confirm their access status to RSAs.

5.4.3.3. Harbours, Marinas and Near-Shore Boat Storage Facilities

A total of 153 facilities were identified as areas from which boats could be stored and launched. For harbour and marinas access to the sea is implicit however, only boat yards or other near-shore storage facilities (aggregated under the *storage* category) with a visible ramp or slipway were included. These 153 facilities had a mean numerical boat capacity of 63 ±81 (mean ±S.D.) with total numerical capacity for ***all*** boats of 9,457 and estimated to cover an area of 5.973 km^2 at a mean density of 2,714 boats km^{-2} (Table 5-12), This apparently large area is conflated significantly by open-water moorings where extents can be ambiguous and of low density (mean ±S.D., 674 ±700).

Should the identified facilities operate at full capacity, we would estimate they would host 3,962 boats involved primarily in recreational sea angling activity. Despite the large area of open-water moorings, marinas had the total highest numerical capacity for ***all*** boats (harbour moorings, 841 [9%]; marinas, 4,240 [45%]; open-water moorings, 3,366 [36%]; near-shore storage 1,010 [11%]). The high capacity of marines is attributable to their large total area (mean ±S.D. 3,713 ±2163 km^2) and higher berth density (mean ±S.D. 0.022 ±0.025 berths km^{-2}). According to the sample (n = 39), harbour moorings had the highest proportion of angling boats with mean ±S.E. 53% ±0.07 (



) nevertheless, open-water moorings were estimated to carry the largest number of angling boats—if operating at capacity—with a total of 1,562 boats with mean ±S.D. of 19 ±12 and covering an area of 5.2 km^2.

It should be noted that capacities and densities of marinas and harbour moorings were subject to reduced error as their extents were clearly delineated under Google Earth (GE), hence there was less interpretation in mapping extents and assessing unoccupied berths. All categories were subject to the same difficulties in the identification of boats primarily associated with angling as a likely primary activity. Dedicated angling boats were generally relatively easy to identify, though these could be used primarily for hobby potting or other non-angling activities. Cruisers, ribs and powerboats may also be involved in angling activity, though probably at a reduced average activity level, nevertheless they were all assigned into the *other* category (i.e. excluded) for the purposes of this report.

5.4.3.3.1. Spatial maximum capacity point distribution as a proxy of effort

Random spatial distribution of points representing the maximum angler boat capacities for each boat storage facility over a 10 km sea bounded radius are presented in Appendix 23. In interpreting these data it is important to appreciate that the points —representing virtual boats—are randomised within the sea bounded radius. The results give an indication of relative effort averaged across inshore areas (< 10 km) and being derived from boat launch facilities provide a good proxy of relative activity in lieu

of detailed survey data. Particular areas of elevated activity are around the major ports and harbours, which provide extensive facilities for the recreational boat angler.

Ultimately the spatial distribution of boat sea angling will tend to be highly patchy both spatially and temporally, and concentrated at locations which aggregate fish species nevertheless, limits on the operating distances of small boats, dictated by fuel costs, tides, time and safety do introduce upper bounding limits on operating distances, the quantification of which would enhance future works using similar methodologies. When considering the relative point densities displayed, it is likely some degree of private boat effort will be coincident with charter boat intensity (see Appendix 30 and section 5.3.4.2).

Table 5-12. Boat storage facility categories with estimates of the sum of facility capacities (∑ capacity) and mean capacity ±S.D. Angling boat capacities were based on bootstrapped sample estimates of angling boat proportions multiplied by the sum of all capacities. Densities were similarly calculated, based on facility areas polygonised under Google Earth (Google 2013). See Appendix 22 for proportion estimates.

Facility	∑ Capacity (nr.)	Capacity mean (boat nr.)	∑ Angling boat capacity (nr.)	Angling boat capacity mean (nr.)	Density mean (km^2)	∑ Area (km^2)	Area mean ±S.D.
Harbour Moorings (*n* = 17)	841	49 ±60	451 [336–566]	27 ±32	3,714 ±3,206	0.173	0.010 ±0.011
Marina (*n* = 25)	4,240	170 ±123	1,487 [948–2,026]	59 ±43	3,713 ±2163	0.545	0.022 ±0.025
Moorings (*n* = 82)	3,366	41 ±52	1,562 [1,061–2,063]	19 ±24	674 ±700	5.163	0.063 ±0.107
Storage (*n* = 29)	1,010	35 ±26	462 [237–688]	16 ±12	7,037 ±4,550	0.092	0.003 ±0.003
All (*N* = 153)	9,457	62 ±81	3,962 [2,582–5,342]	26 ±31	2,714 ±3,461	5.973	0.039 ±0.083

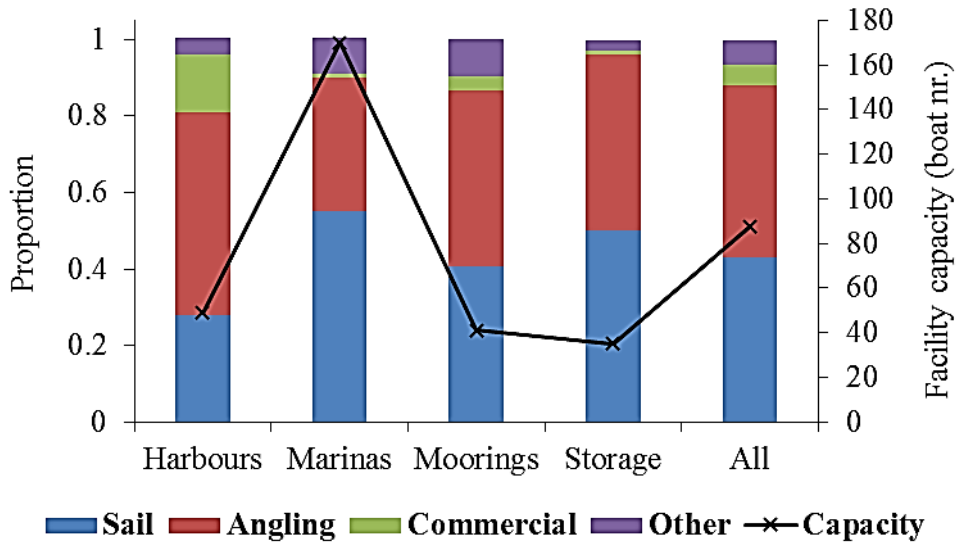


Figure 5-19. Boat storage facility capacity estimates (secondary right axis applies to lined data series) by category from the population estimates (*N* = 153) and numerical proportion of boats according to the boats' assigned likely primary function, derived from sampling (*n* = 39). Capacities and proportions estimated from Google Earth satellite imagery, Google Street View and associated images (Google 2013). See Appendix 22 for proportion estimates.

Virtual boat point frequencies by Marine Character Area suggests that the Severn Estuary (16%) and Milford Haven (13%) MCAs had the greatest boat density as shown in Figure 5-20. In North Wales, Red Wharf and Conwy Bays (8%) appeared to be subject to the highest level of private boat activity.

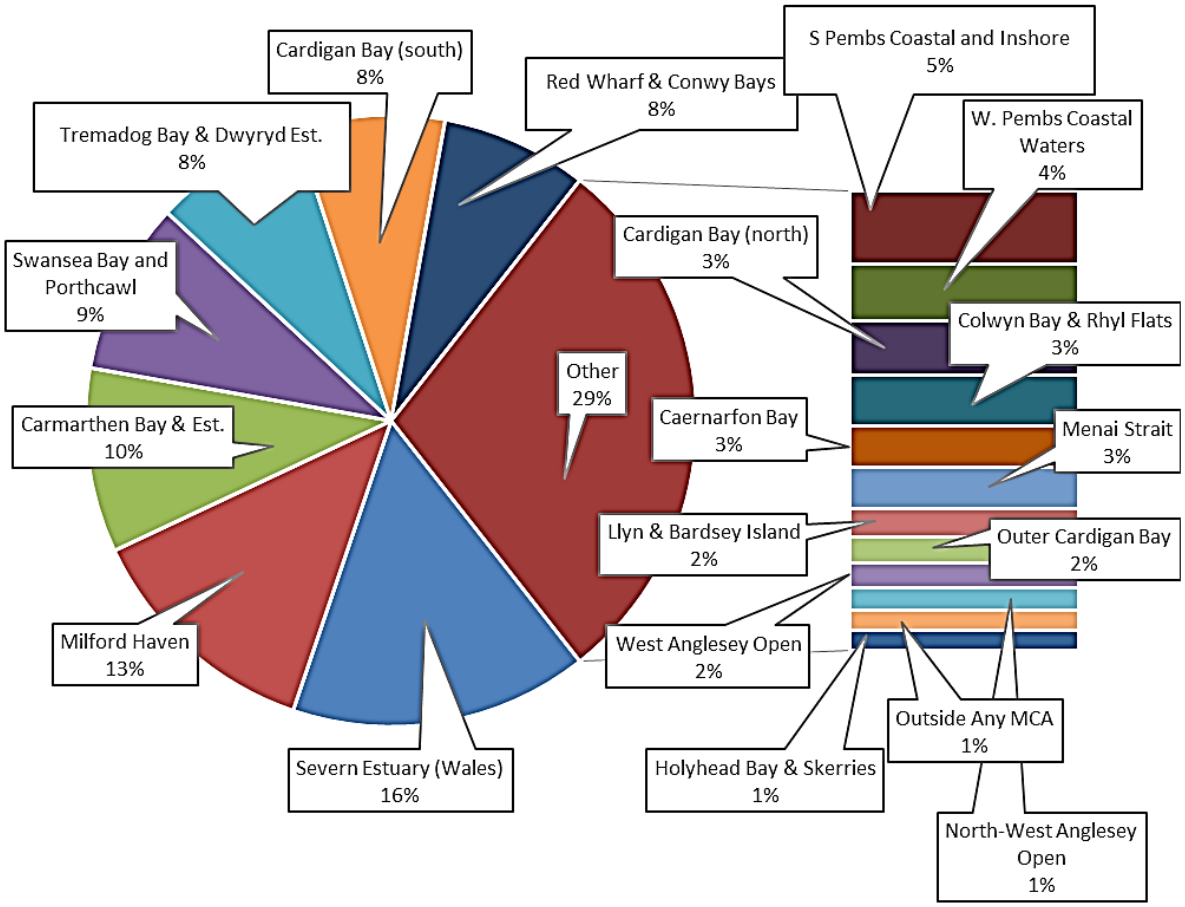


Figure 5-20. Spatial distribution of point frequencies for Marine Character Areas with > 1%. These data represents the maximum angler boat capacities for each boat storage facility randomised over a 10 km sea bounded radius. Randomised point distributions are presented in Appendix 23.

5.4.3.4. Pembrokeshire Wales Activity Mapping Project

The effort intensity of private boats involved in RSA according to Pembrokeshire Wales Activity Mapping (WAM) data is visually presented in Figure 5-21. Total effort from sampled data was 359 boat days year^{-1} representing just 1.0% of the total boat angler days per annum of the 34,495 estimated private boat days for the whole of Wales. This low intensity estimation follows that of WAM shore effort intensities, with total estimates for the relevant MCAs summing to ~33% of Wales wide effort (Figure 5-20, Appendix 22). Minimum and maximum intensities by 100 km^2 cells were 0.001 and 1.8 boats days year^{-1} km^{-2} respectively, with mean ±S.D. of 0.37 ±0.57 boats days year^{-1} km^{-2}. Mean absolute effort ±S.D. across the 22 cells in Figure 5-21 was 17.1 ±25.6 boat days year^{-1} with a cell maximum of 119 days year^{-1}.

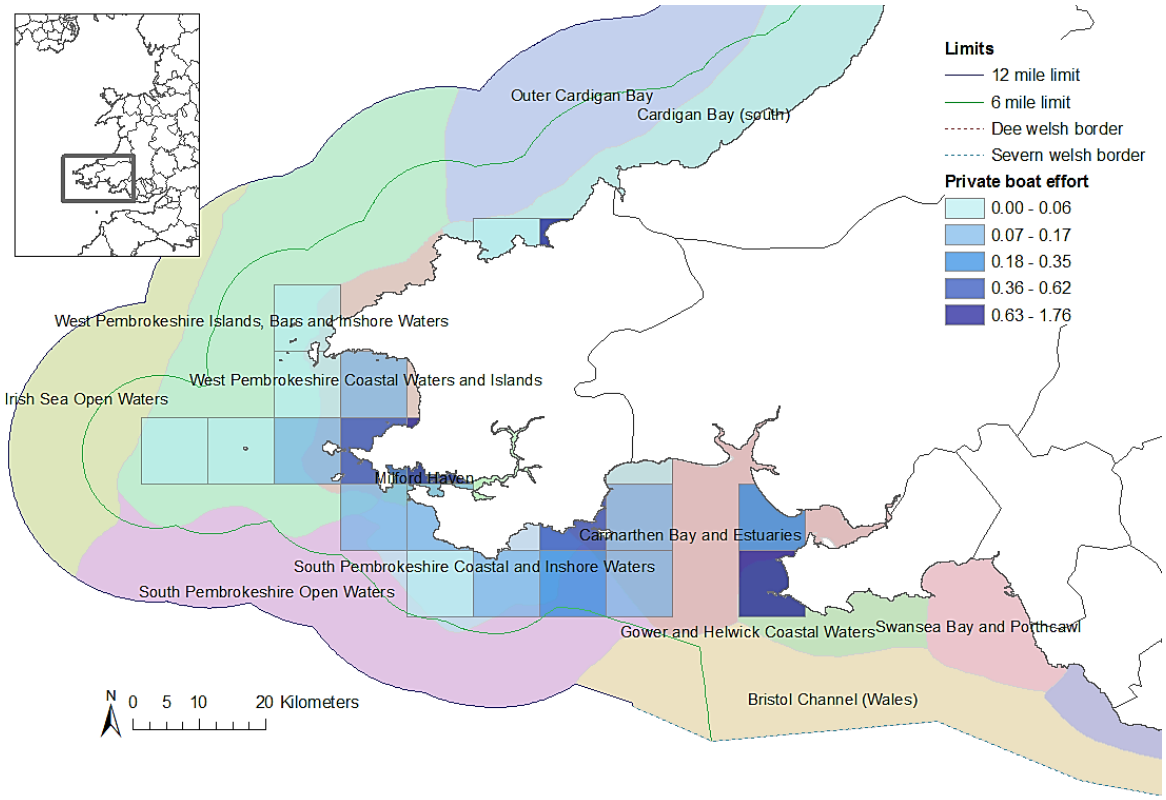


Figure 5-21. Pembrokeshire Wales Activity Mapping derived total private boat effort aggregated to 100 km^2 cells, standardised by area. Units are boat days km^{-2} $year^{-1}$. Interpret areas with no bounding grids as no data. The area of cells abounding the shoreline have been adjusted to account for the land encroachment. Marine Character Areas are underlayed.

5.4.3.5. CEFAS Boat Census

The survey recorded a total of 389 boats participating in recreational bass angling across Wales in 2012, with a by-port mean ±S.D. of 13 ±12 (*N* = 30). The highest reported count was in the vicinity of the port of Conwy, North Wales at 47. The spatial distribution of these data are presented in Appendix 27 and tabulated under

Appendix 26.

There is uncertainty in the specifics of the data collection methodology, for example the strength of evidence and qualifying criteria required for a boat to be assigned to the angling (i.e. rod and line) boat métier, which is based largely on local expert knowledge (Pickett 1990). Although the spatial data presented concords largely with expectations there are some unexpected figures; certainly the value of 47 boats for Conwy is unusually high in the primary author's opinion, and the historical data shows an unexplained marked increase of 12 to 47 boats (391%) between 2009 and 2010.

When interpreting the spatial data it is important to consider the collection methodology, which is supposed by this report's authors to be largely intended for semi-qualitative activity level reporting, as exampled by Pickett (1990). Importantly, the spatial dimension measure is not by unit area but by coastal length and the data makes no inference as to actual private boat angling locations. The data is similar in character to the underlying harbours, marinas and near shore treatment of section 5.3.3.2, accepting the different data collection and processing methodologies.

The CEFAS boat census data, Pembrokeshire Wales Activity Mapping and the storage facility treatment of this report are produced on a single map in Appendix 28.

5.4.4. Charter Boats: Spatial Review

The charter boat sector was relatively easy to identify as business is customer driven hence service promotion and the publication of contact details both online and in the print media is common place. The distribution of charter boats by home ports are given in Figure 5-22. In total 60 vessels were identified as operating from Welsh ports, though the absence of an official registration scheme means the actual figure could be greater. Coverage was thought to be good, as current numbers were comparable to the 56 identified by both Richardson (2006) and Monkman (2013). It should be noted that there are some seasonal shifts of vessels between ports, most notable from Rhyl to the River Mersey during late autumn and winter, primarily in response to weather and the availability of cod in the River Mersey.

It was not possible to identify the extent of English charter vessels with access to Welsh grounds (Figure 5-22B), however Minehead (*N* = 4), Portishead (*N* = 2), Watchet (*N* = 1) and Ilfracombe (*N* = 5) have some charter vessels (numbers in parentheses) that may operate within 12 nm of the Welsh coast. Equivalently, there will be an unquantified degree of activity transfer to English territorial waters by Welsh vessels operating from ports between Bury Port and Penarth.

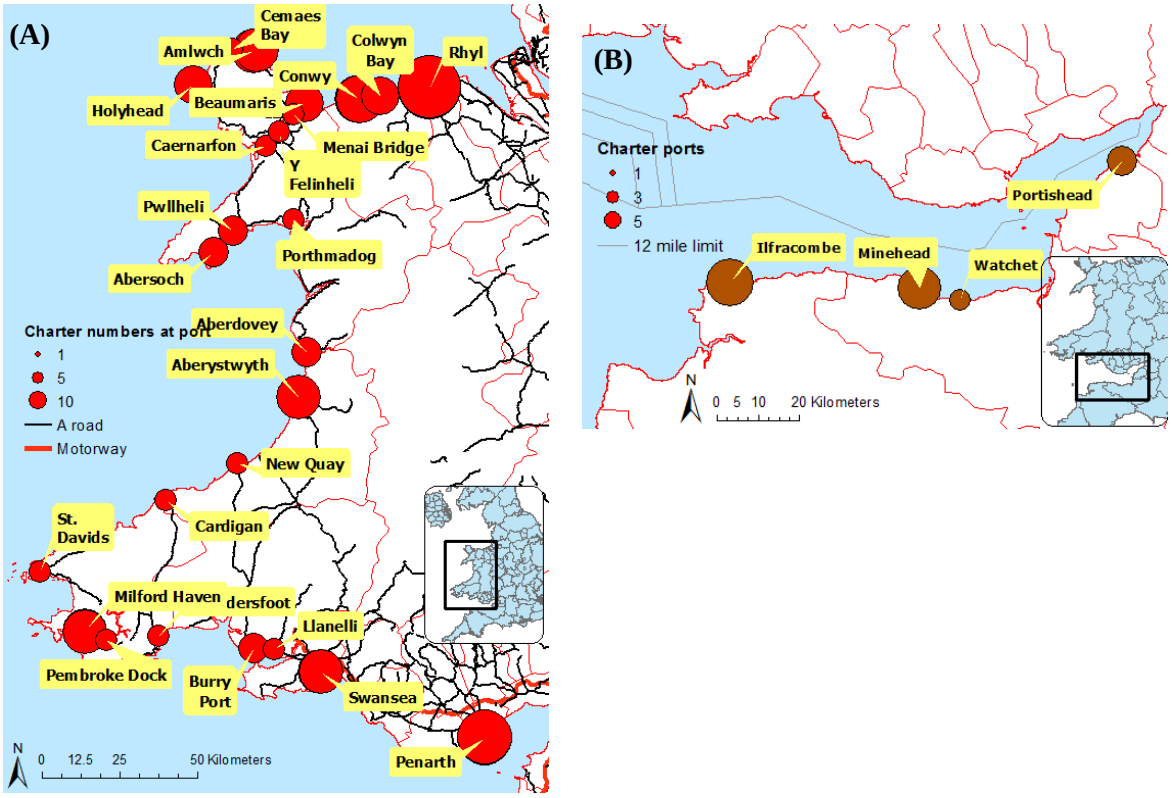


Figure 5-22. Number of charter boats by home port in Wales (A), overlaid with main arterial road routes. (B) Number of charter vessels by port with access to Welsh territorial waters.

5.4.4.1. Richardson (2006)

Richardson's 2006 spatial interview and activity data are presented in Appendix 30, showing the distribution of charter effort and area standardised effort (*intensity*) across Welsh waters. These data are aggregated by the Marine Character Areas (MCA) (see Appendix 2) to give total absolute effort (boat days year^{-1}) and an intensity (boat days km^{-2} year^{-1}) (Appendix 31 and Appendix 32) across the MCAs. The data are tabulated under Appendix 33. A total of 3,282 boat days year^{-1} were estimated to have occurred across the 29 MCAs of Wales, with an effort mean ±S.D. by MCA of 113 ±165. The intensity ±S.D. across all MCAs was 0.24 ±0.26. The highest absolute effort of 845 boat days year^{-1} occurred in the North Anglesey Coastal MCA, followed by the Bristol Channel with an intensity of 311 ±12. The highest intensity mean ±S.D. of 1.10 ±0.09 boat days km^{-2} year^{-1} was in the Colwyn Bay and Rhyl Flats MCA.

Examination of the spatial distribution of effort in Appendix 30 highlights the importance of the Constable Bank area in providing grounds for the North Wales coast charter sector in the Colwyn Bay and Rhyl Flats MCA. The ports of this coastal stretch host the largest number of charter boats across Wales. The spatial pattern of effort is notably different in Cardigan Bay compared to the high effort areas in the Bristol Channel, North West Anglesey and Rhyl Flats. Cardigan Bay activity, particularly the North Cardigan Bay MCA (mean ±S.D. intensity 0.36 ±0.02) is characterised by patterns of localised effort. This effort concentration is almost certainly a result of skippers targeting reef structures and localised rocky patches, known as the Sarnau, which extend westward from the mainland and aggregate popular target species (section 3.3.1, Figure 5-2).

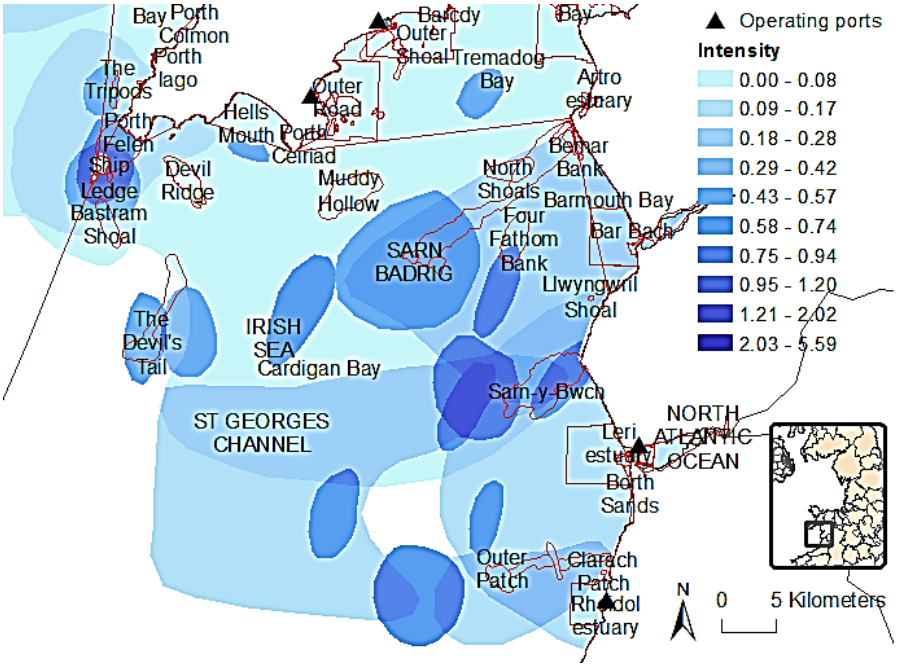


Figure 5-23. Charter boat intensity (boat days km^{-2} year^{-1}) for Cardigan Bay from Richardson's (2006) 2003–2004 survey data overlaid with sea bed named features (EDINA 2013, Seazone 2014).

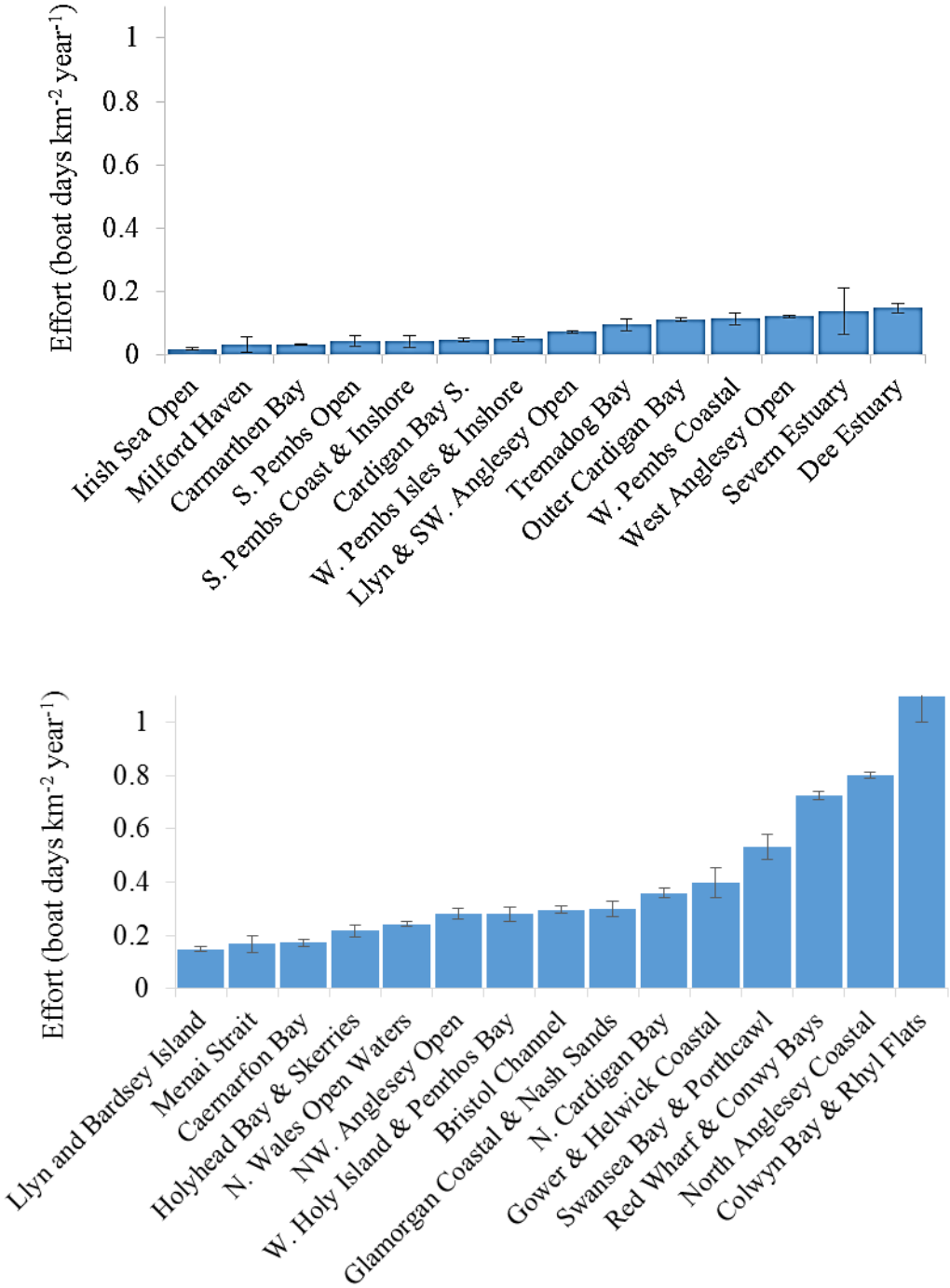


Figure 5-24. Mean charter boat effort ±S.D. (boat days km^{-2} year^{-1}), standardised by the area (km^2) of the Marine Character Area Note y-axes have the same magnitude. Calculated from Richardson's (2006) 2003–2004 survey data, extrapolated to the 2015 charter boat fleet.

5.4.4.2. FishMap Môn

The project surveyed 26 charter boat operators (93% coverage) , who provided spatial activity maps of their trip frequencies and angler numbers for three years prior to the 2011–2012 surveys. Because of inter-year variation in responses, the previous two years were used in the calculation of intensities. Average trip durations were between 4 and 6 hours. Intensity levels calculated from the project are presented in Appendix 34. In general intensity appears to be diffuse, however this could be due to intended or unintended recall biases however. Several areas of high intensity our apparent and these are predominantly in the vicinity of wrecks, demonstrating the importance of these habitats to some charter boat businesses.

Total angler days per year were estimated at 19,329 for this near census like dataset. This figure broadly concords with the total Wales wide estimate of 34,495—derived from the Sea Angling 2012 survey—with North Wales having the largest number of charter vessels. Estimates derived from Richardson's (2006) unpublished survey data (see methods section 5.3.4.1 and results section 5.4.1) gave 43,835 angler days per year. The Marine Character Areas subject to the highest amount of effort per unit area were North Wales Open Waters, Holy Island West and Penrhos and North Anglesey Coastal Waters (Table 5-13).

Table 5-13. Marine Character Area (MCA) relative charter boat angling intensity means ±S.D. (angler days km^{-2} year^{-1}) with minimums and maximums. ∑ *angler days* is total angler days within the Marine Character Area (MCA). *MCA area effort* is the sum of angler days divided by the total MCA area (angler days km^{-2} year^{-1}). Totals and means will be deflated for Colwyn Bay and Rhyl Flats, and Llŷn and Bardsey Island because of partial study coverage. Top 3 total values by measure highlighted. The number of 1 km^2 cells within the MCA area is *N*, i.e. number of cells used in the calculation of Within sample means.

MCA	Within sample mean effort ±S.D.	Min.	Max.	∑ angler days year^{-1}	MCA area effort
Caernarfon Bay (*N* = 261)	0.76 ±2.46	0.0	17.7	160 (1%)	0.3 (0.2%)
Colwyn Bay and Rhyl Flats (*N* = 146)	30.7 ±52.4	0.0	162	1,382 (7%)	5.9 (3.8%)
Holy Island West and Penrhos Bay (*N* = 47)	11.0 ±16.1	0.20	74.8	516 (3%)	13.5 (8.8%)
Holyhead Bay and The Skerries (*N* = 58)	9.22 ±17.15	0.099	86.8	534 (3%)	7.1 (4.6%)
Llŷn and Bardsey Island (*N* = 138)	0.29 ±0.58	0.0	4.20	31 (0%)	0.1 (0.0%)
Llŷn and South West Anglesey Open Waters (*N* = 30)	0.099 ±0.000	0.099	0.099	3 (0%)	0.0 (0.0%)
Menai Strait (*N* = 26)	3.87 ±6.91	0.30	25.7	101 (1%)	3.7 (2.4%)
North Anglesey Coastal Waters (*N* = 61)	9.61 ±28.05	0.20	149	586 (3%)	10.5 (6.8%)
North Wales Open Waters (*N* = 398)	49.8 ±162.3	0.0	1,047	10,660 (55%)	101.0 (65.9%)
North-West Anglesey Open Waters (*N* = 134)	7.55 ±21.02	0.099	73.4	1,011 (5%)	1.2 (0.8%)
Outside National Limits (*N* = 65)	13.4 ±38.0	0.30	257	872 (5%)	n/a
Red Wharf and Conwy Bays (*N* = 224)	21.7 ±131.1	0.0	1,162	3,431 (18%)	10.0 (6.5%)
West Anglesey Open Waters (*N* = 139)	0.29 ±0.25	0.099	0.80	41 (0%)	0.1 (0.0%)

Anecdotal information under informal interview (Monkman, 2013) indicated that after construction and settlement, windfarms may increase fish aggregation and improve recreational sea angler boat catches, there is some support for this—under an assumption that activity tends to occur where angling quality tends to be better. Figure 5-26 shows the FishMap Môn derived intensity from 2011–2012, after construction of the windfarm in 2008–2009, contrasted with Richardson (2006) derived intensity data prior to the construction Figure 5-25. Visual comparison suggests a temporal shift of the intensity centre towards the windfarm installation. Both surveys used face to face interviews with admiralty maps for respondents to qualify their spatial effort. Unfortunately no other historical data were available to compare activity at other windfarm constructions and peer reviewed literature on the subject for the UK is scant.

Figure 5-25. Intensity data from Richardson (2006) mapped data, showing location of Rhyl Flats windfarm, constructed after Richardson's work. See Appendix 30 for full map.

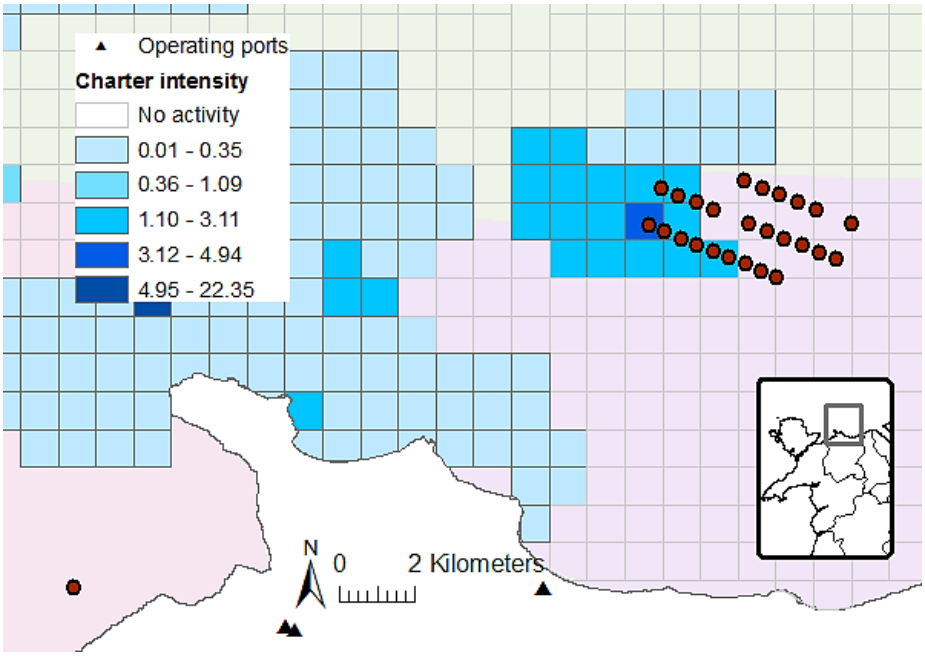


Figure 5-26. FishMap Môn charter boat intensity levels (people ha^{-1} $week^{-1}$) off the north coast of Wales after wind farm construction in 2008–2009, with particular focus on the windfarm associated intensity (points are turbine locations).

5.5. Discussion

In general terms there exists reliable estimates for key recreational sea angler (RSA) metrics, for example average trip durations by shore; charter boat and private boat platforms, socioeconomic stratifications; per angler trip days per year, and target species. Those presented are derived either from the Sea Angling 2012 survey (Armstrong *et al.*, 2013)—which did not survey RSAs fishing in Wales—or non-random self-selecting surveys. These data then would be deemed insufficient under aims to accurately estimate population wide effort and catch within quantifiable degrees of statistical confidence unless it is possible to correct for inherent biases. However, under marine spatial planning the accurate estimation of total sea angler induced fish mortality is not typically required (accepting special cases) and therefore the calculated metrics are arguably fit for purpose. In any case, they provide a useful source of information of the potential impact of marine spatial planning decisions and indicates how further information on RSA might be collected.

Spatial data on shore angling across Wales was poor, although the FishMap Môn and Pembrokeshire Wales Activity Mapping (WAM) projects have been successful in piloting methodologies for collecting spatial data on recreational sea angling. These two projects covered approximately 1/3 the length of the Wales coastline though activity may have been under-reported in some areas. Both WAM and FishMap Môn would have unquantifiable biases arising through non-randomised sampling designs

The majority of the shore angling data therefore relied on predicting activity locations based primarily on the occurrence of angling venues from grey literature sources. In addition, data sources were temporally separated, with information drawn from sources ranging over some three decades. This reliance on historical data was borne out of necessity, but highlights the requirement to engage in a well-designed nationwide RSA survey if robust effort and catch data were justified to meet the requirements of pertinent legislation as introduced in sections 2.2 and 2.5.

Though these data would be inappropriate for making rigorous predictions of total shore angling population effort (for example), the authors' believe the mined location point data correlates well with areas of increased activity. Visual comparison of intensities between FishMap Môn and WAM shore data are in general agreement with the point data. Unfortunately the sparse spatial layers so derived are unsuited to geostatisical tests of interlayer covariance statistical permutation testing. This work provided a detailed map of sea angling locations which are of sufficient resolution and reliability to indicate to stakeholders where activity is likely to occur, both for consideration under marine spatial planning, under local marine management and for future logistical planning of national surveys of RSA should resource be available for the extension of the creel based approaches piloted under the North Wales Recreational Sea Angler Pilot Surveys and FishMap Môn.

Determining the angling locations of private boat anglers across Wales was problematic, data coverage across Wales from survey sources was patchy, with location and effort measures once again

provided primarily by the FishMap Môn and WAM projects and covering approximately a 1/3 of the coastline. The novel use of online geospatial data allowed predictions to be made on the probable effort centres at a low spatial resolution. A substantial amount of work would be required to get a high resolution Wales wide picture of private boat spatial effort.

A major limitation of the private boat distribution assessment approach taken (as presented) is that boat densities were based on predicted maximum capacities of boat storage/berthing facilities. Further work could identify seasonal activity trends, and surveys targeting berthing and storage sites identified here-in would allow occupancy levels to be estimated. Nevertheless, it is reasonable to assume that the capacity of boat facilities was a reasonable proxy for occupancy and corresponding RSA private boat activity levels. If the identification of valued fishing grounds were deemed necessary then the data provided would greatly facilitate access point intercept style surveys, a recognised survey instrument to elucidate spatial activity and minimise bias.

Despite it being possible to estimate occupancy alongside capacity and proportion of potential angling boat types, occupancy was considered to be subject to excessive variation within the limitations of time and available imagery. Proportions would be subject to the same underlying biases as total occupancy, but the magnitude of such biases was expected to be comparatively low.

In contrast to shore and private boat platforms, the spatial distribution and magnitude of charter boat activity was good, with near census-like coverage, albeit from 2003. Results showed higher charter activity in North Wales, despite the extensive boat berthing facilities and higher population densities of the South Wales coastal regions. This apparently counter-intuitive observation is probably attributable to the predominance of private boat launching facilities in South Wales, with marina facilities on the North Wales coast being limited to a number of small ports and slipways. It is possible that population demographics may also play a significant role. Data on species catches is data poor for charter boats operating in Wales, though Sea Angling 2012 results may be expected to be comparable.

High resolution RSA effort levels provide indicators of the areas and coastal environments in which anglers choose to fish however, spatial effort magnitude should not be the only measure of value considered when assessing the ability of the Welsh fishery to deliver socioeconomic benefits or considering recreational sea angling in marine spatial planning.

6. SECTOR STRENGTHS, WEAKNESSES, OPPORTUNITIES AND THREATS

A SWOT analysis was conducted among the project authors with additional inputs sought from Roger Cook of the Welsh Federation of Sea Anglers and Malcolm Gilroy, owner of the Angling Bait Centre on Anglesey. Attempts were made to contact alternative businesses to request input, but no responses were forthcoming. Items in the analysis are listed in alphabetic order, the team tried to avoid listing items which could not reasonably be affected, for example unpredictable effects of climate change on weather.

6.1. SWOT Tabulation

Internal Strengths	Internal Weaknesses
1. Active consultation & co-operation between sea angling organisations and fisheries and environmental managers. 2. Coastal variation—a variety of different coastal location types within short distances (e.g. Rock ledges and surf beaches). 3. Diverse charter boat services across the country. 4. Good competition venues. 5. Largely unlimited coastal access. 6. Marine environment and landscape—Wales is perceived as having an attractive and clean marine environment. 7. Prestige species—opportunities to catch prestige and sport fish species (e.g. bass and tope). 8. Road infrastructure. 9. Safe and well regulated charter sector. 10. Spatial protection of the marine environment—a large proportion of the Welsh coastal waters out to 12 nm are protected by legislation to preserve biodiversity, species and habitats. 11. Species variety—wide variety of species available for sea anglers to catch. 12. Strong RSA networks—Welsh Federation of Sea Anglers and a range of sea angling clubs provide a supporting framework for new and existing anglers. 13. Year-round angling opportunities.	1. Complex and confusing legislation on illegal fishing may divert enforcement effort and decrease reporting of genuine transgressions. 2. Costs of launching, parking and boat storage perceived as high among anglers. 3. Disparate facilities for boat storage and launching in some areas. 4. Heavy commercial and IUU fishing pressure particularly on bass. 5. Lack of charter opportunities in mid Wales 6. Lack of coherent marketing and promotion. 7. Lack of facilities at some locations. 8. Limited enforcement capacity. 9. Limited official support to the sector and its requirements. 10. Little to no network of experienced sea anglers involved in coaching and or formal education programmes. 11. Poor signage for beach and boat angling 12. Poor strategic development and support/marketing infrastructure. 13. Poor transport links to the west coast of Wales limits day visitors. 14. Public transport infrastructure limited for some areas, including international airport access. 15. Sector representation is on a voluntary basis and fragmented. 16. Spatial and temporal patterns of sea angling not know at high resolution and no rolling programme to assess this.

External Opportunities	External Threats
1. Cross-over of freshwater anglers to sea angling. 2. Development of angling only zones to reduce interactions with other users of the marine environment and enhance the angling experience[20]. 3. Enhance synergies with tourism sector(s) to increase income delivered to local rural economies. 4. Extension and promotion of guided experiences to promote Wales as a venue and recruit new anglers. 5. Lure fishing and Light Rock Fishing (LRF) easily accessible to traditionally under represented angler demographics, e.g. females. 6. New and existing venues, accommodation, facilities and marketing initiatives can be substantially improved and there is European money available to assist this. 7. Promotion and support for organised competitions. 8. Promotion through initiatives to target groups under-represented in the current sea angler demographic. 9. Tackle costs and availability make access to the sport relatively low cost.	1. Abundance and size decreases in prestige angler species through localised RSA induced pressure (e.g. wrecks). 2. Abundance and size decreases in prestige angler species through commercial pressure (e.g. the bass 'situation') 3. Conflicts with other marine users 4. Decreasing uptake of the sport by young people. 5. Increased regulation of sea angling. 6. Habitat and species protection measures intersecting with valued angling areas and prestige species. 7. Launch capacity, launch and storage prices. 8. Licensing costs and regulation in charter sector reducing operating margins. 9. Loss of sea angling tackle shops and other commercial services due to competition from online only retailers. 10. Negative perceptions of sea anglers from animal welfare and environmental impacts perspective 11. Parking charges at venues. 12. Reduced investment leading to decline in facility quality, or removal of existing sea angler targeted services (e.g. degeneration of slipways can reduce private boat and kayak launching at venues, in particular out of season where launching may not be supported by a tractor launch service). 13. Loss of easy access venues for less-abled sea anglers due to maintenance, health and safety or other issues (e.g. closure of piers and breakwaters or restrictions on harbour access). 14. Loss of sea anglers to fishing opportunities outside of Wales. 15. Loss of sea anglers to fresh water angling. 16. Reductions in localised bait availability (through overexploitation for example) or access to collect (e.g. black lugworm, peeler crab and sandeel) may reduce local sea angler numbers.

[20] See for example, http://www.devonandsevernifca.gov.uk/angling

There are a great variety of species and fishing venue types available across Wales, including easy access opportunities provided by pier and breakwaters. In particular Wales is highly regarded for its large number of prestige species. The primary aspirational shore species is bass but several areas are renowned for the opportunity for a shore angler to catch tope, among other species such as rays and smooth hound. Charter boat anglers also aspire to catch tope, primarily for sport and black bream. Wales also has excellent opportunities to catch blue shark and porbeagle on specialist charter vessels, although porbeagle are an IUCN[21] red listed species. Nevertheless, despite this perceived strength, the reported reduction of charter boat trips—anecdotally associated with the historical loss of prestige species such as the angel shark and skates (in particular the common skate, *Dipturus batis*), and decreases in other species, such as the thornback ray and cod—serves as a warning to how fish abundance and quality could negatively impact RSA numbers (Radford *et al.* 2009).

Undoubtedly a great strength of Wales is its environment which is protected by multiple designations. Aesthetic appreciation of the natural environment is frequently reported as a primary reason that anglers participate in the sport (see Radford *et al.* 2009 for example) and the seasonal increases in recreational sea angling (RSA) at the Mid Wales coastal regions is probably associated with tourists combining overnight family stays with a variety of marine based activities which include sea angling. This is an important synergy to exploit with overnight stays significantly contributing to total spending. There could be opportunities to improve the marketing and promotion of sea angling within the holiday sector. It is perceived that there is little cross promotion of RSA with other water sports and a general under promotion of Wales as an RSA venue in general across the UK and abroad.

Further work could be justified to determine the barriers to people recruiting to the sport. The perceptions of other marine users of sea anglers could be negative, certainly there is some anecdotal evidence of this from personal communication with recreational divers for example. Within the sea angling community there is a recognition of the problem of littering, with *rubbish* appearing in the word cloud in Appendix 9. The promotion of conservation and environmental issues within supported coaching and education programmes may be a route forward, along with the promotion of sea angling organisations, such as the Welsh Federation of Sea Anglers who would provide an excellent platform and reservoir of expertise on which to build an holistic approach to targeted RSA promotion and recruitment.

Previous surveys support the benefits of other anglers as a gateway to the participation of others. Simpson and Mawle (2005) found that having someone to go angling with was the factor most likely to encourage lapsed anglers to re-join the sport (N = 330, 40% of responses) and under 16's to fish in the future (N = 132, 48%). Information on how to fish appeared next in the two lists at 19% for lapsed

[21] The porbeagle shark, *Lamna nasus* on the International Union for Conservation of Nature red list at http://www.iucnredlist.org/details/11200/0

anglers and 33% for young anglers, also supporting the potential benefit of coordinated dissemination of promotion and informational materials and angler mentoring in some form. Despite this, respondents to Substance (2012) stated that cost was a major barrier to fishing more frequently, highlighting the importance of the lower cost shore angling to participants in manual occupations (Hargreaves *et al.* 2013a).

Drew (2004) noted that anglers' responses indicated a decrease in access to venues, particularly man-made structures exampled by docks and piers. Access restrictions to port controlled structures were partially attributable to increased security measures following the UK wide response to the threat of terrorism. Health and Safety issues have also contributed to access reductions, such as restriction of vehicular access to the Peel Ports owned Holyhead Break Water, Holy Island in 2014 and on-foot access to Trefor Pier on the Northern Llŷn Peninsular due to the instability of the structure.

In surveys, sea anglers rank catch size and number as a major factor in their enjoyment of the sport, Drew (2004) ranked fishing quality as the most important factor in safeguarding fishing for sea anglers. RSAs were also aware that water quality influenced their catch, in particular citing examples of sea angling improvements associated with programmes to reduce chemical and biological effluent in rivers such as The Mersey and Thames. Respondents to Drew (2004) commented on parking availability and increases in parking charges, linking such increases with decreases in angler activity at a specific venue, though no examination of effort displacement was made.

Turning to the charter boat sector, Richardson (2006) collected opinions from charter boat skippers under face to face interview. During these interviews they were asked by Richardson which were the main issues skippers faced in the day to day running of their businesses. The charter operators' open ended responses and a categorised frequency of their prime area of concern based on these responses is given in Appendix 35 .and Table 6-1 respectively. Despite the original interviews having occurred over 10 years ago, it is reasonable to assume that the same issues face charter operators today, certainly under the previous assumption of a largely unchanged fleet. Of the 50 recorded interviews, 31 (62%) provided a relevant comment.

Table 6-1. Charter operator classified response frequencies of comments relating to issues which affected their business. Data from Richardson (2006) from face to face interviews held in 2003–2004.

Category	***N***	**Percent**
Fishing quality	6	29%
Weather	6	29%
Regulation	4	19%
Business	2	10%
Other	2	10%
Marine protection	1	5%

Some charter boats provide specialist services, for example offshore angling for the greater pelagic sharks (e.g. blue shark) and wreck fishing. These businesses could be adversely affected by legislation and localised reduction of wreck aggregated species, either by commercial operations or within sector over exploitation. Negative effects could be subtle, by for example reducing catch rates and fish quality below a critical level of client expectation.

The reduced species list caught from shore in comparison to charter and private boats shows an expectation of species not reasonably available to the majority of shore anglers, in particular tope and black bream. However, it is important to realise that there are localised shore angling venues whose popularity is associated with their ability to provide opportunities to catch tope and rays for example. To maintain and expand the private and charter boat sectors, the continued availability of species not typically available to the shore angler, or of significantly greater size is critical.

Within Wales, the expert knowledge of Roger Cook (Welsh Federation of Sea Anglers) indicated a likely decline in the charter sector since the 1970s. These suspected charter capacity decreases were attributed in part to decreases in elasmobranch stocks, in particular, angel shark, spurdog and thornback ray; nevertheless, comparing this study with that of Richardson (2006) and Drew (2004) suggests that the charter sector has remained numerically stable over the last decade. The potential decline may have also been associated with anecdotal decreases in dedicated boats and the loss of multi-purpose boats involved in commercial inshore fishing and therefore available for RSA chartering (Roger Cook, pers. comms.). Dual coding of boats for angling could encourage skippers to provide angling during weekends and the high season when most charter boats are fully booked, and provide a training opportunity for new recreational charter boat skippers. Better linkages between sea and freshwater angling would also allow retention of tourist spend on angling when sea angling is not possible due to poor weather. However, funding is needed to realise these opportunities.

Other comments also arose during the Nautilus (2000) work where charter boat operators expressed concerns over the availability and costs of parking close to boat pick-up and drop-off points – these are particularly important for charter boat anglers who can carry a considerable amount of gear. Hargreaves *et al.* (2013) reported a drop in business during 2012–2013 with some operators ceasing business during that period. The primary reasons cited for the drop in business were weather and a reduction in spending capital attributed to the economic downturn. Reductions in catch quality were also raised as possible cause.

6.2. Targeting Improvements

In support of the treatment above, This Survey sought to gain an indication of the factors most likely to increase single angling trip length and the likelihood of increasing multi-day and multi-visitor sea angling centric stays. Figure 6-1 and Appendix 36 tentatively indicate that *fish size and quality*, *amenities* and *parking services* are stronger influences of trip and visit durations, but *fish size and quality* was ranked 4th as an influencer of propensity to *stay overnight* at 1%, contrasted against a maximum of 1.4% for *carpark security*. *Parking services* were ranked in the top 3 for all duration indicators. *Fish size and quantity* had the highest overall influence score of 10.6%, 3% of which was attributable to *enjoyment enhancement*, ranked below *environmental improvements* at 3.4% under the *enjoyment enhancement* category. Examination of responses suggests that *stay overnight* was not unambiguously associated with taking some form of accommodation and may indicate a misinterpretation of the question by some respondents.

Summing across improvement categories (Appendix 36) indicated that *enjoyment enhancement* was the most likely outcome (30.2%) of 'improvements', followed by increasing the number of session at the venue in question (venue specific data not shown). Increasing enjoyment at a specific venue would not necessarily deliver an average overall increase in angling effort per annum across the sampled anglers as activity would be subject to an unknown displacement of effort. 18.1% of selected responses across improvement categories were associated with *bringing along family and friends* (9.9% for *stay overnight*), it may be assumed this would be associated with increased expenditure.

Fish size and quantity have been frequently cited as a driver for changes in overall angling frequency and anglers have perceived a decrease in catch size and frequency (Drew Associates 2004, Richardson *et al.* 2006, Radford *et al.* 2009, Monkman 2013). Radford *et al.* (2009) also included a case study of the Firth of Clyde from which he concluded that there was evidence that historical reductions in angling activity were directly attributable to stock declines, which particularly impacted the charter sector.

Though the direct coupling of effort and catch quality have not been systematically studied in UK recreational marine fisheries, the importance of the quality of angling in driving effort is perhaps self-evident. The extent to which displacement to other species and methods may buffer such effects is unknown. There are emerging trends in the use of light rock fishing (LRF), salt water fly fishing and other lure based techniques to capture species on light tackle to improve the sporting challenge which support changes in sea angling activity in response to perceived decreases in sea angling quality.

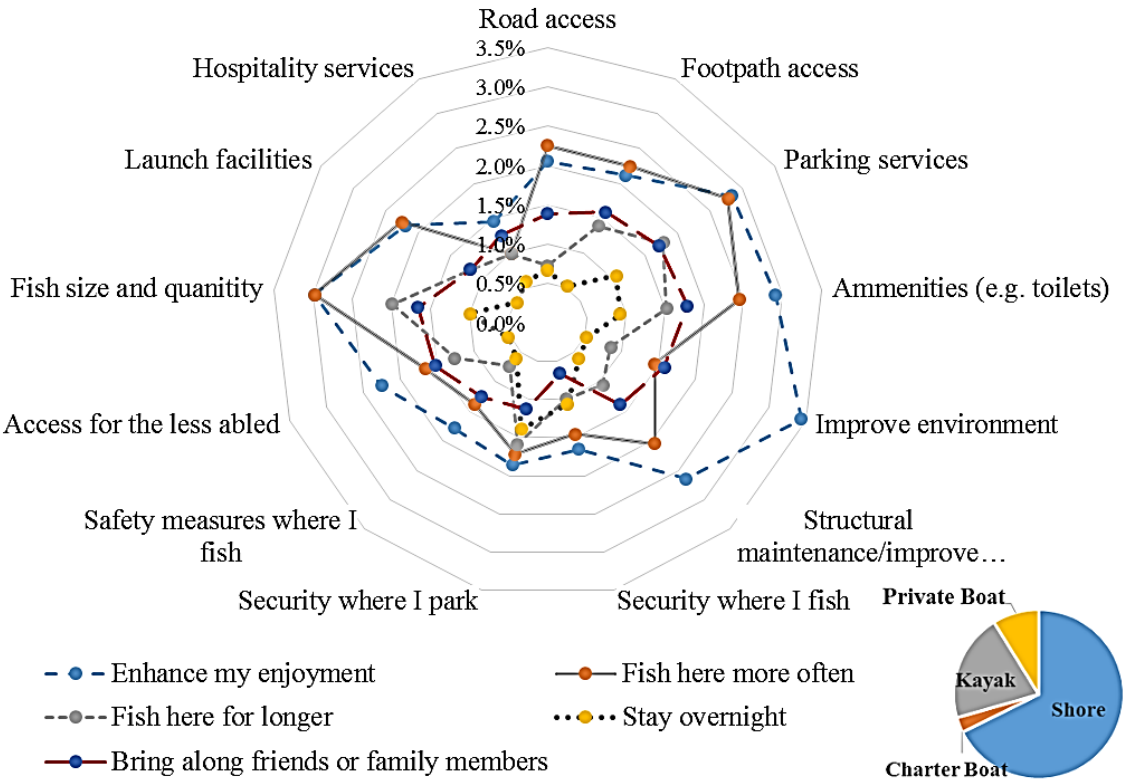


Figure 6-1. Percentage responses across total responses by effect category and effect type, in response to the question *check up to 3 items you feel will have the biggest chance of having the stated effect* (question responses = 122, total responses = 774). Where the key lists the effects and the categories are the data labels (for example *Improve environment* and *Parking services*). Inset pie chart gives platform proportions of respondents completing this question series. *Structural maintenance/improve…* was *Structural and maintenance improvements*.

This chapter largely neglects to make specific recommendations to obviate threats and exploit opportunities, the reader is recommended to review the Wales Fisheries Strategy – Implementation Plan for Recreation Sea Angling of August 2009, published by Welsh Assembly, which gives an extensive treatment of a sea angling strategy for Wales.

7. REFERENCES

AFYD, 2015-last update, Afyd | Angling for youth development [Homepage of AFYD], [Online]. Available: http://www.afyd.co.uk/ [3/18/2015, 2015].

ANGLING TRUST, 2015-last update, Just Take 5 - Help Stop Litter Spoiling Our Beaches And Coastline [Homepage of Angling Trust], [Online]. Available: http://anglingtrust.net/page.asp?section=796&sectionTitle=Help+Stop+Litter+Spoiling+Our+Beaches+And+Coastline [3/17/2015, 2015].

ARMSTRONG, M., BROWN, A., HARGREAVES, J., HYDER, K., PILGRIM-MORRISON, S., MUNDAY, M., PROCTOR, S., ROBERTS, A., ROCH, N. and WILLIAMSON, K., 2013a. *Sea Angling 2012 – a survey of recreational sea angling activity and economic value in England. Defra report, © Crown copyright 2013.* 2013. Lowestoft: Marine Management Organisation.

ARMSTRONG, M. and HYDER, K., 2013b. *Sea Angling 2012 - a survey of recreational sea angling activity and economic value in England. Annex 4: An on-site survey of recreational sea angling catches from the shore and from private and rental boats in England in 2012.* DEFRA.

ARON, H., ENO, C. and JONES, B., 2014. *Natural Resources Wales: FishMap Môn Project Report 2014.* 2014. NRW.

ASFMC, 2015-last update, Atlantic States Marine Fisheries Commission, summer flounder and Atlantic striped bass. [Homepage of ASFMC], [Online]. Available: http://www.asmfc.org/species/summer-flounder; http://www.asmfc.org/species/atlantic-striped-bass2015].

BARTHOLOMEW, A. and BOHNSACK, J.A., 2005. A review of catch-and-release angling mortality with implications for no-take reserves. *Reviews in Fish Biology and Fisheries,* **15**(1-2), pp. 129-154.

BEAUFORT RESEARCH, 2005. *Fishing Wales Campaign Evaluation September 2005.* Beaufort Research.

BEYER, H.L., 2015-last update, Geospatial Modelling Environment | SpatialEcology.Com [Homepage of Hawthorne L. Beyer], [Online]. Available: http://www.spatialecology.com/gme/index.htm [3/15/2015, 2015].

BROWN, A., 2012a. *The National Angling Survey 2012: Survey Report.* Manchester: Substance.

BROWN, A., 2012b. *Assynt Angling Research: Final report, Part of the Social and Community Benefits of Angling Research for the Big Lottery Fund.* Manchester: Substance.

BROWN, A., DJOHARI, N. and STOLK, P., 2012c. *Fishing For Answers: The final report of the social and community benefits of angling.* Manchester: Substance.

BROWN, A., MUNDAY, M., ROBERTS, A., ROCHE, N., ARMSTRONG, M., HYDER, K. and OUGHTON, E., 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, A., STOLK, P. and DOJHARI, N., 2010. *Angling: a social research overview.* Manchester: Substance.

CAMPBELL, G., 2015-last update, Boatlaunch.co.uk Home Page [Homepage of Geoff Campbell], [Online]. Available: http://www.boatlaunch.co.uk/ [1/3/2015, 2015].

CAPPELL, R. and LAWRENCE, R., 2005. The motivation, demographics and views of south west recreational sea anglers and their socio-economic impact on the region. *Invest in Fish South West Report*, pp. 118.

CASTING FOR RECOVERY, 2015-last update, Breast Cancer Fly Fishing Retreats [Homepage of Casting for Recovery], [Online]. Available: http://castingforrecovery.org/ [3/18/2015, 2015].

CHAMBERS, C., HAINES, R. and PITTS, J., 2013. *Wales Activity Mapping: Economic Valuation of Marine Recreation Activity Final Report.* London: Marine Planning Consultants.

CHESTER UNIVERSITY, 2014-last update, Analysing the physiological demands of competitive angling. [Homepage of Chester University], [Online]. Available: http://www.chester.ac.uk/node/26184 [3/18/2015, 2015].

COATES, P., 1983. *Fishing bait collection in the Menai Strait and its relevance to the potential establishment of a marine nature reserve with observations on the biology of the main prey species, the ragwom Nereis virens.* Bangor, North Wales: Bangor University.

COOKE, S.J. and COWX, I.G., 2006. Contrasting recreational and commercial fishing: searching for common issues to promote unified conservation of fisheries resources and aquatic environments. *Biological Conservation*, **128**(1), pp. 93-108.

DREW ASSOCIATES, 2004. *Research into the Economic Contribution of Sea Angling commissioned by the Economics and Statistics Group of the Department for Environment, Food and Rural Affairs (DEFRA).* Drew Associates.

EDINA, 2013-last update, Digimap Home Page [Homepage of EDINA], [Online]. Available: http://digimap.edina.ac.uk/digimap/home [5/14/2013, 2013].

EIFACC, 2008. *European Inland Fisheries Advisory Commission (EIFAC) code of practice for recreational fisheries. EIFAC Occasional Paper 42.* Rome: FAO.

ENVIRONMENT AGENCY, 2006. *Fishing for the future. Angling in 2015.* Environment Agency.

ENVIRONMENT AGENCY, 1/9/2014, 2014-last update, New online service to help monitor salmon and sea trout stocks [Homepage of Environment Agency], [Online]. Available: https://environmentagency.blog.gov.uk/2014/09/01/new-online-service-to-help-monitor-salmon-and-sea-trout-stocks/ [10/04/2015, 2015].

ESRI, 2010. *ArcMap 10.0.* Build 2414 edn. ESRI.

ESRI, 2015-last update, ArcGIS Help 10.2 - How Kernel Density works [Homepage of ESRI], [Online]. Available: http://resources.arcgis.com/en/help/main/10.2/index.html#/How_Kernel_Density_works/009z0000001000000/ [5/11/2015, 2015].

ET Spatial Technologies, 2014. *ET GeoWizards 11.2.* Demonstration edn. ET Spatial Technologies.

EUROPEAN COMMISSION, 2014. *EU (2014) DIRECTIVE 2014/89/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 July 2014 establishing a framework for maritime spatial planning.* EC.

EVANS, J.S., OAKLEAF, J., CUSHMAN, S.A. and THEOBALD, D., 2014. *An ArcGIS Toolbox for Surface Gradient and Geomorphometric Modelling.* 2.0-0 edn. http://evansmurphy.wix.com/evansspatial: Jeffrey Evans.

FEINBERG, J., 2015-last update, Wordle - Beautiful Word Clouds [Homepage of Jonathan Feinberg], [Online]. Available: http://www.wordle.net/ [4/22/2015, 2015].

FERTER, K., HARTMANN, K., KLEIVEN, A.R., MOLAND, E., OLSEN, E.M. and JECH, J.M., 2014. Catch-and-release of Atlantic cod (Gadus morhua): post-release behaviour of acoustically pretagged fish in a natural marine environment. *Canadian Journal of Fisheries and Aquatic Sciences*, **72**(999), pp. 1-10.

FERTER, K., WELTERSBACH, M.S., STREHLOW, H.V., VØLSTAD, J.H., ALÓS, J., ARLINGHAUS, R., ARMSTRONG, M., DOROW, M., DE GRAAF, M. and VAN DER HAMMEN, T., 2013. Unexpectedly high catch-and-release rates in European marine recreational fisheries: implications for science and management. *ICES Journal of Marine Science: Journal du Conseil*, **70**(7), pp. 1319-1329.

FINLEY, R., 7/Jul/2013, 7/Jul/2013-last update, SurveyMonkey, online survey and questionnaire software. [Homepage of SurveyMonkey], [Online]. Available: http://www.surveymonkey.com/home/ [7/9/2013, 2013].

FREUDENBERG, P. and ARLINGHAUS, R., 2010. Benefits and constraints of outdoor recreation for people with physical disabilities: Inferences from recreational fishing. *Leisure Sciences*, **32**(1), pp. 55-71.

FRIJLINK, S. and LYLE, J.M., 2010. *An evaluation of motivations, attitudes and awareness of Tasmanian recreational fishers.* Institute for Marine and Antarctic Studies.

GARTNER, W.C., LOVE, L.L. and ERKKILA, D., 2002. *Economic Impact and Social Benefits Study of Coldwater Angling in Minnesota.* Minnesota: University of Minnesota Extension Service.

GET HOOKED ON FISHING, 2015-last update, Home page of the angling charity Get Hooked On Fishing. [Homepage of Get Hooked on Fishing], [Online]. Available: http://www.ghof.org.uk/ [3/18/2015, 2015].

Google, 2013. *Google Earth 7.1.2.2041. Wales, Tile N51.25 degrees on 4/Oct/2013. <http://www.google.com/earth/index.html> [Viewed 10 March 2015].* . Google.

GOUDGE, H. and MORRIS, E.S., 2011. *North Wales Recreational Sea Angler (RSA) pilot surveys: Discussion of the pilot methodologies and recommendations for future surveys.* CCW.

GOUDGE, H., MORRIS, E.S. and SHARP, R., 2009. *North Wales Recreational Sea Angler (RSA) pilot surveys: Winter results December 2007 to March 2008.* CCW.

GOUDGE, H., MORRIS, E.S. and SHARP, R., 2010. *North Wales Recreational Sea Angler (RSA) pilot surveys: Summer results July to October 2008.* CCW.

GRENFELL, C., 2013. *Variations in the abundance and spatial distribution of Palaemon serratus (Decapoda: Palaemonidae) in the littoral zone of South Wales*, Bangor University.

HARGREAVES, J., 2012. *Sea Angling 2012 Results of the national household survey (January 2012 - December 2012 results). Steering group presentation.* Presentation edn. Marine Management Organisation.

HARGREAVES, J., BROWN, A., PILGRIM-MORRISON, S., WILLIAMSON, K., ARMSTRONG, M. and HYDER, K., 2013. *Sea Angling 2012 - a survey of recreational sea angling activity and economic value in England. Annex 3: A survey of charter boat sea angling catches in England.* DEFRA.

HARGREAVES, J., PILGRIM-MORRISON, S., WILLIAMSON, K., BROWN, A., ARMSTRONG, M. and HYDER, K., 2013a. *Sea Angling 2012 - a survey of recreational sea angling activity and economic value in England. Annex 1: A household survey of recreational sea angling.* DEFRA.

HM Government, 2009a. *Marine and Coastal Access Act 2009. Section 61.* HM Government.

HM Government, 2009b. *Marine and Coastal Access Act 2009. Section 51 (2).* HM Government.

HM Government, 2009c. *Our seas – a shared resource High level marine objectives. 1–12.* HM Government.

HM Government, 2011. *UK Marine Policy Statement. 1–51.* HM Government.

HYDER, K., ARMSTRONG, M., PROCTOR, S., HARGREAVES, J., PILGRIM-MORRISON, S., WILLIAMSON, K. and BROWN, A., 2013. *Sea Angling 2012 - a survey of recreational sea angling activity and economic value in England. Annex 5: An online survey of recreational sea angling catches in England.* DEFRA.

ICES, 2013. *Report of the ICES Working Group on Recreational Fisheries Surveys 2013, 22-26 April 2013.* Esporles, Spain: ICES.

ICES, 2014a. *Report of the Working Group on Recreational Fisheries Surveys (WGRFS). ICES CM 2014\ACOM:37.* ICES.

ICES, 2014b. *Report of the ICES Advisory Committee 2014. ICES Advice, 2014. Books 1-11.* ICES.

JENKS, G.F., 1967. The data model concept in statistical mapping. *International yearbook of cartography,* **7**(1), pp. 186-190.

JOHNSON, G., 1984. *Bait collection in a proposed marine nature reserve. MSc thesis.*, Ecology and Conservation Unit, University College London.

JONES, D., 1/1/2015, 2015-last update, Wales Activity Mapping Home Page [Homepage of walesactivitymapping.org], [Online]. Available: http://www.walesactivitymapping.org.uk/about/ [3/12/2015, 2015].

KENTER, J.O., BRYCE, R., DAVIES, A., JOBSTVOGT, N., WATSON, V., RANGER, S., SOLANDT, J.L., DUNCAN, C., CHRISTIE, M., CRUMP, H., IRVINE, K.N., PINARD, M. and REED, M.S., 2013. *The value of potential marine protected areas in the UK to divers and sea anglers.* Cambridge; UK. UNEP-WCMC.

LADLE, M. and VAUGHAN, A., 2003. *Hooked on Bass.* 2 edn. Crowood Press.

LAWRENCE, K.S. and SPURGEON, J., 2007. *Economic evaluation of inland fisheries: welfare benefits of inland fisheries in England and Wales. Science Report SC050026/SR1*. Environment Agency.

LONGBOTTOM, M., 1970. The distribution of *Arenicola marina* (L.) with particular reference to the effects of particle size and organic matter of the sediments. *Journal of experimental marine biology and ecology,* **5**(2), pp. 138-157.

MAWLE, G.W. and PEIRSON, G., 2009. *Economic evaluation of inland fisheries: managers report from science project SC050026/SR2. 58.* Bristol, UK: Environment Agency.

MCMANUS, P., STOREY, J. and WHITE, J., 2011. *Identifying the health and well-being benefits of recreational fishing Identifying the health and well-being benefits of recreational fishing. 64pp.* Fisheries Research and Development Corporation and the Centre of Excellence for Science, Seafood and Health; Curtin Health Innovation Research Institute.

MILLER RESEARCH, 2014. *The economic impact of outdoor activity tourism in Wales.* Visit Wales.

MONKMAN, G.G., 2013. *Recreational bass angling in Wales: Approaches to data collection and the distribution of angling effort in the recreational European sea bass (Dicentrarchus labrax L.) fishery*, Bangor University.

NATIONAL TRUST, 2006. *Valuing Our Environment - Economic Impact of the Coastal and Marine Environment of Wales.* London: National Trust.

NATURAL RESOURCES WALES, 2015-last update, Natural Resources Wales/ FishMap Môn [Homepage of Natural Resources Wales], [Online]. Available: http://fishmapmon.naturalresourceswales.gov.uk/ [5/13/2015, 2015].

NAUTILUS CONSULTANTS LTD., 2000. *Study into Inland and Sea Fisheries in Wales: Final Report.* Wales: Nautilus Consultants Ltd.

NOAA, 3/3/2015, 2014-last update, Fisheries of the United States, 2013. A Statistical Snapshot of 2013 Fish Landings. [Homepage of ICES], [Online]. Available: http://www.st.nmfs.noaa.gov/Assets/commercial/fus/fus13/materials/FUS2013_FactSheet_FINAL.pdf 2015].

NOAA, 2015-last update, RECREATIONAL FISHERIES STATISTICS, Better Fishing, Better Data – How We Count Your Catch. Available: http://www.st.nmfs.noaa.gov/recreational-fisheries/index [3/19/2015, 2015].

OLIVE, P., 1993. Management of the exploitation of the lugworm *Arenicola marina* and the ragworm *Nereis virens* (Polychaeta) in conservation areas. *Aquatic Conservation: Marine and Freshwater Ecosystems,* **3**(1), pp. 1-24.

ORDNANCE SURVEY, 2015-last update, 1:50 000 Scale Gazetteer | Business and government | Ordnance Survey. Available: http://www.ordnancesurvey.co.uk/business-and-government/products/50k-gazetteer.html [3/12/2015, 2015].

ORMSBY, J., 2004. *A Review of the Social, Motivational and Experiential Characteristics of Recreational Anglers from Queensland and the Great Barrier Reef Region.* Townsville, Australia: Great Barrier Reef Marine Park Authority.

PANTIN, J.R., MURRAY, L.G., HINZ, H., LE VAY, L. and KAISER, M.J., 2015. *The Inshore Fisheries of Wales: a study based on fishers' ecological knowledge.* 42. Bangor University, Fisheries and Conservation Science Group.

PAWSON, M.G., GLENN, H. and PADDA, G., 2008. The definition of marine recreational fishing in Europe. *Marine Policy,* **32**(3), pp. 339-350.

PEARSON, A., 1968. *Sea Fishing North Wales and Anglesey.* 1 edn. London, UK: Ernest Benn Ltd.

PICKETT, G.D., 1990. Assessment of the UK bass fishery using a log-book-based catch recording system. *Great Britain Ministry of Agriculture Fisheries and Food Directorate of Fisheries Research Fisheries Research Technical Report,* pp. 1-33.

PRETTY, J., PEACOCK, J. and HINE, R., 2007. Green exercise in the UK countryside: Effects on health and psychological well-being, and implications for policy and planning. *Journal of Environmental Planning and Management,* (50), pp. 211-231.

RADFORD, A., RIDDINGTON, G. and GIBSON, H., 2007. *The Economic evaluation of inland fisheries: The economic impact of freshwater angling in England & Wales. Science Report – SC050026/SR2*. Environment Agency.

RADFORD, A., RIDDINGTON, R. and GIBSON, H.G., 2009. *Economic Impact of Recreational Sea Angling in Scotland.* SAG/0005/07. Edinburgh: Scottish Government.

RICHARDSON, E.A., 2006. *Socioeconomic and ecological implications of an ecosystem approach to marine resource management for Wales, UK*, University of Wales, Bangor.

RICHARDSON, E.A., KAISER, M.J., EDWARDS-JONES, G. and RAMSAY, K., 2006. Trends in sea anglers catches of trophy fish in relation to stock size. *Fisheries Research (Amsterdam),* **82**(1-3), pp. 253-262.

RODRIGUEZ, G., 1972. Behavioural rhythms in littoral prawns. *Journal of the Marine Biological Association of the United Kingdom,* **52**(01), pp. 81-95.

Seazone, 2014. *HydroSpatial One [SHAPE geospatial data], Scale 1:25000, All tiles: intersecting with Welsh coastal waters to 12 nautical miles, Updated: 4 February 2014, Seazone, Using: EDINA Marine Digimap Service, http://digimap.edina.ac.uk, Downloaded: 2015-03-01*. UK: Seazone.

SHARK ALLIANCE, 2015-last update, The Shark Alliance, UK shark tagging programme [Homepage of Shark Alliance], [Online]. Available: http://www.ukshark.co.uk/ [3/17/2015, 2015].

SILVERMAN, B.W., 1988. *Density Estimation for Statistics and Data Analysis.* London: Chapman and Hall.

SIMPSON, D. and MAWLE, G.S., 2005. *Public Attitudes to Angling 2005.* Environment Agency.

SIMPSON, D. and MAWLE, G.W., 2010. *Public Attitudes to Angling 2010.* Bristol, UK: Environment Agency.

STARK, M., BROWN, A. and LLOYD, M., 2012. *Fishing for Life: A national strategy for getting people fishing 2012-2015.* Angling Trust.

TNS, 2003. *Taylor Nelson Sofres. RSGB. 2003. Sea angling omnibus survey.* London, UK: TNS.

TNS GLOBAL, 2014a. *The Great Britain Tourism Survey. Volumes and Values of Domestic Tourism in Great Britain – 2013. On behalf of Visit England, Visit Scotland and Visit Wales.* TNS Global.

TNS GLOBAL, 2014b. *The Great Britain Day Visit Survey (2014). GB Day Visits 2013. On behalf of Visit England, Visit Scotland and Visit Wales.* TNS Global.

UNITED KINGDOM HYDROGRAPHIC OFFICE, 2013-last update, UKHO British Admiralty Maps, published under license by Digimap [Homepage of Digimap], [Online]. Available: http://digimap.edina.ac.uk/digimap/home [2/20/2013, 2013].

VANSTAEN, K. and SILVA, T., 2010. *Integrated inshore and offshore fishing activities data layer in aggregate producing REC areas. MEPF/09/P116.* DEFRA.

WALES ACTIVITY MAPPING PROJECT, 2014-last update, Wales Activity Mapping [Homepage of Wales Activity Mapping Project], [Online]. Available: http://www.walesactivitymapping.org.uk/ [11/25/2014, 2014].

WELTERSBACH, M.S. and STREHLOW, H.V., 2013. Dead or alive—estimating post-release mortality of Atlantic cod in the recreational fishery. *ICES Journal of Marine Science: Journal du Conseil*, **70**(4), pp. 864-872.

8. APPENDICES

Appendix 1. List of data sources identified as potentially relevant

List of sea angling related sources evaluated for relevance to this report. R, source has a degree of relevance to the study but contains no suitable data; S, contains study relevant data; U, source found to have limited to no congruency with this report. Highlighted rows keyed as follows: Data adapted or reproduced in this report, Data used in this reports economic estimations, Data used in activity/effort estimates and spatial distributions.

Source	Coverage	Date	Source type	compiler	owner	Description	Collection method(s)	Suitability
Motivation, Demographics [and Socioeconomics of] South West [..] Anglers	England, South West	2005	Organised Survey	Nautilus Consultants	Nautilus Consultants	Economic and activity surveys using creel, match and tackle shop intercept and telephone surveys.	Intercept and self-selecting survey with pseudo random elements	R – Contextual relevance
Economic impact of Recreational Sea Angling in Scotland	Scotland		Organised Survey	Cogent Research	Scottish Government	Radford's extensive telephone omnibus survey into Scottish sea angling. Included self-selecting online survey, case studies (industry interests – e.g. tackle shops) and stakeholder interviews (Charters). Detailed economic and effort assessment. No catch estimation. Survey responses prone to recall bias as recall period large.	Randomised, self-selection, expert knowledge and fisher knowledge	R – Contextual relevance
Study into Inland and Sea Fisheries in Wales	Wales	2000	Report	Nautilus Consultants	Welsh Government	Estimates based entirely on fisher knowledge of 2 people	Fisher and expert knowledge.	R – Contextual relevance
The economic value of recreational angling on the Dee estuary	Wales, North	2007	Thesis	Lee	Bangor University			R – Contextual relevance
Wales Activity Mapping: Economic evaluation of marine recreation activity. BUSINESS SURVEY	Wales, Pembrokeshire	2012	Survey	Marine Planning Consultants	Welsh Government	Small self-selecting survey of businesses, combined with larger scale Wales Activity Mapping project over 2008-2010. Primary output is value per activity per location.	Self-selecting survey	R – Contextual relevance
Defining the economic and environmental values of sea bass – Final Report	England, Sussex	2014	Report	MRAG	MRAG	An economic analysis covering bass in the Sussex IFCA based on input-output tables from SA2012 for recreational and Seafish 2007 input-output analysis		R – Contextual relevance.
Substance - Social and community benefits of angling	UK	1905	Survey	Substance	Substance	Extensive reports with a focus on socioeconomics. Results obfuscated by fresh and game angling. Data poor for Wales with no differentiation by platform.	Self-selecting questionnaire based methods.	R – Contextual relevance.

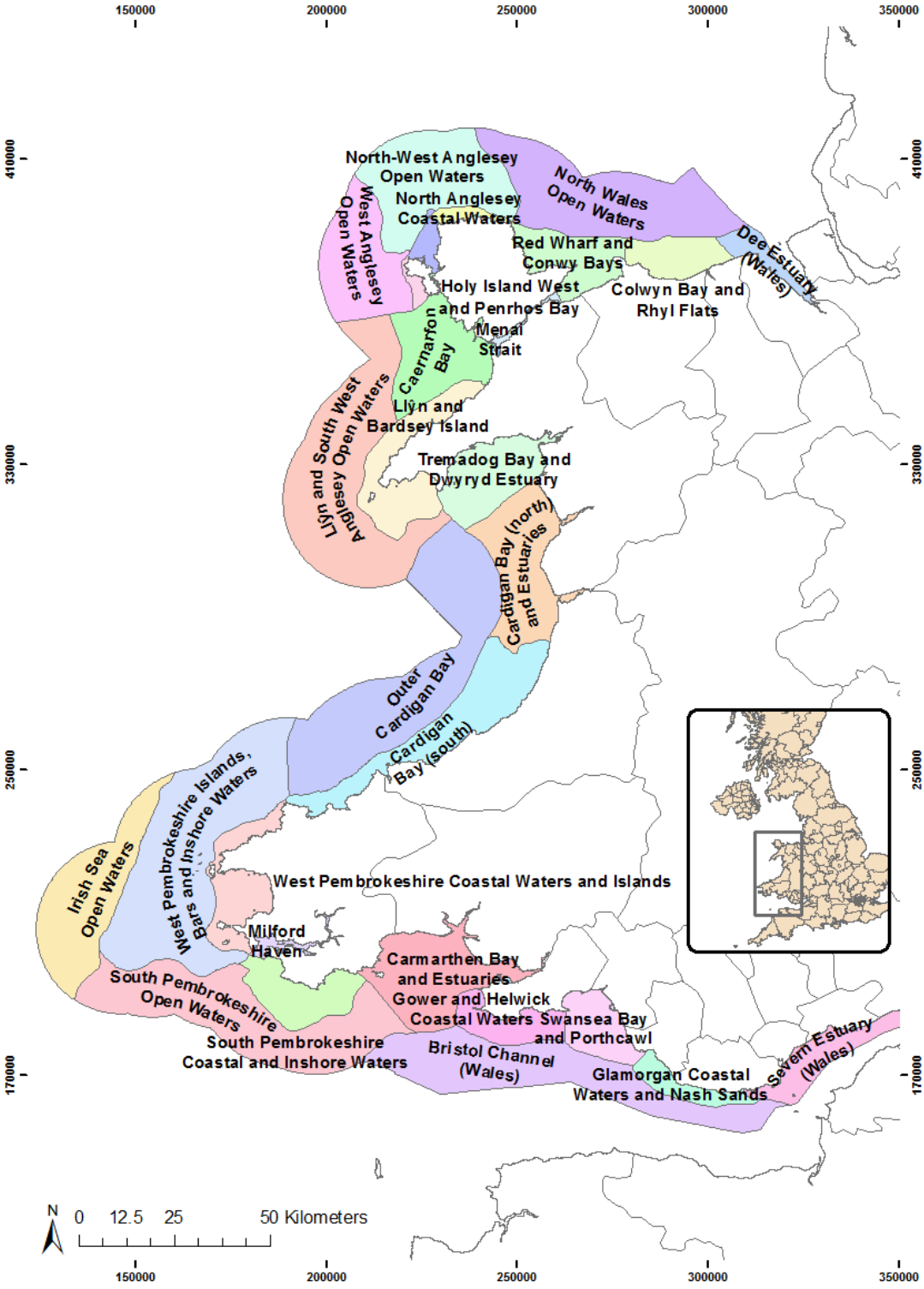
Value of [..] MPAs to [divers and anglers]	UK	2012	Survey	Multiple	Multiple	MPA centric, self-selecting online survey of anglers and divers, disseminated online, emails to club members and traditional advertising methods. No distinction made between charter and private boat. In depth WTP style economic analysis.	Various self-selection based instruments.	R – Contextual relevance.
The ecological impact of intertidal recreational bait collection	Unspecified	2004	Thesis	Harries	Bangor University	MSc thesis to read		R – Contextual relevance.
Fishing bait collection in the Menai Strait	Wales, North	1983	Thesis	P. Coates	P. Coates	Focuses on the exploitation of RSA bait species in the Menai Strait	Experimental, observational and expert knowledge	R – Contextual relevance.
The environmental impacts of bait-digging at Lleiniog Beach, Anglesey.	Wales, North	1994	Thesis	Spikes	Bangor University	Self-explanatory		R – Contextual relevance.
The tourism and recreational carrying capacity of Anglesey's coastal destinations Rhosneiger and Benllech	Wales, North	2006	Thesis	Hesketh	Bangor University	MSc thesis to read		R – Contextual relevance.
Socioeconomic [..] implications [..] to marine resource management for Wales	Wales	2006	Survey	E. A. Richardson	Bangor University	Comprehensive geographically specific work for doctorate thesis, Bangor University. Includes very extensive effort and economic surveys with excellent coverage of charter boat sector and economic analysis of the recreational sector.	Self-selection based instruments and face to face interviews over 2+ years.	S – Comprehensive with excellent coverage.
FishMap Môn	Wales, Anglesey	2012	Survey	Natural Resources Wales	Natural Resources Wales	None randomised creel survey primarily across Anglesey and approximately 50 miles of surrounding mainland coast.	None randomised creel.	S – Detailed spatial effort for all platforms
Wales Activity Mapping: CORE	Wales, South West	2008 – 2010	Survey	Multiple	Multiple	Creel, offsite, self-selected and expert instruments used in data collection. Does NOT appear to differentiate by platform, however locations are mapped, hence Boat/Shore can be inferred. Multiple organisations involved. NRW, PCF, EA, Crown Estate.	Expert knowledge and observation.	S – Detailed spatial effort for shore and boat
North Wales Pilot Surveys	Wales, North	2008	Survey	Marine Ecological Solutions	Natural Resources Wales	Onsite survey aimed primarily at effort and catch assessment of shore angling in North Wales. Only a single charter boat trip sampled for species catch composition. Makes recommendations for future survey approaches.	None randomised creel.	S – Detailed spatial effort for shore platform
Sea Angler Magazine Trophy Catches	Wales	1974 – 2003	Fisher knowledge	Richardson (2006)	N/A	RSAs submit catch records to Sea Angler magazine for Wales, transcribed direct from paper magazine.	RSA recorded	S – Limitations in use due to bias need to be considered.
Web and social media	Wales	Various	Fisher knowledge	N/A	N/A	Multiple sites exist, providing expert knowledge on fishing venues locations. Data aggregation services (e.g. google) can give proxies of popularity.	Manual review of sources.	S – Limitations in use due to bias need to be considered.

Angling Guide to Wales	Wales	1975	Grey literature	Clive Gammon	Unknown	Self-explanatory	Fisher knowledge	S – Locations
Shore Fishing: A Guide to Cardigan Bay	Wales, Mid	2013	Grey literature	John Mason	John Mason	Self-explanatory	Fisher knowledge	S – Locations
Lavers guide to sea angling in North Wales and Merseyside	Wales, North	1999	Grey literature	Phil Simpson	Lavers	Self-explanatory	Fisher knowledge	S – Locations
Sea Fishing North Wales and Anglesey	Wales, North	1968	Grey literature	Anthony Pearson	Publisher	Self-explanatory	Fisher knowledge	S – Locations
Sea Angling 2012 Internet and creel surveys	England	2012	Survey	CEFAS	CEFAS/MMO	First statistically rigorous sea angling survey in UK. Multiple instruments were used in economic, effort and catch assessments	Stratified random for effort with ONS standards compliant national survey. Self-selection elements in economic assessment.	S – Population & economic expansion though stratification transfer.
Opinions and Lifestyle Survey 2012	UK	2012	Organised Survey	Office of National Statistics	Office of National Statistics	Statistically sound national doorstep survey in which SA2012 questions were inserted. Includes respondents from Wales. Primarily used in population expansion for detailed economic, effort and catch estimates for SA2012, BUT, this has respondents from Wales.	Stratified random, ONS standards compliant.	S – Population & economic expansion though stratification transfer
UK Tourism Statistics (Multiple Years)	UK	2013	Survey	TNS Global	Multiple	National survey, held annually on both domestic and overseas visitors. Report does not contain angling data as participation is low, but evidence suggests it is collected (data referenced in other reports).	Stratified random, ONS style survey.	S – Population & economic expansion though stratification transfer.
Economic Impact of Outdoor Activity Tourism in Wales	Wales	2014	Survey	Miller Research	Visit Wales	Industry targeted interviews and self-selecting internet survey of participants to collect quantitative economic and activity participation level data. Participant targeting of visitors to Wales was primarily though social media channels.	Self-selection and expert knowledge.	S – Population & economic expansion though stratification transfer.
Great Britain Day Visitor Survey	UK	2011 - 2014	Survey	TNS Global	Visit England, Visit Scotland, Visit Wales	AS GBTS, but Day visits	Stratified random, ONS style survey.	S – Population & economic expansion though stratification transfer.
Great Britain Domestic Overnight Holidays	UK	2011 – 2014	Survey	TNS Global	Visit England, Visit Scotland, Visit Wales	AS GBTS, but holidays involving a minimum of 1 nights stay.	Stratified random, ONS style survey.	S – Population & economic expansion though stratification transfer.
Great Britain Tourism Survey	UK	2011 – 2014	Survey	TNS Global	Visit England, Visit Scotland, Visit Wales	UK wide, but has good coverage of wales (sponsored by Visit Wales). Unknown if addresses angler activity, but has spend figures for accommodation (for e.g.). Data source of the Great Britain Day Visitor Reports and the Domestic Overnight Tourism Reports.	Stratified random, ONS style survey.	S – Population & economic expansion though stratification transfer.

RSGB Omnibus Survey	UK	2003	Survey	Research Surveys of Great Britain (Taylor Nelson Sofres)	Unknown	Household survey, not angling specific. Used for population expansion in Drew (2004) study.	Stratified random, ONS style survey.	S – Provides historical comparative estimates through Drew (2004). Raw data unavailable.
Drew Associates	England & Wales	2003	Survey	Drew Associates	DEFRA	Comprehensive pseudo random creel and postal survey instruments, population expansion using RSGB Omnibus results. Postal survey from club membership frame. Postal and telephone survey of businesses for economic assessment.	Stratified random, ONS style survey.	S – Provides historical comparative estimates. Raw data unavailable.
CEFAS Small Boats Census.	Wales	To 2012	Survey	CEFAS	CEFAS/MMO	Coastal survey of small boats landing fish into ports including Wales with a recreational metier.	Intercept and observation survey	S – Though limited spatial resolution and coastal observation only.
Club Match Cards	Wales	Various	Fisher knowledge	N/A	RSA Entities	Record cards, recorded by anglers as part of organised or informal competitive angling.	RSA recorded	U – Bias and use permission problematic.
Recreational Sea Angling Diversification Study	England, North East	2004	Report	North Eastern Sea Fisheries Committee	Unknown	Evaluates potential of alternative target species for diversification of the for-hire market. Questionnaire distributed to clubs and charters (not provided).	Self-selection and fisher knowledge	U – Focus on charter business diversification.
Ramsey Sound MCZ Assessment.	Wales		Survey	NRW	NRW	Data collected as part of MCZ assessments	Expert knowledge and observation.	U – Insufficient detail.
MMBFC Members Diaries	Wales, South	To 2012	Fisher knowledge	MMBFC	MMBFC	Mumbles Motor Boat fishing club catch diary data to 2012, centred on Swansea Bay area.	Fisher knowledge	U – Insufficient spatial extent.
Sea Fishing Atlas of Wales	Wales	To 2010	Fisher knowledge	NRW	NRW	GIS mapped metiers of commercial gears from expert knowledge sourced from WAG fisheries agencies and professional fisher bodies relating to 2000 - 2010. Broad scale maps on hobby netting.	Fisher and expert knowledge from fisheries experts and the fishing industry. Supplemented by information contained in published reports. Give a general indication of fishing activity over the period 2000 to 2005	U – No RSA data.
Recreational Bass Angling in Wales: [..] Data collection [and] Effort Distribution	Wales	2013	Thesis	G. Monkman	Bangor University	Assessment of angler diary records and effort distribution (primarily of bass anglers) across shore, private boat and charter records.	Social media data mining	U – Restricted to bass.
When the tide goes out - The biodiversity and conservation of the shores of Wales	Wales	1996 – 2006	Survey	CCW	Natural Resources Wales	10 year survey of intertidal habitats across wales, with extensive GIS mapping. Includes what may be an extensive source of angling effort distribution and bait collection impacts.	Observational and expert knowledge	U – Spatial scale too large, data sparse for RSA.

Monitor of Engagement with the Natural Environment	England	2009 – 2014	Survey	Natural England	Natural England	Official Statistics designated by the UK Statistics authority. Not aimed at angling assessments but has economic and visit frequency data for Angling. Cross tabulation may allow extraction of Sea Angling specific trips.	Stratified random, ONS standards compliant.	U – Sufficient detail unavailable.
Time Use Survey	UK	Various	Survey	Unknown	Unknown	Stratified Random questionnaire based survey of activity. Need to examine further what data is available.	Stratified random, ONS style survey.	U – Sufficient detail unavailable.
Fishing Campaign Evaluation	Wales	2005	Survey	Beaufort Research	Beaufort Research	Survey aimed at assessment of visiting anglers, and their response to a fishing campaign. Raw data would be required to extract economic data, as no differentiation made between sea and fresh water anglers for spend figures.	Self-selection based survey from registered respondents.	U – Sufficient detail unavailable.
Bass Anglers Sports fishing Society	UK	Various	Fisher knowledge	BASS	RSA Entities	Catch cards and records from BASS, data poor for wales. Time series probably weak	RSA submitted	U – Too data sparse for Wales.
National Federation of Sea Anglers (NFSA) Specimen Records	UK	1976 – 2001	Fisher knowledge	NFSA	Unknown	Records of fish captures submitted and compiled by the now defunct NFSA	RSA submitted	U – Very poor spatial resolution.
Bass Fishing from the Shore in South East Wales	Wales, South	2009	Grey literature			Self-explanatory	Fisher knowledge	Un – Unavailable

Appendix 2. Marine Character Areas for Wales, March 2015.



March 2015 revision of the Marine Character Areas for Wales. Marine character areas seek to divide up Welsh terrotorial waters according to meaningful and recognisable boundaries which take account of a variety of multiple ecological, sociological and economic factors.[22]

[22] http://democracy.swansea.gov.uk/documents/s20350/16%20b%201%20of%202%20-%20Draft-marine-character-areas.pdf

Appendix 3. List of species anglers expressed as target preference from Richardson (2006) (All platforms).

Charter Boat

Species	Angler Number	Percent
Angel Shark	1	0.2%
Ballan wrasse	3	0.6%
Bass	86	**18.6%**
Blue shark	3	0.6%
Bream (Black)	48	**10.4%**
Bull Huss (Greater Dogfish)	15	3.2%
Cod	47	10.2%
Conger Eel	17	3.7%
Dab	11	2.4%
Dogfish (Lesser)	7	1.5%
European Eel (Anguilla anguilla)	1	0.2%
Flatfish	2	0.4%
Flounder	6	1.3%
Gurnard	6	1.3%
Ling	1	0.2%
Mackerel	17	3.7%
Mullet	1	0.2%
None	1	0.2%
Plaice	7	1.5%
Pollack	34	7.4%
Ray (Small Eyed)	1	0.2%
Rays	31	6.7%
Saithe (Coley, Coalfish)	1	0.2%
Sharks (Great)	1	0.2%
Smooth Hound (Starry)	23	5.0%
Spurdogs (Spiny Dogfish)	1	0.2%
Thornback Ray	3	0.6%
Tope	62	**13.4%**
Tub Gurnard	1	0.2%
Turbot	9	1.9%
Whiting	15	3.2%

Private Boat

Species	Angler Number	Percent
Ballan Wrasse	1	0.5%
Bass	54	**26.9%**
Bream (Black)	14	7.0%
Bull Huss (Greater Dogfish)	2	1.0%
Cod	24	**11.9%**
Conger Eel	2	1.0%
Dab	2	1.0%
Dogfish (Lesser)	2	1.0%
Flounder	2	1.0%
Herring	1	0.5%
Mackerel	18	9.0%
Mullet	1	0.5%
Plaice	8	4.0%
Pollack	17	8.5%
Rays	13	6.5%
Smooth Hound (Starry)	3	1.5%
Sole	2	1.0%
Thornback Ray	1	0.5%
Tope	28	**13.9%**
Triggerfish	2	1.0%
Whiting	3	1.5%
Wrasse (Other)	1	0.5%

Shore

Species	Angler Number	Percent
Ballan Wrasse	18	2.5%
Bass	194	**26.9%**
Blue shark	1	0.1%
Bream (Black)	11	1.5%
Bull Huss (Greater Dogfish)	14	1.9%
Cod	97	**13.4%**
Conger Eel	17	2.4%
Dab	8	1.1%
Dogfish (Lesser)	19	2.6%
European Eel	2	0.3%
Flatfish	7	1.0%
Flounder	44	6.1%
Garfish (Garpike)	4	0.6%

Haddock	1	0.1%
Mackerel	53	**7.3%**
Marlin	1	0.1%
Mullet	11	1.5%
None	3	0.4%
Plaice	30	4.2%
Pollack	41	5.7%
Ray (Blonde)	1	0.1%
Ray (Small Eyed)	3	0.4%
Rays	48	6.6%
Rockling Species	2	0.3%
Saithe (Coley, Coalfish)	3	0.4%
Salmon	2	0.3%
Scad (Horse Mackerel)	1	0.1%
Sea Trout (Sewin)	2	0.3%
Smooth Hound (Starry)	23	3.2%
Sole	5	0.7%
Spurdogs (Spiny Dogfish)	2	0.3%
Thornback Ray	4	0.6%
Tope	9	1.2%
Tub Gurnard	1	0.1%
Turbot	5	0.7%
Whiting	35	4.8%

Appendix 4. Sea angler preference species, multiple sources.

Cross study angler target species, grey cells highlight top 3 target species by study and study stratification. Percentages are calculated 'within' presented data (i.e. columns). Richardson's charter boat, private boat and shore data were derived from angler interviews. Platform is the angler's fishing method during survey. The charter skipper column of Richardson was derived from a different questionnaire targeted at charter boat skippers (Annex 3). Richardson's data were collected in 2003 and 2004. Online survey is new data collated as part of this study in 2015. North Wales Recreational Sea Angler Pilot Survey (Goudge *et al.* 2010, Goudge and Morris 2011, Richardson 2006) data were collected in 2007 and 2008. Richardson's platform data and online survey data were based on a tri-ranked weighted species preference (see methodology for a detailed description).

Species	Richardson (2006)					
	Charter Boat (%) (n = 242)	Private Boat (%) (n = 82)	Shore (%) (n = 326)	Charter Skipper (%) (n = 48)	Online Survey (%) (n = 133)	NWPS (%) (n = 185)
Bass	21.6	36.2	35.8	6.5	37.5	26.6
Bib or Poor Cod	0.0	0.0	0.0	1.4	0.3	0.0
Bull Huss	2.6	1.2	2.1	4.5	1.6	0.9
Cod	11.3	10.9	14.2	6.8	13.7	14.3
Conger Eel	3.1	0.5	1.9	3.7	1.4	2.5
Dab	2.0	0.7	0.8	2.3	1.2	0.5
Dogfish	1.4	0.5	2.8	7.7	0.3	1.8
European Eel	0.1	0.0	0.2	0.0	0.3	0.0
Flounder	1.3	1.2	5.4	0.3	1.8	1.4
Garfish	0.0	0.0	0.4	0.0	0.1	0.0
Greater Pelagic Sharks	1.2	0.0	0.1	1.4	1.7	0.0
Gurnards	1.2	0.0	0.1	3.4	0.3	0.0
Herring	0.0	0.3	0.0	1.1	0.1	0.0
Ling	0.1	0.0	0.0	1.1	0.2	0.0
Mackerel	2.1	9.0	7.0	9.9	4.0	17.3

Table continued over …

Continued: Sea angler preference species, multiple sources.

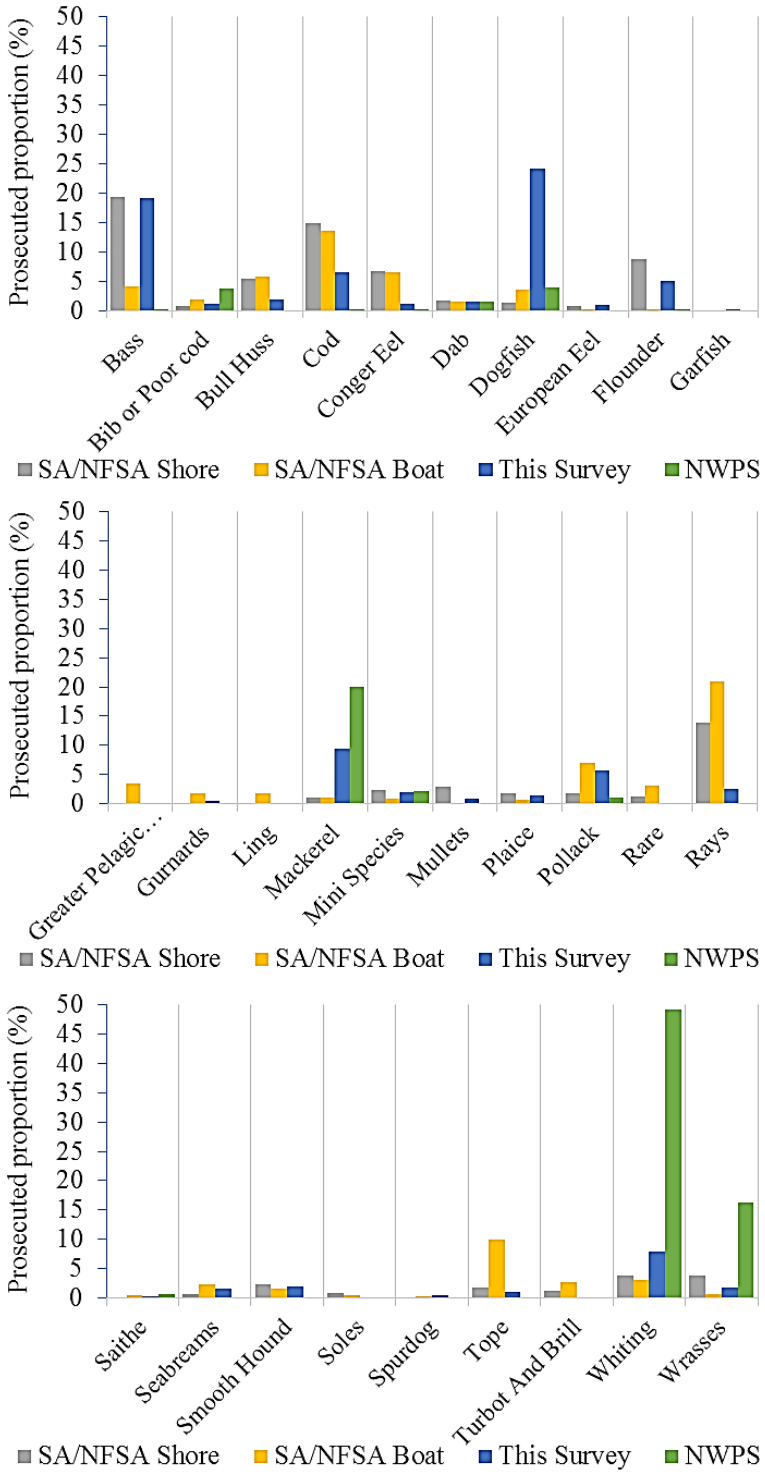
Species	Richardson (2006)				Online Survey (%) (n = 133)	NWPS (%) (n = 185)
	Charter Boat (%) (n = 242)	Private Boat (%) (n = 82)	Shore (%) (n = 326)	Charter Skipper (%) (n = 48)		
Mini Species	0.0	0.0	0.3	0.3	0.1	0.2
Mullets	0.2	0.3	1.1	0.0	1.8	0.2
Plaice	1.5	2.8	3.4	0.9	3.3	5.1
Pollack	7.2	7.1	4.5	8.8	2.9	6.5
Rare	0.2	1.1	0.2	0.0	1.0	0.0
Rays	6.2	4.7	7.2	10.2	4.8	5.2
Saithe	0.1	0.0	0.3	2.8	0.3	0.0
Salmon and Sea Trout	0.0	0.0	0.5	0.0	1.2	0.0
Seabreams	8.8	5.2	1.2	4.5	6.3	0.5
Smooth hound	4.4	1.6	3.2	1.1	3.8	1.8
Soles	0.0	0.5	0.6	0.0	0.0	0.0
Spurdog	0.0	0.0	0.0	2.3	0.6	0.5
Tope	17.7	14.3	0.9	8.2	5.5	1.1
Turbot and Brill	2.3	0.0	0.4	1.7	1.8	0.0
Whiting	3.1	1.2	3.3	8.2	0.7	7.3
Wrasses	0.3	0.7	2.0	0.6	1.2	6.0

Appendix 5. Fish species caught by sea anglers fishing in Wales

Species	North Wales Pilot Surveys (n = 1763)		Historical Sea Angler and NFSA Data (n = 1504)		Online Survey (n = 133)
	Summer Shore (%)	Winter Shore (%)	Shore (%)	Boat (%)	
Bass	0.2	0.0	19.3	4.2	19.2
Bib or Poor cod	7.3	0.2	0.8	2.0	1.1
Bull Huss	0.0	0.0	5.4	5.7	1.9
Cod	0.1	0.4	14.9	13.6	6.5
Conger Eel	0.2	0.0	6.8	6.5	1.2
Dab	0.4	2.7	1.8	1.4	1.6
Dogfish	5.2	2.5	1.4	3.5	24.1
European Eel	0.0	0.0	0.8	0.1	1.0
Flounder	0.2	0.4	8.8	0.2	5.1
Garfish	0.0	0.0	0.0	0.0	0.1
Greater Pelagic Sharks	0.0	0.0	0.0	3.5	0.1
Gurnards	0.0	0.0	0.1	1.9	0.5
Ling	0.1	0.0	0.2	1.8	0.0
Mackerel	39.9	0.0	1.1	1.0	9.4
Mini Species	4.4	0.2	2.4	0.9	1.9
Mullets	0.3	0.0	2.9	0.1	1.0
Plaice	0.1	0.0	1.8	0.8	1.4
Pollack	2.2	0.0	1.9	7.0	5.7
Rare	0.0	0.0	1.2	3.0	0.2
Rays	0.1	0.0	13.9	21.0	2.6
Saithe	0.2	1.3	0.2	0.5	0.3
Seabreams	0.4	0.0	0.6	2.3	1.6
Smooth Hound	0.0	0.0	2.3	1.5	2.0
Soles	0.0	0.0	0.9	0.6	0.0
Spurdog	0.0	0.0	0.0	0.4	0.4
Tope	0.1	0.0	1.8	9.9	1.0
Turbot And Brill	0.0	0.0	1.3	2.7	0.1
Whiting	5.8	92.4	3.8	3.1	8.0
Wrasses	32.6	0.0	3.9	0.7	1.7

Species caught by sea anglers, values are within column percentages. Greyed cells are the top 3 within column values. North Wales RSA Pilot Summer and Winter survey from angler interview and observation data in 2007 and 2008; percentages are derived from catch frequencies. Sea Angler (SA) is a magazine and SA data were compiled by Richardson (2006). The National Federation of Sea Anglers (NFSA) data are catches submitted by members. SA and NFSA records are from 1990 to 2004.

Appendix 6. Percent catches by species for boat and shore from Wales centric surveys



Percent catches by species derived from catch frequencies collated from the Wales centric coverages of Goudge *et al.* (2009, 2010), Richardson (2006) and this survey (methods in 3.2.1). Greater Pelagic = the greater pelagic sharks, primarily blue shark with an occasional porbeagle (unpublished informal charter skipper interviews from Monkman 2013). SA, Sea Angler catch records; NFSA, National Federation of Sea Anglers trophy records; NWPS, North Wales Recreational Sea Angler Pilot Surveys catch records.

Appendix 7. Catch proportions of cod, bass and rays by Marine Character Area

Catch proportions of the 3 most frequently caught species of Richardson's (2006) Sea Angler magazine transcribed data from 1972–2003 by Marine Character Area. [1]Percentages calculated by column within this table; [2]Percentages calculated by species within this table; [3]Percentage is the sum of within table catches (559) ÷ total catches (964). Top 3 records per column are greyed.

Marine character area	Bass	Cod	Rays	Total[1]
Caernarfon Bay	14 (5.5%)	3 (1.7%)	9 (7.2%)	26 (5%)
Cardigan Bay (north) and Estuaries	13 (5.1%)	3 (1.7%)	2 (1.6%)	18 (3%)
Cardigan Bay (south)	19 (7.5%)	8 (4.5%)	11 (8.8%)	38 (7%)
Carmarthen Bay and Estuaries	39 (15.3%)	1 (0.6%)	3 (2.4%)	43 (8%)
Colwyn Bay and Rhyl Flats	25 (9.8%)	5 (2.8%)	8 (6.4%)	38 (7%)
Dee Estuary (Wales)	0	0	0	0 (0%)
Glamorgan Coastal Waters and Nash Sands	15 (5.9%)	23 (12.8%)	37 (29.6%)	75 (13%)
Gower and Helwick Coastal Waters	34 (13.3%)	1 (0.6%)	0	35 (6%)
Holy Island West and Penrhos Bay	2 (0.8%)	1 (0.6%)	3 (2.4%)	6 (1%)
Holyhead Bay and The Skerries	2 (0.8%)	1 (0.6%)	0	3 (1%)
Llŷn and Bardsey Island	7 (2.7%)	2 (1.1%)	3 (2.4%)	12 (2%)
Menai Strait	12 (4.7%)	17 (9.5%)	0	29 (5%)
Milford Haven	0	0	1 (0.8%)	1 (0%)
North Anglesey Coastal Waters	4 (1.6%)	1 (0.6%)	0	5 (1%)
Red Wharf and Conwy Bays	7 (2.7%)	2 (1.1%)	0	9 (2%)
Severn Estuary (Wales)	9 (3.5%)	51 (28.5%)	10 (8.0%)	70 (13%)
South Pembrokeshire Coastal and Inshore Waters	10 (3.9%)	0	0	10 (2%)
Swansea Bay and Porthcawl	22 (8.6%)	54 (30.2%)	32 (25.6%)	108 (19%)
Tremadog Bay and Dwyryd Estuary	10 (3.9%)	0	5 (4.0%)	15 (3%)
West Pembrokeshire Coastal Waters and Islands	11 (4.3%)	6 (3.4%)	1 (0.8%)	18 (3%)
Total[2]	255 (46%)	179 (32%)	125 (22%)	559 (58%)[3]

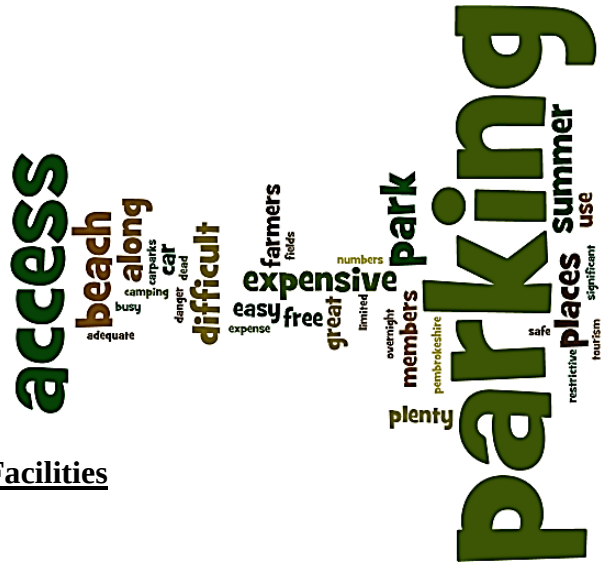
Appendix 8. Preference of surveyed sea anglers for common bait species of the Wales coast

Common Name	Binomial	25% or fewer trips		25% + to 50% of trips		50% + to 75% of trips		75% + of trips		Did Use or Collect	
		Used (%)	Col. (%)	Used (%)	Col. (%)	Used (%)	Col. (%)	Used (%)	Col. (%)	∑ Use (%)	∑ Col. (%)
Clams (not razor)	-	15	9	1	1	0	2	1	2	17	13
Cockle	*Cerastoderma edule*	20	12	2	1	0	1	0	2	22	15
Crab (common shore)	*Carcinus maenas*	25	24	20	8	13	5	6	11	64	47
Crab (edible)	*Cancer pagarus*	17	9	2	2	2	1	1	3	21	15
Crab (hermit)	*Pagurus bernhardus*	18	9	2	2	2	1	1	2	23	13
Crab (velvet swimmer)	*Necora puber*	15	6	4	2	1	2	2	4	21	14
Lug worm (black)	*Arenicola defodiens*	15	12	18	8	15	5	22	11	70	36
Lug worm (blow)	*Arenicola marina*	18	15	14	10	15	3	20	7	66	34
Mussel	*Mytilus edulis*	24	14	4	1	2	1	1	2	31	18
Oyster (all species)	Various spp.	11	6	0	0	0	1	0	0	11	7
Prawn	*Palaemon serratus*	24	10	5	2	3	2	2	5	34	18
Rag worm (harbour)	*Hediste diversicolor*	18	12	19	6	8	4	11	3	56	25
Rag worm (king)	*Nereis virens*	21	14	15	2	8	4	17	2	61	21
Rag worm (white)	*Nephtys hombergii*	18	10	2	1	2	2	2	2	26	14
Razor clam	Ensis spp.	23	14	10	0	5	4	1	4	39	21
Sandeel/Launce	*Ammodytes tobianus/Hyperoplus lanceolatus*	25	13	21	3	10	3	11	2	66	21
Shrimp	*Crangon crangon*	18	9	2	1	2	2	0	3	22	15
Whelk	*Buccinum undatum*	12	8	1	1	0	1	0	0	13	9

Angler trip bait utilisation categories and times collected (Col.) when angling or collecting bait in Wales, expressed as a within category percentage of common bait species available around the Wales coast from an online survey with 133 respondents in February to March 2015. Greyed cells highlight top 3 percentages in each column.

Appendix 9. Interactions with other users – word cloud

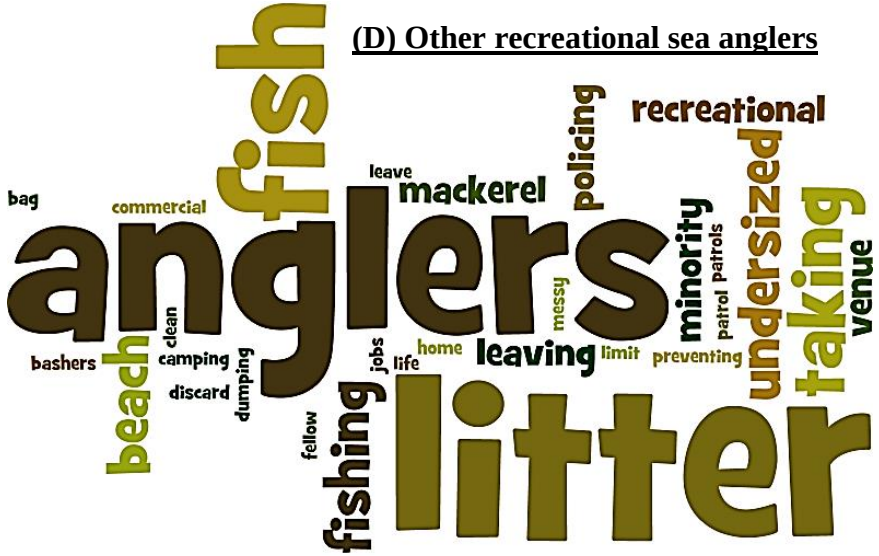
(A) Commercial fishing



(B) Facilities

(C) Other recreational users

(D) Other recreational sea anglers



Word clouds for categorised open ended responses (as specified) to This Survey's question *what positively or negatively affected [your] fishing?* Based on top 50 words, post filtered to remove extraneous text, for example 'although' *et cetera*.

(E) All recreational sea fishers

(F) All other responses

(G) All comments together

Continued: Word clouds for categorised open ended responses (as specified) to This Survey's question *what positively or negatively affected [your] fishing?* Based on top 50 words, post filtered to remove extraneous text, for example 'although' *et cetera*. For (G) fish, fishing, angling, anglers and synonyms removed.

Appendix 10. Match venues of the Welsh Federation of Sea Anglers.

Welsh Shore Match Venues and numbers of anglers fishing there

Compiled by Roger Cook from information provided by committee members of the Welsh Federation of Sea Anglers.

Blue Bridge, Queensferry	40
Mostyn	40
Talacre	60
Prestatyn	60
North Shore Llandudno	120
Conwy	40
Colwyn Bay	60
Penmaenmawr	40
Bangor Pier	60+
Bryn Siencin	60
Holyhead Breakwater	80
Nefyn	40
Pwllheli	80
Abererch	60
Borth	100
Aberystwyth Tanybwlch	40
Llanrhystud	30
Aberaeron	40
Cei Bach	40
Freshwater East	30
Freshwater West	30
Newgale Sands	30
Broadhaven	30
Dale	30
Lydstep Haven	30
Penally	30
South Tenby	30
Castle Beach Tenby	30
North Tenby	30
Coppet Hall	30
Wisemans Bridge	30
Amroth	120
Pendine Sands	120
Llanstephan & Tywi Est.	30
Ogmore to Rest Bay	80
Oxwich	60
Llangenith	60
Aberavon, Swansea	150
Cold Knap, Barry	120
Cardiff Foreshore	100
(more with Port Authority permission via WFSA)	
St Brides, Newport	150

Appendix 11. Spatial distribution of target species, reproduced from Drew (2004)

Location	Port	Main Target Species and any special characteristics of venue	Principal Shore Angling Locations	Main Target Species and any special characteristics of venue
Colwyn Bay	Rhyl	Mackerel, Pollack, Flounder, Plaice, Dogfish, Whiting, Gurnard, Ray and Tope	Rhyl	Bass, Flounder, Dab and Eels.
	Rhos-on-Sea		Colwyn Bay	Dab, Whiting, Flounder and Bass.
	Conway		Llandudno	Bass, Plaice, Flounder, Dab and Dogfish,
	Bangor			
	Beaumaris			
Anglesey	Amlwch	Mackerel, Pollack, Flounder, Plaice, Dogfish, Whiting, Gurnard, Ray and Tope	Penmon	Mackerel & Bass
	Cemaes		Moelfre	Bass, Conger Eel, Tope, Whiting, Cod, Pouting, Dogfish and Pollack.
	Holyhead		Amlwch	Dab, Whiting, Codling and Dogfish.
	Menai Bridge		Carmel Head	Bass, Ray, Dogfish, Flounder, Pollack and Coalfish.
			Holyhead	Bass, Dab, Flounder, Wrasse and Coalfish.
			Menai Strait	Bass, Tope, Mullet and Wrasse.
West Wales	Port Dinorwic	Tope, Pollack, Ray, Bream, Plaice, Dogfish, Mackerel, Gurnard and Whiting	Dinas Dinlle	Bass, Ray, Dogfish, Whiting, Coalfish, Codling.
	Caernarfon		Nefyn & Trevor	Bass, Flounder, Dab and Dogfish.
	Abersoch		Llŷn Beaches	Flounder, Plaice, Ray, Dogfish, Dab, Cod and Coalfish.
	Pwllheli		Tremadog Bay	Bass, Flounder, Dab, Plaice and Mullet.
	Barmouth		Barmouth Estuary & Viaduct	Bass, Mullet, Flounder, Plaice and Dab.
	Tywyn	Tope, Pollack, Ray, Bream, Plaice, Dogfish, Mackerel, Gurnard and Whiting.	Mouth of the Dysynni	Bass, Flounder and Dogfish.
Cardigan Bay	Aberystwyth	Rays, Conger Eel, Bull Huss, Pollack, Pouting, Plaice, Dab and Flounder:	Aberdovey Estuary	Plaice, Dab, Flounder and Bass.
			Aberystwyth	Bass, Dogfish, Whiting, Mackerel, Pollack and Tope.
	New Quay		New Quay Headland	Conger, Mackerel, Pollock and Wrasse.

Location	Port	Main Target Species and any special characteristics of venue	Principal Shore Angling Locations	Main Target Species and any special characteristics of venue
			Aberaeron Harbour	Mullet and Wrasse.
			Cardigan	Bass, Tope, Pollack, Dogfish, Ray, Conger Eel, Dab, Pouting, Whiting, Rockling and Gurnard.
Fishguard Bay	Fishguard	Conger, Bull Huss, Pouting, Plaice, Dab, Flounder Mackerel, Pollack, Conger Eel, Ray and Tope.	Fishguard Port Breakwater	Rays, Conger, Bull Huss, Pollack, Pouting, Plaice, Dab and Flounder.
	Solva	Tope, Skate, Pollack, Gurnard and Mackerel	Aberiddy Bay	Pollack, Mackerel, Wrasse, Tope and Ray.
	Angle		St David's	Mackerel, Pollack, Wrasse and Conger Eels.
			Newgale	Bass, Flounder and Codling
Carmarthen Bay	Milford Haven	Tope, Skate, Pollack, Gurnard and Mackerel.	Milford Haven	Bass, Flounder and Mullet.
	Pembroke Dock	Flounder and Mullet:	Pembroke Dock	Flounder and Mullet.
	Pendine	Rays, Conger, Bull Huss, Pollack, Pouting, Plaice, Dab and Flounder:	Cefn Sidan , The Storm Beaches & Caldy Island	Bass and Flounder.
			Barafundle Bay	Dogfish, Rays and Tope.
South Wales	Swansea	Bass, Mullet, Ray, Plaice, Flounders, Dogfish, Tope, Smooth hound, Mackerel, Coalfish, Conger Eel, Cod, Codling and Whiting.	Broughton Bay	Ray, Flounder, Tope and Dogfish.
	Penarth – Barry		Burry Holms	Bass, Ray and Dogfish.
	Newport		Rhosilli	Bass, Pollack, Mackerel, Wrasse, Dogfish, Conger, Tope and Rays.
			Porthcawl	Bass, Eels, Rays, Dogfish and Codling.
			Southerndown	Thornback and Small Eyed Ray, Smooth hound, Bass and Codling.
			Penarth Pier to Lavenock Point.	Conger Eel, Mullet, Bass, Flounders, Thornback Ray, Whiting, Cod and Codling.
			Newport	Bass, Mullet, Ray, Plaice Flounders, Dogfish, Tope, Smooth hound, Mackerel, Coalfish, Conger Eel, Cod, Codling and Whiting.

Appendix 12. Inflation in angler expenditure categories

Table A, Consumer Price Indices (CPI) for 2003 and 2013 for categories used in the economic assessment of Richardson (2006). Parenthesis enclosed value for category gives % importance weight adjusted inflation rate for the category.

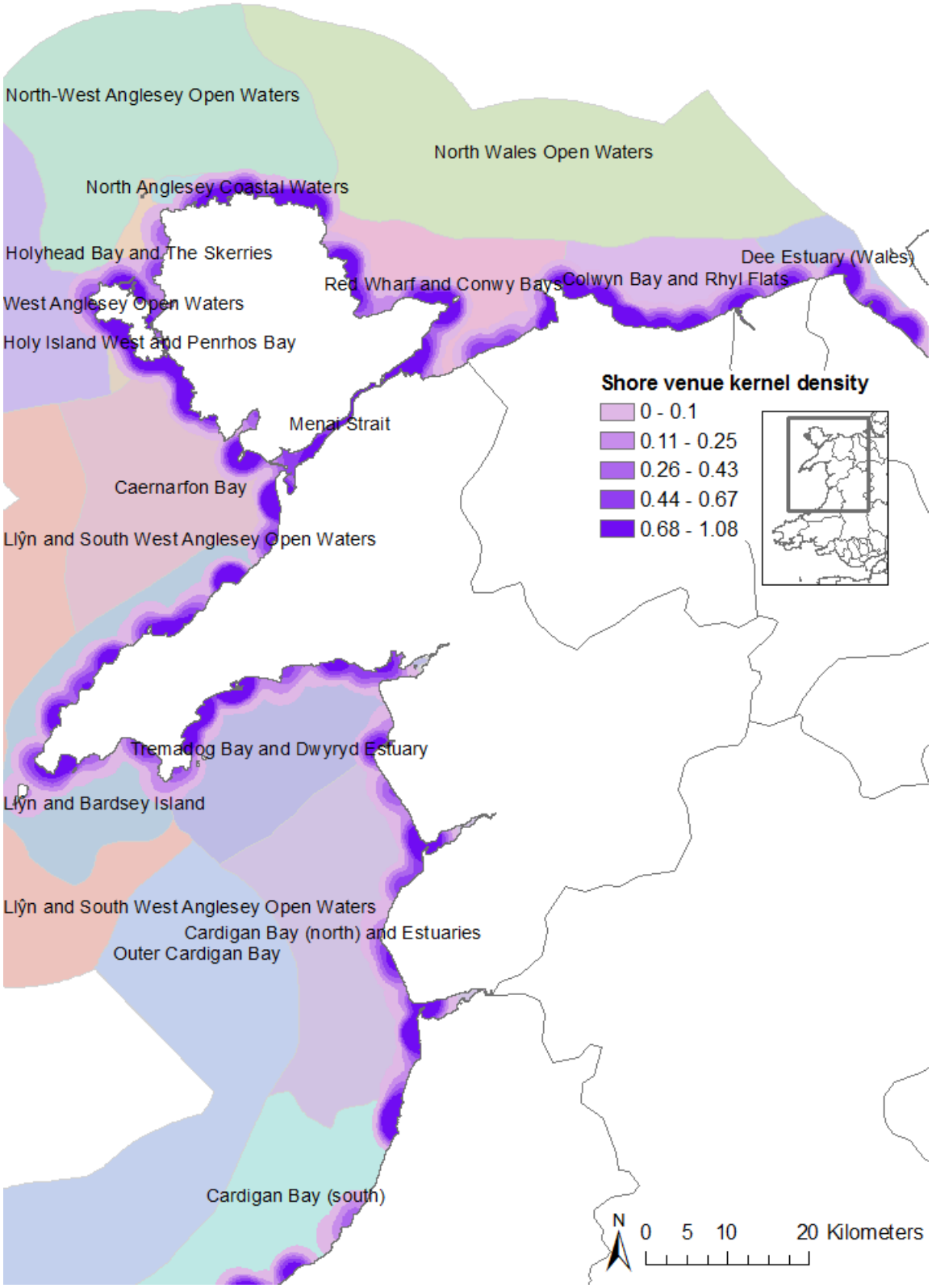
Category	Item	% of importance	CPI	CPI 2003	CPI 2013	Inflation (%)
Angling equipment (-9.8%)	Fishing tackle	100	CPI index 09.3.2 : equipment for sport camping and open-air recreation	110.2	99.4	-9.80
Boat costs (73.3%)	Maintenance	3	CPI index 07.2.1 : spare parts & accessories	96.8	120.4	24.38
	Maintenance	3	CPI index 07.2.3 : maintenance & repairs	87.7	136.4	55.53
	Fuel	74	CPI index 07.2.2 : fuels & lubricants	87.1	155.1	78.07
	Insurance	8	CPI index 12.5.4 : insurance connected with transport	100.7	185.1	83.81
	Storage and launching fees	12	CPI index 12.7 : other services (includes self-storage)	85.7	131.7	53.68
Travel (71.1%)	Fuel	80	CPI index 07.2.2 : fuels & lubricants	87.1	155.1	78.07
	Car rental	10	CPI index 07.3.2 : passenger transport by road	90.6	135.5	49.56
	Parking	10	CPI index 07.2.4 : other services for personal transport equipment	91.9	125.4	36.45
Food and drink (40.3%)	Food and non-alcoholic beverages	33	CPI index 01 : food and non-alcoholic beverages	97.9	143.9	46.99
	Restaurant & cafe	33	CPI index 11.1.1 : restaurants & cafes	94.6	131.2	38.69

	Canteens	33	CPI index 11.1.2 : canteens	94	127	35.11
Magazines, books, subscriptions (35.3%)	Magazines	50	CPI index 09.5.2 : newspapers and periodicals	94.6	143.2	51.37
	Books	50	CPI index 09.5.1 : books	97.3	116.1	19.32
Competition fees (48.7%)	Competition fees	100	CPI index 09.4.1 : recreational and sporting services	93	138.3	48.71
Membership fees (48.7%)	Membership fees	100	CPI index 09.4.1 : recreational and sporting services	93	138.3	48.71
Accommodation (32.2%)	Hotel, B&B	100	CPI index 11.2 : accommodation services	90.8	120	32.16

Table B, Average price of bait and charter fees during 2003 and 2014 and the relative inflation.

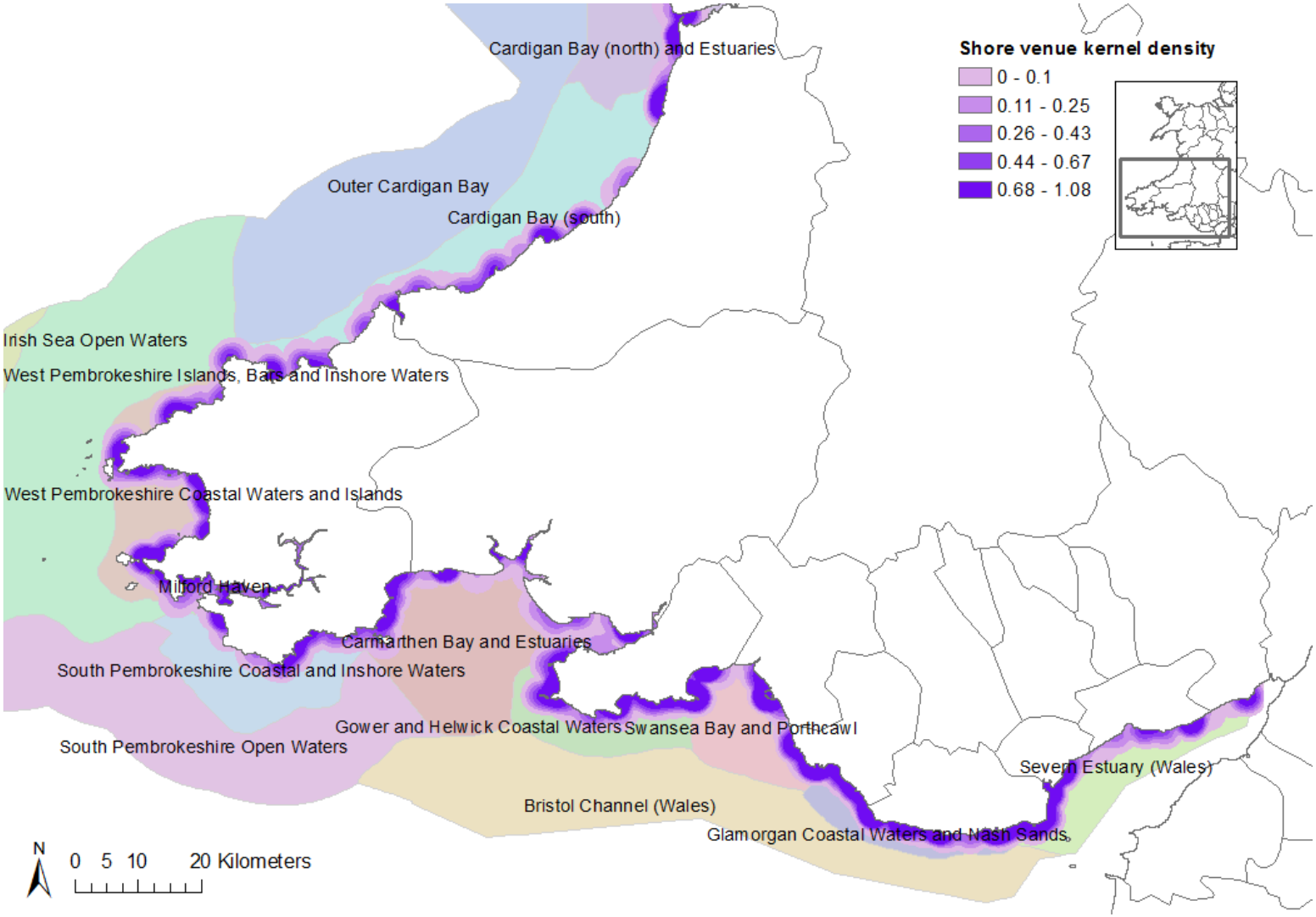
Category	Item	% of importance	Average price 2003	Average price 2014	Inflation (%)
Bait (26.4%)	Bait	100	1.5	1.9	26.4
Charter fees (32.4%)	Charter fees	100	5.38	4.06	32.4

Appendix 13. Kernel density of sea angling shore venues for North and Mid Wales



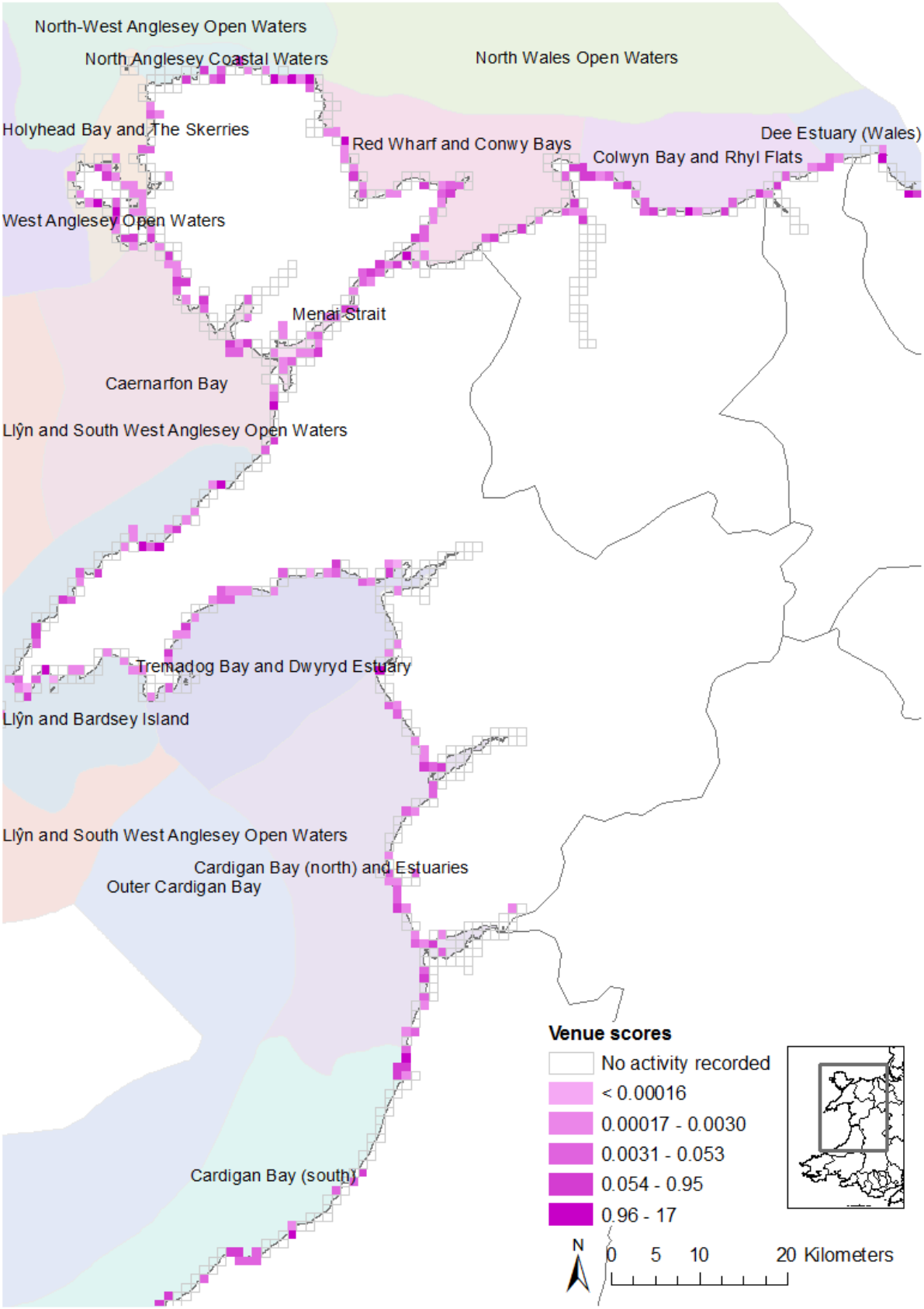
Kernel density (venue number km^{-2}) of sea angling shore venues (N = 2,700) for North and Mid Wales from 14 heterogeneous data sources; categorised as social media, survey and published sea angling books.

Appendix 14. Kernel density of sea angling shore venues for South Wales



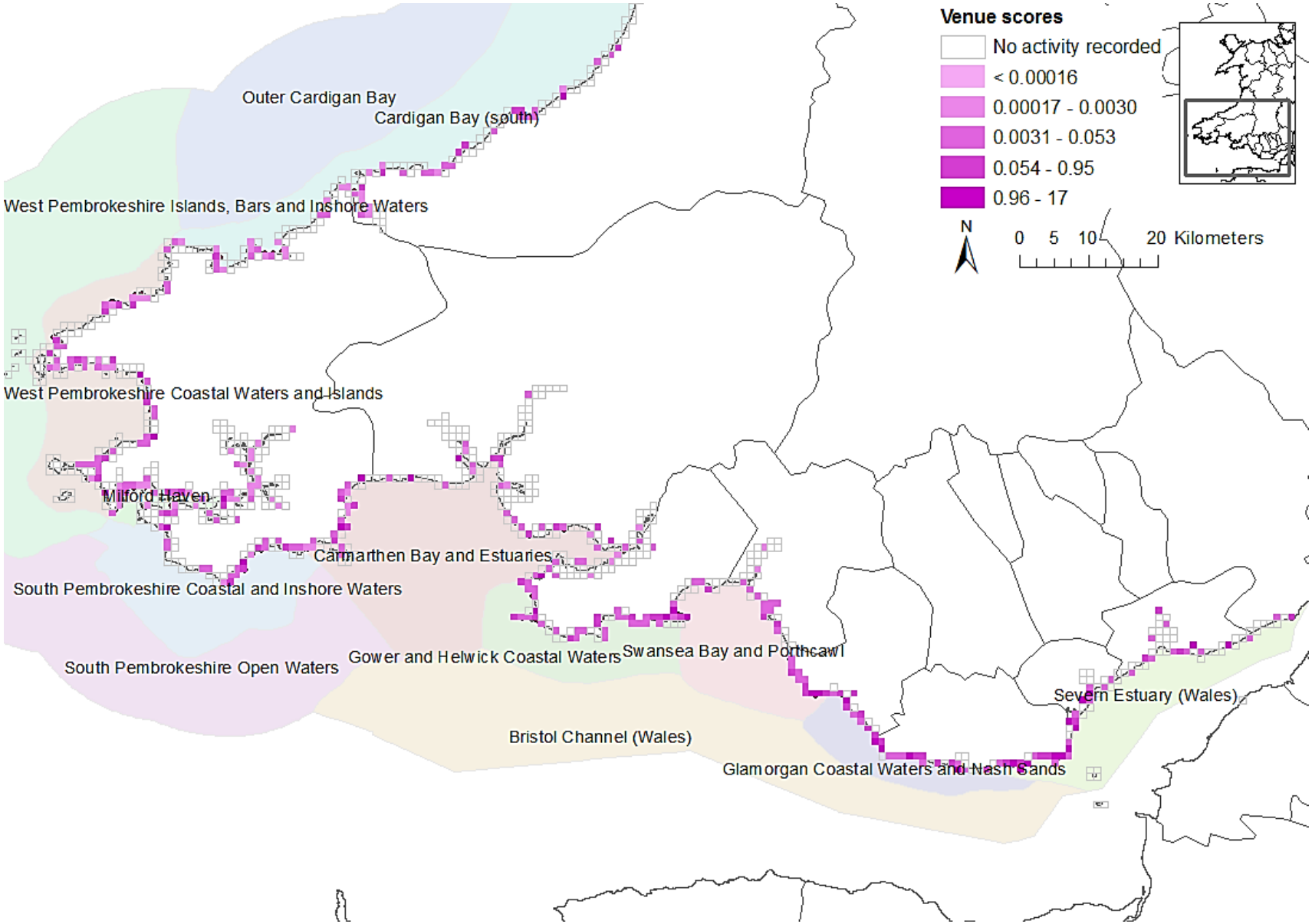
Kernel density (venues km^{-2}) of sea angling shore venues (N = 2,700) for South Wales from 14 heterogeneous data sources; categorised as social media, survey and published sea angling books.

Appendix 15. Scoring of shore angling venue densities for North and Mid Wales



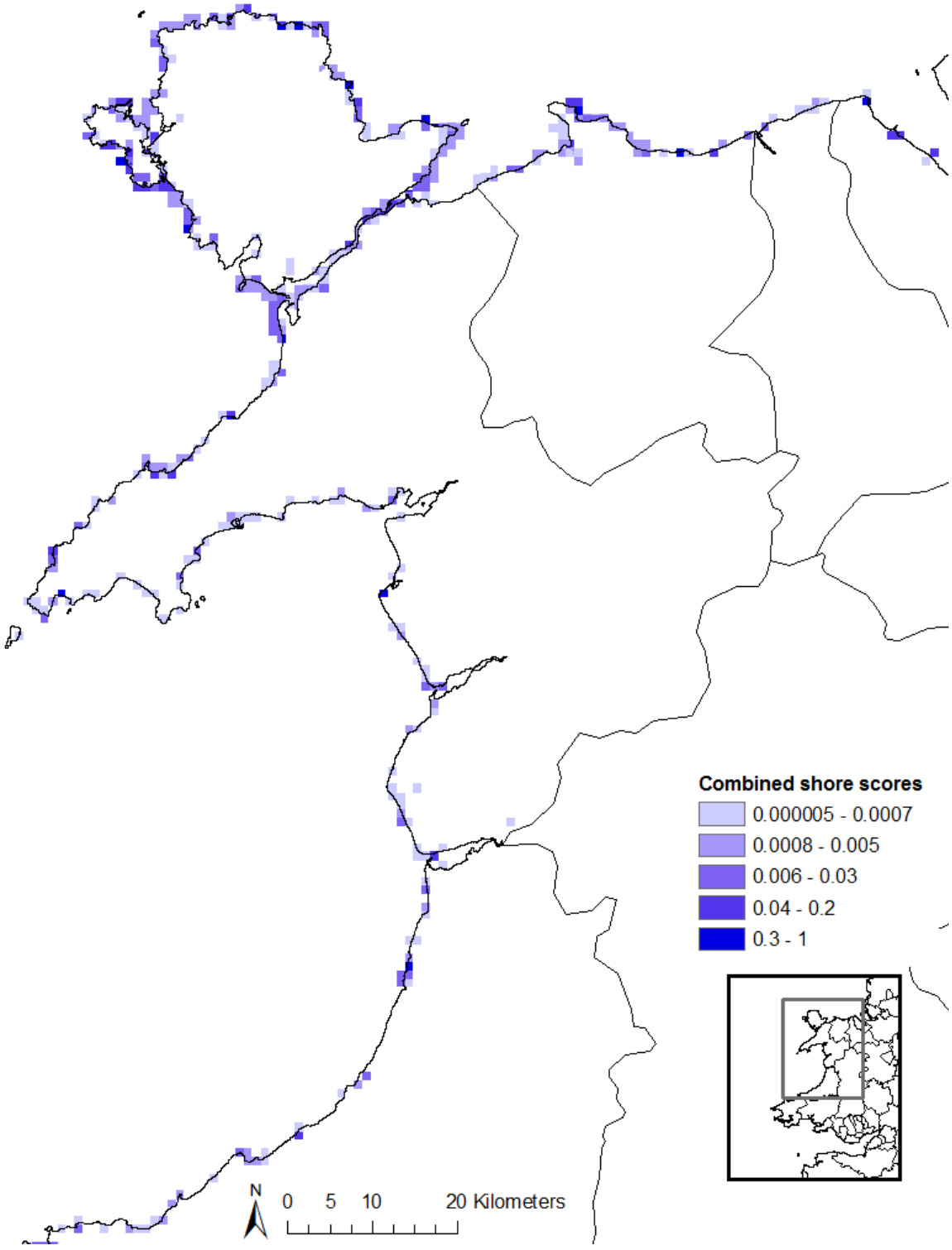
Weighted scoring of venue densities to 1 km^2 cells derived from 17 separate data sets reporting recreational sea angler shore fishing locations for North and Mid Wales

Appendix 16. Scoring of shore angling venue densities for South Wales



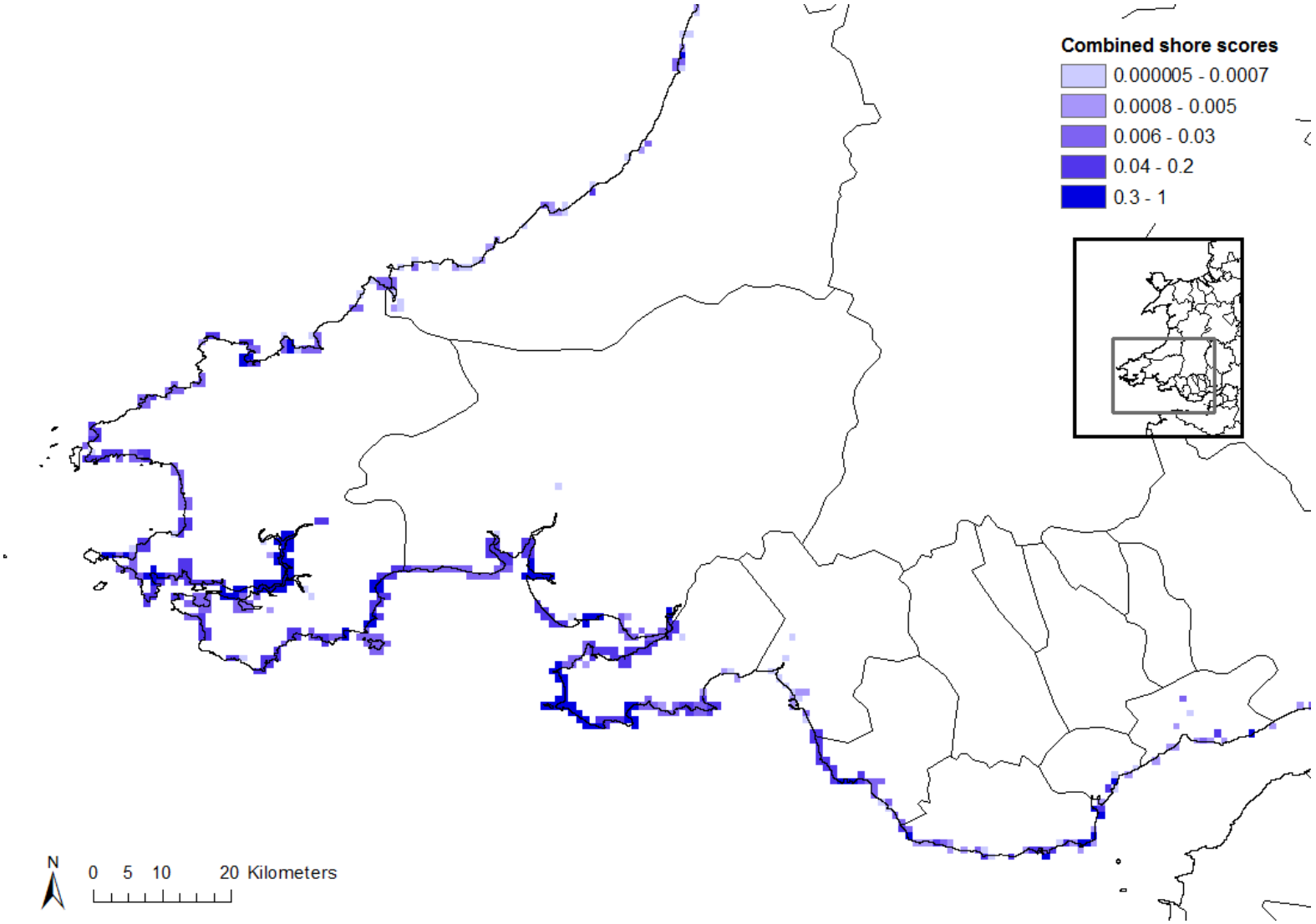
Weighted scoring of venue densities to 1 km^2 cells derived from 17 separate data sets reporting recreational sea angler shore fishing locations for South Wales.

Appendix 17. Merged and normalised shore angler activity scores for North and Mid Wales



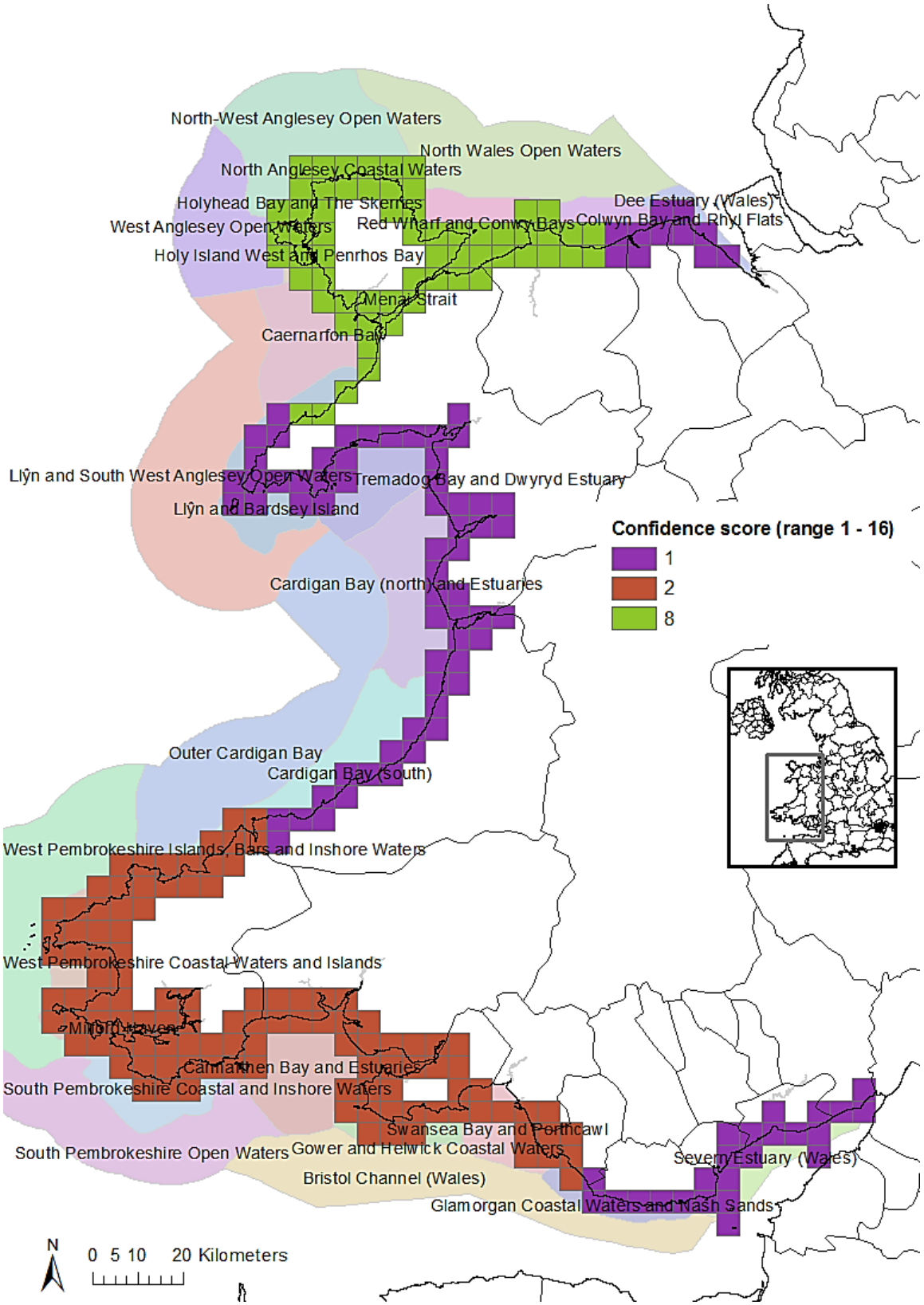
Amalgamation of shore angler's effort scores, scores are unitless however, intensities are directly comparable with South Wales coverage in Appendix 18. Marine character areas omitted for visual clarity.

Appendix 18. Merged and normalised shore angler activity scores for South Wales



Amalgamation of shore angler's effort scores, scores are unitless however, intensities are directly comparable with South Wale coverage in Appendix 17. Marine character areas omitted for visual clarity.

Appendix 19. Shore angler activity data confidence map for Wales



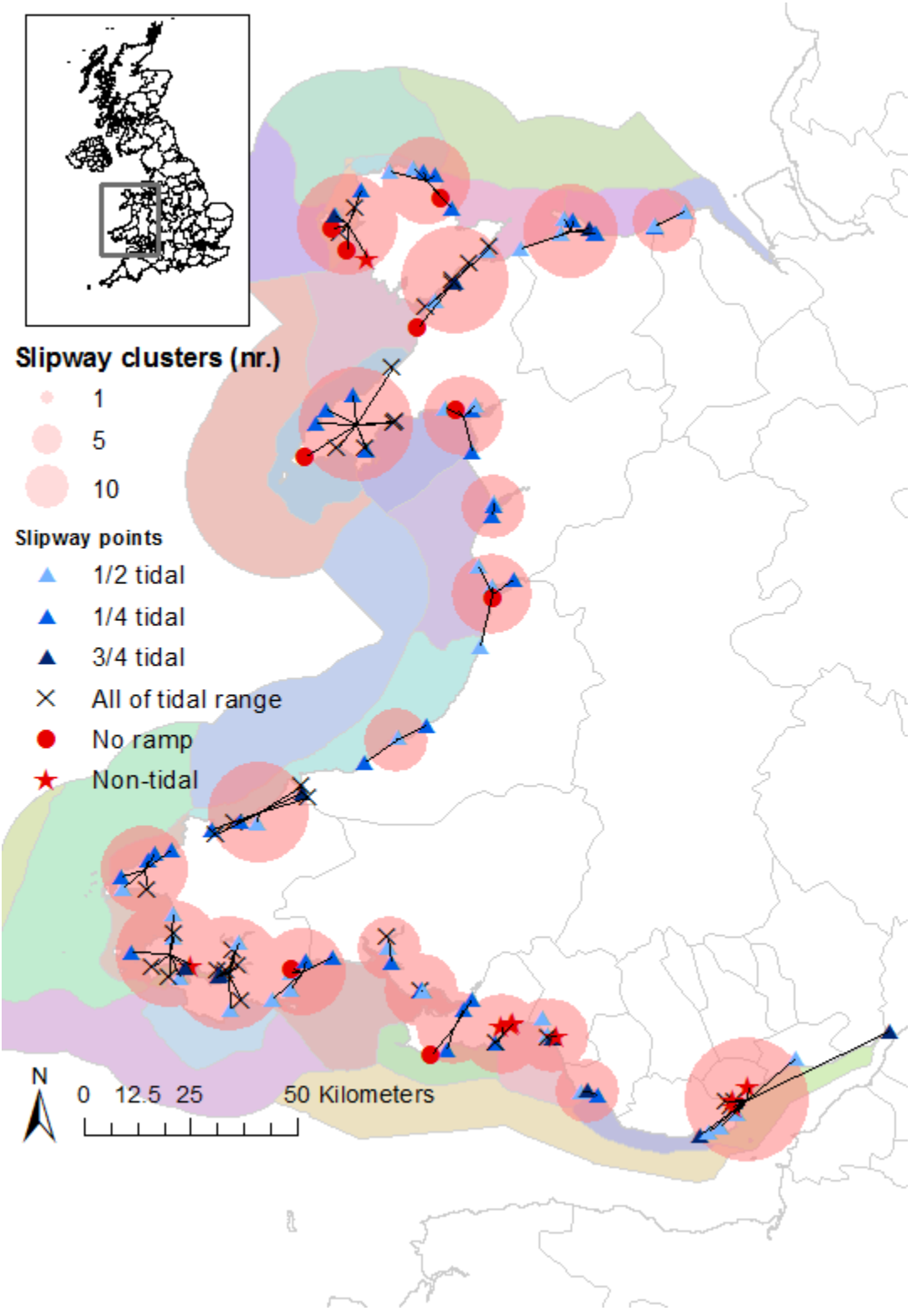
Confidence map for shore angling activity in 25 km^2 cells, calculated from a scored matrix with value range of 1–16 (Table 5-1). The highest confidence scoring survey contributing to the effort data within the 25 km^2 cell coverages was the score as displayed. Marine character areas underlayed and labelled. Red, Pembrokeshire Wales Activity Mapping; Blue, Point density angling locations of This Survey; Orange, FishMap Môn.

Appendix 20. Slipway numbers by tidal range and marine classification area

Summary of slipways according to their tidal range/extent by the adjoining marine classification area (MCA). Total gives the slipway sum per MCA (by row) with bracketed percentage, top 3 by number are greyed. Data sourced or extracted from Google Earth (2013) and Campbell (2015).

Marine Classification Area	Slipway tidal range/extent						
	1/4 tidal	1/2 tidal	3/4 tidal	All	No ramp	Non-tidal	Total
Caernarfon Bay	0	0	0	0	1	1	2 (1%)
Cardigan Bay (north) and Estuaries	4	3	0	0	1	0	8 (6%)
Cardigan Bay (south)	4	3	1	4	0	0	12 (9%)
Carmarthen Bay and Estuaries	7	5	0	2	1	0	15 (11%)
Colwyn Bay and Rhyl Flats	4	3	1	0	0	0	8 (6%)
Glamorgan Coastal Waters and Nash Sands	1	0	1	0	0	0	2 (1%)
Gower and Helwick Coastal Waters	1	0	0	0	1	0	2 (1%)
Holy Island West and Penrhos Bay	0	0	0	1	2	0	3 (2%)
Holyhead Bay and The Skerries	1	1	1	1	0	0	4 (3%)
Llŷn and Bardsey Island	3	0	0	2	1	0	6 (4%)
Menai Strait	0	2	1	4	0	0	7 (5%)
Milford Haven	0	2	3	7	0	1	13 (10%)
North Anglesey Coastal Waters	2	2	0	0	0	0	4 (3%)
Red Wharf and Conwy Bays	1	2	0	1	1	0	5 (4%)
Severn Estuary (Wales)	0	4	2	3	0	3	12 (9%)
South Pembrokeshire Coastal and Inshore Waters	0	1	0	1	0	0	2 (1%)
Swansea Bay and Porthcawl	1	3	1	2	0	4	11 (8%)
Tremadog Bay and Dwyryd Estuary	2	2	0	3	1	0	8 (6%)
West Pembrokeshire Coastal Waters and Islands	5	3	0	2	0	0	10 (7%)

Appendix 21.Slipway locations with tidal range across Wales.



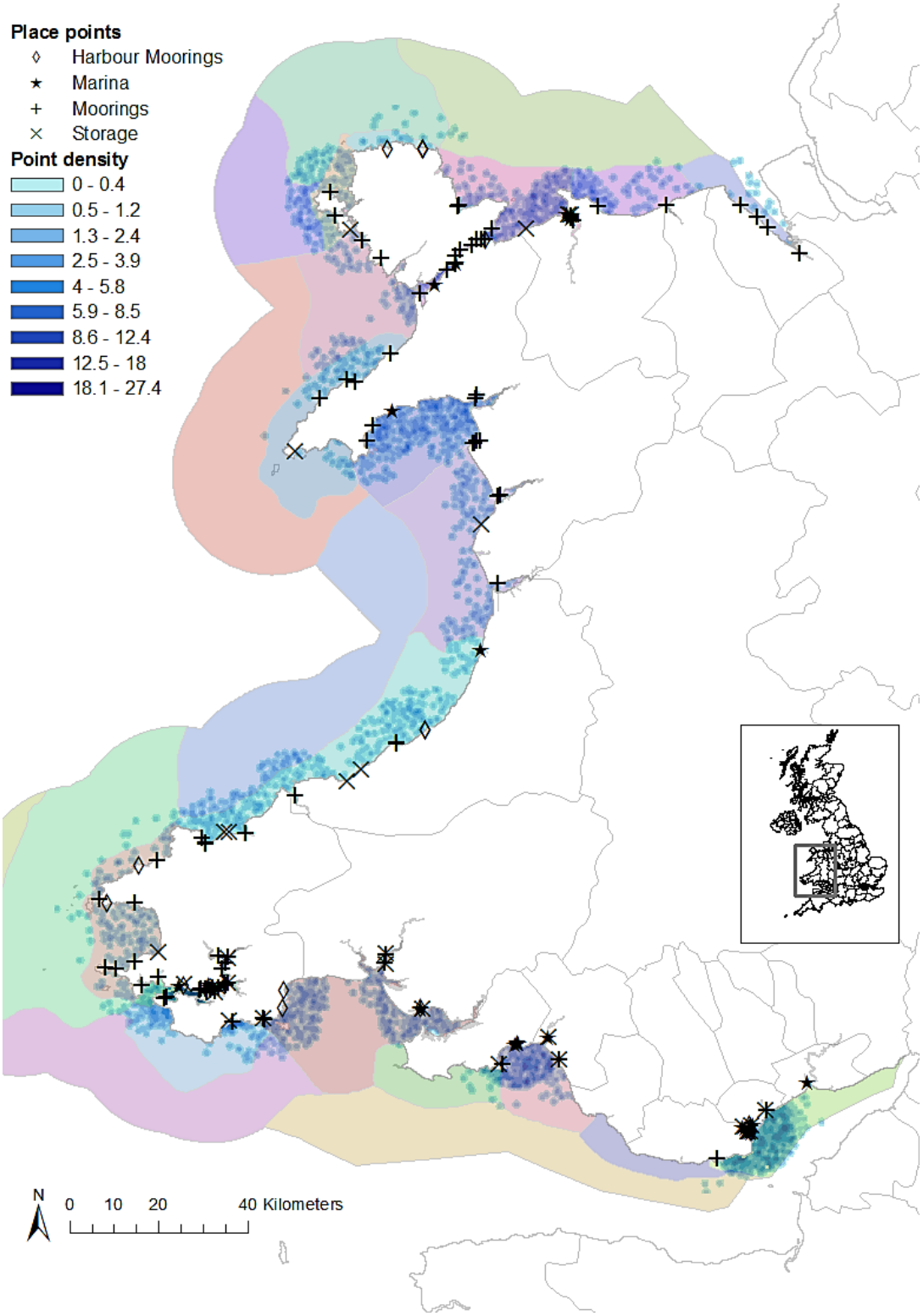
Slipway locations across Wales by slipway extent with Marine Character Areas outlined as detailed under Appendix 2. Slipway locations clustered (circles, *N* = 13) using k-means procedure giving cluster centroid, linked by line projections to sites assigned to linking cluster.

Appendix 22. Sampled boat storage facility capacity and boat activity type proportions by count

Sample estimates of boat storage facility type capacity and proportions by primary boat activity type using bias corrected and accelerated bootstrapping (*N* = 1000). Mean ±Standard Error with 95% confidence intervals. Mean bias is a measure of the difference between bootstrap estimates and averages. Data derived from Google Earth satellite imagery, Google Street View photography and Google Earth associated photography.

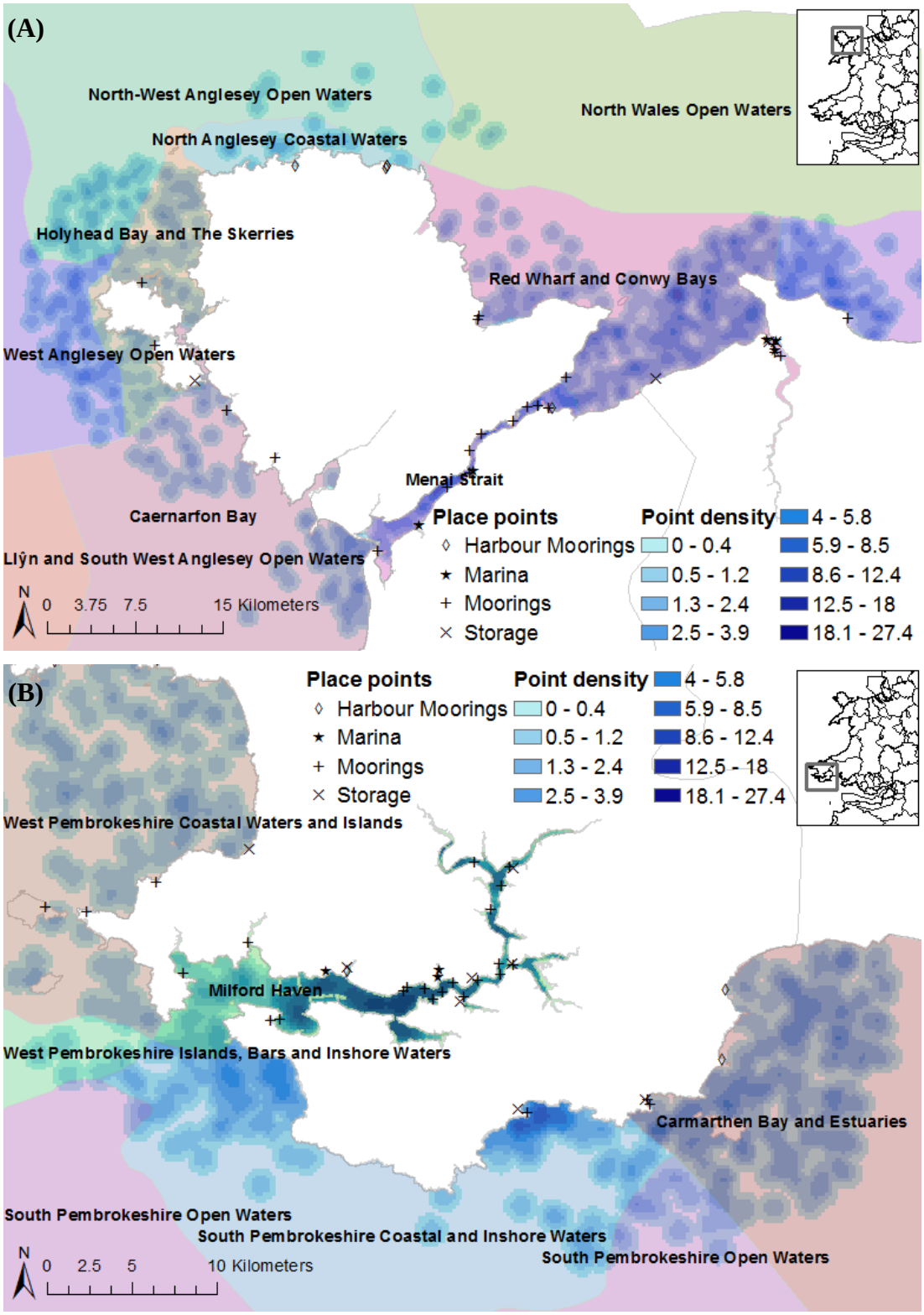
Facility	Statistic	Mean ±S.E.	Mean Bias	Min	Max
Harbour Moorings (*n* = 10)	Sail boat proportion	0.28 ±0.07 95% CIs [0.15 - 0.41]	0.0033	0	0.60
	Angling boat proportion	0.53 ±0.07 95% CIs [0.40 - 0.70]	0.0034	0.21	1
	Commercial boat proportion	0.15 ±0.06 95% CIs [0.05 - 0.25]	-0.0055	0	0.50
	Other boat proportion	0.044 ±0.023 95% CIs [0.010 - 0.079]	-0.0012	0	0.20
Marinas (*n* = 10)	Sail boat proportion	0.55 ±0.07 95% CIs [0.42 - 0.66]	-0.0011	0.10	0.92
	Angling boat proportion	0.35 ±0.07 95% CIs [0.22 - 0.49]	7.5E-04	0.080	0.85
	Commercial boat proportion	0.0093 ±0.0050 95% CIs [0.0000 - 0.0194]	6.1E-05	0	0.043
	Other boat proportion	0.094 ±0.024 95% CIs [0.049 - 0.140]	2.8E-04	0	0.25
Moorings (*n* = 10)	Sail boat proportion	0.40 ±0.09 95% CIs [0.24 - 0.56]	-1.6E-04	0	0.83
	Angling boat proportion	0.46 ±0.08 95% CIs [0.32 - 0.62]	-7.6E-05	0.067	1
	Commercial boat proportion	0.037 ±0.021 95% CIs [0.007 - 0.080]	1.1E-04	0	0.22
	Other boat proportion	0.096 ±0.021 95% CIs [0.046 - 0.143]	1.2E-04	0	0.19
Storage (*n* = 9)	Sail boat proportion	0.50 ±0.11 95% CIs [0.30 - 0.68]	-0.0018	0	1
	Angling boat proportion	0.46 ±0.11 95% CIs [0.23 - 0.70]	0.0018	0	1
	Commercial boat proportion	0.012 ±0.012 95% CIs [0 - 0.025]	2.5E-05	0	0.11
	Other boat proportion	0.027 ±0.018 95% CIs [0 - 0.063]	3.7E-05	0	0.17
All (*N* = 39)	Sail boat proportion	0.43 ±0.04 95% CIs [0.33 - 0.54]	0.003	0	1
	Angling boat proportion	0.45 ±0.04 95% CIs [0.38 - 0.52]	-0.002	0	1
	Commercial boat proportion	0.053 ±0.018 95% CIs [0.022 - 0.088]	-4.0E-04	0	0.50
	Other boat proportion	0.066 ±0.012 95% CIs [0.043 - 0.092]	-1.5E-04	0	0.25

Appendix 23. Randomised spatial dispersion of virtual private boats derived from maximum boat storage facility capacity estimates for Wales



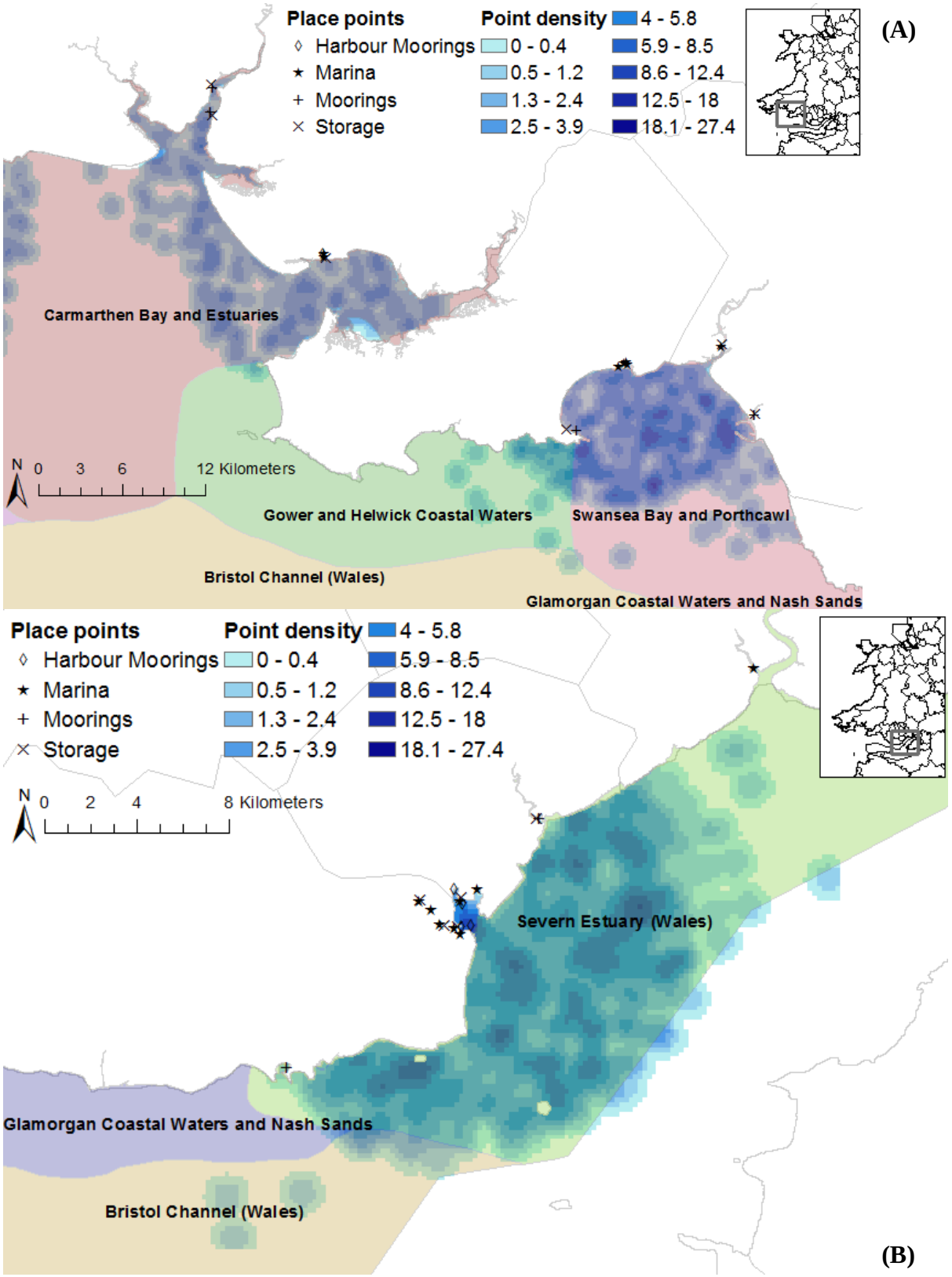
Relative randomised densities of private boats across Wales to a 10 km sea-bound radius of launch equipped parent boat storage facilities. It is **critical to note** that points do not directly represent observed boat angling locations, nor are they a measure of absolute effort. Point densities are a theoretical snapshot of maximum relative boat density (boats km^{-2}) by a caveated estimate of maximum boat storage facilities (methodology: section 5.3.3.2), distributed over a unit area. Marine character areas (Appendix 2) are underlayed.

Appendix 24. Randomised spatial dispersion of virtual private boats derived from maximum boat storage facility capacity estimates for Anglesey and Conwy Bay, and Milford Haven.



Relative randomised densities of private boats for (A) Anglesey and Conwy bay, and (B) Milford Haven, to a 10 km sea-bound radius of launch equipped parent boat storage facilities. Point density units are boats km^{-2}. Marine character areas (Appendix 2) are underlayed and labelled. See methods and Appendix 23 caption for limitations.

Appendix 25. Randomised spatial dispersion of virtual private boats derived from maximum boat storage facility capacity estimates for the Gower Peninsular.



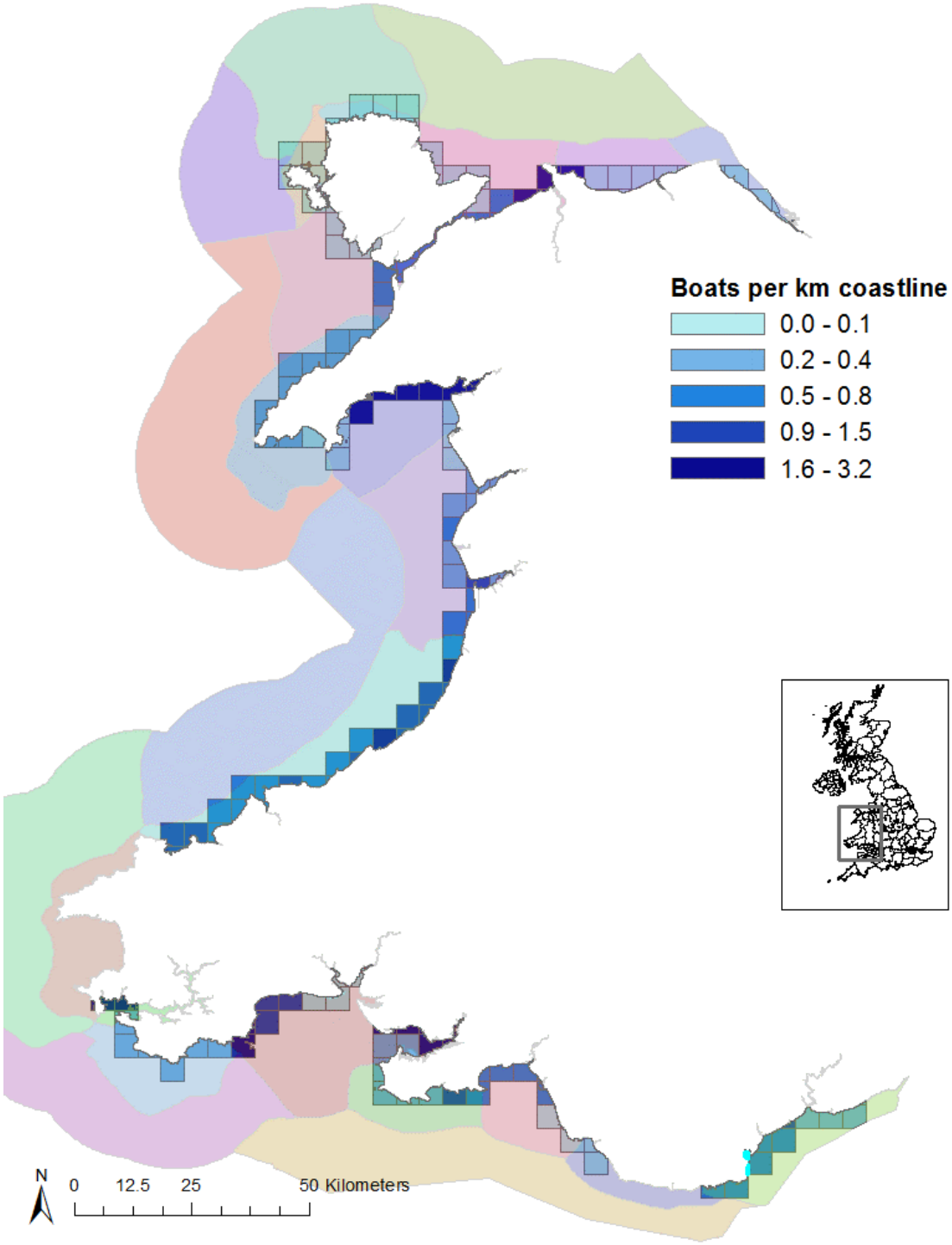
Relative randomised densities of private boats for (A) Gower Peninsular, and (B) Cardiff Bay, to a 10 km sea-bound radius of launch equipped parent boat storage facilities. Point density units are boats km^{-2}. Marine character areas (Appendix 2) are underlayed and labelled. See methods and Appendix 23 caption for limitations.

Appendix 26. CEFAS port census recreational boat numbers by port

CEFAS listed ports and number of boats involved in recreational bass angling. Top 3 boat numbers greyed.

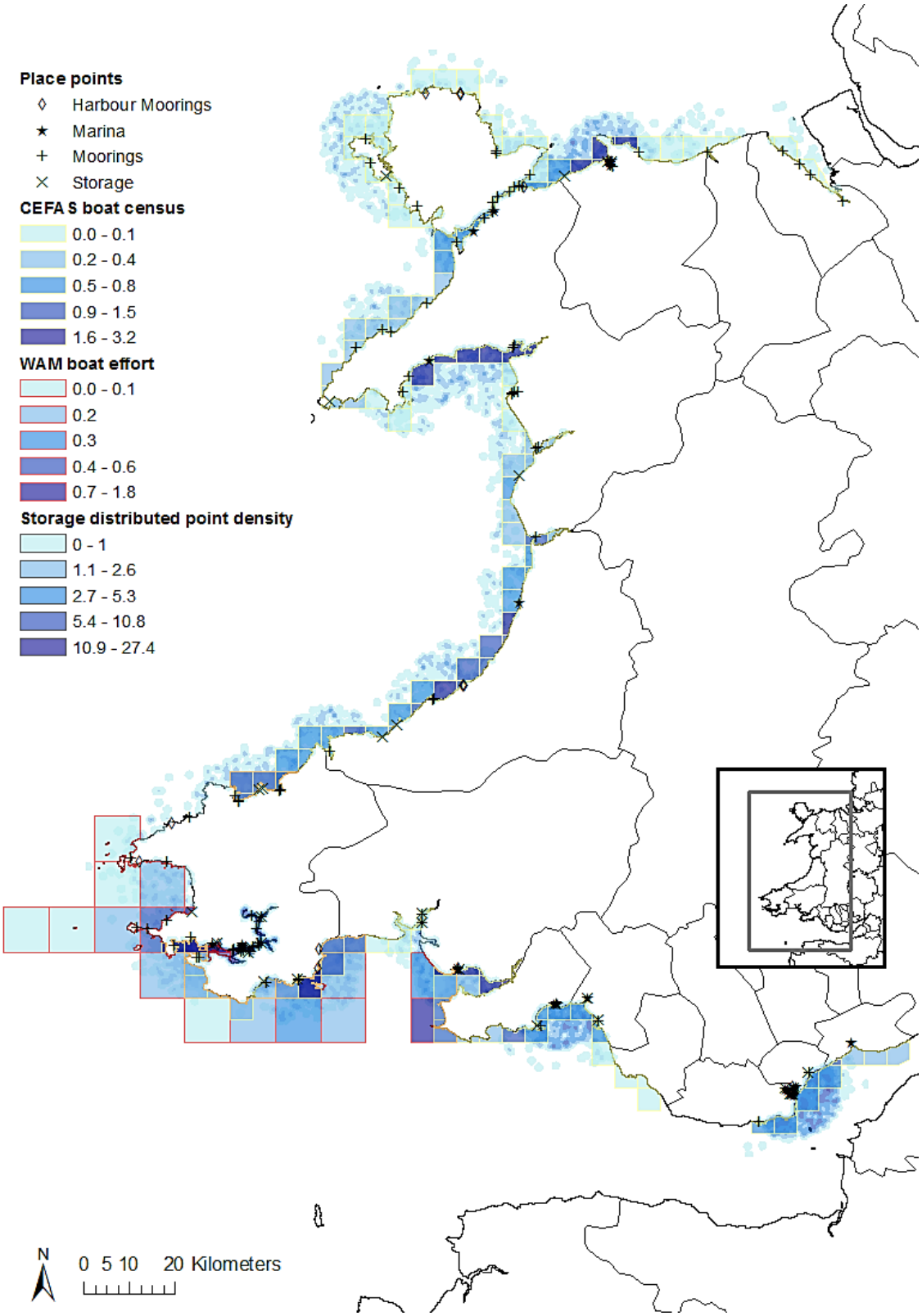
CEFAS port code	Port name	Number of Boats
898	Rhyl-Connah's Quay	0
802	Conwy	47
888	Bangor	10
880	Anglesey	18
877	Caernarfon-Bangor	7
876	Aberdaran-Caernarfon	17
872	Pwllheli-Aberdaran	0
868	Portmadog-Pwllheli	47
860	Traeth Bach area	0
856	Barmouth	12
854	Aberdovey-Tywyn	9
849	Aberystwyth-Borth	17
844	Aberaeron	21
843	New Quay	6
842	Llangranog	8
845	Cardigan	18
837	Fishguard	11
801	Milford Haven	23
830	Freshwater	5
827	Manorbier/Lydstep	0
811	Tenby	7
825	Saundersfoot	11
824	Pendine	0
809	Burry port	22
820	Llanelli/Burry Port	11
806	Gower	15
805	Swansea/Port Talbot	23
807	Porthcawl	1
803	Cardiff	17
804	Newport	6

Appendix 27. CEFAS port census bass angling boats per kilometre of coastline



Recreational bass angling boats standardised by high water coastline length (boats km^{-1}) and transferred to 25 km^2 cells. Data derived from the 2012 CEFAS port census data (Pickett 1990). Marine character areas are underlayed.

Appendix 28. Overlayed layers for private boat activity for Wales



The three private boat layers, CEFAS port census (25 km^2 yellow outlined cells), Pembrokeshire Wales Activity Mapping (100 km^2 red outlined cells) and this report's randomised spatial dispersion of maximum storage capacity estimates overlayed, with 5 category Jenks classifier sharing common colour key for each layer. Between layer numbers are not directly comparable and should be interpreted as relative effort only. Place points gives the centroids of mapped boat storage facilities.

Appendix 29. North Wales sea angler pilot survey summer (final) revision–pertinent questions

9. Which locations do you regularly fish from (optional)? _____

10. During an average angling session approximately how long would you fish for?

Pleasure angling _____ Match angling_____ Boat angling _____

13. Are you using a specific technique to catch a target species today? Yes / No Which species are you hoping to catch today? _____

14. Which species do you target between April-October and between November-March?

Apr-Oct_____

Nov-Mar_____

This recording form aims to fulfill part of the government's commitment to collect information on recreational angling activities in the UK. Any personal information you provide is confidential and will not be passed on.

Name (surveyor):_____ Location:_____ Date:_____

Angler ID	Start time	End Time	Species Caught or enter 'No Fish'	Time Caught	Size (cm)	Bait Used	Lost Gear (tally)	Number of Rods	Returned (Y / N)	Survived (Y / N)

This recording form aims to fulfill part of the government's commitment to collect information on recreational angling activities in the UK. Any personal information you provide is confidential and will not be passed on.

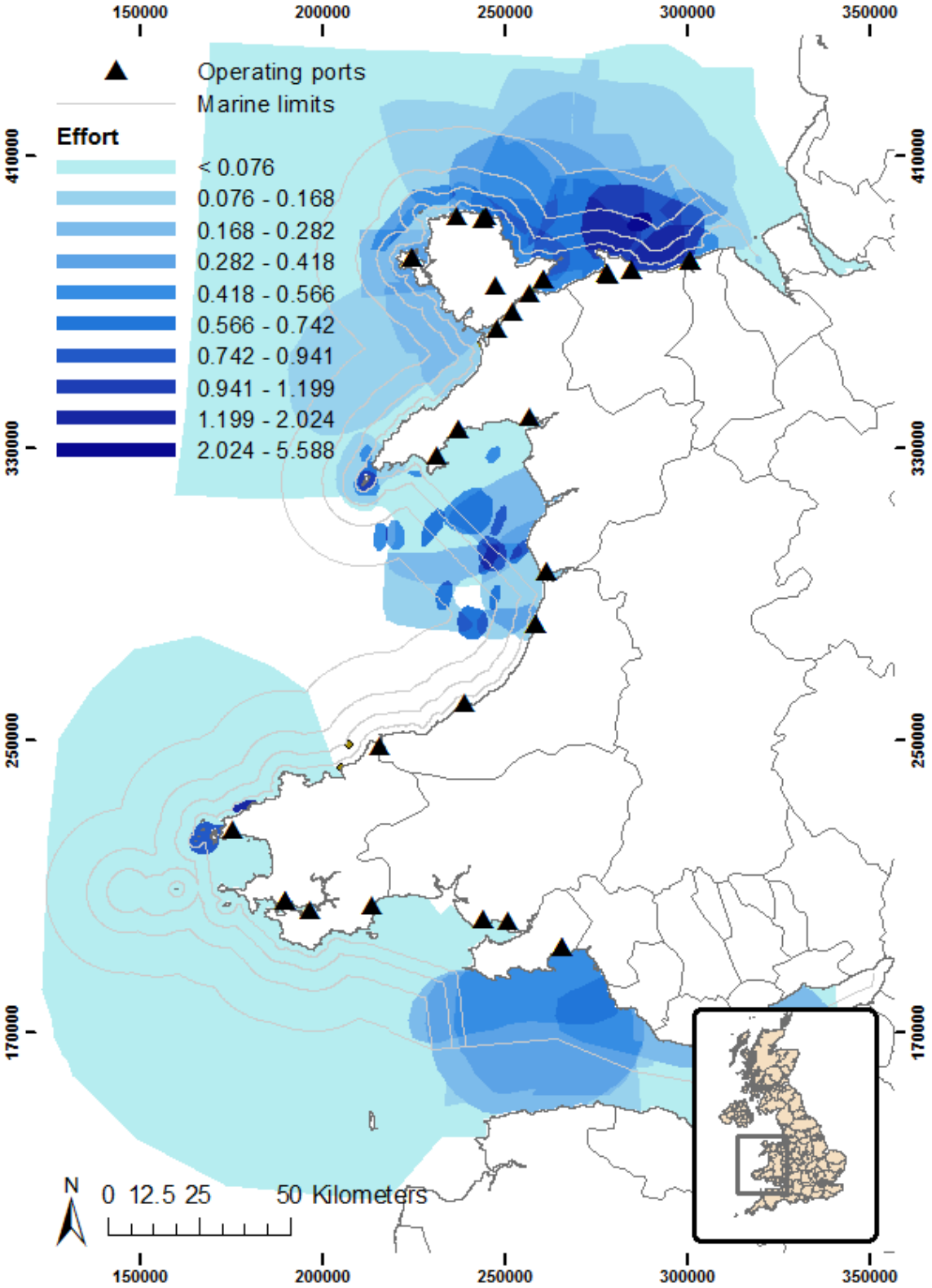
THANK YOU FOR CONTRIBUTING

Name (optional):_____ Location:_____ Date:_____ **ID**

Start time for recording:_____ End time for recording:_____

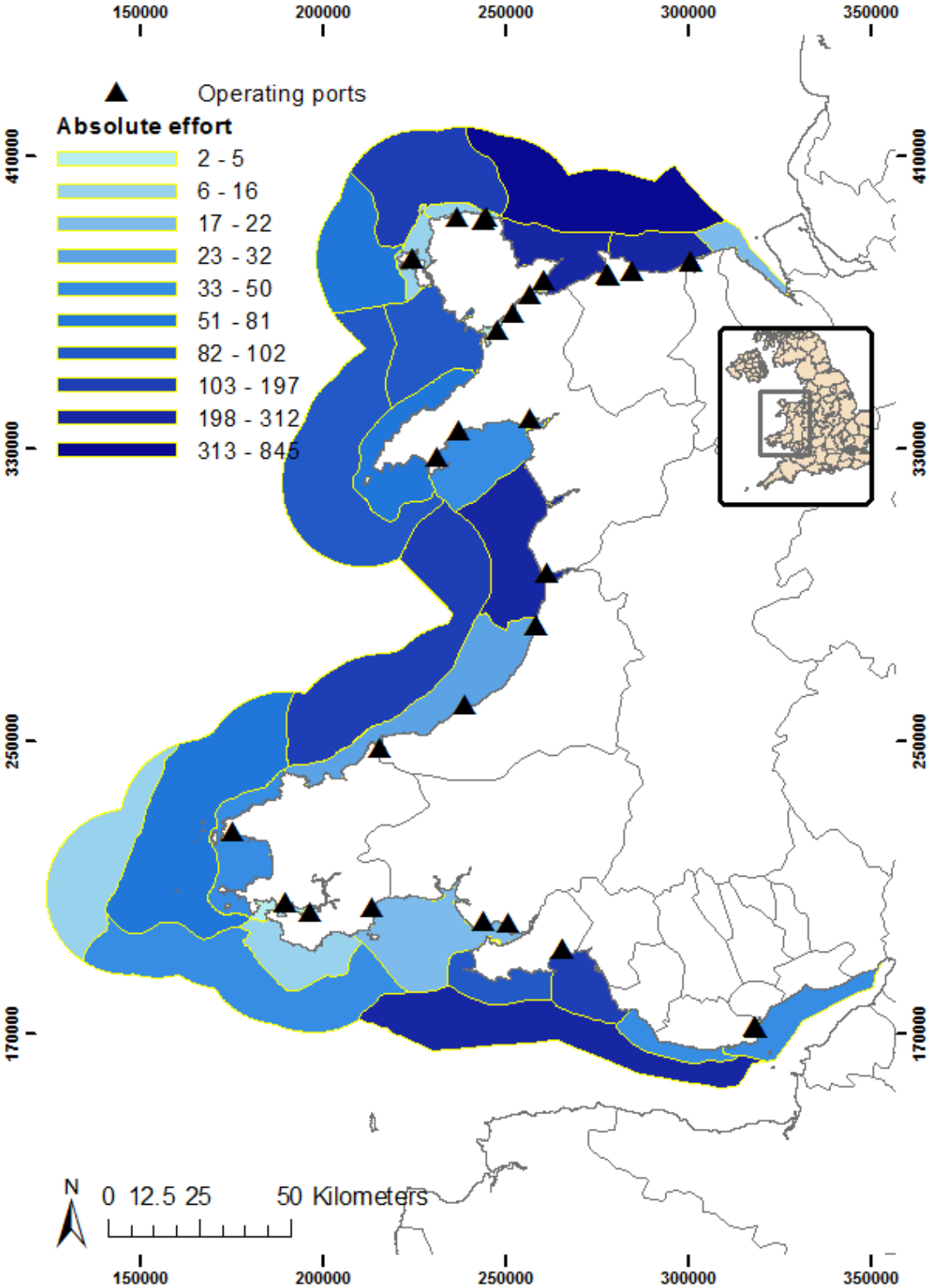
Species Caught	Time caught	Approx Size (cm)	Kept (tick)	Returned (tick)

Appendix 30. Annual spatial distribution of charter intensity



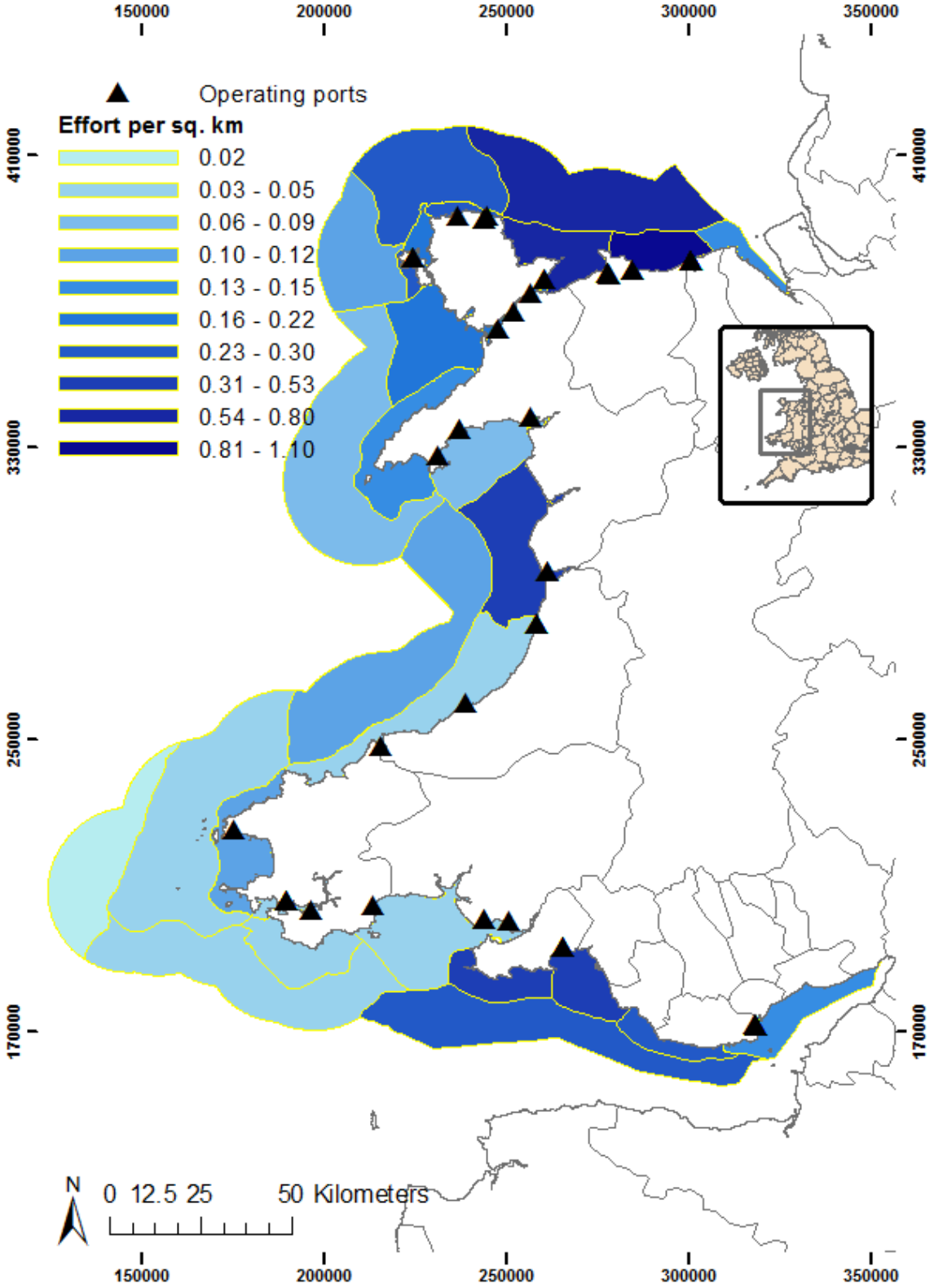
Annual charter boat standardised effort (intensity) in boat days km^{-2} $year^{-1}$. Derived from survey data (N = 50) collected in 2003–2004 by Richardson (2006) (estimated 89% survey coverage). Limits shown are 1 nautical mile (nm), 3 nm, 6 nm and 12 nm. Triangles show charter boat operating ports in 2015.

Appendix 31. Absolute annual charter effort by Marine Classification Area.



Absolute annual effort (boat days year^{-1}) by Marine Character Areas (Appendix 2). Based on unpublished data of Richardson (2006). Data from 50 charter skippers from a contactable population of 56 (89%). Triangles show charter boat operating ports in 2015.

Appendix 32. Annual charter effort per square kilometer, by Marine Character Areas



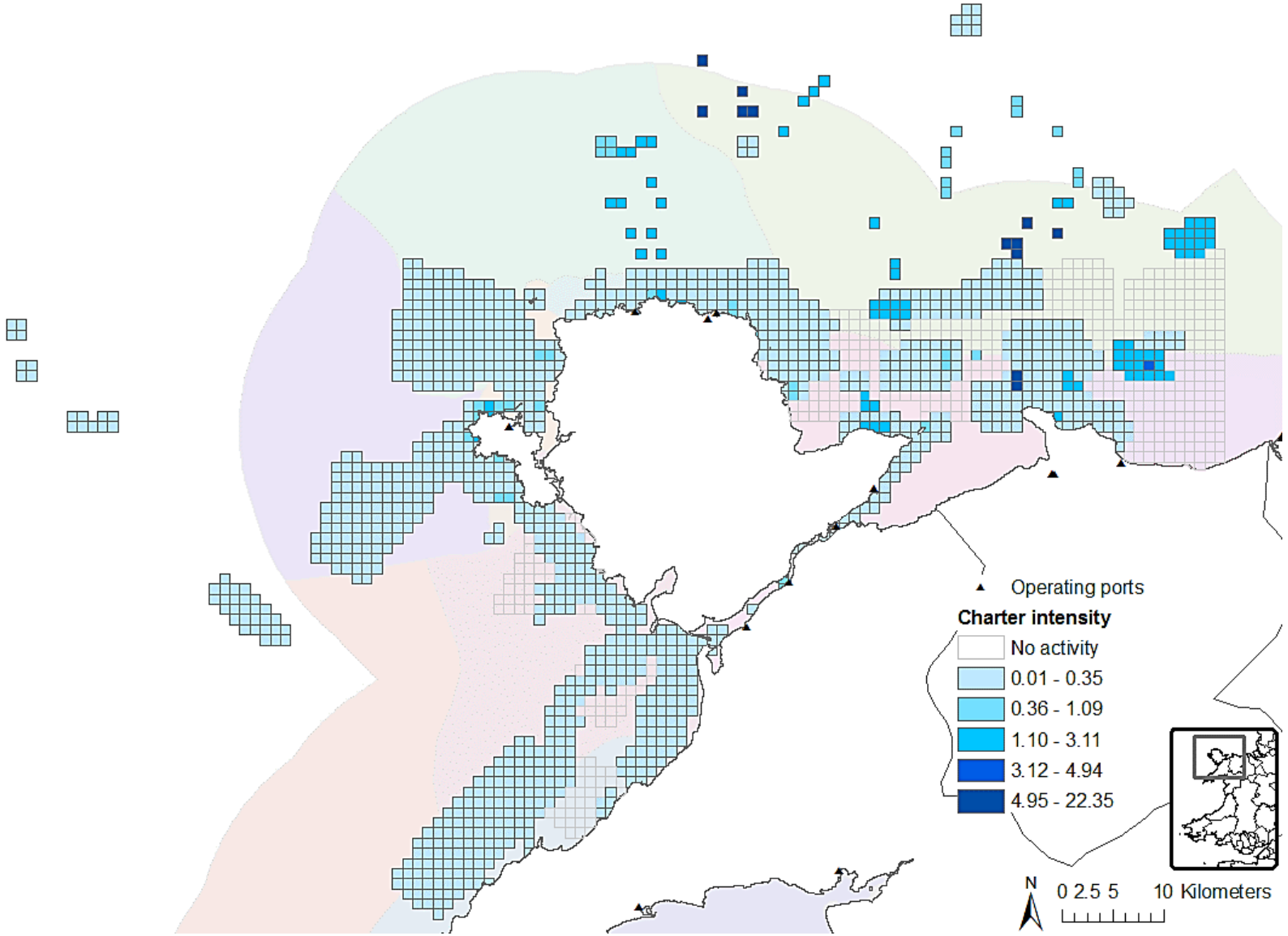
Absolute annual effort (intensity; boat days km^{-2} $year^{-1}$) by Marine Character Areas (Appendix 2). Based on 2003–2004 survey data of Richardson (2006). Data from 50 charter skippers from a contactable population of 56 (89%). Triangles show charter boat operating ports in 2015.

Appendix 33. Charter boat effort total and area standardised effort by Marine Character Area for Wales

Total effort (boat days year^{-1}) and effort standardised by total Marine Character Area area (boat days km^{-2} year) estimated from Richardson's (2006) data with stratification transfer to the 2015 charter boat fleet. *N* is the number of unique intersecting charter skipper coverages contributing to the reported metrics.

Marine character area	Total effort boat days year^{-1}	Effort boat days km^{-2} year^{-1}
Bristol Channel (Wales) (*N* = 45)	312 ±12	0.30 ±0.01
Caernarfon Bay (*N* = 24)	92.8 ±7.5	0.17 ±0.01
Cardigan Bay (*N*orth) and Estuaries (*N* = 33)	234 ±11	0.36 ±0.02
Cardigan Bay (south) (*N* = 6)	31.9 ±3.9	0.047 ±0.006
Carmarthen Bay and Estuaries (*N* = 8)	21.9 ±1.8	0.033 ±0.003
Colwyn Bay and Rhyl Flats (*N* = 28)	258 ±22	1.10 ±0.09
Dee Estuary (Wales) (*N* = 10)	18.8 ±1.9	0.15 ±0.02
Glamorgan Coastal Waters and Nash Sands (*N* = 16)	47.2 ±4.4	0.30 ±0.03
Gower and Helwick Coastal Waters (*N* = 16)	96.1 ±13.7	0.40 ±0.06
Holy Island West and Penrhos Bay (*N* = 11)	10.7 ±1.0	0.28 ±0.03
Holyhead Bay and The Skerries (*N* = 16)	16.4 ±1.7	0.22 ±0.02
Irish Sea Open Waters (*N* = 4)	14.0 ±2.6	0.019 ±0.004
Llŷn and Bardsey Island (*N* = 22)	69.1 ±4.0	0.15 ±0.01
Llŷn and South West Anglesey Open Waters (*N* = 23)	102 ±6	0.073 ±0.004
Menai Strait (*N* = 9)	4.57 ±0.91	0.17 ±0.03
Milford Haven (*N* = 2)	2.02 ±1.43	0.033 ±0.023
North-West Anglesey Open Waters (*N* = 42)	197 ±7	0.24 ±0.01
North Anglesey Coastal Waters (*N* = 13)	15.6 ±1.1	0.28 ±0.02
North Wales Open Waters (*N* = 104)	845 ±12	0.80 ±0.01
Outer Cardigan Bay (*N* = 25)	160 ±9	0.11 ±0.01
Red Wharf and Conwy Bays (*N* = 60)	250 ±5	0.72 ±0.01
Severn Estuary (Wales) (*N* = 3)	40.7 ±21.7	0.14 ±0.07
South Pembrokeshire Coastal and Inshore Waters (*N* = 2)	14.8 ±6.6	0.043 ±0.019
South Pembrokeshire Open Waters (*N* = 4)	50.3 ±19.3	0.042 ±0.016
Swansea Bay and Porthcawl (*N* = 17)	144 ±13	0.53 ±0.05
Tremadog Bay and Dwyryd Estuary (*N* = 5)	41.0 ±7.7	0.095 ±0.018
West Anglesey Open Waters (*N* = 26)	72.3 ±2.7	0.12 ±0.00
West Pembrokeshire Coastal Waters and Islands (*N* = 6)	41.9 ±6.7	0.11 ±0.02
West Pembrokeshire Islands, Bars and Inshore Waters (*N* = 5)	80.5 ±11.2	0.050 ±0.007

Appendix 34. FishMap Môn charter boat effort



FishMap Môn charter boat intensity (anglers km-2 week-1). Triangles are ports hosting charter boats involved in recreational sea angling. Marine Character Areas (see Appendix 2) are underlayed. (Aron, 2014).

Appendix 35. Charter boat operator responses under interviews in 2003–2004

Charter boat operator open ended responses under face to face interviews held in 2003–2004 by Richardson (2006). Data previously unpublished.

Issue	Comment
Business	Boat makes very little, do charters to pay for the boat, but only just covers itself.
	You can't make a living at the charter business
Fishing Quality	[low stock levels] caused by commercial fishing
	bass catches in SW approaches have been terrible
	Trawlers - our Josie grace, Ilfracombe
	Releasing fish is important: look after the future.
	Wrecks have been hammered.
	Big drop in catches [in 2002]. This was significant as I'm better at finding marks. There is too much commercial fishing effort as angling has no effect, especially on migratory species.
Marine Protection	[Closed areas] take livelihoods. Seasonal better perhaps
Other	Limits [should be] imposed on some species, e.g. black bream - can catch lots.
	My key species are tope and bream. But diversity is also important. Can take up to 17 species per day.
Regulation	Stopping charter fishing. Fewer customers, lots of regulations.
	Extensive rules and regulations: need risk assessment, first aid, sea survival, fire-fighting, RYA ticket.
	Used to be lots of charter boats but relatively few now. Were hardly any rules and regs. and it’s expensive now. Need qualifications and can't just inherit.
	DTI licences for no. of passengers, and MCA for distance covered. Costs of licenses are high.
Weather	Lost 37% trips in 20 years due to weather.
	Britain getting windier, has affected trips a lot.
	Up to 40% of trips cancelled because of weather.
	50% can be cancelled. I network with local B&Bs and bait shops for customers.
	Chartering is too weather dependent. Need second job.
	Biggest issue is weather. Lots of cancelled trips, can't make a living out of chartering.

Appendix 36. Response frequencies for potential drivers of increased sea angling effort from This Survey.

Answer Options (ALL)	Enhance my enjoyment	Fish here more often	Fish here for longer	Stay overnight	Bring along friends or family members	Total
Road access	2.1%	2.3%	0.7%	0.7%	1.4%	7.1%
Footpath access	2.1%	2.3%	1.4%	0.5%	1.6%	7.9%
Parking services	2.8%	2.8%	1.8%	1.1%	1.7%	10.2%
Ammenities (e.g. toilets)	2.9%	2.4%	1.5%	0.9%	1.8%	9.6%
Improve environment	3.4%	1.5%	0.9%	0.5%	1.6%	7.9%
Structural maintenance/improvements	2.6%	2.1%	1.1%	0.6%	1.4%	7.7%
Security where I fish	1.7%	1.5%	1.0%	1.1%	0.7%	5.8%
Security where I park	1.9%	1.7%	1.6%	1.4%	1.1%	7.7%
Safety measures where I fish	1.8%	1.4%	0.7%	0.6%	1.3%	5.8%
Access for the less abled	2.3%	1.7%	1.3%	0.5%	1.5%	7.2%
Fish size and quanitity	3.0%	3.0%	2.0%	1.0%	1.7%	10.6%
Launch facilities	2.2%	2.3%	1.2%	0.5%	1.2%	7.3%
Hospitality services	1.5%	1.0%	1.0%	0.6%	1.3%	5.3%
Total	30.2%	25.7%	16.1%	9.9%	18.1%	

Percentage responses frequencies across total responses (question responses = 122, total responses = 774) by effect category and effect type, in response to the question *check up to 3 items you feel will have the biggest chance of having the stated effect at [up to 3 locations]*. Grey highlights are the top 3 columnar percentages