Cyfoeth Naturiol Cymru
Natural Resources Wales

Assessment of the impacts of recreational sea angling in Wales

Report No: 455

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(based on an initial document prepared under contract by APEM Ltd)

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Fodd bynnag, rhoddir cydnabyddiaeth i'r angen am fwy o ymchwil i effeithiau amgylcheddol gweithgareddau genweirio hamdden ar y môr yn fyd-eang ac yn Ewrop (Eero *et al.*, 2014; Hyder *et al.*, 2014; Gallagher *et al.*, 2017; Hyder *et al.*, 2018). Nod yr adolygiad hwn oedd coladu tystiolaeth o effeithiau amgylcheddol posib genweirio hamdden ar y môr ar gynefinoedd morol, pysgod, adar a rhywogaethau megaffawna morol rhynglanwol ac islanwol yn nyfroedd tiriogaethol Cymru (h.y. o fewn 12 milltir forol i'r arfordir). Gwnaeth yr astudiaeth nodi'r pwysau allweddol a'r llwybrau effaith sy'n deillio o weithgareddau genweirio hamdden ar y môr a sensitifrwydd tebygol derbynyddion (cynefinoedd a rhywogaethau) lle gallai gweithgareddau genweirio hamdden ar y môr ddigwydd yng Nghymru. Llywiwyd yr astudiaeth gan adolygiad llenyddiaeth wyddonol estynedig, gan ddefnyddio tystiolaeth o effeithiau genweirio hamdden ar y môr lle'r oedd ar gael o Gymru, rhannau eraill o'r DU neu wledydd eraill lle y bo'n briodol. Canfuwyd bod bylchau sylweddol yn y sylfaen dystiolaeth a thynnwyd sylw at y rhain drwy gydol yr adroddiad.

At ddibenion yr adolygiad, mae genweirio hamdden ar y môr wedi'i ddiffinio fel a ganlyn gan Armstrong *et al.* (2013) a Monkman *et al.* (2015) "*Unrhyw bysgota ar gyfer rhywogaethau morol sy'n defnyddio gwialen a lein neu lein llaw yn bennaf lle mai'r diben yw hamdden ac nid i werthu neu fasnachu'r pysgod a ddaliwyd*". Mae'r diffiniad yn cynnwys genweirio personol, pysgota ar gwch a logwyd a chystadlaethau genweirio (nid yw'r diffiniad yn cynnwys pysgota â phicell fôr, rhwydo, potio neu leiniau hir a physgodfeydd lled-gynhaliol neu fasnachol). Mae'r effeithiau genweirio hamdden ar y môr sydd wedi cael eu hystyried o safbwynt genweiriwr môr yn taflu ei lein yn unig ac nid effeithiau posib ehangach gweithgareddau ategol megis: palu am abwyd/casglu abwyd, mynediad, aflonyddwch gweledol a sŵn, angori cychod a sbwriel cyffredinol, y mae llawer ohonynt yn destun prosiectau eraill sy'n cael eu cynnal gan Cyfoeth Naturiol Cymru.

Mae effeithiau canlynol y gweithgareddau genweirio hamdden ar y môr wedi cael eu hystyried yn yr asesiad hwn:

- Diddymu rhywogaethau pysgod mewn ffordd fiolegol
- Aflonyddu ar wely'r môr
- Tacl coll neu a adawyd
- Cyflwyno rhywogaethau estron

Caiff y canfyddiadau allweddol sy'n ymwneud â phob pwysau eu crynhoi isod.

Diddymu rhywogaethau pysgod mewn ffordd fiolegol

Er bod rhai astudiaethau wedi rhoi cipolwg defnyddiol ar weithgareddau genweirio hamdden ar y môr a rhywogaethau a ddaliwyd yng ngogledd Cymru (e.e. Goudge *et al.*

(2009 a, b); gweler adran 5.1), nid oes digon o dystiolaeth sy'n ymwneud â'r ymdrech genweirio bresennol, cyfanswm y daliadau (gan gynnwys arwyddocâd perthynol dal rhywogaethau allweddol wedi'u targedu gan bysgodefydd genweirio hamdden ar y môr a physgodfeydd masnachol) a marwolaethau ar ôl rhyddhau i ddeall effaith gyffredinol diddymu biolegol yng Nghymru. Mae dealltwriaeth bellach o'r ffactorau hyn yn allweddol i ddeall effaith y pwysau hwn ar stociau pysgod sy'n deillio o enweirio môr hamdden yn nyfroedd tiriogaethol Cymru.

Lle mae rhywogaethau targed genweirio hamdden ar y môr hefyd o bwys masnachol, mae'r pwysau ar y stociau hynny o bysgodfeydd masnachol yn llawer uwch yn gyffredinol nag ar gyfer gweithgareddau genweirio hamdden ar y môr. Ar gyfer rhywogaethau megis draenogiaid y môr Ewropeaidd (*Dicentrarchus labrax*), ystyriwyd yn flaenorol bod gweithgareddau genweirio hamdden ar y môr yn ffactor allweddol sy'n cyfrannu at farwolaethau cyffredinol, gan arwain at osod terfynau bagiau. Fodd bynnag, nid oes digon o ddata ar gael ar hyn o bryd ar nifer y draenogiaid y môr Ewropeaidd sy'n cael eu dal yng Nghymru a chyfraniad gweithgareddau genweirio hamdden ar y môr at y stoc. I rywogaethau megis cleiriach, nad ydynt fel arfer o ddiddordeb masnachol mawr neu nad ydynt yn destun pysgodfeydd masnachol a dargedir yng Nghymru ar hyn o bryd, gall gweithgareddau genweirio hamdden ar y môr (sy'n arwain at farwolaethau ar ôl cael eu rhyddhau) fod yn bwysau mwy sylweddol na physgota masnachol. Ar gyfer cleiriach, sy'n dueddol o fod yn diriogaethol, gallai gweithgareddau genweirio hamdden ar y môr effeithio ar strwythur oedran poblogaethau mewn lleoliadau lle ceir pysgota dwys.

Nodwyd bod genweirio hamdden ar y môr yn risg bosib i oroesiad merfogiaid duon, yn enwedig pan fydd pysgota'n digwydd mewn ardaloedd nythu yn ystod y tymor bridio oherwydd ei fod yn debygol o aflonyddu ar ymddygiad gofal rhieni ar nythod a warchodir ac yn cynyddu'r risg o ysglyfaethu ar wyau (Pinder et al, 2016). Er bod y llwybr effaith hwn wedi'i gydnabod mewn safleoedd yn Lloegr, dylid nodi nad oes tystiolaeth gadarn ar hyn o bryd o weithgareddau genweirio hamdden ar y môr yn un o ardaloedd bridio'r rhywogaeth hon yng Nghymru.

Caiff rhywogaethau pysgod mudol o bwysigrwydd cadwraeth (er enghraifft, eog yr Iwerydd, brithyll y môr, y llysywen Ewropeaidd, y wangen a'r herlyn) eu diogelu o dan sawl darn o ddeddfwriaeth cadwraeth yn y DU ac Ewrop. Yn gyffredinol, ni chaiff y rhywogaethau hyn eu targedu gan weithgareddau genweirio hamdden ar y môr, er y gallai brithyllod y môr gael eu targedu o bryd i'w gilydd mewn dyfroedd arfordirol. Mae asesiadau blynyddol gan Cyfoeth Naturiol Cymru ar stociau eog yr Iwerydd mewn prif afonydd eogiaid yn dangos bod statws yr holl stociau eogiaid 'mewn perygl' neu'n 'debygol o fod mewn perygl' o fethu â chyflawni eu targedau rheoli hyd at o leiaf 2024; mae'r un peth yn wir am ddau draean o stociau brithyllod y môr. Cyflwynwyd gweithdrefnau dal a rhyddhau gorfodol ar gyfer eogiaid ym mhob afon yng Nghymru ar ddechrau 2020 o dan is-ddeddf. Cydnabyddir y byddai unrhyw farwolaethau ychwanegol ymhlith y cyfryw rywogaethau'n annymunol.

Aflonyddu ar wely'r môr

Yn gyffredinol, ychydig o dystiolaeth sydd ar gael o aflonyddu ar gynefinoedd gwely'r môr ac epiffawna cysylltiedig sy'n deillio o weithgareddau genweirio hamdden ar y môr. Er bod tystiolaeth helaeth ar gael o bwysau crafu oherwydd offer pysgota masnachol, mae lefel y pwysau crafu oherwydd gweithgareddau genweirio hamdden ar y môr lawer yn is ac ystyrir ei fod yn annhebygol o fod yn sylweddol i unrhyw gynefin morol neu rywogaeth fenthig.

Mae peth tystiolaeth o Barth Cadwraeth Morol Sgomer, yn ogystal ag astudiaethau yn

UDA yn nodi bod posibilrwydd y gall tacl genweirio hamdden ar y môr faglu a pheri difrod dilynol i epiffawna digoes megis gorgoniaid, cwrel caregog a sbyngau. Fodd bynnag, mae diffyg data mewn perthynas â lleoliad a lefel y gweithgareddau genweirio hamdden ar y môr dros gynefinoedd o'r fath yng Nghymru (e.e. sbyngau bregus a chymunedau anthosoaidd ar greigiau islanwol) yn golygu bod lefel datguddiad cynefinoedd benthig o'r fath i'r pwysau hwn yn parhau i fod yn ansicr i raddau.

Tacl coll neu a adawyd

Gall tacl genweirio hamdden ar y môr coll neu a adawyd olygu y gall pysgod, adar neu famaliaid morol gael eu maglu gan leiniau neu fachau pysgota plastig neu gallant eu llyncu, a allai beri niwed parhaus i'r anifail unigol neu ei ladd. Er bod sawl adroddiad o effeithiau o'r fath ar draws y byd (e.e. Wells *et al*., 1998, Ferris and Ferris, 2004, Campbell, 2013, Adimey *et al*., 2014), mae angen dealltwriaeth well o swm y tacl coll/a adawyd, y prif fannau lle mae tacl yn cronni a'r effaith ar fywyd gwyllt yn nyfroedd Cymru i asesu a yw'r effeithiau'n sylweddol ar lefel y boblogaeth i unrhyw rywogaeth (h.y. o ran hyfywedd y boblogaeth).

Cyflwyno rhywogaethau estron

Mae gan enweirio môr hamdden y potensial i hwyluso lledaeniad rhywogaethau estron ar hyd arfordir a dyfroedd arfordirol Cymru. Er nad oes gwybodaeth hanfodol ynghylch cyflwyno rhywogaethau estron o ganlyniad i weithgareddau genweirio hamdden ar y môr yn y DU a Chymru ar gael ar hyn o bryd, mae nifer o lwybrau credadwy lle gellid cyflwyno rhywogaethau estron o ganlyniad i weithgareddau genweirio hamdden ar y môr, gan gynnwys gwaredu ar abwyd byw nad yw'n lleol/estron heb ei ddefnyddio, a chael gwared ar ddeunydd pecynnu gwymon a ddefnyddir i gludo/mewnforio abwyd byw, a all gynnwys rhywogaethau teithiol (‘hitchhiker’). Gall cyflwyno rhywogaethau estron i'r amgylchedd arfordirol neu forol gael effaith economaidd a chymdeithasol negyddol yn y pen draw, yn ogystal ag effeithiau amgylcheddol.

Argymhellion

Er mwyn gwella dealltwriaeth o effeithiau gweithgareddau genweirio hamdden ar y môr yng Nghymru, mae sawl maes lle gallai tystiolaeth ychwanegol fod yn ddefnyddiol. Gall y rhain gynnwys:

- Dull gwell o fapio dosbarthiad gofodol a thymhorol yr ymdrech genweirio hamdden ar y môr a swm y daliadau ledled Cymru, gan gynnwys dealltwriaeth o rywogaethau a thechnegau targed;
- Dealltwriaeth well o gyfran y pysgod o rywogaethau gwahanol sy'n cael eu rhyddhau yn ystod gweithgareddau genweirio hamdden ar y môr (h.y. wedi'u dal ond yna eu rhyddhau yn hytrach na'u cadw) a chyfraddau marwolaeth ar ôl eu rhyddhau;
- Gweithredu system cofnodi marwolaethau mamaliaid morol, crwbanod ac adar oherwydd maglu gan offer genweirio hamdden ar y môr gan gorff neu sefydliad priodol (er enghraifft Rhaglen Ymchwil Cymru i Forfilod wedi Tirio); a
- Chasglu data mwy cadarn ar fathau o abwyd a ddefnyddir a dulliau o ddod o hyd i abwyd gan enweirwyr.

Cydnabyddir y gall costau casglu peth o'r dystiolaeth hon fod yn uchel ac yn anodd ei chyfiawnhau yn erbyn blaenoriaethau gwario eraill. Yn ogystal â chasglu tystiolaeth neu fel dull amgen o bosibl, gellid rhoi ystyriaeth bellach i hyrwyddo arferion genweirio hamdden ar y môr mwy cynaliadwy fel ffordd o ymdrin â risgiau amgylcheddol yn uniongyrchol. Er enghraifft, gallai hyn gynnwys:

- Paratoi a dosbarthu canllawiau i annog arferion dal a rhyddhau diogel ar gyfer genweirwyr glannau a chychod;
- Paratoi a dosbarthu canllawiau ar osgoi taflu/gadael tacl;
- Paratoi a dosbarthu canllawiau clir ar leihau risgiau i rywogaethau estron o ganlyniad i abwyd neu gyfarpar pysgota.

Mae ymgyrchoedd cyfredol wedi ceisio ymdrin â llawer o'r pynciau hyn, er y gall datblygu a dosbarthu canllawiau presennol, defnyddio technegau newydd a'r dystiolaeth orau sydd ar gael ar hyn o bryd, gynyddu eu llwyddiant. Dylai unrhyw wersi a ddysgwyd ynghylch y rhesymau dros lwyddiant neu fethiant gael eu hystyried wrth lunio unrhyw ddeunydd newydd.

Gallai canllawiau cenedlaethol newydd, sy'n cyfleu brandio eglur a neges gyson, gael eu datblygu ar y cyd â chyrff genweirio hamdden cenedlaethol a'u dosbarthu drwy glybiau pysgota a siopau tacl a thrwy negeseuon ar-lein. Er bod dulliau gwirfoddol o'r fath yn cael anhawster i gyflawni lefelau uchel o gydymffurfiaeth, mae'r dull hwn yn debygol o fod yn ffordd cost isel, gymesur ac ymarferol o leihau rhai o effeithiau amgylcheddol mwy sylweddol genweirio hamdden ar y môr.

2. Executive Summary

The recreational sea angling (RSA) sector is a valuable social and economic asset to Wales. For example, Armstrong *et al.* (2013) estimated that 76,000 Welsh residents participated in RSA activities, whilst Monkman *et al.* (2015) estimated that the average annual expenditure of visiting sea anglers in Wales was £39 million, whilst the annual average expenditure by Welsh sea anglers in Wales was £87 million.

However, recognition is being given, to the need for further research into the environmental impacts of RSA activities both globally and in Europe (Eero *et al.*, 2014; Hyder *et al.*, 2014; Gallagher *et al.*, 2017; Hyder *et al.*, 2018). The aim of this review has been to collate evidence of the potential environmental impacts of RSA on intertidal and subtidal marine habitats, fish, bird and marine megafauna species in Welsh territorial waters (i.e. within 12 nautical miles (NM) of the coast). The study identified the key pressures and impact pathways arising from RSA activities and the likely sensitivity of receptors (habitats and species) where RSA activities may occur in Wales. The study was informed via an extensive scientific literature review, using evidence of RSA impacts where available from Wales, other parts of the UK or other countries where appropriate. Substantial gaps in the evidence base were found to exist and these have been highlighted throughout the report.

For the purposes of this review, RSA has been defined following Armstrong *et al.* (2013) and Monkman *et al.* (2015) 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*". The definition includes personal angling, charter-boat fishing and angling competitions (the definition does not include spearfishing, netting, potting or lng lines and semi-subsistence or commercial fisheries). The impacts of RSA that have been considered are solely from the point of a sea angler casting their line and not wider potential impacts from ancillary activities such as: bait-digging/collection, access, visual and noise disturbance, vessel anchorage and general litter, many of which are the subject of other projects being conducted by NRW.

The following impacts of RSA activities have been considered within this assessment:

- Biological removal of fish species
- Seabed disturbance
- Lost and discarded tackle
- Introduction of non-native species

The key findings relating to each of these pressures are summarised below.

Biological removal of fish species

Whilst some studies have provided a useful insight into RSA activities and species caught in north Wales (e.g. Goudge *et al*. (2009 a, b); see Section 5.1), there is insufficient evidence relating to current angling effort, total catches (including the relative significance of catches of key species targeted by both RSA and commercial fisheries) and post-release mortality to understand the overall effect of biological removals in Wales. Further understanding of these factors are key to understanding the impact of this pressure on fish stocks arising from RSA in Welsh territorial waters.

Where RSA target species are also of commercial importance, the pressure on those stocks from commercial fisheries is generally much greater than for RSA activities. For species such as European seabass (*Dicentrarchus labrax*), RSA activity has previously been considered to be a noteworthy contributor to overall mortality, leading to the imposition of bag limits. However, there is currently inadequate data regarding the number of European seabass caught in Wales and the contribution RSA has to the stock. For species such as wrasses, which are currently typically of limited commercial interest or not the subject of targeted commercial fisheries in Wales, RSA activities (leading to post-release mortality) may be a more significant pressure than commercial fishing. For wrasses, which tend to be territorial, RSA activities may affect the age structure of populations at locations that are intensively fished.

RSA has been identified as a potential risk to the recruitment of black bream, particularly when fishing occurs in nesting areas during the breeding season as it is likely to disrupt parental care behaviours of guarded nests and an increased risk of predation on eggs (Pinder *et al,* 2016). While this impact pathway has been recognised at sites in England, it should be noted that there is currently not robust evidence of RSA occurring in any breeding areas of this species in Wales.

Migratory fish species of conservation importance (for example Atlantic salmon, Sea trout, European eel, Twaite and Allis shad) are protected under several pieces of UK and European conservation legislation. These species are generally not targeted by RSA, although sea trout may be occasionally targeted in coastal waters. Annual assessments by NRW on Atlantic salmon stocks in principal salmon rivers indicate that the status of all salmon stocks are ‘At risk’ or ‘Probably at risk’ of failing to achieve their management targets until at least 2024; a similar story exists for two thirds of sea trout stocks. Mandatory catch and release of salmon was introduced on all rivers in Wales in early 2020 under a byelaw. It is recognised that any additional mortality on such species would be undesirable.

Seabed disturbance

In general, there is little evidence of disturbance to seabed habitats and associated epifauna arising from RSA activities. While there is extensive evidence of abrasion pressure from commercial fishing gears, the level of abrasion pressure from RSA activities is much lower and is considered unlikely to be significant for any marine habitat or benthic species.

Some evidence from the Skomer Marine Conservation Zone (MCZ), as well as studies in the USA indicate there is a potential pathway for RSA fishing tackle to entangle and subsequently cause damage to sessile epifauna such as gorgonians, stony corals and sponges. However, a lack of data relating to the location and intensity of RSA activity over such habitats in Wales (e.g. fragile sponge and anthozoan communities on subtidal rock) means that the level of exposure of such benthic habitats to this pressure remains uncertain.

Lost or discarded tackle

Lost or discarded RSA tackle can lead to the entanglement or ingestion of plastic fishing line or hooks by fish, birds or marine mammals, which could cause lasting damage to, or death of, the individual animal. Whilst there are multiple reports of such impacts around the world (e.g. Wells *et al*., 1998, Ferris and Ferris, 2004, Campbell, 2013, Adimey *et al*., 2014), a better understanding of the amount of lost/discarded tackle, hotspots where tackle accumulates and the impact on wildlife in Welsh Waters is required to assess whether the impacts might be significant at population level for any species (i.e. with respect to population viability).

Introduction of non-native species

RSA has the potential to facilitate the spread of non-native species (NNS) along the coastline and coastal waters of Wales. Whilst crucial information regarding the introduction of NNS from RSA activities in the UK and Wales is currently unavailable, there are a number of credible pathways via which introduction of NNS from RSA activity may occur, including the disposal of unused non-local/non-native live bait, and disposal of seaweed packaging material used for live bait shipping/import, which may contain 'hitchhiker species'. Introduction of an NNS to the coastal or marine environment may ultimately have negative economic and social impacts in addition to environmental impacts.

Recommendations

In order to improve understanding of the impacts of RSA activities in Wales, there are several areas where additional evidence may be helpful. These could include:

- Improved mapping of the spatial and temporal distribution of sea angling effort and of catch volumes across Wales, including an understanding of target species and techniques;
- Better understanding of the proportion of fish of different species released during RSA (i.e. caught but released rather than retained) and post-release mortality rates;
- Implementing recording of marine mammal, turtle and bird species mortality due to entanglement with RSA gear by an appropriate body or organisation (for example the Cetacean Strandings Investigation Programme); and
- Collecting more robust data on bait type use and bait sourcing from anglers.

It is recognised that the costs of collecting some of this evidence may be high and difficult to justify against other spending priorities. In addition to evidence collection or possibly as an alternative to it, further consideration might usefully be given to promoting more sustainable RSA practices as a means of directly addressing environmental risks. For example, this could include:

- Preparing and disseminating guidance to encourage safe catch and release practices for shore and boat anglers;
- Preparing and disseminating guidance on avoidance of littering/discarding tackle;
- Preparing and disseminating clear guidance on minimising NNS risks from bait or fishing equipment.

Existing campaigns have attempted to address many of these topics, although developing and disseminating current guidance, using new techniques and current best available evidence, may increase their success. Any lessons learnt regarding reasons for success or failure should be taken into account when designing any new material.

New national guidance, providing a clear branding and a consistant message between areas, could be developed in conjunction with national recreational angling bodies and disseminated through angling clubs and tackle shops and online messaging. While such voluntary approaches struggle to achieve high levels of compliance, this approach is likely to be a low cost, proportionate and practical way of reducing some of the more significant environmental impacts of RSA.

3. Introduction

3.1 Background and aims of the project

The aim of this project has been to collate evidence to assess the potential impacts of recreational sea angling (RSA) on intertidal and subtidal marine habitats, fish, bird and marine megafauna species, that are present in Welsh waters. Given the limited available data on the spatial distribution or intensity of RSA activities that may be affecting habitats and species in Wales, this assessment is based upon the key pressures and impact pathways arising from RSA and the sensitivity of receptors (habitats and species) where RSA activities may occur. Consideration has been given to the biological traits (i.e. life history and survivability) that may influence the likelihood of RSA activities causing impacts upon marine habitats and species in Welsh waters. This approach allows the identification of habitats and species that are most sensitive to RSA activities, whilst highlighting evidence gaps that may focus further studies that may be undertaken in the future.

Given the large number of different habitats and species present in Welsh waters the assessment has been conducted qualitatively. The qualitative assessment identifies the presence of impact pathways between RSA activities and the habitats and species, and the relative sensitivity of these habitats and species. Recent studies of national-scale angling effort are emerging around Europe, such as Gordoa *et al.* (2019). This project facilitates prioritisation of further work to collect data on the spatial distribution of RSA for the most sensitive habitats and species, to allow targeted and more detailed quantitative assessments of impacts to be conducted where required.

For the purposes of this project, RSA is defined as fishing from the shore or boats using rod and line only. Specifically, the definition following Armstrong *et al.* (2013) and Monkman *et al.* (2015) has been adopted for this report, whereby RSA 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*". The definition includes personal angling, charter-boat fishing and angling competitions. The definition does not include spearfishing, netting, potting or long lines and semi-subsistence or commercial fisheries. Furthermore, the impacts to be considered from RSA are solely from an angler casting their line into the sea, and do not consider wider potential impacts from bait-digging, access, visual and noise disturbance, vessel anchorage and general litter.

The diffuse nature of RSA makes assessing the pressure on the underlying fish populations challenging. Identifying the magnitude and intensity of the activity (and thus the pressure on wild stocks) is particularly problematic due to anglers having the rights to fish without the purchase of either a licence or permit to access the water. Some work to quantify the amount of recreational fishing (including RSA) is conducted by ICES when developing the Total Allowable Catch (TAC) limits for certain commercial fisheries. A variety of studies of RSA in the UK have been completed to date to estimate national recreational sea angler numbers and angling effort, illustrated in Table 3.1 below (Monkman *et al.*, 2015), with the latest being a Defra RSA study in 2012 (Armstrong *et al.*, 2013). These studies cover both England and Wales.

Table 3.1 RSA participant survey estimates of sea-angler numbers in England and Wales (ICES, 2015)

Source	Survey year	Estimated number of recreational sea anglers
National Opinion Polls (NOP) Market Research Ltd. (1970)	1970	1,280,000
National Opinion Polls (NOP) Market Research Ltd. (1980)	1980	1,791,000
National Rivers Authority (1995)	1994	1,104,000
Drew Associates (2004)	2003	1,450,000
Simpson and Mawle (2005)	2005	2,035,705
Armstrong *et al.*, (2013)	2012	960,000

More recently, the Welsh Government commissioned a review on the spatial distribution of RSA that occurs in Wales (Monkman *et al.*, 2015). Cefas, on behalf of Defra, Welsh Government and Marine Scotland, has also been conducting a project (The Sea Angling Diary, http://www.seaangling.org/) to encourage sea anglers in the UK to keep and submit a diary of their catches to provide data on the effort and distribution of RSA activities, and further the knowledge of the biology and catch rate of the target species. The data collected by the Sea Angling Diary project could support further spatial analysis of RSA activities.

3.2 Economic and social importance of RSA for Wales

The RSA sector is a valuable social and economic asset to Wales, driving local economies, attracting many visitors to Wales. It is also enjoyed by an estimated 76,000 Welsh residents (Armstrong *et al.*, 2013). Monkman *et al.* (2015) recorded 54 charter boats in operation throughout Wales (with an additional 12 charter boats operating within 12 NM of the Welsh Coast out of northern ports of Devon and Somerset), and identified 47 sea angling clubs.

Monkman *et al.* (2015) summarised the economic value of RSA in Wales in several ways: they estimated the total annual expenditure of visiting sea anglers in Wales from one-day trips and overnight trips, 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 RSA spending was estimated as 1,706 Full Time Equivalent (FTE), representing ~0.13% of the total FTEs in Wales in 2007 (with a further 500 FTEs supported indirectly).

3.3 Main methods of RSA carried out in Wales and species caught

Wales has approximately 2,120km of coastline (Welsh National Marine Plan, 2019) offering a diverse range of fishing environments. The fish species primarily targeted by shore or boat-based sea anglers in Wales, or those that may be caught when fishing for these species (i.e. by-caught), are shown in Table A1.1. in Appendix 1. Examples of primary target species for shore-based and boat-based sea anglers in Wales include

European seabass (*Dicentrarchus labrax*), Atlantic cod (*Gadus morhua*), tope (*Galeorhinus galeus*) and various ray species.

Of these target species, a number are designated in Wales as marine species of principal importance, also called Section 7 species. These include Atlantic cod and tope, mentioned above, but also herring (*Clupea harengus*), whiting (*Merlangius merlangus*), ling (*Molva molva*), European plaice (*Pleuronectes platessa*), blonde ray (*Raja brachyura*), thornback ray (*Raja clavata*), undulate ray (*Raja undulata*), Atlantic mackerel (*Scomber scombrus*), sole (*Solea solea*) and spiny dogfish (*Squalus acanthias*).

Other fish species that are also designated as species of principal importance, which are not specifically targeted but which have the potential to be caught are the diadromous fish species Allis shad (*Alosa alosa*), Twaite shad (*Alosa fallax*), European eel (*Anguilla anguilla*), smelt (*Osmerus eperlanus*), Atlantic salmon (*Salmo salar*) and Sea trout (*Salmo trutta*), the latter occasionally targeted in estuaries and coastal waters. Any person of 13 years and over in Wales requires a rod licence (from NRW) to fish for salmon, trout, smelt and eels and this is relevant to coastal waters out to 6nm.

The diverse Welsh coastline and seasonal weather conditions mean that RSA activity varies seasonally, with typically higher levels of activity in summer months around the coast due to holiday anglers, but more local, targeted fisheries, at other times. Fish movements, migration patterns and weather conditions may also influence the numbers of anglers targeting different species at different times of year. Key summer species include Atlantic mackerel, wrasse species, pollack (*Pollachius pollachius*) and European seabass (Monkman *et al.*, 2015). Targeting of Atlantic cod and whiting in the winter bolster angler numbers, though few coastal areas in Wales have large cod, with smaller, immature cod (codling) more abundant (Sharp, R. pers. comm.) In spring, thornback ray and European plaice are migrating inshore after breeding and as a result are targeted throughout spring and summer (Monkman *et al.*, 2015).

Charter boats primarily target Atlantic mackerel, European seabass, smooth hound (*Mustelus mustelus*), tope and rays, switching to smaller species, such as flatfishes, whiting and gurnards according to client experience, competency and preference. Some vessels also target cod, rays, pollack and conger eel (*Conger conger*) on deep water wrecks. During winter, fishing is primarily for dabs and whiting, some immature cod (Monkman *et al.*, 2015) and larger cod from areas such as the Bristol Channel (Sharp, R. pers. comm.).

Surveys of anglers in north Wales were undertaken by the Countryside Council for Wales (CCW, now NRW) in 2007-2008 (Goudge *et al.*, 2009; 2010), which recorded high numbers of Atlantic mackerel caught in the summer and whiting in the winter. European seabass was identified as the most targeted species during the summer, but made up only 0.24% of the catch, and similarly in the winter, Atlantic cod was identified as one of the two most targeted species (along with European seabass) but comprised only 0.3% of the catch. It should be noted that this study principally trialled methodologies of recording sea angling activity in north Wales, see section 5.1.

The main generic types of fishing gears used for RSA in Wales are presented in Table 3.2.

Table 3.2 Generic recreational sea angling fishing gears used in Wales

Shore Angling	Boat angling
Bottom fishing with a weight (e.g. beachcasting) – the most common form of fishing from beaches, piers/jetties	Bottom fishing with a weight
Lure fishing (including spinning, feathering and flyfishing) – use of soft or hard-bodied lures	Lure fishing (including spinning, feathering, flyfishing, pirking and jigging) – use of soft or hard-bodied lures
Float fishing (including freelining) – use of float to suspend bait above the seabed	Float fishing (including freelining) – use of float to suspend bait above the seabed

3.4 Fisheries and environmental legislation in Wales relevant to RSA

Table 3.3 shows a full list of the fish species which are protected under environmental legislation in Wales. Table 3.4 shows the A brief summary of fisheries legislation of specific relevance to RSA activities in Welsh waters is then provided.

Table 3.3 Marine fish species protected under environmental legislation in Wales. Note, not all of these species will be targeted. A note is made where species is not currently found in Wales.

Legislation	Species
Wildlife and Countryside Act 1981 (as amended)	Basking shark White skate Spiny seahorse Giant goby *(not present in Wales)* Couch's goby *(not present in Wales)* Angel shark *(partial protection under Schedule 5)* Allis shad *(partial protection under Schedule 5)* Twaite shad *(partial protection under Schedule 5)* Short-snouted seahorse *(not present in Wales)* Sturgeon *(partial protection under Schedule 5)*
EU Habitats Directive 92/43/EEC	Allis shad Twaite shad Sea lamprey River lamprey Atlantic salmon Sturgeon (note: no SACs for this species in Wales and only occasionally found in UK waters)
Environment (Wales) Act 2016 Section 7	Allis shad Twaite shad European eel Sea lamprey Atlantic salmon Brown / Sea trout Whitefish

Legislation	Species
	River lamprey Smelt (Sparling) Sand eel Herring Common Skate Cod Tope shark Porbeagle shark Sea monkfish Whiting European hake Ling Plaice Blonde ray Thornback ray Undulate ray White or bottlenosed skate Mackereal Sole Spiny dogfish Horse mackerel
OSPAR threatened and/or declining fish species (in OSPAR Region III: Celtic Seas)	Allis shad European eel Basking shark Common skate Spotted ray Cod Long-snouted seahorse Sea lamprey White skate Atlantic salmon Spurdog Porbeagle shark Angel shark Portuguses dogfish *(not present in Wales)* Leafscale gulper shark *(not present in Wales)* Short-snouted seahorse *(not present in Wales)*

Note – some fish species will also be protected under CITES; see https://www.cites.org/eng

Sources:
https://www.gov.uk/government/publications/protected-marine-species/fish-including-seahorses-sharks-and-skates; https://www.ospar.org/work-areas/bdc/species-habitats/list-of-threatened-declining-species-habitats; https://www.biodiversitywales.org.uk/Environment-Wales-Act

Tablze 3.4. Marine SACs in Wales with fish as a primary or qualifying feature

SAC name	Fish feature
Cardigan Bay	River Lamprey and Sea lamprey
Camarthen Bay and Estuaries	Allis shad and Twaite shad, River lamprey and Sea lamprey
Dee Estuary (Wales)	River Lamprey and Sea lamprey
Severn Estuary (Wales)	River Lamprey and Sea lamprey, Twaite shad
Pembrokeshire Marine	River Lamprey and Sea lamprey, Allis shad and Twaite shad

European seabass (*Dicentrarchus labrax*)

*Council Regulation (EU) 2020/123 fixing for 2020 the fishing opportunities for certain fish stocks and groups of fish stocks, applicable in Union waters and, for Union fishing vessels, in certain non-Union waters) (*https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32020R0123&from=EN required that recreational fisheries, including from shore are limited to catch-and-release only during 01 January to 29 February and 1 December to 31 December 2020. From 1 March to 30 November 2020, not more than two European seabass may be retained per fisherman per day.

Furthermore, a minimum landing size of 42cm is in place for European seabass under EU Regulation 2015/1316 derogating from Council Regulation (EC) No. 850/98, as regards the minimum conservation reference size for seabass (*Dicentrarchus labrax*).

In European seabass nursery areas around Wales, there is a prohibition on fishing for bass by any fishing boat within the areas, and during the periods specified under *The Bass (Specified Areas) (Prohibition of Fishing) Order 1990 as amended.*

Tope (*Galeorhinus galeus*)

Fishing for tope, other than by rod and line, is prohibited in Wales under The Tope (Prohibition of Fishing) (Wales) Order 2008 – SI No. 1438. Article 5 of this legislation prevents recreational sea anglers from landing any rod and line caught tope. For tope incidentally taken on board commercial vessels, there is a nominal by-catch retention allowance of upto 45kg per day. This legislation was introduced to prevent the development of a targeted commercial fishery https://senedd.wales/Laid%20Documents/SUB-LD7077-EM%20-%20The%20Tope%20(Prohibition%20of%20Fishing)%20(Wales)%20Order%202008%20-%20EXPLANATORY%20MEMORANDUM%20-06062008-87369/sub-ld7077-em-e-Cymraeg.pdf.

Sea Fisheries District legacy byelaws

Following the introduction of the Marine and Coastal Access Act 2009 and associated Orders, any byelaws that were in place as of 1st April 2010 within the former Sea Fisheries Districts in Wales, were 'rolled over' via savings provisions to enable continued implementation by the Welsh Government. This included legislation in relation to minimum landing sizes amoungst other topic areas. Legislation relevant to recreational and commercial fisheries, including legacy Sea Fisheries Committees byelaws that still apply, are detailed on the Welsh Government's Sea Fisheries website (https://gov.wales/sea-fisheries). It should be noted that some of these byelaws listed may have now been revoked or superceeded and this page will continue to be updated over time.

It should be noted that NRW fisheries byelaws are also relevant to tidal waters (https://naturalresources.wales/guidance-and-advice/business-sectors/fisheries/angling-byelaws/?lang=en).

4. Assessment Methodology

4.1 Welsh marine species and habitats under consideration

The assessment of the impacts of RSA in Wales has reviewed a broad range of evidence with the aim of assessing the impacts of RSA on a wide range of marine species and habitats present in Welsh waters. As described in Section 3 above, the assessment is limited to rod and line RSA from the shore or vessels.

Marine species and habitats protected under the Habitats Directive (Council Directive 92/43/EEC), the EU Birds Directive (2009/147/EC), Section 7 of the Environment (Wales) Act 2016, the OSPAR List of Threatened and/or Declining Species and those protected under the Habitats and the Wildlife and Countryside Act 1981 (as amended) are of particular importance and any impacts identified on these species and habitats have been highlighted where relevant pathways from RSA exist. See Appendix 3 for a list of protected Welsh habitats and species which could potentially by relevant to RSA.

The process for the identification of target fish species for inclusion in this report has included review of the list of Welsh records from RSA administered by the Welsh Federation of Sea Anglers (WFSA, 2016) and discussion with NRW. A list of what is considered the main target species in Wales is, and included in this assessment, is given in Appendix 1. Additional comment is provided for some further species of conservation importance (see Section 5.1). European whitefish / Gwyniad (*Coregonus lavaretus / Coregonus pennantii*) and Arctic char (*Salvelinus alpinus*) are not considered, as whilst they are estuarine species, in Wales they are only known to be present in Llyn Tegid (whitefish) and a few other Welsh lakes.

4.2 RSA impacts under consideration

To achieve the aim of the assessment, the potential impacts from RSA activities (defined from the point of a sea angler casting their line) for consideration have been identified. These are:

1. **Biological removal of fish species** – RSA catch is defined as those individuals which are targeted and caught (and potentially landed) by sea-anglers. This impact will consider whether those individuals landed by sea anglers are kept or returned to the sea (if/where known). If returned, whether the likelihood of effective survival is high or low. Survival by species will be influenced by induced stress during capture, handling post-capture and capture methods/gear type.

2. **Seabed disturbance** – This will consider impacts from disturbance that may be caused to the seabed by RSA methods that make contact with the seabed, or through lost or discarded tackle which may end up on the seabed. During active fishing, this pressure is likely to be greatest on shallow shorelines where tackle is retrieved across the seabed. There may also be pressure from boat angling in areas of reef. Examples of seabed disturbance that could be caused during RSA activities, or arise from lost or discarded tackle, include hooking of seabed flora or invertebrates and subsequent tearing or detachment, or dragging of gears across the seabed causing abrasion of the seabed.

3. **Lost and discarded tackle** – There is the potential for taxa such as birds and marine mammals (seals, cetaceans) to become entangled or hooked by lost or discarded recreational fishing tackle. This section considers the evidence relating to fishing gear and its impacts on these species.

4. **Impact of introduction of non-native species** – This impact considers the potential for the spread of non-native species (NNS) through the use or discarding of non-native bait species, hitchhiking species, damp fishing gear and the potential impacts from competition with native species.

Toxicity is another potential impact from lost fishing tackle on the environment. This relates to the potential for biologically available lead to enter marine sediments and the food chain, for example, from lost or discarded weights. However, lost lead fishing tackle is not readily dissolved in aquatic systems (annual corrosion rates of lead are usually low) (Jacks and Byström, 1995) and can remain intact for decades to centuries (Rattner *et al*., 2008). The impacts of toxicity from recreational angling were investigated for this report, however, available evidence suggests this impact to be insignificant and, as such, it is not considered further.

Wider impacts that may occur from RSA activities, beyond the point of a sea-angler casting their line, are not considered in detail within the assessment. Many are considered within other projects currently being undertaken by NRW, and are stated and acknowledged here for completeness and to ensure appropriate consideration can be given to them at a later point in any management of RSA activities. Wider impacts that may occur from RSA activities include:

- Litter;
- Bait digging or collection (e.g. digging for bait worms and boulder turning);
- Disturbance from access, trampling of habitats; and
- Anchoring/mooring of RSA craft.

4.3 Literature review methodology

To assess the sensitivity of different species and habitats in Welsh waters to RSA activities, a detailed literature review of studies on the impacts of RSA that may be relevant to Welsh habitats and species was conducted following CEE guidelines (CEE, 2009; CEE, 2013). The general search terms used to identify literature on the impacts of RSA, and the databases searched, are described further in Appendix 2.

The evidence available on each impact from the literature review is summarised in the following sections below. The literature identified from this review has been used to conduct the assessment of potential impact pathways for Welsh habitats and species. In general, a greater volume of literature was identified relating to the impacts of fish catch and by-catch from RSA, with less evidence available for the impacts of seabed disturbance, as the majority of research on this topic was focussed on commercial fishing methods.

5. Literature review of RSA impacts

This section presents the evidence for the following impact pathways:

- Biological removal;
- Seabed disturbance;
- Lost or discarded tackle; and
- Introduction of non-native species

5.1 Impact 1 – Biological removal

This section reviews the evidence of impacts arising from the biological removal of fish species through RSA. The evidence (where available) of impacts arising from the biological removal of fish species is presented for the top 12 fish species/species groups of primary interest to shore and boat anglers in Wales (see Appendix 1). Additional comment is provided for some additional species of conservation importance (in this report this term has been taken to include Section 7 fish species, which are species of principal importance for maintaining and enhancing biodiversity in Wales; see Table 3.3). However, some of these species are not generally targeted by RSA activities but may be caught as bycatch. Some of these Section 7 fish species are also covered by other designations.

The impact of biological removals for each fish species will depend on a range of factors including population/stock status, the total fishing mortality from RSA catches (where species targeted by commercial and recreational sea angling), life history traits and post-release mortality (i.e. survivability if returned to the sea). The potential influence of these factors is briefly described below and then evidence of impacts of biological removal on species' populations is presented where it was available.

Data regarding RSA activity and catch data from three key studies are summarised, where appropriate, for each species. These studies are:

1) *Pilot recreational sea angler shore surveys by Goudge et al. (2009a, b) at popular sites across north Wales in December 2007 to March 2008 (winter surveys) and June to October 2008 (summer surveys).*

   This study trialed a survey methodology to record sea angling activity in north Wales, including in relation to the numbers and species of fish caught between groups of anglers classified by their sea angling frequency and experience (from novice to top match anglers). Data was collated using targeted questionnaires and direct observation of anglers at sea angling locations, during matches and on charter boats. The study outputs provided useful data on the percentage of anglers targeting and catching particular species, and information on post-release mortality and loss or discarding of tackle. Specifically, recreational sea anglers were asked about the species they target during the winter and summer (n = 122 and 174 anglers, respectively) and also the number and species of fish caught during the survey were recorded (by both the anglers and the surveyors) (n = 661 and 1,224 fish, winter and summer respectively). However, it must be noted that the surveys were only conducted in north Wales and hence the results cannot be extrapolated to the whole of Wales. Furthermore, the pilot survey methods suffered from significant bias as survey locations were not randomly chosen. Sites and dates were chosen to maximise the likelihood of meeting anglers and therefore collect catch data. The winter surveys (where data was collected) focused on scheduled club angling events, which usually guaranteed anglers would be present at a given site.

2) *The numbers and sizes of trophy fishes caught in Wales by Richardson et al. (2006).*
   This paper provided local data on the species targeted and caught during RSA trophy fishing in Wales via private boats (n = 92), charter boats (n = 242), and shore anglers (n = 326). As these data were only collected for trophy fish (trophy fishing refers to when recreational anglers target the largest individuals of a species with the goal of catching a 'record' size (e.g. with respect to weight or length) fish), not wider fish populations, there they may not be completely representative of the distribution of catch by RSA in Welsh waters. However, this is a useful study which has highlighted the species preferences of Welsh trophy anglers and highlighted species that may have been impacted by this fishing.

3) *A review of recreational sea angling activity in the UK and Wales by Monkman et al. (2015).*
   This review provided an overall summary of total angling effort in Wales, an insight into the different species caught in Welsh waters and those of greatest perceived value. Data from Goudge *et al*. (2009a, b) and Richardson *et al*. (2006) are included.

Stock status and proportional take from RSA

Information on stock status and the proportional removal by RSA may be available from ICES for quota species managed under the Common Fisheries Policy (Walmsley, 2018). Where such information is available, these factors have been considered for each species reviewed. If individuals are caught from populations that are small and / or decling then the species may be considered to be at higher risk of significant impacts.

Life history traits

The life history traits of fish species, and prey/predator relationships, will also influence the effect of RSA catch upon fish populations in Wales. Some fish may be highly vulnerable to exploitation by virtue of their slow growth and/or late maturity, whereas others, which are fast growing and/or early maturing may be less so and hence removal may be expected to have a lesser impact upon the wider population.

Seasonality

Seasonal factors and the time of year that fish are caught may also influence the effect of RSA catch in Wales upon fish populations. For example, for species that aggregate to spawn, removing an individual male from a spawning aggregation may have a greater effect than removing the same individual outside of the spawning period (e.g. Black bream (*Spondyliosoma cantharus*), Pinder *et al*. 2016). Water temperature is another factor suggested to influence post-release survival where extremes of temperature have been shown to increase fish vulnerability to mortality due to effects on physiological processes (Cooke *et al.* 2006).

Post-release survivability

Some anglers target particular fish species, and whilst angling may catch other fish species that are not the primary target species (such as whiting caught when targeting cod or dabs). Such unwanted species may be returned to the sea (i.e. released). Many anglers also release the fish species they were specifically targeting (i.e. catch and release). There is an obligation to return certain fish caught that are below the Minimum Conservation Reference Sizes (MCRS) to the sea immediately.

Goudge *et al*. (2009a, b) surveyed recreational sea anglers in north Wales during their normal fishing activities in the summer and winter to ascertain their perceptions on post-release survival of RSA caught fish. The anglers in this study regarded whiting, poor cod, pouting, and dab as having poor survival rates after release, whereas bass, dogfish, flounder and mackerel were considered to have good survival rates (Goudge *et al*., 2009a, b). In the summer 30% of the fish caught by anglers were released immediately, with 8% of these confirmed to be floating on the surface, either dead or injured (whilst the surveyors were watching) (Goudge *et al*., 2009a). Anglers also suggested during this study that smaller fish tend to die more easily than larger fish. In the winter, 31% of fish were immediately released with 18% of these confirmed to float on the surface (majority were whiting). Generally, the more experienced anglers quoted lower overall survivorship rates compared to novice anglers. It should be noted that although an angler may believe that a released fish has survived because they see the fish swim away, mortality may occur later, for example, due to damage incurred during handling by the angler (Sharp, R. pers. comm.).

In some European countries, recreational sea anglers release more than 50% of captured Atlantic cod, European seabass, pollack, and sea trout catches (Ferter *et al*., 2013). Reasons for release varied between countries and species and included legal restrictions (e.g. minimum landing sizes and daily bag limits) and voluntary catch and release programmes. The fate of these fish by species however, is mostly unknown. Release rates are likely to be variable by species (and the desirability of the species to anglers), and influenced by landing size, bag limits as well as angler attitudes and experience. Where species caught by RSA are commonly returned to the sea rather than kept, available evidence relating to the survivability of the species has been reviewed.

Meta-analysis of release mortality studies by Bartholomew and Bohnsack (2005) showed mean percent mortality varied by species and within species of marine and freshwater fishes with hooking location being the most important mortality factor. Other factors which significantly contributed to mortality were use of natural bait, hook removal from deeply hooked fish, use of J-hooks (vs. circle hooks), deeper depth of capture, warm water temperatures and extended handling times. Survival rate varied by species, body-size, depth of capture, ambient conditions (e.g. water temperature) and handling is also supported by McLoughlin and Eliason (2008).

Cooke *et al*. (2006) found that mortality rates of released fish are influenced by a number of factors including environmental conditions, fishing gear, angler behaviour, and species-specific characteristics. Some of the factors that may affect the outcome are intrinsic, such as fish sex, age, previous exposure to stressors, maturity, condition, size, and degree of satiation, or environment. These factors are largely out of the realm of angler control and have been poorly studied. Anglers generally control the other factors that can influence the outcome of an angling capture. This includes choice of fishing equipment (terminal tackle and gear, e.g., bait/lure/fly type, hook type, rod, reel, and line test), behaviour of the angler during the fight, when the fish is landed, where the fish is landed (e.g. when shore fishing, the fish may be reeled in across the beach), if it is exposed to air, and how it is handled and released. For example, Alos *et al*. (2008) found that hook size was the most important predictor of deep-hooking, which is reduced by the use of large hooks. Large hooks also reduced the incidence of hooking injuries, with a small reduction in catch rate. Barotrauma is also a key factor in survival post-release (Alos, 2008; Ferter *et al*., 2015a).

Primary target fish species

European seabass - *Dicentrarchus labrax*

Goudge *et al*. (2009a) stated that 63% of anglers surveyed in north Wales target European seabass in the summer months, with 17% specifically targeting using specific equipment to catch bass at the time of the survey, however, European seabass only contributed 0.24% of total summer catches and none were caught during the winter (Goudge *et al*., 2009b). During the winter survey, 47% of anglers stated they targeted European seabass at other times of the year (Goudge *et al*., 2009b). European seabass is an important and highly targeted trophy species for RSA in Wales, comprising 21.6% of the expressed target species for charter boat anglers, 36.2% of private boat anglers, and 35.8% of shore based anglers (Richardson, 2006; Monkman *et al.*, 2015). Spawning stock biomass within ICES divisions 4.b-c, 7.a and 7.d-h (inclusive of those relevant to Welsh Waters i.e. 7.a, 7.g and 7.f) has been declining since 2009, primarily due to overexploitation of commercial fisheries, and is just above safe biological limits (B_{lim}) as reported by ICES (2019a). Within the same ICES divisions in 2018, 'recreational removals' of seabass were estimated to be approximately 11% of the total removals (i.e. including removals from commercial fisheries) (ICES, 2019a). Post-release mortality from common recreational angling gear was estimated to be 5% for European seabass (ICES, 2019a).

Despite a high fecundity and short population doubling time, European seabass have experienced poor recruitment since 2008, prompting a number of catch and landing restrictions to RSA activity. Bag limits, a minimum landing size and spatial restrictions are currently in place for European seabass caught by RSA (see Section 3.4).

Release rates for European seabass in England are high for shore-caught European seabass (80%) but lower for boat based European seabass (50%) (Armstrong *et al.*, 2013). However, there is a limited understanding of post-release mortality rates of European seabass caught using RSA methods. Lewin *et al*. (2018) demonstrated that survival probability varied widely based on bait, hooking and air exposure time, but estimated a post-release mortality of 5% based on angling practices utilised in Wales, although deep hooking incidents resulted in mortality as high as 76.5%. Atlantic cod - *Gadus morhua*

Goudge *et al*. (2009b) stated that 41% of anglers surveyed in north Wales targeted cod in the winter months, with no targeting of cod in the summer, however they comprised only 0.3% of the total catches during the survey. Atlantic cod were a highly targeted species by RSA activities for trophy fishing in Wales, comprising 11.6% of the expressed target species for charter boat anglers, 10.9% of private boat anglers, and 14.2% of shore anglers (Richardson, 2006, Monkman, *et al.*, 2015). Cod stocks have declined markedly since the 1980s and are currently below safe biological limits in the southern Celtic Seas (ICES, 2019b), whilst the biomass index of the stock in the Irish Sea recently decreased to the lowest value since 1993 (ICES, 2019c), Despite a high fecundity and short generational period, recruitment of cod has been particularly poor in recent years (Pinsky and Byler, 2015, ICES, 2019b). The proportion of recreational landings compared to commercial harvest has not been quantified in Wales. In England, the release rates for cod is 50% of all shore caught and 20% of boat caught individuals released back into the sea (Armstrong *et al.*, 2013). Comparable data on the release rates for cod in Wales was not available, however, anecdotal information suggests that the release rate of cod and codling by anglers in Wales is likely to be high as most of the cod caught are under the Minimum Conservation Reference Size (MCRS). Furthermore, post-release mortality of cod is poorly understood and has not been assessed in Wales. Current RSA mortality rates in other European countries have been estimated between 2% and 11% but are strongly associated with water temperature and barotrauma within the experimental methodology and cannot be confidently extrapolated for cod fishing techniques used in Wales (Ferter *et al.*, 2015b; Weltersbach and Strehlow, 2013).

Wrasse species

In north Wales, wrasse species were one of the most common fish caught during summer sea angling activities, making up to 31% of total catches during summer RSA shore surveys (Goudge *et al*., 2009a, Monkman *et al.*, 2015). Goudge *et al*. (2009a, b) stated that 17% of anglers surveyed in north Wales targeted wrasse during the summer and 8% of anglers surveyed in the winter stated they target wrasse throughout the year. Wrasse species in Wales (such as ballan wrasse and cuckoo wrasse) were reportedly targeted by less than 1% of boat-based trophy anglers and between 2% to 3% of shore-based anglers (Monkman *et al.*, 2015; Richardson *et al.*, 2006). The British Sea Angling website https://britishseafishing.co.uk/wrasse/ states that due to being long-lived, slow growing and their late age of first maturity, in addition to being territorial, wrasse numbers can be noticeably reduced by anglers. In England, nearly all of shore caught wrasse and half of boat caught wrasse are released back into the sea (Armstrong *et al.*, 2013), however, the equivalent statistics were not available for Wales. Their post-release mortality is not known, although the British Sea Angling website states that wrasse species are extremely sensitive to changes in water pressure suggesting individuals caught in deeper water may experience swim bladder barotrauma (https://britishseafishing.co.uk/wrasse/), For this reason a high percentage of the larger ballan wrasse do not survive being released (Sharp, R., pers. comm.).

Whiting - *Merlangius merlangus*

Recreational sea angler surveys in north Wales indicated that whiting was the most commonly caught species through the year (75% of all catches in the winter survey) and that anglers perceived whiting to have a low survival rate when returned to the sea (Goudge *et al*., 2009b). Whiting are targeted by 3.1% of charter boat angling, 1.2% of private boat angling, and 3.3% of shore angling in Wales (Richardson, 2006; Monkman *et al*., 2015). In England, the release rates for the species are high, measuring 90% for shore angling and 70% for boat angling (Armstrong *et al.*, 2013), however, the equivalent statistics for Wales were not available. Whiting stocks are below safe biological limits and recruitment is low in the Irish sea and southern Celtic Sea (ICES, 2019d,e).

Pollack - *Pollachius pollachius*

Pollack made up 2.2% of catches during summer RSA shore surveys undertaken in north Wales (Goudge *et al*., 2009a). Approximately 16% of anglers surveyed mentioned they specifically target pollack during the summer months (Goudge *et al*., 2009a). Pollack comprised 7.2% of the expressed target trophy species by charter boats, 7.1% of private boats, and 4.5% of shore anglers (Richardson, 2006, Monkman *et al*., 2015). Radford *et al*. (2018) estimated that recreational catches of pollack in the Celtic Seas and English Channel could comprise a substantial component of total landings (43% of total removals) although it was noted that this estimate was driven by high and potentially overestimated recreational catches in France (Radford *et al*. 2018 and references therein). No information is available to assess the post-release survival of the species. The available information is insufficient to evaluate the exploitation and the trends of pollack in Wales.

European plaice - *Pleuronectes platessa*

Plaice made up 0.08% of catches during summer RSA shore surveys undertaken in north Wales (Goudge *et al*., 2009a). However, approximately 12.4% of anglers surveyed mentioned they specifically target plaice during the summer months and 7.4% anglers in the winter mention they target plaice throughout the year (Goudge *et al*., 2009a, b). They have been recorded as the target trophy species for 1.5% of charter boat hires, 2.8% of private boat angling, and 3.4% of shore angling (Monkman *et al.*, 2015). Plaice biomass has been increasing since 2007 in the Bristol Channel and Celtic Sea and since 2012 in the Irish Sea, although recruitment has declined in recent years in the Irish Sea (ICES, 2019f;g). The proportion of landings from recreational sea fishing has not been estimated for this species. Plaice mature between 2-3 years for males and 4-5 years for females, which have a high fecundity that varies between 60,000 and 100,000 eggs per female (Rijnsdorp, 1991).

Black sea bream - *Spondyliosoma cantharus*

Black sea bream is a highly valued recreational fish and is primarily available in habitats accessible by boat. Black bream made up 0.4% of catches during summer RSA shore surveys undertaken in north Wales (Goudge *et al*., 2009a). Approximately 4% of anglers surveyed mentioned they specifically target black bream during the summer months (Goudge *et al*., 2009a). Black sea bream comprised 8.8% of charter boat targeted trophy species, 5.2% of private boat, and a small amount of shore angler preference (1.2%) (Richardson *et al.*, 2006; Monkman *et al.*, 2015). Post-release survival of black bream has not been assessed anywhere across its range. However, other bream species (red sea bream *Pagrus major* and yellowfin bream *Acanthopagrus australis*) have shown a high post release survival from hook and line (recreational) fishing techniques (>80%) (Chopin *et al.*, 1996). Recreational sea angling has been identified as a potential risk to the recruitment of the species as it is likely to disrupt parental care behaviours of guarded nests and increase the risk of predation on eggs (Pinder *et al.*, 2016). Kingmere MCZ in Sussex, designated in 2013, has black bream as a feature and there is currently a byelaw in place, managed by Sussex Inshore Fisheries and Conservation Authority (IFCA), which manages fishing activities at this site to protect this species. Black bream is not a quota species under the Common Fisheries Policy and hence spawning stock biomass and fishing mortality from commercial fishing activity across relevant ICES sub-divisions has not been assessed.

Mackerel - *Scomber scombrus*

The majority of catches observed during the summer RSA shore surveys in north Wales were mackerel which made up 38.9% of the total catches (Goudge *et al*., 2009a). Approximately 53% of anglers surveyed mentioned they specifically target mackerel during the summer months and 9% of anglers surveyed in the winter stated they target mackerel at other times of year (Goudge *et al*., 2009a, b). Radford *et al.* (2018) found that percentage contribution to total removals of Atlantic mackerel (i.e. recreational and commercial) by recreational fisheries was 2% in the North Sea and Skagerrak. The spawning stock biomass peaked in 2014 for all northeast Atlantic regions but has since been in decline (ICES 2019h). Studies have shown that mackerel are susceptible to post-release mortality if they have been handled, due to skin damage interfering with their ability to maintain osmotic balance (e.g. Pawson and Lockwood, 1980; Lockwood *et al.,* 1983).

Flounder - *Platichthys flesus*

During RSA shore surveys in north Wales, flounder made up 0.24% of the total summer catches (Goudge *et al*., 2009a) and 0.4% of winter catches (Monkman *et al*., 2015). Approximately 13.4% of anglers surveyed mentioned they specifically target flounder during the summer months and 4.9% of anglers surveyed in the winter stated they target flounder throughout the year (Goudge *et al*., 2009a, b). During the spring and summer, flounder are caught by regular and competition anglers as they migrate back inshore after breeding. There are no data relating to the current stock status or fishing mortality of flounder in ICES divisions which are relevant to Welsh waters. No information is available to assess the post-release survival of the species.

Dab - *Limanda limanda*

Summer RSA shore surveys in north Wales found dab made up 0.4% of the total catches whilst, during the winter, dab contributed 2.2% of the total catch (Goudge *et al*., 2009a). Approximately 12% of anglers surveyed mentioned they were specifically targeting dab on the day they were questioned whilst and 5.4% stated they target dab more widely between April to October. Around 2% of anglers questioned during the winter survey stated they target dab at other times of the year (Goudge *et al*., 2009a, b). During fishing for cod and bass, dab may be caught, however, these are not highly valued due to their small size (Monkman *et al* 2015). Dab reach a size of 20-25 cm at sexual maturity and a maximum size of 40 cm (Fishbase, undated-a). Dab consist of 2% of targeted trophy charter boat preferences, and only 0.7% and 0.8% for private boat and shore angler preferences, respectively (Richardson, 2006, Monkman *et al*., 2015). No information is available regarding post-release survival or the stock status in Welsh waters.

Turbot - *Scophthalmus maximus*

Turbot made up 0.08% of catches during summer RSA shore surveys in north Wales (Goudge *et al*., 2009a). Approximately 0.8% of anglers surveyed during the winter mentioned they specifically target turbot during the year (Goudge *et al*., 2009b). There is no information with regard to the status of turbot stocks or exploitation rates in the waters around Wales.

Tope - *Galeorhinus galeus*

Approximately 4% of shore anglers surveyed during the winter in north Wales mentioned they specifically target tope during the year (Goudge *et al*., 2009b), although boat anglers are likely to target tope in greater numbers. Tope made up 17.7% of charter boat target trophy species and 14.3% of private boat species (Monkman *et al.*, 2015). Tope made up 0.08 % of catches during summer RSA shore surveys (Goudge *et al*., 2009a). Tope have a number of life history characteristics that make them vulnerable to overexploitation, including a low fecundity, aggregating nature, and long generational period (~12 years)

(Carpenter, 2009). However, The Tope (Prohibition of Fishing) (Wales) Order 2008 prohibits the landing of tope caught by rod and line, effectively making recreational fishing for the species catch and release only. There is a gap in understanding of post-release mortality of tope shark in Wales.

Smooth hound *Mustelus mustelus* and Starry smooth hound *Mustelus asterias*

Wales is highly regarded as an area for fishing for smooth hounds and charter boats regularly target this species in north Wales (Monkman *et al*., 2015). Approximately 7.4% of anglers in the summer mentioned they target smooth hounds during the summer months and 6.6% of anglers surveyed during the winter mentioned they specifically target smooth hounds during the year (Goudge *et al*., 2009a, b). Starry smooth hounds are reportedly targeted by 4.4% of charter boats, 1.6% of private boats, and 3.2% of shore anglers as trophy catches in Wales (Monkman *et al.*, 2015). Smooth hounds are believed to be caught on a catch-and-release protocol for most recreational fisheries in Britain, though unlike tope they are not the subject of a statutory instrument (British Sea Fishing, undated). However, post-release survival has not been quantified across its range. Furthermore, landing data has been historically poor from commercial fisheries and there is a need to better understand post-release mortality rates for the species.

Thornback Ray - *Raja clavata*

Thornback rays are popular fish with recreational sea anglers; during the spring and summer, thornback rays migrate inshore after breeding and are targeted by regular and competition anglers (Monkman *et al*., 2015). Goudge *et al*. (2009b) noted that 0.82% of anglers in north Wales in the winter months will specifically target thornback rays during the year. During the summer, 0.08% of the total catches were thornback rays (Goudge *et al*., 2009a). These rays are the most commonly seen large rays in Welsh waters and mature at a size of between 60 and 80 cm in length at approximately five to 10 years of age, depending on sex (Whittamore and McCarthy, 2005). A survey conducted during the late 20th century in the Irish Sea and Bristol Channel revealed a marked decline in the previously common thornback ray, along with the extirpation of larger species such as white skate, and common skate, undoubtedly through commercial overexploitation (Brander, 1981; Dulvy *et al.*, 2000). A study by Richardson (2006) reported that the weight of the heaviest trophy catch of thornback ray in Welsh waters, had decreased significantly over time between 1976 and 2002. This decline coincided with a decrease in total numbers caught recreationally, with no Welsh-caught catches of trophy thornback ray reported to the National Federation of Sea Anglers between 2000 and 2002. ICES (2019i) stated that more accurate long-term assessments of thornback ray stocks and exploitation status are required.

Blonde Ray *Raja brachyura* and Small-eyed Ray *Raja microocellata*

Blonde rays have a patchy distribution in the Celtic Sea and can be locally abundant around areas such as the Irish Sea and Bristol Channel (ICES, 2018a). Catch data for recreational fisheries were not available for this species. Blonde rays reach maturity at 4-5 years of age at around 80-90 cm in length, their maximum size is around 120 cm in length (Gibson-Hall, 2018). Length of maturity for small-eyed rays approximately 74 cm, with a maximum length of 80cm, however, age of maturity is unknown (Fishbase, undated-b). ICES (2019j,k) has limited information on the stocks of blonde rays and small-eyed rays meaning the abundance, stock and exploitation status could not be assessed for the Celtic Sea and Bristol Channel.

The small-eyed ray is found in localised abundance in the Bristol Channel (Ellis *et al.*, 2010, ICES, 2018a). Goudge *et al*. (2009a, b) found that 8.4% of anglers in north Wales stated they target rays during the summer months, and 6.6% of anglers from in the winter months will specifically target rays during the year. Monkman *et al*. (2015) reported only 0.1% of summer fish caught in Wales were rays. There is no information regarding the post-release survival of these species.

Other fish species targeted or caught

Spurdog/spiny dogfish - *Squalus acanthias*

Due to a lack of management measured before 2009, spurdog recruitment and biomass has substantially decreased in the northeast Atlantic since the 1960s (ICES 2018b). Currently, a maximum landing size of spurdog (100 cm) is in place to reduce the targeting of mature females, however recovery of the stocks is slow (ICES, 2018b). Spurdog is a long-lived, slow growing and late maturing species and, therefore, ICES (2018b) state it is particularly vulnerable to fishing mortality. Occurrence in survey hauls around the UK has reduced by more than 60% between 1985 and 2005 (Ellis *et al*., 2005). Spurdog is reportedly targeted by a small number of recreational sea anglers in Wales (0.2% charter boat; 0.3% shore) (Richardson *et al.*, 2006) and is primarily caught on a catch and release basis, with over 95% returned to the water (Armstrong, 2013; Monkman *et al.*, 2015). However, there is a critical gap in our understanding of post-release mortality for the species that has not been quantified for any recreational fisheries across its range.
European eel *Anguilla anguilla*

Goudge *et al*. (2019b) found that 5% of anglers targeted the European eel in north Wales during the summer survey. European eels make up less than 1% of the trophy species caught by boat (0.1%) and shore (0.8%) anglers in Wales (Richardson *et al.*, 2006). If by-caught (as well as if targeted on a catch and release basis), then when returned, some individuals are likely to suffer mortality though survival rates are currently uncertain. Weltersbach *et al*. (2016) estimated mortality of European eel 23 weeks post-hooking at between 27% and 50% but did not assess against a control group to identify the mortality rate of fish that were not hooked. These mortality rates should therefore be treated with caution and are likely to be an overestimate. Due to the precarious nature of the population, eels are caught on a catch and release policy in Wales to help the population recover from its severely depleted state. The impact of these recreational fisheries on European eel stocks, including from RSA by-catch in Wales, remains largely unquantified though the effect of RSA by-catch upon the population will depend upon the age and life stage of the individual.

Migratory species

There are a range of other fish species that are of conservation importance that may very rarely be caught by recreational sea anglers as a bycatch species. This includes migratory species such as Atlantic salmon, Sea trout, Twaite and Allis shad and European eel.

Annual assessments by NRW on Atlantic salmon stocks indicate that the status of all salmon stocks in principal salmon rivers are ‘At risk’ or ‘Probably at risk’ of failing to achieve their management targets untril at least 2024; a similar story exists for two thirds of sea trout stocks.

Mandatory catch and release of salmon was introduced on all rivers in Wales in early 2020 under a byelaw. This byelaw shall not apply to any person who lawfully takes a salmon and returns it immediately to the water with the least possible injury. These byelaws were brought in as part of a range of measures designed to protect vulnerable and declining salmon stocks. Measures have also been put in place to protect sea trout in many rivers and other controls on angling methods to improve the survival of released fish (https://naturalresourceswales.gov.uk/about-us/news-and-events/news/new-all-wales-fishing-byelaws-come-into-force/?lang=en). Twaite and Allis shad are listed on Schedule 5 of the Wildlife and Countryside Act and protected from intentional killing, injury or taking by virtue of section 9(1) and (4) of the Act.

Apart from Sea trout, which may be targeted in some Welsh coastal waters and estuaries and in some circumstances (see rod byelaws) kept by rod licence holders, the other migratory species listed above are only rarely caught as bycatch by RSA and the numbers of individuals captured is thought to be very small. The populations of many migratory species are threatened and /or declining and any additional mortality is undesirable.

Ecosystem impacts of biological removals

The removal of fish species may have further impacts on the food web and habitats associated with the target species, particularly if removals are of a sufficient magnitude. McPhee *et al.* (2002) highlights the high risk of trophic impacts resulting from the removal of higher-order carnivores, and the changes in prey availability and foraging success through RSA. For instance, the removal of carnivorous sea breams may facilitate increased survivorship of benthic invertebrates (Andrew and Chorat, 1982; McClanahan and Muthiga, 1988). If a particular prey species increases in abundance because of a reduction in predator numbers, it may result in the competitive exclusion of weaker competitors (McClanahan and Muthiga, 1988).

Schroeder and Love (2002) provides a review of some of the indirect effects of RSA in California, finding that large predators may disappear when a reef is fished even lightly, and this in turn may alter ecosystem structure through top-down, trophic cascades (Dayton *et al.*, 1995; Boehlert, 1996; Pinnegar *et al.*, 2000). Parravicini *et al.* (2013) found that cascading trophic effects from recreational fishing pressure and the loss of higher predators was causing an abundance of sea urchins in the Ligurian Sea (NW Mediterranean), which was subsequently delaying the recovery of the seabed habitats from date mussel harvesting 20 years previously. Finally, Altieri *et al.* (2012) found that the localised depletion of top predators at sites accessible to recreational anglers in Cape Cod, Massachusetts, USA, has triggered the proliferation of herbivorous crabs, which in turn results in runaway consumption of saltmarsh vegetation. This study illustrated the dominant role that some consumers can play in regulating marine plant communities and the indirect effects of recreational sea angling activities when targeting specific trophic niches. Studies on these trophic cascades as a result of RSA do not yet exist in Wales, however, may increase understanding of the wider effects of biological removals.

Evidence gaps for Welsh waters

Intensity of RSA activity and catch data

Whilst there is some understanding of the proportions of species which make up the total catches in Wales, a more detailed understanding is needed of recent RSA catches and preferences by sea anglers. Furthermore, whilst it is generally accepted that pressure on fish stocks from commercial fishing is much greater than from recreational sea angling for commercially targeted species, further data regarding the relative pressure (removals) on certain species impacted by the activies of both sectors would be beneficial to stock management.

The Cefas Sea-Angling Diary is currently being undertaken to collect further data on RSA catch around England and Wales. This project has been conducted since 2016 and is an incentivised scheme to encourage sea anglers to record their catch. It is ultimately a fisher-led survey and, therefore, any limitations within the data must be acknowledged when used (such as potential under-reporting, sample size and sampling bias limitations). However, the project is likely to provide an enhanced dataset to that which is currently available in Wales and provide valuable information on the magnitude and value of RSA activities in Welsh waters to assist better decision making.

An alternative approach to fisher-led surveys is to implement a regulator-led or academic institution-led survey programme to monitor RSA catch around Wales. Studies such as Goudge *et al*. (2009a, b) and Hyder and Armstrong (2013) provide useful sampling methodologies which could be developed to provide a more thorough insight into the magnitude of RSA activities and impact.

Any fisher-led or regulator-led survey programme would need to record data on the fish species caught, locations fished, fishing effort (ideally in hours) gears and bait used, and return proportion (and whether alive or dead). Supplementary information such as fish size and photographs of individuals could also be considered.

Other options that may be more cost effective could include use/analysis of flickr photographs, angling fora (e.g. created through the World Sea Fishing Forum) and/or information provision by charter boat skippers.

Post-release mortality

RSA post-release mortality rates for most species in this section are unknown in both Wales and the UK. Individual fish survival rates will depend upon the methods used for capture and the length of time the fish is out of the water. The impacts on species populations will also depend on the time of year that fish are caught.

The majority of studies focus on immediate or latent (often up to a maximum of 96 hours) survival of the individuals under consideration, and do not consider the longer-term outcomes for these individuals in terms of delayed mortality, increased risk of predation or reduction in recruitment or spawning success, otherwise termed 'cryptic mortality' (Coggins *et al*., 2007). Whilst any estimates of survival following release could be used, the potential uncertainty within these longer-term effects must also be acknowledged. Some evidence relating to cryptic mortality may be available from tagging studies on species caught by recreational sea anglers where the species have been re-caught, (e.g. SSACN, https://www.ssacn.org/)

Summary

To summarise, crucial information on stock assessments in Wales (including the relative importance of RSA versus commercial catches for species targeted by both sectors) and post-release mortality are lacking for the majority of species assessed in this report. However, studies on the fishing preferences of recreational sea anglers in north Wales have given some insight into RSA activities in this region (although it is important to note that the survey locations were not randomly chosen; see Section 5.1). For example, Goudge *et al*. (2009 a, b) found that the majority of species caught in north Wales were whiting, in the winter, and mackerel and wrasse in the summer months. Although bass and cod were highly targeted by anglers, the number of catches of these species during the surveys was low (although not unexpected as these species would not have been present at the location at that time of year). Anecdotal evidence from anglers suggests that post-release mortality is higher for smaller fish species (although the fact that more smaller fish under the minimum landing size may be released by these anglers may have accounted for this) and there are few studies looking at this mortality (Goudge *et al*. 2009a, b). It is important to note that this study did not seek record mortality, but was focussed on methods of recording, asking additional questions about survivability. It is suggested by Cooke *et al*. (2006) that a large variety of factors such as fish age, sex, choice of fishing equipment, behaviour of the angler when the fish is landed, and how long the fish is handled and out of water before release.

Where RSA target species are also of commercial importance, the pressure on those stocks from commercial fisheries is generally considered by ICES stock assessments to be much greater than for RSA activities. However, for species such as European seabass, RSA activity has previously been identified as a significant contributor to overall mortality, leading to the imposition of bag limits across Europe. For species such as wrasses which historically have not been of commercial interest, the main source of biological removal may be from RSA activities. In the case of wrasses, which tend to be territorial, RSA activities may affect the age structure of populations at locations that are intensively fished.

Recreational sea angling has been identified as a potential risk to the recruitment of black bream, particularly when fishing occurs in nesting areas during the breeding season, as it is likely to disrupt parental care behaviours of guarded nests (Pinder *et al.*, 2016). While this impact pathway has been recognised at sites in England, it should be noted that there is currently not clear evidence of RSA occurring in breeding areas of this species in Wales.

Migratory fish species of conservation importance (Section 7 species; see Table 3.3) are not generally targeted by RSA. If salmon are caught, they should be released immediately with minimum injury and without delay. Sea trout under 23cm and over 60cm, which may be more likely to be caught in coastal waters than salmon, should also be released with minimum injury and delay.

As well as the direct removal of individuals by RSA, removal can cause dynamic changes to the ecosystems associated with them. Trophic cascades as a result of recreational removals of top predatory fish, have been observed to change the abundance of invertebrate species due to reduced predation (Altieri *et al.,* 2012, Parravicini *et al.,* 2013). Further information about this impact in Wales is needed to assess how habitats and species, particularly those in need of conservation, may be affected by RSA.

In Wales, more information regarding fish stocks and post-release mortality is required to better understand the overall effect of biological removals. Further data are needed to increase understanding of current angling effort, species caught, total numbers caught and species preferences by Welsh anglers, for example, through the continuation of previous studies such as Goudge *et al*. (2009a, b). Identification of both species and target areas which are potentially vulnerable to removals could aid in the management of biological removals around Wales.

5.2 Impact 2 - Impact of seabed disturbance

This section reviews the evidence of impacts arising from RSA activities where gears may come into contact with the seabed, resulting in abrasion or disturbance to the seabed surface or associated epifauna or flora.

The habitats and species thought to be exposed to this pressure are based on the project team's knowledge of the habitats over/on which most recreational sea angling is likely to occur:

- Shore-based angling:
    - Intertidal and shallow subtidal 'clean' sedimentary shores (i.e. without large volumes of epifauna or flora which are likely to cause snagging of the tackle)
    - Shallow subtidal rocky habitats
- Boat based angling:
    - Subtidal 'clean' sediment
    - Subtidal reef or rocky habitats
    - Subtidal wrecks

Sessile benthic epifauna

There is very limited published evidence of impacts from recreational sea angling on sessile benthic epifauna, with most evidence relating to impacts of commercial fishing gears, which represent a much more intensive and widely distributed pressure. Fishing lines and weights may impact sessile invertebrates such as corals, sponges, gorgonians etc., causing abrasion and potential weakening (e.g. hook and line fishing gear, Chiappone *et al.*, 2005, Florida, USA; monofilament fishing lines, Asoh *et al.*, 2004, Hawaii, USA). A photographic time series of individual pink sea fans (*Eunicella verrucosa*), in the Skomer MCZ, showed evidence of tissue damage resulting from persistent and extensive fouling from fishing line (Burton *et al.*, 2017). A study investigating impacts from commercial potting on reef habitat reported no differences to numbers of *E. verrucosa* in areas with potting excluded, vs control areas where potting continued (Coleman *et al.,* 2013). Healthy *E. verrucosa* were able to recover from minor damage and scratches to the coenenchyma (the tissue that surround and link the polyps) (Tinsley, 2006). This suggests where low levels of abrasion from recreational fishing lines occurs, healthy sea fans should be able to recover.

Benthic habitats

No evidence of abrasion impacts from RSA activities has been identified for intertidal or subtidal mud and sand habitats. While RSA activities may result in fishing tackle being retrieved across these habitats (particularly when fishing from the shore), these habitats are already subject to high levels of natural disturbance from tidal currents and waves and the additional pressure from retrieval of fishing gear is likely to be minimal.

Seagrass (*Zostera spp.)* beds, such as those present in Pembrokeshire, the Llŷn Peninsula and Anglesey https://lle.gov.wales/catalogue/item/MarineBAPOSPARHabitats/?lang=en), are not physically robust (D'Avack *et al.*, 2015). There are many reports of commercial fishing gear physically damaging seagrass beds (e.g. Gonzalez-Correa *et al.*, 2005; Neckles *et al.*, 2005). No evidence has been found regarding the impacts of RSA activities to seagrass beds, but the risk is thought to be much lower than for commercial fishing gear, given the much lower weight and intensity of RSA gear. No evidence of abrasion impacts from RSA activities on kelp beds was identified in the review. While such features are potentially susceptible to abrasion at large scales, the intensity of this pressure from RSA activities is considered to be too low to cause widespread or long-lasting damage. Where lines become entangled with kelp, particularly when shore fishing, they tend to break, although when boat fishing with heavier gears, whole plants can be removed.

In areas of shellfish beds, such as mussel beds (blue mussel beds, Intertidal *Mytilus edulis* beds on mixed and sandy sediments, *Musculus discors* beds), commercial fishing is known to cause removal of patches of mussel beds (Holt *et al.*, 1998). For horse mussel beds, which occur off the north Llŷn Peninsular and north west Anglesey (NRW, 2019), impacts of towed commercial fishing gear (e.g. scallop dredges) have been recorded as damaging reefs, particularly older specimens which have can have brittle shells (Holt *et al.*, 1998). No evidence of damage to shellfish beds from RSA activities has been identified and any effect of abrasion is likely to be minimal compared to commercial fishing activity.

Studies of intertidal reefs of *Sabellaria alveolata* (Cunningham *et al.*, 1984) have found that the reef recovered within 23 days from the effects of trampling, (i.e. treading, walking or stamping on the reef structures) by repairing minor damage to the worm tube porches. Similarly, Vorberg (2000) found that subsequent to being damaged by a 3m beam trawl *S. alveolata* worms rebuilt the reef within 5 days, indicating if superficial damage occurs recovery can occur rapidly. Therefore, whilst RSA activities may cause minor abrasion to such reefs, any impacts are likely to be minimal.

Sea-pen and burrowing megafauna communities are found predominantly on plains of fine mud at water depths ranging from 15-200m. Therefore, they are primarily at risk from abrasion from boat angling activities. No specific evidence of impacts from RSA activities was identified. While there is evidence of impacts from commercial fishing activities, the intensity of abrasion from commercial fishing activity is much greater.

Submarine structures made by leaking gases and carbonate reefs are geological structures that would be considered insensitive to minor abrasion pressures from RSA activities.

Lithothamnion corallinoides (maerl) beds occur in coarse clean sediments of gravels and clean sands predominantly at depths of 1-10m. No specific evidence of impacts from RSA activities on maerl beds was identified in the review. While there is evidence of impacts from commercial fishing activities (e.g. abrasion from towed demersal fishing gear which may cause *L. corallinoides* to break up into smaller fragments; Kamenos *et al.*, 2003), any effect of abrasion from RSA is likely to be minimal compared to commercial fishing activity.

Fish spawning grounds

No evidence of abrasion impacts to fish spawning grounds from RSA activities has been identified in the review.

Retrieval of fishing gear over habitats used by demersal spawners (e.g. sandeel or herring) could plausibly disturb, damage or detach eggs of these species, although no evidence has been identified of these impacts.

Given the low level of abrasion pressure from retrieval of RSA gears, the overall impact on fish habitats is likely to be minimal.

Evidence gaps for Welsh waters

There is little or no evidence of abrasion impacts from RSA activities on benthic habitats or sessile benthic species. While evidence exists from the commercial fishing sector, the intensity and spatial extent of abrasion pressure from this sector are much greater than for RSA activities. Given the low level of abrasion pressure form RSA activities, impacts are generally considered to be minimal.

Summary

There is little evidence of disturbance to seabed habitats and associated epifauna arising from RSA activities. While there is extensive evidence of abrasion pressure from commercial fishing gears, the level of abrasion pressure from RSA activities is much lower and is considered unlikely to be significant for any marine habitat or benthic species.

However, evidence from the Skomer MCZ, as well as studies in the USA do indicate that there is a potential pathway for RSA fishing tackle to entangle and subsequently cause some damage to sessile epifauna such as gorgonians, stony corals and sponges. However, a lack of data relating to the location and intensity of RSA activity over such habitats in Wales (e.g. fragile sponge and anthozoan communities on subtidal rock), which would be a component of Annex 1 reef habitat, means that the level of exposure of such benthic habitats to this pressure remains uncertain.

5.3 Impact 3 - Impact of lost or discarded tackle

This section reviews the evidence of impacts arising from lost or discarded RSA tackle on fish, marine mammals, turtles and seabirds. Impacts have the potential to arise through injury or mortality from ingestion of lost baited hooks and line and/or entanglement in lost hooks and fishing line (McPhee *et al.*, 2002). Lost or discarded recreational fishing tackle may represent a relatively small proportion of the plastic and lead found in the marine environment, however, it may have an impact on localised coastal areas and species where RSA activities are higher (Lloret *et al*., 2014).

Abandoned, lost or discarded fishing gear (ALDFG) in the marine environment has the potential to have detrimental impacts on fish stocks (through continued catch of target and non-target species), other taxa (e.g. birds, turtles or marine mammals through entanglement or ingestion) or benthic habitats (e.g. through abrasion). Whilst commercial fishing is considered to be the greatest source of ALDFG globally, recreational fishing is also considered to be a potential source (FAO, 2009). For example, in a study of the impact of lost fishing gear in the Mediterranean, Ruitton *et al*. (2019) reported that recreational sea fishing activities contributed in a significant way to lost fishing gear in the form of fishing lines, lead, lures, hooks etc. However, it is not known how the fishing methods or intensity in that study compare to those in Wales and no evidence was sourced relating to the magnitude of ALDFG arising from recreational sea fishing in Welsh waters.

Seabed disturbance may also arise from the presence of lost or discarded tackle on the seabed. Its movement with tidal currents or entanglement with objects, has the potential to cause disturbance (e.g. abrasion) to the seabed and or associated biological community. Evidence of these impacts are reviewed in Section 5.2. Lost and discarded tackle can also accumulate on rocky reef (an Annex 1 habitat), especially at sea angling hotpots, with potential noticeable impacts to its aesthetic quality. However, whether this impact negatively affects the reef's structure and function and typical species has not been quantified.

Fish species and invertebrate species

Several studies have investigated the impact of lost or discarded commercial fishing (such as gillnets) on the entanglement of fish and invertebrate species (Kaiser *et al*., 1996, Laist *et al*., 1997, Stelfox *et al*., 2016); however, there are no known studies which address the impact of lost or discarded recreational fishing tackle on fish species. The effects of abrasion and entanglement on invertebrate species is reviewed in Section 5.2 above.

Marine mammal and turtle species

Lost or discarded fishing line can entangle a variety of animals including marine mammals (Allen *et al.*, 2012; Bansemer and Bennett, 2010). Wells *et al.* (1998) concluded that, although often overlooked, the number of deaths or serious injuries to bottlenose dolphins in Florida from recreational sea fishing, particularly entanglement in discarded fishing line (from anglers or commercial longlines), could exceed that from the region's commercial net fisheries. In some instances, retained hooks from recreational fishing have also been known to cause direct mortality or increased risk of bacterial infection (Borucinska *et al.*, 2001; Osinga, 2006; Adams *et al.*, 2015).

Evidence from America shows that discarded tackle from RSA activities can pose a risk of entanglement and hooking of marine mammal and turtle species. Globally, monofilament and micro-multifilament lines, used in both commercial and recreational sea fishing gears, have been documented as one of the most significant sources of entanglement in marine mammals (Laist, 1997). Some of this evidence comes from locations where sportfishing uses heavier lines than might typically be used in Welsh waters and therefore care is required in interpreting the evidence in a Welsh context.

At Skomer Island, Wales, injuries were reported to seals 25 grey seals, attributed primarily to commercial multifilament netting (NRW, 2018). However, monofilimant line was also mentioned as an obvious pollutant to seals and a plausible risk remains to this species from any discarded recreational fishing gears. Harbour seals are also vulnerable to entanglement; however, their limited presence in Welsh waters reduces the likelihood the species will be affected by Welsh angling activities.
Commonly seen cetacean species in Wales include harbour porpoise which is present throughout Welsh coastal waters, particularly around Anglesey, Cardigan Bay and the Pembrokeshire coast (Heinänen and Skov, 2015); and bottlenose dolphin which is one of the most frequently recorded cetacean species in Welsh waters, with a predominantly coastal distribution (Baines and Evans, 2012). There are potential impact pathways from

discarded fishing tackle to both these species from entanglement or ingestion (e.g. Wells *et al.*, 2008).

Studies on bottlenose dolphin in Florida, USA indicate that a high intensity of recreational sea angling correlates with increased interaction with fishing gear and decrease in local species population (Powell and Wells, 2011; Adimey *et al.*, 2014). However, no evidence was found indicating interaction between these species and recreational angling in Wales, possibly due to the relatively lighter lines used by RSA in Wales. In the UK, including Wales, the common dolphin is a predominately offshore species and hence it is considered unlikely to be exposed to any lost and discarded RSA tackle in shallow coastal waters.

Leatherback and loggerhead turtles ingest baited hooks during feeding (Rudloe and Rudloe, 2005). Adimey *et al.* (2014) reported in Florida that between 1997-2009, 3.1% of stranded loggerhead turtles and 1.6% of stranded leatherback turtles were found with hook and line gear either entangled or ingested. Adimey *et al*. (2014) stated that most of the gear was lightweight to which they suggested may indicate the turtle interacted with recreational fishing activities, however, the origin of the gear was ultimately unknown. From 1997 to 2017, there have been 25 sightings of loggerhead turtles in Welsh waters and from 1997 to 2007 there have been 140 sightings of leatherbacks (Penrose and Gander, 2017). Whilst these species may be exposed to lost or discarded tackle in Wales, their low numbers in Welsh waters means that any impacts upon global populations is likely to be limited.

Bird species

Abraham *et al.* (2010) and Campbell (2013) suggest that most of the injuries from recreational angling on birds result from interactions with fishing tackle that has been lost or discarded on the shore or in the water. Lost fishing lines can also pose a risk for coastal birds whose limbs or beaks can become entangled (Ferris and Ferris, 2004). Given the high number of cormorants that are reported with internal tackle injuries by Campbell (2013), it is believed most deaths occur when individuals ingest baits that have been lost on the seabed due to snagging. Fatalities can be caused by the ingestion alone or subsequent drowning. Abraham *et al.* (2010) indicated that gull species were equally likely to be hooked internally or tangled externally, whilst shags and gannets were more likely to just be hooked internally.

There is evidence indicating that birds interact with active recreational fishing by depredating baited hooks or catches. For example, Abraham *et al*. (2010) and Campbell (2013) reported some individual animals were affected by active fishing where, for example, a line was cast and accidentally hooked/entangled a bird. One study in New Zealand reported the most common bird species caught in this way included petrels and gulls (Abraham *et al* 2010). However, direct mortality of these birds during the fishing activity was judged to be relatively low (for example, birds were reported as unharmed in 77% of the capture incidents in New Zealand; Abraham *et al* 2010).

Evidence gaps for Welsh waters

Whilst the pathway for the potential ingestion of or entanglement with hooks and lines exists for lost or discarded RSA gear in Welsh waters, the frequency of lost or discarded line and subsequent density on the seabed/intertidal is unclear. Lost or discarded fishing tackle was recorded in a survey of anglers in north Wales (Goudge *et al*., 2009a). The survey found that 16% of 232 anglers noted loss of gear during normal fishing activity, 33% of these losses occurred whilst fishing for mackerel (Goudge *et al*., 2009a). Goudge *et al*. (2009b) reported tackle being lost during normal fishing activity. Although not relating to tackle, Goudge *et al*. also reported that accidental littering as a result of wind or incoming tide likely contributed to the presence of litter on a beach in north Wales. Further information on discarded gear from RSA activities is needed to increase understanding of the scale and abundance across Wales. Dedicated studies on recreational ghost fishing gear (which may also include recreational nets) in other countries such as Lloret *et al.* (2014) in the Mediterranean have provided a useful insight into the scale of discarded recreational tackle. Evidence suggests that ALDFG can have a significant impact on a variety of species, however, no evidence relating to the direct impacts of lost or discarded gear in Wales were identified.

Summary

Whilst the presence of the lost or discarded tackle undoubtedly represents a potential impact pathway for fish, marine mammal and bird species in Welsh waters, a better understanding of the amount of lost/discarded tackle, hotspots where tackle is found and the impact of these on wildlife is required. Overall, this impact pathway can lead to the entanglement or ingestion of monofilament fishing line or hooks which could cause lasting damage to or death of the individual, with multiple reports of these direct impacts across the world (Wells *et al*., 1998, Ferris and Ferris, 2004, Campbell, 2013, Adimey *et al*., 2014). An increase in the available data on entanglement and ingestion of fishing gear around Wales is required to fully understand the scale of this impact along the coastline and whether the impacts might be significant at population level for any species.

5.4 Impact 4 - Impact of introduction of non-native species

This section reviews the evidence of the potential introduction of non-native species from RSA activity. Recreational angling (the term recreational angling is not defined in the document in relation to whether it refers to freshwater and sea angling), has been recognised as a potential human pathway of non-native species introduction by the EU (Convention on the Conservation of European Wildlife and Natural Habitats, 2014). There is rising concern about the effects of releasing exotic bait or algal packaging materials used by recreational anglers into the coastal environment (Lloret and Font, 2011; Font *et al.*, 2018). Although shipping and aquaculture industries have received attention as a introductory and/or dispersal mechanism for aquatic invasive species, the potential risks of introducing marine species associated with RSA bait use remains relatively unknown (Weigle *et al.*, 2005).

Marine NNS, and invasive NNS (INNS) particularly, pose a significant threat to global biodiversity and can have detrimental environmental and socio-economic impacts. INNS can have a negative impact on native species and habitats through smothering, predation and outcompeting native species for space and food and bioengineering which may ultimately alter ecosystem functioning (Molnar *et al*., 2008). As such, preventing the introduction of new NNS into Welsh waters and preventing the spread of those already present in some areas of Wales (for example the slipper limpet *Crepidula fornicata*) is of vital importance.

Bait

Bait species used in the UK primarily comprise polychaetes, small crustaceans, shellfish, cephalopods, small fish or fillets of larger fish. In Wales, lug worms, green shore crab, sandeel and rag worm have been identified as the most widely used baits, with many Welsh anglers purchasing bait for their fishing activities (Monkman *et al*., 2015). Purchased bait which has been gathered in another part of the UK or internationally, may pose a risk of containing non-native species within the packaging as well as pathogens and parasites.

The use of non-native baits during RSA activities, such as slipper limpets or non-native crab or oyster species (Monkman *et al.* (2015) reported that 11% of anglers in Wales used "various species" of oyster for bait, hence it is possible that this may include the Pacific Oyster *Magallana gigas*), represents a direct risk of introduction of NNS to areas where they are not currently present. Slipper limpets are commonly used as bait along the south coast of the UK (FitzGerald, 2007, British Sea Fishing, 2012) due to their very dense and extensive populations, however, their presence in Wales is currently limited to the south and south west of Wales (Swansea Bay, Milford Haven) and has reached very high abundances in the Milford Haven Waterway, where populations in some habitats can exceed 1,000 individuals/m^2 (Bohn *et al*., 2012; Bohn 2014). There is the potential risk that slipper limpets could be transferred to north Wales by anglers who have taken bait with them from these areas, for example, for competitions or tourism. However, it can be noted that under the Wildlife and Countryside Act 1981 (as amended) the release of slipper limpets to the sea (i.e. re-depositing a live slipper limpet in the sea once it has been removed) is an offence. This includes the use of live or fresh slipper limpets as angling bait, or disposal at sea, which may allow the escape of eggs and larvae into the marine environment (https://www.gov.uk/government/news/slipper-limpets-not-permitted-to-be-used-as-bait-or-disposed-at-sea).

Seaweeds are often used as a main packing material in live bait shipping and are often discarded into the water after fishing (Cohen *et al*., 2001, Haska *et al*., 2012). These seaweeds have been reported to have live non-native epibiota attached after transportation (Cohen *et al*., 2001, Haska *et al*., 2012). Cohen *et al*. (2001) found the presence of several non-native species from the east coast of the USA (Maine) in bait boxes sold in San Francisco Bay. Cohen *et al*. (2001) believe that established populations of non-native species, such as periwinkle *Littorina saxatalis* and green shore crab *Carcinus maenas,* along the San Francisco coastline are likely a result of baitworm imports. 'Hitchhiker' species have been reported present in the packing materials of nearly all target species of live bait, and on the bait itself in a study by Passarelli and Pernet (2019). Where baits are packaged with seaweeds and imported into Wales, the potential risk of non-native algae, and associated epibiota inhabiting these algae, establishing increases (Cohen *et al.*, 1995; Cohen *et al.*, 2001; Lau, 1995; Weigle *et al*., 2005). There is limited information available on the amount of imported bait used in Wales, however, it is reported that bait purchased by Welsh anglers includes peeler crabs from Devon, the Thames and Morecambe Bay and ragworms from the Solent and the Thames. Furthermore, historically lugworms have been imported from the Wadden Sea (Sharp, R., pers. comm.).

The level of risk posed by RSA activities in relation to the introduction of NNS from discarded bait or bait packaging cannot be quantified and thus remains uncertain.

Damp fishing gear

Studies on freshwater invasive species has highlighted that damp fishing gear has the potential to transport species to new locations. Fielding (2011) found that the invasive shrimp *Dikerogammarus villosus* can survive for up to 15 days on damp angling equipment. Equally, the highly invasive zebra and quagga mussels can survive for between three and five days out of water, potentially allowing for overland dispersal of non-natives (Ricciardi *et al*., 1995). Anderson *et al.* (2014) found that in the UK, 64% of freshwater anglers use their equipment/boat in more than one catchment within a fortnight and 12% of anglers do so without either cleaning or drying their kit between uses. Furthermore, 8% of anglers had used their equipment overseas without cleaning or drying which could facilitate both the introduction and secondary spread of non-native species in the UK. Whilst no similar study has been identified for sea-anglers, a similar risk may exist where anglers are travelling within Wales, the UK and Ireland to fish. The GB Recreational Angling Pathway Action Plan (PAP) includes strategic actions to reduce the introduction and spread of INNS through activities associated with recreational angling, it was signed off in 2020 to address pathways associated with freshwater recreational angling activities in Wales but it does not address marine recreational angling pathways in Wales.

Evidence gaps for Welsh waters

The extent of the use of non-native baits in Wales is not documented. Whilst the impact pathway is known to be present from studies identified across Europe and the USA, the prevalence of exposure in the Welsh marine environment to NNS via RSA has not been quantified. Collection of information, such as the location the bait was imported from, bait species and packaging material should be considered. Similar studies investigating hitchhiking species in bait boxes, such as those by Cohen *et al*., 2001, Haska *et al*., 2012 and Passarelli and Pernet, 2019, would be a useful starting point to understand the potential risk of invasion from this pathway. Further, monitoring of locations with a greater intensity of RSA activities for the presence of NNS and discarded baits would be useful to establish whether the current RSA activities represent a risk of introduction of NNS. Damp fishing gear as a vector was explored in the UK by Anderson *et al*. (2014) through targeted surveys of anglers, however, quantification of non-native species on unwashed fishing gear could be explored.

Summary

Recreational sea angling activities have the potential to facilitate the introduction and spread of NNS along the coastline of Wales which may ultimately have negative economic, social environmental impacts. It is widely accepted that preventing introduction of NNS is the most effective approach to reduce the impact of these species in a new location. Evidence from multiple sources has suggested that non-native species are easily, and frequently, transported across large regions as 'hitchhikers' (Cohen *et al*., 2001, Haska *et al*., 2012, Passarelli and Pernet, 2019) and have potentially started to establish in new locations along other coastlines (Cohen *et al*., 2001). The success of this pathway of introduction is linked to the ability of NNS to survive prolonged periods of time out of water (Ricciardi *et al*., 1995, Fielding, 2011). Crucial information regarding the introduction of NNS from RSA activities in the UK and Wales is currently unavailable, however, could provide a useful tool for tracking the main sources and the NNS at risk of introduction via this pathway.

6. Conclusions and Recommendations

6.1 Conclusions

This study has considered the impacts of RSA activities on a range of Welsh habitats and species. It is considered to be the first study of its kind in Wales, with previous studies on recreational sea angling in Wales focusing on RSA effort or targeted catch proportions (e.g. Richardson *et al.*, 2006; Goudge *et al.*, 2008; Armstrong *et al.*, 2013), or socio-economic benefits of RSA (Monkman *et al.*, 2015).

The study is based on a literature review of the potential impacts from RSA activities on benthic habitats, fish, birds and mammals in Welsh waters. Although there are substantial gaps in the evidence base relating to the impacts of RSA activities in Wales, several credible impact pathways have been identified. Whilst it has not been possible in this review to assess the likely significance of any potential impact on habitats or species (i.e. resulting from their exposure and vulnerability to such pressures), further targeted evidence gathering could help NRW to better understand the relative exposure to, and vulnerability of protected features to these pressures.

Based on the sparse evidence that was available, the review considers the pressures arising from RSA activity that have the greatest potential for impact are:

- The biological removal of fish species:
    - That have slow growth, are long-lived with late maturity or are territorial (i.e. wrasses);
    - That are valued by both the recreational sea angling and commercial fisheries sector (such as European seabass, rays), particularly for stocks where the relative mortality arising from the two sectors is not known. In this instance, a better understanding of the significance of the mortality from RSA is considered a priority; and

- The impact of lost or discarded RSA tackle, particularly in relation to injury and mortality to birds and marine mammals through entanglement or ingestion of the lost or discarded tackle, although as with other impacts, it remains unclear whether effects might be significant at a population level;

- The introduction of NNS. Whilst there may be local knowledge regarding the transfer of baits in Wales, there is currently no available data relating to the introduction of NNS from RSA activities in Wales. The review has judged that, based on evidence of hitch hiker species in seaweed bait packaging, and anecdotal information of the discarding of live bait at the end of RSA activities (for example at competitions), there is a credible pathway for the introduction of NNS to arise from the activity.

In contrast to the above impact pathways, seabed disturbance (for example, abrasion arising from the retrieval of tackle across the seabed) was not considered to be a significant pressure for most intertidal or benthic habitats. Some evidence indicated localised potential for lines to become entangled, on sessile epifauna, for example sea fans, which may cause damage to the sea fan tissue over time. However, the level of such pressure is considered to be low unless localised fishing intensity is very high.

6.2 Recommendations

In order to improve understanding of the impacts of RSA activities in Wales, there are several areas where additional evidence may be helpful. These include:

- Improved mapping of the spatial and temporal distribution of sea angling effort and of catch volumes across Wales, including an understanding of target species and techniques;
- Better understanding of the proportion of fish of different species released during RSA (i.e. caught but released rather than retained) and post-release mortality rates;
- Implementing recording of marine mammal, turtle and bird species mortality due to entanglement with RSA gear by an appropriate body or organisation (for example the Cetacean Strandings Investigation Programme); and
- Collecting better data on bait type use and bait sourcing from anglers.

It is recognised that the costs of collecting some of this evidence may be high and difficult to justify against other spending priorities. In addition to evidence collection or possibly as an alternative to it, further consideration might usefully be given to education programmes and promoting more sustainable RSA practices as a means of directly addressing environmental risks. For example, this could include:

- Preparing and disseminating guidance to encourage safe catch and release practices for shore and boat anglers;
- Preparing and disseminating guidance on avoidance of littering and losing or discarding tackle;
- Preparing and disseminating guidance on minimising the transfer of NNS from bait or fishing equipment.

Existing campaigns have attempted to address many of these topics in the past, although developing and disseminating current guidance, using current best available evidence new techniques, may increase their success. Any lessons learnt regarding reasons for success or failure should be taken into account when designing any new material.

New guidance could be developed in conjunction with national recreational angling bodies and disseminated through angling clubs and tackle shops. While such voluntary approaches generally struggle to achieve high levels of compliance (e.g. Prior, 2011), this approach is likely to be a low cost, proportionate and practical way of reducing some of the more significant environmental impacts of RSA.

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8. Appendices

Appendix 1: Key Fish Species caught in Welsh Waters

Table A1.1: List of species that may be specifically targeted or caught by recreational sea anglers in Wales

Top 12 primary target species

Shore Angling	Boat Based angling
European seabass	European seabass
Cod*	Cod*
Wrasses	Whiting*
Whiting*	Pollack
Pollack	Black sea bream
Black sea bream	Mackerel
Mackerel*	Plaice
Plaice*	Dab
Flounder	Turbot
Dab	Tope (catch and release only)*
Rays**	Rays**
Smooth hounds	Smooth hounds

Other species targeted or bycaught

Shore angling	Boat Based angling
Bull Huss (greater-spotted dogfish)	Bull Huss (greater-spotted dogfish)
Lesser-spotted dogfish	Spurdog
Pouting	Sharks (porbeagle*, mako, thresher, blue*)
Rocklings	Lesser-spotted dogfish
Sole*	Poor cod
Coalfish	Pout
Garfish	Soles
Gurnards	Herring*
Gobies	Garfish
Blennies	Coalfish
Dragonets	Gurnards
European eel*	Conger eel
Conger eel	Rocklings
Mullets	Wrasses
N/A	Ling*
N/A	Brill
N/A	Tuna species

* Cod, Whiting, Mackerel, Plaice, Tope, Porbeagle Sharks, Blue Sharks, Sole, Herring, European eel and Ling and Marine species of principal importance under the Environment (Wales) Act 2016.
** Blonde, thornback and undulate rays are marine species of principal importance under the Environment (Wales) Act 2016
Source: https://www.biodiversitywales.org.uk/Environment-Wales-Act

Source: Species list supplied by NRW

9. Appendix 2: Literature review search terms

The general search terms used to identify literature on the impacts of recreational sea angling (RSA) are shown in Table A2.1. These search terms were used in the Science Direct (https://www.sciencedirect.com/) and Google Scholar (https://scholar.google.co.uk/) libraries, as well as specialist libraries such as Aquatic Sciences and Fisheries Abstracts (http://www.fao.org/fishery/asfa/en) and Searchable Ornithological Research Archive (https://sora.unm.edu/).

Table A2.1: Literature review search terms

Literature search terms
Recreational sea-angling
Recreational sea angling
Sea angling
Sea-angling
Rsa
Shore angling
Shore-angling
Boat angling
Boat-angling
Sea angling catch
Sea angling by-catch
Sea angling discarded tackle
Sea angling entanglement
Sea angling habitat disturbance
Sea angling seabed disturbance
Sea angling non-native bait
Sea angling prey
Impacts sea angling
Angling impacts
Sea angling Wales
RSA Wales
Sea angling Welsh
Bycatch
Discarded recreational fishing tackle
Fishing weights

For each search term, the titles, authors and dates of at least the first 100 literature results were reviewed for their relevance and suitability. For some of the more productive search terms, up to over 200 results were reviewed to ensure that all relevant studies were captured within the review. Those results which were considered to provide relevant evidence for the aims of the project were then accessed and reviewed where freely available.

10. Appendix 3: Welsh habitats and species considered

Table A3.1: Full list of protected welsh marine habitats with potential relevance to this assessment of impacts of RSA in Wales (note coastal / deep offshore habitats removed)

Name	**Reason for inclusion**
Blue mussel beds	Environment (Wales) Act 2016 Section 7 Habitat
Carbonate reefs	Environment (Wales) Act 2016 Section 7 Habitat
Coastal lagoons	Habitats Directive Annex I
Estuaries	Habitats Directive Annex I
Estuarine rocky habitats	Environment (Wales) Act 2016 Section 7 Habitat
Fragile sponge & anthozoan communities on subtidal rocky habitats	Environment (Wales) Act 2016 Section 7 Habitat
Horse mussel beds	Environment (Wales) Act 2016 Section 7 Habitat, OSPAR List of Threatened and/or Declining Species & Habitats
Intertidal boulder communities	Environment (Wales) Act 2016 Section 7 Habitat
Intertidal mudflats	Environment (Wales) Act 2016 Section 7 Habitat, OSPAR List of Threatened and/or Declining Species & Habitats
Intertidal *Mytilus edulis* beds on mixed and sandy sediments	OSPAR List of Threatened and/or Declining Species & Habitats
Large shallow inlets and bays	Habitats Directive Annex I
Maerl beds	Environment (Wales) Act 2016 Section 7 Habitat
Mud habitats in deep water	Environment (Wales) Act 2016 Section 7 Habitat
Mudflats and sandflats not covered by seawater at low tide	Habitats Directive Annex I
Musculus discors beds	Environment (Wales) Act 2016 Section 7 Habitat
Ostrea edulis beds	OSPAR List of Threatened and/or Declining Species & Habitats
Peat and clay exposures	Environment (Wales) Act 2016 Section 7 Habitat
Reefs	Habitats Directive Annex I
Sabellaria alveolata reefs	Environment (Wales) Act 2016 Section 7 Habitat
Sabellaria spinulosa reefs	OSPAR List of Threatened and/or Declining Species & Habitats
Salicornia and other annuals colonising mud and sand	Habitats Directive Annex I
Saline lagoons	Environment (Wales) Act 2016 Section 7 Habitat

Name	Reason for inclusion
Sandbanks which are slightly covered by sea water all the time	Habitats Directive Annex I
Seagrass beds	Environment (Wales) Act 2016 Section 7 Habitat
Sea-pen and burrowing megafauna communities	OSPAR List of Threatened and/or Declining Species & Habitats
Sheltered muddy gravels	Environment (Wales) Act 2016 Section 7 Habitat
Submarine structures made by leaking gases	Habitats Directive Annex I
Subtidal mixed muddy sediments	Environment (Wales) Act 2016 Section 7 Habitat
Subtidal sands and gravels	Environment (Wales) Act 2016 Section 7 Habitat
Tidal swept channels	Environment (Wales) Act 2016 Section 7 Habitat
Zostera beds	OSPAR List of Threatened and/or Declining Species & Habitats

Table A3.2: Full list of protected marine species found in Wales with potential relevance to the assessment of impacts of RSA in Wales.

Macroalgae and coral species

Common name	Latin name	Reason for inclusion
Bearded red seaweed	*Anotrichium barbatum*	Environment (Wales) Act 2016 Section 7 Species
A red seaweed	*Cruoria cruoriaeformis*	Environment (Wales) Act 2016 Section 7 Species
A red seaweed	*Dermocorynus montagnei*	Environment (Wales) Act 2016 Section 7 Species
Burrowing anemone	*Edwardsia timida*	Environment (Wales) Act 2016 Section 7 Species
Pink sea-fan	*Eunicella verrucosa*	Environment (Wales) Act 2016 Section 7 Species
A stalked jellyfish	*Haliclystus auricula*	Environment (Wales) Act 2016 Section 7 Species
Coral maerl	*Lithothamnion corallinoides*	Environment (Wales) Act 2016 Section 7 Species
A stalked jellyfish	*Lucernariopsis campanulata*	Environment (Wales) Act 2016 Section 7 Species
Peacock's tail	*Padina pavonica*	Environment (Wales) Act 2016 Section 7 Species
Common maerl	*Phymatolithon calcareum*	Environment (Wales) Act 2016 Section 7 Species

Benthic invertebrates and shellfish species

Common name	Latin name	Reason for inclusion
Tentacled lagoon worm	*Alkmaria romijni*	Environment (Wales) Act 2016 Section 7 Species
Icelandic cyprine or Ocean quahog	*Arctica islandica*	Environment (Wales) Act 2016 Section 7 Species, OSPAR List of Threatened and/or Declining Species & Habitat
Fan mussel	*Atrina fragilis*	Environment (Wales) Act 2016 Section 7 Species
Dog whelk	*Nucella lapillus*	OSPAR List of Threatened and/or Declining Species & Habitats
Native oyster	*Ostrea edulis*	Environment (Wales) Act 2016 Section 7 Species, OSPAR List of Threatened and/or Declining Species & Habitats
Crayfish, crawfish or spiny lobster	*Palinurus elephas*	Environment (Wales) Act 2016 Section 7 Species
Lagoon sea slug	*Tenellia adspersa*	Environment (Wales) Act 2016 Section 7 Species

Fish species

Common name	Latin name	Reason for inclusion
Allis shad	*Alosa alosa*	Environment (Wales) Act 2016 Section 7 Species, OSPAR List of Threatened and/or Declining Species & Habitats, Habitats Directive Annex II, Wildlife and Countryside Act 1981
Twaite shad	*Alosa fallax*	Environment (Wales) Act 2016 Section 7 Species, Habitats Directive Annex II, Wildlife and Countryside Act 1981
Lesser sandeel	*Ammodytes marinus*	Environment (Wales) Act 2016 Section 7 Species
European eel	*Anguilla anguilla*	Environment (Wales) Act 2016 Section 7 Species, OSPAR List of Threatened and/or Declining Species & Habitats.
Basking shark	*Cetorhinus maximus*	Environment (Wales) Act 2016 Section 7 Species, OSPAR List of Threatened and/or Declining Species & Habitats, Wildlife and Countryside Act 1981
Atlantic herring	*Clupea harengus*	Environment (Wales) Act 2016 Section 7 Species.
Common skate	*Dipturus batis*	Environment (Wales) Act 2016 Section 7 Species, OSPAR List of

Common name	Latin name	Reason for inclusion
		Threatened and/or Declining Species & Habitats
Atlantic cod	*Gadus morhua*	Environment (Wales) Act 2016 Section 7 Species, OSPAR List of Threatened and/or Declining Species & Habitats
Tope shark	*Galeorhinus galeus*	Environment (Wales) Act 2016 Section 7 Species
Long snouted seahorse	*Hippocampus guttulatus*	Environment (Wales) Act 2016 Section 7 Species, OSPAR List of Threatened and/or Declining Species & Habitats
Porbeagle shark	*Lamna nasus*	Environment (Wales) Act 2016 Section 7 Species, OSPAR List of Threatened and/or Declining Species & Habitats.
River lamprey	*Lampetra fluviatilis*	Environment (Wales) Act 2016 Section 7 Species, Habitats Directive Annex II
Sea monkfish / Anglerfish	*Lophius piscatorius*	Environment (Wales) Act 2016 Section 7 Species.
Whiting	*Merlangius merlangus*	Environment (Wales) Act 2016 Section 7 Species.
European hake	*Merluccius merluccius*	Environment (Wales) Act 2016 Section 7 Species.
Ling	*Molva molva*	Environment (Wales) Act 2016 Section 7 Species
European smelt (or sparling)	*Osmerus eperlanus*	Environment (Wales) Act 2016 Section 7 Species
Sea lamprey	*Petromyzon marinus*	Environment (Wales) Act 2016 Section 7 Species, OSPAR List of Threatened and/or Declining Species & Habitats, Habitats Directive Annex II
European plaice	*Pleuronectes platessa*	Environment (Wales) Act 2016 Section 7 Species.
Blue shark	*Prionace glauca*	Environment (Wales) Act 2016 Section 7 Species.
Blonde ray	*Raja brachyura*	Environment (Wales) Act 2016 Section 7 Species.
Thornback ray	*Raja clavata*	Environment (Wales) Act 2016 Section 7 Species, OSPAR List of Threatened and/or Declining Species & Habitats
Spotted ray	*Raja montagui*	OSPAR List of Threatened and/or Declining Species & Habitats.
Undulate ray	*Raja undulata*	Environment (Wales) Act 2016 Section 7 Species.
White or Bottlenosed Skate	*Rostroraja alba*	Environment (Wales) Act 2016 Section 7 Species, OSPAR List of Threatened and/or Declining

Common name	Latin name	Reason for inclusion
		Species & Habitats, Wildlife and Countryside Act 1981
Atlantic salmon	*Salmo salar*	Environment (Wales) Act 2016 Section 7 Species, OSPAR List of Threatened and/or Declining Species & Habitats, Habitats Directive Annex II
Brown trout (Sea trout)	*Salmo trutta*	Environment (Wales) Act 2016 Section 7 Species
Atlantic mackerel	*Scomber scombrus*	Environment (Wales) Act 2016 Section 7 Species
Dover sole	*Solea solea*	Environment (Wales) Act 2016 Section 7 Species
Spurdog / Spiny dogfish	*Squalus acanthias*	Environment (Wales) Act 2016 Section 7 Species, OSPAR List of Threatened and/or Declining Species & Habitats
Angel shark	*Squatina squatina*	Environment (Wales) Act 2016 Section 7 Species, OSPAR List of Threatened and/or Declining Species & Habitats, Wildlife and Countryside Act 1981
Scad / Horse mackerel	*Trachurus trachurus*	Environment (Wales) Act 2016 Section 7 Species.

Marine mammal and reptiles

Common name	Latin name	Reason for inclusion
Minke whale	*Balaenoptera acutorostrata*	Environment (Wales) Act 2016 Section 7 Species
Fin whale	*Balaenoptera physalus*	Environment (Wales) Act 2016 Section 7 Species
Loggerhead turtle	*Caretta caretta*	Environment (Wales) Act 2016 Section 7 Species, Habitats Directive Annex II
Common dolphin	*Delphinus delphis*	Environment (Wales) Act 2016 Section 7 Species
Leatherback turtle	*Dermochelys coriacea*	Environment (Wales) Act 2016 Section 7 Species
Long-finned pilot whale	*Globicephala melas*	Environment (Wales) Act 2016 Section 7 Species
Risso’s dolphin	*Grampus griseus*	Environment (Wales) Act 2016 Section 7 Species
Grey seal	*Halichoerus grypus*	Habitats Directive Annex II
Northern bottlenose whale	*Hyperodon ampullatus*	Environment (Wales) Act 2016 Section 7 Species

Mammal species

Common name	Latin name	Reason for inclusion
Otter	*Lutra lutra*	Habitats Directive Annex II

Bird species

Common name	Latin name	Reason for inclusion
Red-throated diver	*Gavia stellata*	Birds Directive Annex I
Great cormorant	*Phalacrocorax carbo*	Birds Directive Annex I
Northern Gannet	*Morus Bassanus*	Birds Directive Annex I
Common tern	*Sterna hirundo*	Birds Directive Annex I
Arctic tern	*Sterna paradisaea*	Birds Directive Annex I
Sandwich tern	*Sterna sandvichensis*	Birds Directive Annex I
Little tern	*Sterna albifrons*	Birds Directive Annex I
Roseate tern	*Sterna dougallii*	Birds Directive Annex I
Little gull	*Hydrocoloeus minutus*	Birds Directive Annex I
Lesser black-backed gull	*Larus fuscus*	Birds Directive Annex I
Puffin	*Fratercula arctica*	Birds Directive Annex I
Manx shearwater	*Puffinus puffinus*	Birds Directive Annex I
European storm petrel	*Hydrobates pelagicus*	Birds Directive Annex I
Great crested grebe	*Podiceps cristatus*	Birds Directive Annex I
Common Shelduck	*Tadorna tadorna*	Birds Directive Annex I
Wigeon	*Anas penelope*	Birds Directive Annex I
Eurasian Teal	*Anas crecca*	Birds Directive Annex I
Greenland white-fronted goose	*Anser albifrons*	Birds Directive Annex I
Northern Pintail	*Anas acuta*	Birds Directive Annex I
Common scoter	*Melanitta nigra*	Birds Directive Annex I
Common redshank	*Tringa totanus*	Birds Directive Annex I
Grey plover	*Pluvialis squatarola*	Birds Directive Annex I
Curlew	*Numenius arquata*	Birds Directive Annex I
Common oystercatcher	*Haematopus ostralegus*	Birds Directive Annex I
Dunlin	*Calidris alpina*	Birds Directive Annex I
Red Knot	*Calidris canutus*	Birds Directive Annex I
Common ringed plover	*Charadrius hiaticula*	Birds Directive Annex I
Bar-tailed godwit	*Limosa lapponica*	Birds Directive Annex I
Black-tailed godwit	*Limosa limosa*	Birds Directive Annex I

11. Data Archive Appendix

No data outputs were produced as part of this project.

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