# Recreational bass angling in Wales: Approaches to data collection and the distribution of angling effort in the recreational European sea bass (*Dicentrarchus labrax L.*) fishery.

Thesis presented to the University of Wales for the degree of Master of Science

By

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# Recreational bass angling in Wales: Approaches to data collection and the distribution of angling effort of the recreational Sea bass (*Dicentrarchus labrax*) fishery.

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## b. EXECUTIVE SUMMARY

This study presents the extent of data available on the recreational European sea bass (*Dicentrarchus labrax* L.) fishery within Wales, seeking to identify and assess exploitable, low cost sources of catch data and to explore new and novel means of collecting data in the future. It is anticipated that these novel approaches will contribute to the sustainable management of the species within Welsh territorial waters by contributing to the development of national data collection strategies to help the Welsh Government meet likely future requirements under the ECs Data Collection Framework, Council Regulation (EC) No 199/2008.

Catch information gathered during the 3 month extent of the project gives relative seasonal and spatial recreational angling effort of the sampled data across Wales and is provided as a 'proof of concept' for the data collection methodologies outlined. In particular the novel exploitation of bass catch data published to angling forums is explored and demonstrated to yield numbers in excess of other sources here-in compared. It is anticipated that this methodology could offer a low cost and reliable pool of recreational angler information of utility across multiple disciplines including coastal management and directed coastal services, sustainable fisheries management and to more efficiently direct national scale survey assessments of recreational angling in the future.

The specification for an online angling diary and associated smartphone application are presented, however evidence suggests that such an application, delivered in isolation by a governmental associated organisation, would fail to provide sufficient catch records to justify any investment, with estimated adoption rates of fewer than 30 users, from visiting and resident anglers prosecuting bass in Welsh waters.

Specific report findings are summarised under the abstracts of sections *2. Recreational sea bass catch records in Wales: scope and new methods of data collection* and *3. Recreational bass angling in Wales: Trends in spatial and temporal effort within sampled populations.*

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## i. LIST OF ABBREVIATIONS

| | |
|---|---|
| BASS | *Bass Anglers' Sportfishing Society* |
| BU | *Bangor University* |
| CCW | *Countryside Council for Wales* |
| CEFAS | *Centre for Environment, Fisheries and Aquaculture Science* |
| CFP | *Common Fisheries Policy* |
| CPUE | *Catch Per Unit Effort* |
| DCF | *Data Collection Framework* |
| DMRP | *Diary Market Research Poll* |
| EC | *European Community (legislative body of the European Union)* |
| EFF | *European Fisheries Fund* |
| EQR | *Effort Quality Rank* |
| EU | *European Union* |
| FAO | *Food and Agriculture Organisation* |
| GH | *Gear Hours* |
| GUI | *Graphical User Interface* |
| ICES | *International Council for the Exploration of the Sea* |
| IDW | *Inverse Distance Weighted Interpolation* |
| KML | *Keyhole Markup Language* |
| LPUE | *Landings Per Unit Effort* |
| MES | *Marine Ecological Solutions* |
| MW | *Mid Wales* |
| NLP | *Natural Language Processing* |
| NRW | *Natural Resources Wales* |
| NW | *North Wales* |
| RSA | *Recreational Sea Angler or Angling* |
| RSF | *Recreational Sea Fisher* |
| RSFD | *Recreational Sea Fisher Diary* |
| RSGB | *Research Surveys of Great Britain* |
| SaaS | *Software as a Service (also see* i. *List of technical terms)* |
| SFCC | *Scottish Fisheries Coordination Centre* |
| SFP | *Sustainable Fisheries Project* |
| SW | *South Wales* |
| TCO | *Total Cost of Ownership* |
| URL | *Uniform Resource Locator* |
| WG | *Welsh Government* |
| WFSA | *Welsh Federation of Sea Anglers* |
| www | *World Wide Web* |

## j. LIST OF TECHNICAL TERMS

| Term | Definition |
|---|---|
| **Scraped** | To derive data direct from World Wide Web pages by automated means, typically this also implies automated structuring of the derived content into machine readable formats. |
| **Aggregate or Roll up** | Traditionally a database term, where a mathematical operation (for example average and sum) is applied to data grouped by a selection of fields. |
| **Software as a Service** | The provision of a software application on an intra- or internet host typically with a web browser client. |
| **Data cleaning/cleansing** | To remove extraneous characters from data, to correct format errors (for example non standard dates) or otherwise convert a dataset into standard machine readable well formed tabulated format. |
| **Parse** | To divide a string of characters (typically words) into their constituent parts. For example, parsing "The quick brown fox" using the space character as the delineator would result in 4 separate strings: "The", "quick", "brown" and "fox". |
| **Natural Language Processing** | The analysis of sentences and paragraphs to determine parts of speech and coreferences among and between chunks of text. |
| **PHP and Perl** | Programming languages, executed by a web server to deliver dynamic content to web browsers. |
| **Plug-in** | A small application packaged up so that it can easily be added and used by a parent program, typically adding additional features to the parent program that would otherwise be absent. |
| **Web server** | A computer running a program which process requests for web pages from users, then delivers the requested output over the world wide web to the uses web browser. |
| **Script (Scripted)** | A program language, typically proprietary, supported by an application to allow the unattended automation of tasks which a user would typically execute while using the application *in-situ*. This allows repetitive tasks to be executed without user intervention, or application actions to be executed late at night without a user being present. |

# 1. OVERARCHING INTRODUCTION

## 1.1. Context

This thesis was delivered in association with the Bangor University (BU) lead project, *Sustainable Use of Fisheries Resources in Welsh Waters*, under funding provided by the European Union's (EU) European Fisheries Fund (EFF) with monies allocated to the Welsh Government (WG) (Welsh Government 2013) to ensure its fisheries meet the requirements of the 2002 reform of the Common Fisheries Policy (CFP) (European Fisheries Fund 2011). The Sustainable Fisheries Project (SFP) is integral to the implementation of the WG's Wales Fisheries Strategy 2008 (WAG 2008) which details the approach for fisheries management across all sea fisheries in Wales, including the recreational sector, to 2020.

SFP is primarily concerned with species identified as commercially important and includes the European bass, *Dicentrarchus labrax* which is a common target for both the commercial inshore fleet and recreational sea fishers (RSF) (Nautilus Consultants Ltd. 2000, Goudge *et al*. 2010). Despite no specific assessment of the economic contribution of bass prosecution, the gross revenue losses under complete removal of the recreational and commercial fishery for all species landed from Welsh waters was estimated at £118 million and £101 million respectively in 2004/5 (Richardson 2006) and though the sterling value of bass landings are relatively small for the commercial sector at ≈ 2% of total (Burgess 2010), it is of high (though formally unquantified under peer review) value as a target species for the recreational fisher (BASS 2004).

As implicitly implied in the inclusion of bass within the SFP, the extent of the Welsh bass fishery is not fully quantified, a position common to this non-quota species within ICES divisions VIIa, VIIf and VIIg (Appendix I) (ICES 2012f). Bass are vulnerable to overexploitation, having high post juvenile geographical fidelity (Pawson *et al*. 2007) and ICES still considers the stock to be data-limited (ICES 2012d) while being subject to increased fishing pressure, particularly during the last 15 years (ICES 2012f). This position has lead to an increased focus at EU member state level to improve bass reporting, a sensible undertaking should bass become subject to a total allowable catch (TAC), thereby bringing the species under EU Council Regulation I224/2009 and subject to reporting under the Data Collection Framework (DCF), though this instrument does not apply to recreational shore fishing at the time of writing. The SFP therefore will serve both to meet future legislative requirements while serving local cross sector fisher interests by ensuring the knowledge is in place to sustainably manage Welsh fisheries.

## 1.2. Bass biology

A comprehensive treatment of the species is given in the definitive review of Pickett and Pawson (1994) with more recent works as referenced, however the following overview of the species is provided for context:

The European bass is an iteroparous oviparous batch spawner and is gonochronistic (Murua and Saborido-Rey 2003). Sex determination is polygenic and affected by temperature (Piferrer *et al.* 2005, Vandeputte *et al.* 2007) and the sexes display dimorphism in size and growth rates (Saillant *et al.* 2001). Tagging by Pawson and Pickett (1996) of 2205 specimens taken over 8 years gives key morphological and maturity data for UK Bass and the following information references his treatment unless otherwise specified. Bass gonadal maturation is strongly associated with length rather than age, total length (TL) at first maturity is 32 cm and 42 cm for males and females respectively, with maturity between 4 and 7 yrs, females have significantly greater length at age for ages > 4 yrs and a separate study by Saillant *et al.* (2001) estimated female weight at ≈ 26% greater than males in fish > 2 yrs (with some yearly fluctuation). Growth was isometric in both sexes (adjusting for intra-year condition variations), with condition for mature fish north of the Severn estuary maximising between September and December then decreasing during the breeding season before recovery commencement in June.

Bass are widely distributed throughout the coastal waters of Europe and Figure 1-1 shows their comparatively high occurrence in the coastal waters of the UK. The tagging study of Kelley (1979) between 1971 to 1975 ($n$ = 912) showed different migratory behaviours between juveniles (< 32 cm) and adults (> 42 cm), with adults migrating to spawning grounds offshore of South Cornwall starting in November and returning through May and June. Juveniles in contrast do not undergo the migration to the breeding grounds and have been found to stay relatively close to tagging points (Pickett *et al.* 2004).

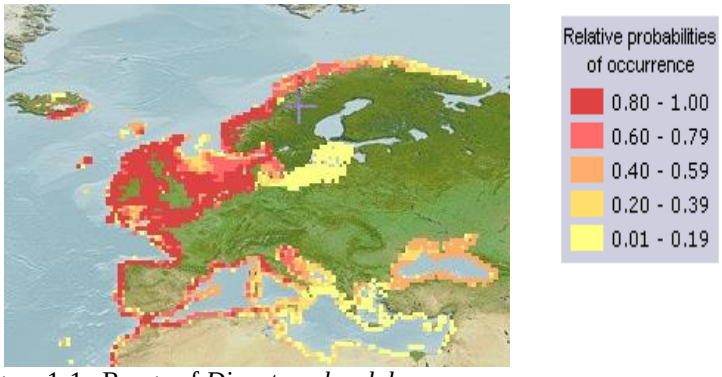



Figure 1-1. Range of *Dicentrarchus labrax* based on standardised distribution as indicated by key. Map data reproduced from Kaschner et al. (2010).

# 2. RECREATIONAL SEA BASS CATCH RECORDS IN WALES: SCOPE AND NEW METHODS OF DATA COLLECTION

## 2.1. Abstract

Primary sources of effort and catch data for the recreational bass fishery were for-hire charter skippers, online forums and angling clubs. Angling magazines provided no accurate indication of effort with their specimen records and organised historical surveys have targeted high footfall areas exampled by competitive matches and popular summer venues like Llandudno pier and Holyhead breakwater which are not associated with the prosecution of bass (Pearson 1968, Gammon 1974).

Clubs had low yields of valid data sources containing bass catches, with only 4 (9%) actively organising bass targeted trips, 3 of which were in South Wales and 1 in North Wales. Response rates were also poor with 29 of 47 (62%) neglecting to reply. In contrast non-response rates in charter skippers were 2% with 20 (36%) prosecuting bass, 8 of which maintained catch diaries. Match cards from organised competitions and observation surveys (primarily provided by Marine Ecological Solutions and limited to North Wales) yielded 51 records of bass from 26,000 gear hours, effort however was accurately recorded.

Aside from the exceptional diary of a single rod and line commercial fisher (terminating in November 1994), forum mined data provided the greatest number of record returns with 1,456 (76%) measures of individual bass and 1,272 (73%) recordings of catch numbers and > 50% of these data had an associated effort measure. Forum data derived under a trial methodology provided the most consistent year on year catch numbers ($M$ = 51.4 ±14.0) and individual bass measure records ($M$ = 168 ±45) between 2006 to the present (September 2013).

Under scrutiny based on a small non-random poll ($n$ = 67) presented here-in, the viability of an online Software as a Service angler diary application, delivered in isolation by a governmental associated organisation, remains to be proven with estimated adoption rates of fewer than 30 users from an estimated visiting and resident cross Wales angling population of 40,000 (Nautilus Consultants Ltd. 2000). The key factors influencing user adoption within the survey sample were usability, security/data access concerns and low personal utility. Support for the data collection parameters defined under the specification was good with 84% agreeing they were of utility. Poll results indicated that providing a smartphone application would boost application adoption by 2 within the target angler population of 40,000.

## 2.2. Introduction

Firstly we need to define the terms *recreational sea angling*, *recreational sea fishing* and *hobby fishing* as they are open to interpretation, Pawson *et al*. (2008) gave a comprehensive treatment of the subject and the range of terms employed across the EU is large and confusing. This thesis uses the following definitions: recreational sea angling (RSA) is the capture of fish by rod and line where the fish are not subsequently sold, recreational sea fishing (RSF) is a superset of RSA, with the no-sell directive, but covers the capture of all finfish species by any method. Hobby fishing is a subset of RSF and encompasses recreational netting and potting.

The recreational fishing sector in Wales is spatially and temporally heterogeneous (Richardson 2006, Goudge *et al.* 2009, Goudge *et al.* 2010), this is unsurprising as the coast ranges over 2740 km (at scale 1:50:000) of highly variable Welsh shoreline and bass are targeted by a variety of methods, including lure fishing with 'spinners' and other 'artificials'; live-baiting under float or by freelining, ledgering a bait on the sea floor; netting with seine, gill and throw nets; and spear fishing across a variety of coastal environments, from surf beaches to high energy reef systems (Pearson 1968, Ladle and Vaughan 2003).

RSFs will frequently report that they have little impact on fish stocks however with particular reference to bass, multiple studies have demonstrated that recreational catch can be comparable to the commercial take (ICES 2005, Herfaut *et al.* 2010, ICES 2012d, ICES 2012f). This demonstrates that if bass are to be correctly managed, as surely they must as such an important species, then the RSF sector must be accounted for, yet the above factors make assessments logistically difficult and financially expensive. The challenges are exacerbated by the recreational sector having no legal registration or licensing requirements which in other countries provide a sampling frame closely mapped to the RSA population as exampled by US Marine National Fisheries Statistics Program (NFSP 1987). Well understood target populations and their sampling frames greatly improved the implementation and all aspects of the statistical analysis of those assessments (Pollock *et al.* 1994, ICES 2009a), it is therefore important under the current socioeconomic climate that novel and comparatively low cost means of assessing the Welsh bass recreational fishery are investigated both to ensure the fishery is sustainably maintained and to meet likely future reporting requirements under EC legislation.

### 2.2.1. Aims and Objectives

- To identify and assess the extent of existing data sources which recreational sea fishers may provide on their bass captures within Wales.
  - To document the catch record yields from the identified recreational angler partitions to inform where data collection effort may be best directed in the future.
  - Partition the recreational angling sector within Wales into logical groups and obtain their historical records for collation and examination into a single repository of data from which estimates of catch per unit effort, size measures, effort and spatial temporal patterns of recreational bass angling may be identified by future studies.
- To investigate new methods of collecting angler effort, catch and individual bass measures with cost effective methodologies to ensure the establishment of long term time series of data for temporal comparison.
  - Produce a specification for a Software as a Service web and smartphone diary application for the collection of RSA fishing activity on a regular basis and with reduced uncertainty.
  - To establish if such an application would offer a return on resource investment in terms of data returns.
  - To investigate other novel technical solutions to the collection of angling data from persons prosecuting bass within Wales from whatever sources may be identified as available and which meet previously defined criteria and to present methodologies on how these sources may be exploited.

## 2.3. Methods

### 2.3.1. The scope of catch record sources in Wales

A variety of RSF centric entities, likely to maintain historical catch records were identified from personal knowledge and discussion with colleagues in BU, NRW, CEFAS and Marine Ecological Solutions, these entities are listed in Table 2-1.

Table 2-1. Listing of entities related to or within the recreational sea fishing sector that may hold historical time series of recreational catch data for bass.

| Type | Description |
|---|---|
| Angling guides | Individuals, typically highly experienced in the pursuit of bass, who run a paid service to tutor private shore and kayak anglers in the capture of bass with rod and line |
| For-hire charter boats | Powered boat, frequently licensed to operate far offshore for the purposes of carrying anglers to catch fish who pay a fee to the boat skipper. |
| Independent, academic and governmental bodies engaged in fisheries | Existing data collated by organisations involved in the assessment of RSF, derived from the above sources via traditional survey methods (for example intercept and telephone surveys). |
| Online sources – forums and social media | World wide web (www) derived information, almost exclusively published by private individuals, though also charter boat skippers and sea angling clubs. |
| Private individual fishing from a privately owned boat. | Individuals owning a powered water borne vessel. |
| Private individuals fishing from shore and kayak | Individuals fishing from shore or kayak. Kayak anglers are included in the shore category, despite on occasion ranging past the 6 mile limit, as they are not restricted to slipways for launching and the vessel is very rarely power assisted (some may use an electric motor). |
| RSF Clubs | Organised groups of anglers, often running informal or formal competitions, frequently providing access at reduced cost to for-hire charters, access to venues which may otherwise be off limits (restricted docks for example) and personal insurance. |

| | |
|---|---|
| Federations | Umbrella entities to which multiple clubs are affiliated, typically providing a unified voice for anglers at the socio-political level. |
| Sea angling magazines | Several periodicals are published aimed at recreational sea anglers, these carry reports of trophy fish, submitted primarily by individual anglers. |

Entities initially targeted for discussion regarding the extent of their historical catch records were federations, clubs and for-hire charter skippers, primarily because contact channels were publicly available on the www; in sea angling magazines, and because they would be amenable to being contacted as part of their day to day business operation. Expert advice from NRW personnel indicated that these sources were most likely to maintain catch records and that data were anticipated to minimise geographical and temporal covariates by repeating angling trips at the same location and time across years. The federation WFSA and the club BASS were also approached and amenable to cooperate with the work.

It was considered that intercepting individual private anglers who successfully target bass would be time consuming and inefficient in view of the study area coverage and though this method is a mainstay of traditional surveys (Pollock *et al.* 1994) it does not meet the criteria of being repeatable year on year at comparatively low cost. Anecdotal evidence and the Welsh Pilot Surveys of 2007/8 (Goudge *et al.* 2009, Goudge *et al.* 2010) indicate that successful bass anglers are a rare population in formal survey terms and also protective of their locations and catch history with respect to bass for fear of localised extirpation by fishers exploiting the species for profit.

Unfortunately the magazine based trophy catch data compiled by Richardson (2006) were no longer available[1] and as Richardson's thesis indicated, it is not possible to obtain effort estimates from this source. The two largest sea angling magazines by readership, Sea Angler and Total Sea Fishing were contacted, however neither magazine holds catch reports in a well formed electronic format and therefore no further consideration of these resources was made.

Bodies engaged in fisheries research provided invaluable feedback though historical datasets with bass catches were limited as there is no regular RSF assessment in Wales. Marine Ecological Solutions (MES) had received a large number of match cards which record the catches of individual anglers during formal club competitions. In addition, data from intercept and observational surveys were obtained.

[1] These data was made available on 16th October 2013 and are now held by professor Michel Kaiser, School of Ocean Sciences, Bangor University, Menai Bridge, Anglesey.

Following initial scoping, the following sources were identified as the most likely to provide a reasonable return of catch data. The methodology for the collection and collation of their data are outlined as follows:

#### *2.3.1.1. Clubs and skippers*

It was anticipated that both clubs and for-hire charter skippers may keep records pertaining to catches, clubs in particular were expected to maintain historical results of specimen catches by members along with match card results (see 2.3.1.2). Hence a contact list of Wales based angling clubs was drawn up from WFSA records, from the online forums World Sea Fishing and Wirral Sea Fishing (Thrussel 2013, Wirral Sea Fishing 2013), www search, and individual details passed on by WFSA and BASS.

A list of charter skippers was compiled primarily from www.cbuk.co.uk, with smaller contributions from web searches, Sea Angler Magazine, Total Sea Fishing magazine and angling forums. Enquiries were directed to the Seafarers Registry, and the Marine Office who informed the author that no comprehensive registry of for-hire charter boats is held.

Priority was given to making contact by telephone, followed by email then finally web form when contacting an entity to discuss the availability and extent of their available data. If no response was achieved in three contact events then no further contact was attempted.

#### *2.3.1.2. Club match cards*

Match card data were derived from two primary sources, the first from competitive shore matches (*competitive*) held by fishing clubs where attendances were frequently in excess of 30 anglers. These data were provided by Marine Ecological Solutions (with the exception of one time series from a Tenby shore angling club) who obtained the results from matches held in North Wales during their work on the 2007/8 pilot surveys previously referenced. To qualify, shore matches as outlined above do not target bass, and may frequently be held to minimise catches across all species (NRW, *Pers. Comm.*)

The second primary source was from boat based angling clubs, these were informal competitions between members, either onboard private vessels or on a privately chartered boat, these will deliberately target bass by employing methods designed to maximise catch or the chance of capturing specimen fish (*bass targeted*) in contrast to competitive matches.

Sources were processed in the same manner, all results were reviewed and the location, participant number, date, duration and any bass catches (size measure and number) recorded. Source details were noted to ensure later stratification by data source type remained possible.

#### *2.3.1.3. Forums*

It was known to the author that online forums were used extensively by RSAs to report their catches, initially these were discounted as a data source due to the volume of records requiring review, the heterogeneity of the reporting population and the likelihood of prestige bias (Campbell *et al.* 2001), however during the progress of the thesis, difficulty in procuring data from the sources outlined above lead to this decision being revised. The bulk of a new methodology in mining online forum data is dealt with in section 2.3.3. A high level summary of the data derived there-in is presented in section 2.4.3**.**

#### *2.3.1.4. Survey data*

Several angling surveys have been carried out over the past 10 years to profile and assess angling activity and estimate its economic value, these surveys represent a large expenditure of human resources, particularly where intercept interviews or direct angler observation have been used as the survey instruments, however data so derived tends to yield CPUE, effort and fish measures of reduced recall and prestige bias when compared by indirect contact methods which rely heavily on respondent recall (Pollock *et al.* 1994, ICES 2009a).

Survey data were obtained from Richardson's 2006 thesis (Richardson 2006), the NRW FishMap Môn project (NRW 2013) and the North Wales Recreational Pilot Surveys of 2007 and 2008 (Goudge *et al.* 2009, Goudge *et al.* 2010), they were examined for incidences of bass catches.

### 2.3.2. Modern approaches to data collection: An online angling diary

The cost and difficulties faced in conducting surveys of recreational fishers is well establish (Pollock *et al.* 1994), hence passive methods to harvest data from anglers could reduce long term costs and ensure the continued collection of data beyond the lifetime of most single project survey efforts. What follows therefore is an outline of the design and specification of a Software as a Service (SaaS) application through which RSFs could record their catches to meet the criteria of an alternative low total cost of ownership solution to providing long term data series of recreational angling catches in Wales, and possibly beyond.

#### *2.3.2.1. Preliminary scoping*

The initial step identified the candidate variables to be collected, these were determined with expert consultation from MES and NRW. Variables identified were reviewed and normalised into a 3 tier hierarchical structure, with variables assigned to the relevant tier, these were: angler, an angler's trip, and at the lowest tier, the anglers catch. Trip and catch fields were documented and

disseminated to both MES and NRW, and to the angling organisations WFSA and BASS, to gather feedback for further refinement of the specification.

Following feedback, the resulting refined variable list informed the questions of a market research poll targeted at recreational sea anglers to gather opinion on the attitudes and viability of a SaaS website and companion smartphone application. Of particular importance was if the investment required to produce such a SaaS application would find sufficient support to justify that investment.

#### *2.3.2.2. Recreational angler opinion poll*

Restricted resources and time made a survey methodology with parametric sample statistic estimators suitable for extrapolation to angler populations unrealistic, in this instance therefore the survey instrument and its dissemination were chosen accepting a likely bias, with a design incapable of providing statistical means of correction. This author suggests that the bias direction would be to inflate estimates of anglers wishing to use an online diary so results would be interpreted as a 'best case' outcome. The logical basis therefore is that if the best case fails to be 'best' enough then any further investment should be considered with caution.

The survey instrument was a 5 point Likert scale based poll, designed to fit on a double sided page of A4, the poll is reproduced in Appendix II. The scale and its phraseology were chosen based on Jones and Loe (2013), and due consideration to avoiding bias in questionnaire design was given (O'Muircheartaigh *et al.* 1993, Lietz 2010).

The questionnaire was published online using Survey Monkey (Finley 7/Jul/2013) and requests to complete the poll were posted on popular www sea angler forums; the forums provide a secondary (simplistic) means of gauging interest as the number of people having viewed the post is recorded. In addition to forum promotion, emails were sent to contacts gathered as outlined in 2.3.1 encouraging completion. Two open club matches were attended where anglers were interviewed in person, or, if inconvenient, given the survey in a prepaid envelope for completion and return at a later date.

Questions were intended to elucidate several aspects of the application development; the amount of information respondents would be willing to provide, the features and information they would like to use and the viability of a companion smartphone application.

Relative response frequencies were aggregated across activity level stratification for visual examination of response trends and plotted on a diverging stacked bar graph to facilitate interpretation (Robbins and Heiberger 2011). Frequency analysis was carried out in IBM SPSS 20 (IBM 2011).

### *2.3.2.3. Estimates of the number of application adopters*

To provide a 'best case' estimate of the total number of adopters in Wales, the number of people exposed to a poll completion request was recorded for each dissemination method (where possible). For forums the number of thread views was used.

The question *'how often do you sea fish per year'* was included and matched the high/medium/low activity stratification determined in a national survey undertaken in 2003 by Research Surveys of Great Britain (RSGB), respondents were also requested to provide the name of their web browser software and smartphone ownership to inform software design decisions (for example, if only 3% of anglers were using Internet Explorer 6, would ensuring IE6 compatibility be justified). UK wide statistics on web and mobile device use were accessed (Netbiscuits 2012) and presented for comparison. Unfortunately respondents' rates partitioned by survey collection method were too low to further partition by the RSGB activity stratification and so the forum yield rate alone was used with all questionnaire responses pooled.

The total estimate of resident and visiting anglers to Wales of 40,000 (Nautilus Consultants Ltd. 2000) was taken as the target population and equation [1] was used to estimate the number of application users *p* where $P_t$ is the sea angler population, $r_l$, $r_m$ ,$r_h$ are the proportion of low, medium and high activity anglers in $P_t$ ; $s_l$, $s_m$, $s_h$ are the ratios of low, medium and high anglers who said they would slightly agree or agree to using an online diary from the survey sample, ***including*** all anglers (partitioned by activity level) who read the forum posts requesting survey participation[2]. C is the SaaS industry conversion rate, a measure of mean user numbers visiting a company's website (or otherwise contacted with targeted marketing) who take up services. A value for C of 0.07 was taken from MECLAB (2011). Table 2-9 in the results section breaks down the calculation into its constituent steps and should be consulted if methodological clarification is required.

$$p = \sum \left| P_t \times \begin{Bmatrix} r_l \\ r_m \\ r_h \end{Bmatrix} \times \begin{Bmatrix} s_l \\ s_m \\ s_h \end{Bmatrix} \times C \right. \qquad [1]$$

[2]This adjustment is intended to account for the author's assumption of selectivity bias where anglers wanting an online diary would be more inclined to take part in the survey.

### 2.3.3. Modern approaches to data collection: Text mining of online reports

Catch record yields from traditional sources were sparse and logistically difficult to obtain, the author was aware of a large collection of historical data deposited by RSAs on www forums, these historical data had the potential to be a productive source of catch records. The following section outlines a trial methodology for the extraction and data handling of these largely unrestricted free text reports submitted to angling forums by recreational anglers. The data extracted is later used in the examination of sampled effort under section 3. *Recreational bass angling in Wales: Trends in spatial and temporal effort within sampled populations.*

#### *2.3.3.1. Forums and thread URL extraction*

The most popular sea angling forums on the www were identified and where necessary accounts created to access submitted angler reports (called *threads*). These threads are found in a dedicated 'folder' within the forum's hierarchy, Figure 2-1 illustrates the principle. For popular forums, threads will be posted across many separate pages, the URL for each of these pages is examined and links manufactured programmatically (the post-link URLs). These post-link URLs were submitted to a web scraping tool (or scraper) (Outwit Technologies 2013)[3] which was scripted by this author to remove the pertinent URLs to individual angler submitted reports (report URLs), an extracted report URL then links to what is the equivalent of the page of a traditional angler's diary entry.


Figure 2-1. Screen capture of a public online forum at http://www.worldseafishing.com/forums. Relevant features are labelled. The first post in a thread (not shown) is that made by the thread author. In a report folder (exampled here as South East Catch Reports and Advice) this first post of a thread is likely to contain information pertaining to recreational catches of sea fish.

[3] To minimise target web server loads, scraper page requests must be limited to 1 every 10 seconds and should only run between midnight and 7 am.

#### *2.3.3.2. Scraping and handling of threads*

All forums were handled with the same protocol (though each requires separate extraction scripts) as follows: Thread URLs were cleaned and processed where necessary and the scraper programmed to interpret the thread URL format from which all reports had their date, title and report texts extracted en-masse. These scraped threads were imported into SQL Server (Microsoft 2008) for subsequent processing. A list of word substitutions for spelling errors and colloquial terms was created and executed in SQL Server (for example, anglers call bass 'silvers', hence all instances of 'silvers' were placed with 'bass') to simplify subsequent processing, this is necessary to improve the yield of reports with potentially pertinent data.

#### *2.3.3.3. Thread post download processing*

The author developed an application in Visual Studio 2008 (VS) (Microsoft 2008a) using the SharpNLP library (richardn 2006). The SharpNLP library was initially assessed for advanced NLP processing however within the project time scale this was untenable and SharpNLP was used to split sentences according to a natural language processing (NLP) rule set. N.B. though it appears deceptively simple, sentence splitting is a complex task.

##### 2.3.3.3.1. Extracting sentences with catch information

To identify sentences containing keywords and numerics likely to indicate a platform (e.g. boat or shore), an effort measure (e.g. fished 4 hours to high tide), the number of fish caught (e.g. landed half a dozen silvers) and measures of size (e.g. caught a five lbs bass) personal knowledge and angler reports were reviewed and a library of these key words and short phrases collated within the database and as program arrays. Sentences were compared by the VS application and if they matched the necessary criteria they were extracted, tagged and finally written to the SQL Server database for manual processing. The extraction process was iteratively amended throughout the processing of the data to help improve extraction rates and reduce missed reports, at the cost of increasing the manual interpretation of extracted sentences.

##### 2.3.3.3.2. Georeferencing threads

To identify the location of the angling activity it was necessary to build a list of place names used by anglers. Names from a national gazetteer of Wales (GeogData 2001) were obtained, in addition the UKHO admiralty maps were reviewed and likely feature names within the 6 nautical mile limit added to the names list (e.g. maritime names of sandbanks, reefs, deeps and submerged/drying rocks).

The www was used to identify fishing location colloquialisms and a subsample of downloaded threads from each forum were reviewed to extract further locations and the geographical position of colloquial names was identified and mapped to the nearest formal place name. Each thread was then checked by the VS program for the presence of any of the compiled names and all sentences with place name matches were written to the SQL Server database for manual processing. Names were subsequently georeferenced as detailed in section 3.3.1.3 and this process was applied to all derived data resulting in 254 separate coastal locations at which trips were able to be associated.

2.3.3.3.3. Final processing of extracted thread sentences

Following application extraction all sentences were examined manually to extract pertinent catch, effort and platform data which were transcribed into Microsoft Excel prior to re-importation into SQL Server for analysis. The data generated from this trial methodology contributed to results in sections 2.4.3 and 3.

## 2.4. Results

### 2.4.1. The scope of catch record sources in Wales

The breakdown of the response from entities contacted is given in Table 2-2. Of the 105 contacts, for-hire charters maintained twice ($n$ = 8) as many records as clubs ($n$ = 4), skippers were also more readily contacted, with only a 2% non-response rate. Comparing the current number of for-hire charters ($n$ = 56) with that of Richardson's 2006 thesis ($n$ = 56) confirms a comprehensive coverage, though well below the 76 given in the Drew Associates assessment of 2006, however ≈ 10 of the charter boat contacts were invalid or had ceased operations. The low rate of refusals (≈ 1%) is encouraging however converting cooperative fishers into physical datasets was challenging, with only 6 separate contributions received at the time of writing.

Table 2-2. Number of contacts by entity type with response rates. Percentages given are with respect to the totals by entity row.

| Entity | Total | Did not respond | Refused to cooperate | Targets bass | Maintains records | Match cards |
|---|---|---|---|---|---|---|
| Club | 47 | 29 (62%) | 1 (2%) | 4 (9%) | 4 (9%) | 2 (4%) |
| Guide | 2 | 0 (0%) | 0 (0%) | 2 (100%) | 2 (100%) | n/a |
| For-hire charter | 56 | 1 (2%) | 0 (0%) | 20 (36%) | 8 (14%) | n/a |

Data arising from organised surveys was sparse for bass catches, Richardson's thesis did not differentiate between species caught by angler (this was predominantly an economic assessment) but did record anglers' top 3 target species for their last trip

MES provided the bulk of the competitive match card data (primarily covering North Wales with the exception of a Tenby based club) this set only yielded 51 records of bass capture over ≈ 26,000 gear hours fished (1 capture per 510 hours) occurring over ≈ 300 matches between September 1991 and November 2012, additionally the MES match cards only had bass landed in 6 matches (2%). The single contributing South Wales club had landings across 21 matches since January 2005, however details of matches with no bass captures were not provided.

Table 2-3 summarises the data derived by the data source classification and Figure 2-2 gives a time series of the number of trip reports by source. Note that more detail regarding forum derived data is given in section 2.4.3. The increase in forum use for reporting purposes is clear, with a sharp increase in reports beginning in 2003. The commercial diary (as it will hence forth be known), derived from a single fisher and recording commercial and recreational angling to 1994 provides a strong time series, however its termination in 1984, as the fisher no longer found bass commercially viable (personal interview), is unfortunate and no other contacts encountered during the pursuit of this thesis indicated that historical data of comparable quality were available, with the exception of another commercial rod and line fisher, already cooperating with the project team, but who was unwilling to share their personal diaries.

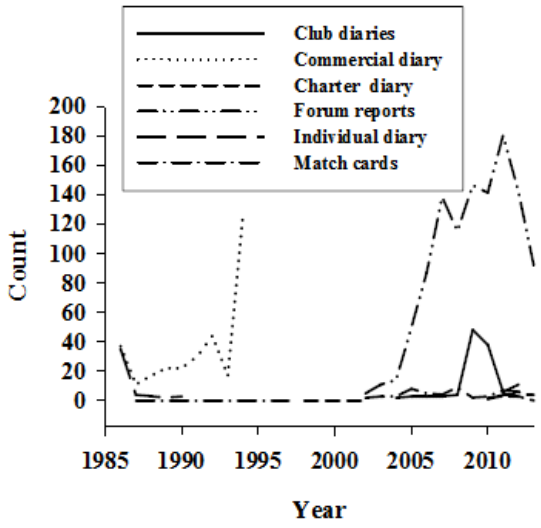



Figure 2-2. Number of individual trip recordings for available data sources.
Individual diaries include those provided by the bass guide and entries from a commercial fisher's diary while engaging in angling as a hobby activity. Match cards include both competitive and bass targeted competitions.

Table 2-3. Data yields derived from data source by classification. Measures are bass length/weight record counts, abundance are fish number records (e.g. caught 7 bass). The guide/individual diary is an amalgamation of data from a bass guide and the non-commercial angling activity of an on-hire charter skipper who also provided the commercial diary. Match card data includes match card records held by Marine Ecological Solutions. Measures with effort and abundance with effort give records where an effort measure was extracted. Greyed cells highlight largest number by column and percentages are calculated by column.

| Data source | Measures total | Measures with effort (count) | Abundance with effort (count) | Start time series | End time series |
|---|---|---|---|---|---|
| Club diary | 221 (7%) | 18 (1%) | 32 (1%) | Jul 2005 | Oct 2012 |
| Commercial diary | 1055 (36%) | 1055 (52%) | 1272 (51%) | Apr 1986 | Nov 1994 |
| For-hire charter | 9 (<1%) | 9 (<1%) | 9 (<1%) | Jun 1998 | Jun 2013 |
| Forum report | 1456 (49%) | 713 (35%) | 893 (36%) | Feb 2004 | Oct 2013 |
| Guide/Individual diary | 51 (2%) | 51 (3%) | 76 (3%) | ***Mar 1986*** | Sep 2013 |
| Match cards (bass targeted) | 124 (4%) | 124 (6%) | 157 (6%) | Jun 2000 | Oct 2012 |
| Match cards (competitive) | 51 (2%) | 51 (3%) | 51 (2%) | Sep 1987 | Jul 2013 |

### 2.4.2. Modern approaches to data collection: An online angling diary

In recognition that this section is rather untypical, discussion of the software specification are kept to a minimum, the primary outcome of the design and specification process is the field list and specification documents. These documents were intentionally delivered in a style removed from the academic milieu to enhance accessibility across promiscuous target audiences; they are presented in Appendix VI and Appendix VII.

Poll respondent rates are given in Table 2-4, there were a total of 41 respondents who answered the questionnaire in full, highlighting the well documented poor yields from indirect contact methods (Thompson 2012), and while the absolute response number solicited from online forums appears favourable, an effort at least equivalent to the 2 match intercept surveys was necessary to maintain angler engagement across the 15 forums used.

Table 2-4. Survey dissemination methods with estimates of respondent numbers exposed to the survey completion request.

| Survey dissemination method | Respondent reach | Return nr. & between group percentage | Response yield |
|---|---|---|---|
| Email request | 67 | 1 (2%) | 1% |
| Facebook FCSG | Unknown | 1 (2%) | - |
| Forum | 2,450 | 22 (54%) | 1% |
| Match (Intercept) | 46 | 9 (22%) | 20% |
| Match (Postal) | 19 | 2 (5%) | 11% |
| Referral | Unknown | 6 (15%) | - |

Web browser and smartphone usage from the online survey and the general UK population are presented in Table 2-5. Of the 67 respondents 39% were from angling matches and the remaining 41 from online sources.

The level of smartphone use in the general UK population (51%) as determined by Ofcom (Ofcom 2013) does not rule out application delivery to mobile devices, this is reinforced by smartphone ownership within sampled respondents of 73%, which is undoubtedly biased by the primary means of collection and survey dissemination via the www, equally www use among respondents was effectively ubiquitous, with 1 respondent not using the technology.

The domination of the Chrome (12%), Firefox (22%) and Internet Explorer (22%) web browsers among respondents, supported by figures for the UK population show that any SaaS application must maintain full functionality on those 3 clients. It is noted that Safari and Opera (in 2013) share the same rendering engine (Apple Inc. 2013) as Chrome hence Chrome support typically ensures the equivalent performance on Safari and Opera.

Table 2-5. Diary poll question results for smartphone and web browser platform usage (second column). UK figures for smartphone (Netbiscuits 2012) and browser usage (NetMarketShare 2013) are given in the third column. Summaries of the percentage of internet capable device ownership in the UK population (Ofcom 2013) are also provided. Grey cells highlight largest values within relevant category.

| **Platform** | **Survey figures** | **UK figures** | **Ofcom figures** | |
|---|---|---|---|---|
| ***Browser*** | ***Number*** | ***Percentage*** | ***Grouping*** | ***Percentage*** |
| Chrome | 4 (12%) | 16% | Smartphone | 51% |
| Firefox | 7 (22%) | 19% | Tablet | 20% |
| I do not use the world wide web | 1 (3%) | - | Laptop/netbook | 56% |
| Internet Explorer | 7 (22%) | 58% | Any internet access | 80% |
| Safari | 3 (9%) | 6% | | |
| Unsure | 10 (31%) | | | |
| | | | | |
| **Smartphone** | | | | |
| Android | 5 (19%) | 26% | | |
| Blackberry | 1 (4%) | 32% | | |
| I do not own a smartphone | 7 (27%) | | | |
| iOS (Apple) | 6 (23%) | 39% | | |
| Unsure | 5 (19%) | | | |
| Windows Mobile 7 or later | 2 (8%) | 2% | | |
| Others | - | 1% | | |

Turning to examine the Likert survey diary poll data responses specifically (see Appendix II for the questionnaire); it was necessary to aggregated across the low, medium and high RSGB activity classifications because of a low response rate (low $n$ = 2, 5%; medium $n$ = 7, 16%; high $n$ = 34, 79%; total $n$ = 42), data are presented in Figure 2-3 and Figure 2-4. The general questions (Figure 2-3C) show that 81% of the sample were willing to cooperate with fisheries based scientific studies, however Table 2-6 indicates that of the 35 who were amendable to cooperation with fisheries scientists 12 (34%) would not use an online diary. More importantly, of those indicating they would use a diary, 3 (7%) would not cooperate with scientists in data collection.

Table 2-6. Response matrix identifying the union of respondents who would cooperate with scientists by providing information on their angling activities ***and*** who would like to use an online diary. Greyed cells highlight the union, cells delineated with the double border represent those respondents who support an online diary, but may not contribute if that diary was associated with a scientific study into their activity.

| | | **I would like to help scientists to understand my sea angling activity** | | | | |
|---|---|---|---|---|---|---|
| | | **Disagree** | **Slightly disagree** | **Neither** | **Slightly agree** | **Agree** |
| **I would like to use an online diary** | **Disagree** | | | 2 (5%) | | 5 (12%) |
| | **Slightly disagree** | | | | 1 (2%) | 1 (2%) |
| | **Neither** | | 1 (2%) | 2 (5%) | 1 (2%) | 4 (9%) |
| | **Slightly agree** | | | 2 (5%) | | 5 (12%) |
| | **Agree** | 1 (2%) | | | 2 (5%) | 16 (37%) |

Respondents were generally prepared to provide non-identifying personal details; with 93.9% ±1.7 of respondents agreeing (slightly agree [SA] and agree [A]) to supply their gender and age; however they would be less inclined to provide telephone, address and name details (SA + A, *M* = 50.4% ±15.7; slightly disagree [SD] + disagree [D], *M* = 37.4% ±13.4). Respondents were willing to supply general profiling information on their fishing habits, with fish caught, gear, reason they go fishing and expenditure having an SA + A response mean across those four questions of 93.3% ±4.2.

With respect to the data collection variables there was agreement that the chosen variables were of utility with a low variance SA + S response mean of 83.9% ±1.3 for wind, sea state, clarity, brightness, gear and bait. Only 3 (7%) respondents noted additional fields they would like to see, these were fishing depth, echo sounder use and voice recognition for catch input. Depth and echo sounder use were requested by an individual kayak angler. Encouragingly this sample of anglers were also conducive to recording fish release and mortality rates (SA + A, *M* = 96.3 ±1.7; SD + D, *M* = 2.4 ±0.0).

The anglers represented in this sample tended not to weigh or measure all fish, favouring to record specimen measures only. The larger number of agree responses in length measurement over weight was surprising and may indicate results biased by match anglers where length is now the preferred form of measure in competitions (MES, NRW, *Pers. Comms.*). 19.5% ±3.4 agreed that the application must have tide and weather integration, which can be costly to design (Software Houses, *Pers. Comms.*).

There was no significant difference in the response means to the 3 questions probing the degree to which respondents would limit access to their data by other application users (ANOVA, $F_{(2,120)} = 0.21$, $p = 0.81$) and the cross question mean of positive responses (75%) shows that the sample group were willing to share catch data, however the survey was not targeted at bass anglers and the nonsignificant result may indicate that the 3 questions were poorly framed.

Moving onto the smartphone targeted question groups with ownership data derived from Table 2-7 (*unsure* counted as ownership); 10 of 41 (24%) respondents expressed a preference for using a smartphone over a web browser application, however cross tabulation (Table 2-7) revealed that 15% could be considered as the sample preferring smartphone use, with 7% preferring to use a smartphone who said they did not own one and 3% being excluded because they would be uncooperative with fisheries scientists.

Table 2-7. Response matrix identifying the union of respondents who would cooperate with scientists by providing information on their angling activities ***and*** who would prefer a smartphone application. Greyed cells highlight the union, cells delineated with the double border are respondents who despite agreeing they prefer a smartphone, either do not own one or who may not contribute if the parent diary application was associated with a scientific study into their activity.

| | | | | **I would like to help scientists to understand my sea angling activity** | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | **Disagree** | **Slightly disagree** | **Neither** | **Slightly agree** | **Agree** |
| **Smart phone ownership** | **No** | **I would prefer to use a smartphone rather than a web site to record my catches** | **D** | 1 (3%) | | 2 (5%) | 1 (3%) | 3 (8%) |
| | | | ***SD*** | | | | | |
| | | | **N** | | | 1 (3%) | 1 (3%) | 4 (10%) |
| | | | **SA** | | | | 1 (3%) | |
| | | | **A** | | | | | 2 (5%) |
| | **Yes** | | **D** | | 1 (3%) | 2 (5%) | | 5 (13%) |
| | | | ***SD*** | | | | | |
| | | | **N** | | | | | 8 (21%) |
| | | | **SA** | | | | | 1 (3%) |
| | | | **A** | | | 1 (3%) | | 5 (13%) |

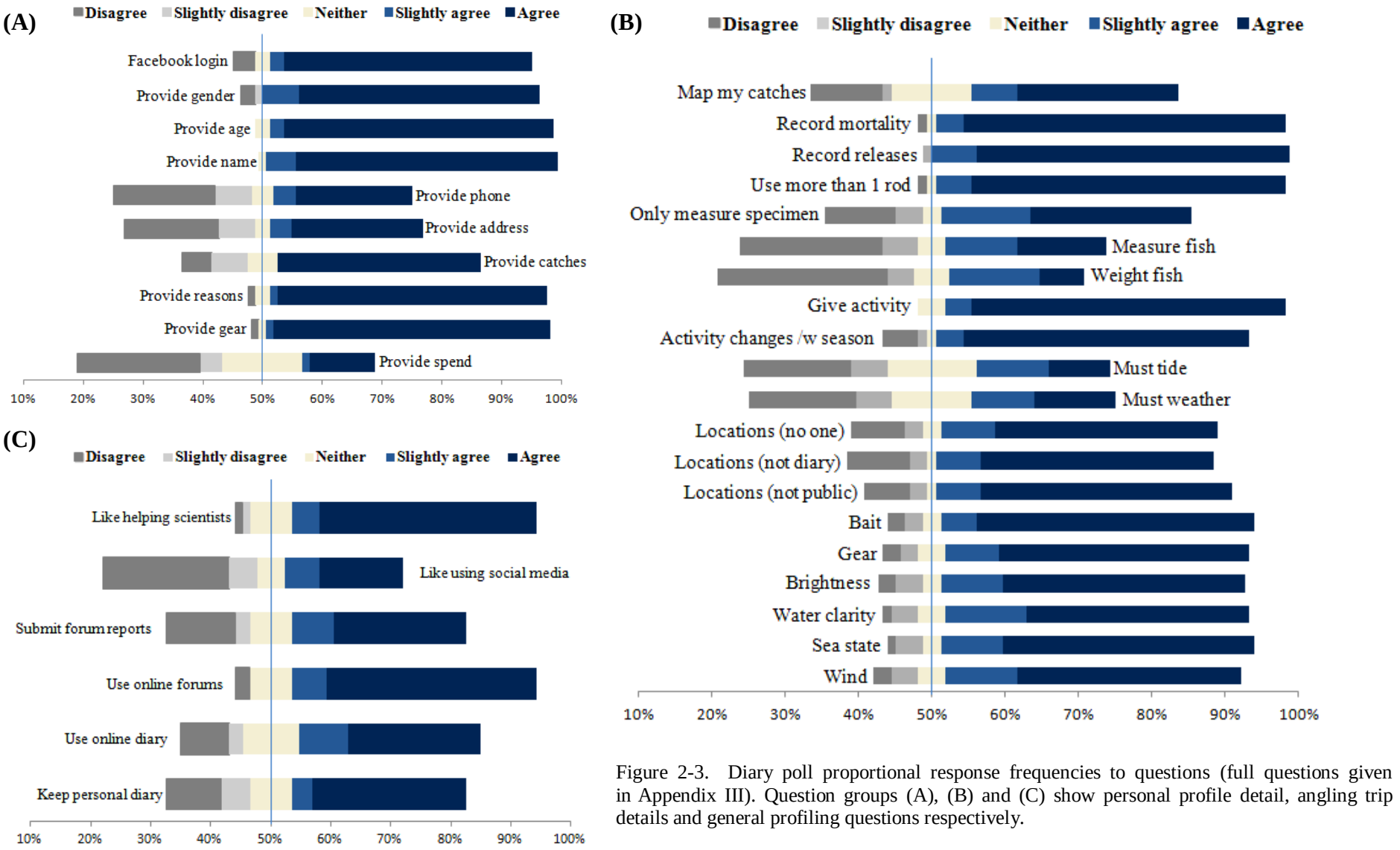



Figure 2-3. Diary poll proportional response frequencies to questions (full questions given in Appendix III). Question groups (A), (B) and (C) show personal profile detail, angling trip details and general profiling questions respectively.

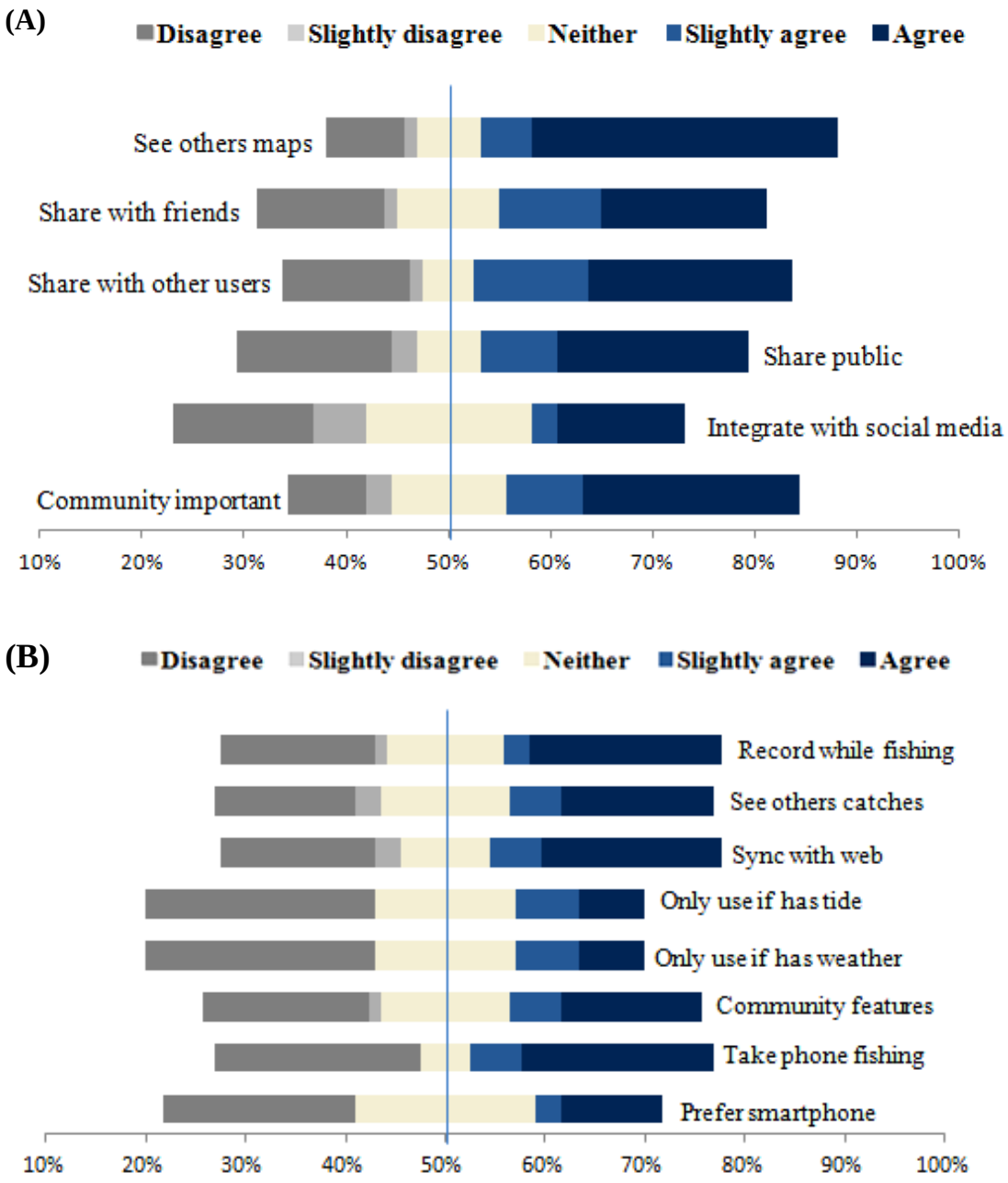


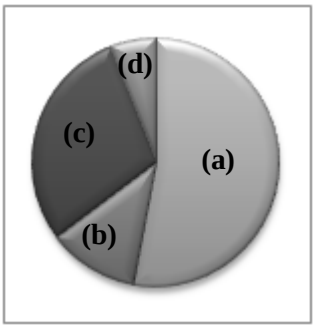

Figure 2-4. Diary poll proportional response frequencies to questions continued (full questions given in Appendix III). Question groups (A) and (B) give opinions on the community and smartphone features respondents would wish to have respectively.

The questionnaire had 4 open questions, the responses received were assigned a summary classification and are reproduced in Appendix III; tabulated summary classifications are presented in Table 2-8. The data is largely self-explanatory, though usability and user interface considerations are clearly the highest end user priority for an online diary SaaS application, with data misuse and privacy ($n$ = 4), and low personal utility ($n$ = 5) being the key cited reasons for not considering online catch recording.

Table 2-8. Categorised responses showing breakdown of open ended questions available to survey respondents. Greyed cells shows most frequent response by question category.

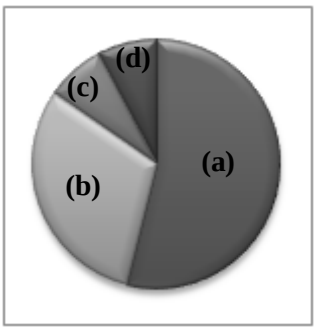
**What features would encourage you to use this electronic diary?**

| **Response classification** | **Nr** |
|---|---|
| (a) Usability | 9 (53%) |
| (b) Value added | 2 (12%) |
| (c) Sustainable management | 5 (29%) |
| (d) Would not use | 1 (6%) |



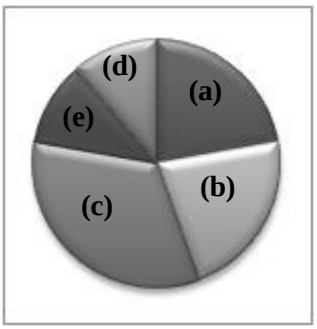

**What features would stop you from using an electronic diary??**

| **Response classification** | **Nr** |
|---|---|
| (a) Poor design | 7 (54%) |
| (b) Poor security | 4 (31%) |
| (c) Cross marketing | 1 (8%) |
| (d) Data privacy | 1 (8%) |




**If you object to using an online angling diary, can you please tell us why?**

| **Response classification** | **Nr** |
|---|---|
| (a) Misuse by official bodies | 2 (22%) |
| (b) Insufficient catches | 2 (22%) |
| (c) No personal utility | 3 (33%) |
| (d) Security | 1 (11%) |
| (e) Data privacy | 1 (11%) |



Online diary adoption rates appear in Table 2-9, with a total of 24 forecasted adopters, the figures do indicate a natural trend in increased willingness to record catch data online with increased activity, though sample size is small ($n$ = 22) and would require further investigation to determine significance and effect size. The calculated selectivity adjustment primarily derived from the 2,450 anglers (95% of the total) viewing the request to complete online was the biggest factor in the low adoption prediction. It is worth noting that no correction was applied to adjust for the 7% of respondents who indicated they would use an online diary, but would not cooperate with scientists in data collection.

Table 2-9. Figures and final estimate of the number of sea anglers resident or visiting Wales who would adopt an online diary application, based on the high, medium and low activity population stratification estimates of Research Surveys of Great Britain (2003) and Welsh recreational sea angler population from Nautilus Consulting (2000). Conversion rate from MECLAB 2011. Fractions show derivation of bias adjustment, based on the number of positive responses to the question *'would you use an online diary'*, out of the predominantly forum derived number of respondents exposed to the survey who did not participate.

| **Description** | **Activity stratification** | | |
|---|---|---|---|
| | **Low** | **Medium** | **High** |
| Sea angler population of Wales (Resident and visiting) | | 40000 | |
| Activity proportion ($r_{l,m,n}$) | *0.513* | *0.205* | *0.282* |
| Anglers in activity stratification | 20520 | 8200 | 11280 |
| Selectivity bias adjustment ($s_{l,m,h}$) | 0.0007 (1/(2570**0.513*)) | 0.0132 (7/(2570**0.205*)) | 0.0193 (14/(2570 **0.282*)) |
| Anglers after adjustment | 15.6 | 108.9 | 217.9 |
| SaaS conversion rate (C) | | 0.07 | |
| Number of adopters | 1 | 8 | 15 |

Table 2-10 shows that 2 of 39 (5%) respondents would use a smartphone application but not an online SaaS service, cross tabulating the results with the '*help scientists*' question showed there was no union between those preferring a smartphone and a negative response to '*help scientists*'; or between those preferring a smartphone who do not own one, and not wishing to use an online diary (results not shown). This set of smartphone adopters would be excluded from the estimates in Table 2-9, considering an additional 2 of 2,570 adopters (without activity stratification and assuming C = 0.7) gives an estimated 2 (8%) *additional* users across the population of 40,000.

Table 2-10. Response matrix identifying the union of respondents who indicated they would not like to use an online diary but would prefer to use a smartphone to record catches. Greyed cells highlight the union.

| | | I would prefer to use a smartphone to record my catches | | | | |
|---|---|---|---|---|---|---|
| | | **Disagree** | **Slightly disagree** | **Neither** | **Slightly agree** | **Agree** |
| **I would like to use an online diary** | **Disagree** | 4 (10%) | | 2 (5%) | | 1 (3%) |
| | **Slightly disagree** | 1 (3%) | | | 1 (3%) | |
| | **Neither** | 4 (10%) | | 4 (10%) | | |
| | **Slightly agree** | 2 (5%) | | 1 (3%) | 1 (3%) | 2 (5%) |
| | **Agree** | 4 (10%) | | 7 (18%) | | 5 (13%) |

### 2.4.3. Modern approaches to data collection: Text mining of online reports

A summary of the catch record yields scraped from angler submitted forum reports are given in Table 2-11, 8 forums with 81,822 separate threads potentially containing catch data for all RSA targeted sea fish species were identified for scraping.

Table 2-11. Number of angler threads posted to World Wide Web forums. Date from is the date of the first report. *'With keyword bass'* gives report numbers which contained the word bass (and synonyms of), *'reports with valid catch data'* gives the number and between forums percentage of reports in which valid catch data were identified. The bolded date highlights the earliest record.

| **Forum name** | **Total reports** | **Date from** | **With keyword bass** | **Reports with valid catch data** |
|---|---|---|---|---|
| Anglers Afloat | 5,387 (7%) | May-07 | 89 (1%) | 11 (1%) |
| Cast and Catch | 1,984 (2%) | Sep-05 | 257 (3%) | 40 (4%) |
| Fishing 4u | 6,005 (7%) | Feb-07 | 265 (3%) | 25 (2%) |
| North Wales Kayak Fishing | 584 (1%) | Sep-07 | 112 (1%) | 7 (1%) |
| Seafishing.org | 1,150 (1%) | Oct-06 | 168 (2%) | 19 (2%) |
| South Wales Kayak Angling | 438 (1%) | Sep-10 | 73 (1%) | 9 (1%) |
| Wirral Sea Fishing | 3,063 (4%) | **Feb-02** | 923 (12%) | 287 (26%) |
| World Sea Fishing | 63,211 (77%) | *May-04* | 5696 (75%) | 712 (64%) |
| ***Total*** | ***81,822*** | | ***2810*** | ***1,110 (1.4% yield)*** |

The popularity of World Sea Fishing is apparent with over 60,000 separate report posts, in the context of this thesis, it was impractical to process this volume of threads, hence the title and first 250 characters of each thread were tested for the keyword bass, if this condition was met, the scraper download the first thread post for processing with the VS2008 authored application, all post were scraped from the other forums.

In total 20,060 unique threads were downloaded over approximately 56 hours; of the 20,060 threads, 14,853 were successfully assigned a location from the 6,366 item list of Welsh location names collated for the purpose. Following processing of the 14,853 reports, 4,040 individual sentences across 4 sentence categorisations were extracted which matched keyword criteria, sentence numbers by categorisation appear in Figure 2-5. The 4,040 sentences required manual processing to extract relevant information from them, this resulted in 1,110 threads identified as containing pertinent bass catch data.

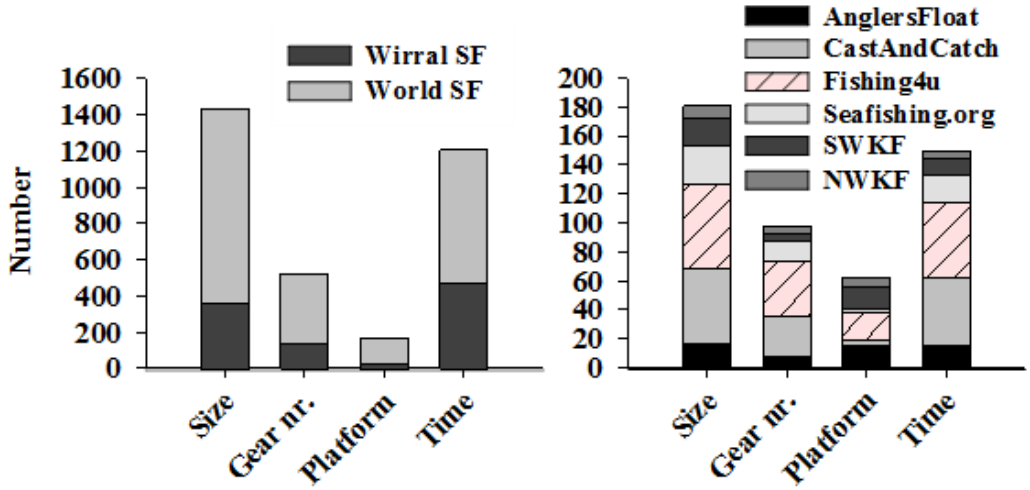



Figure 2-5. Number of candidate sentences identified according to their keyword categorisation. *Size* = a length or weight measure; *Gear nr* = number of rods or people present; *Platform* = whether from boat, shore or kayak; *Time* = indication of effort. Stacks are by forum (note the different ordinate scales), SWKF is South Wales Kayak Fishing, and NWKF is North Wales Kayak Fishing.

Figure 2-6 shows the number of threads with verified bass catch records by forum and includes a total across all forums. The periodicity of reports, with numbers peaking in the summer months is apparent, as is the upward trend of report submissions since the first establishment of the 2 most popular forums, Wirral Sea Fishing and World Sea Fishing in the early 2000s. It should be noted that the 2013 time series was truncated as results were gathered in late September and early November. Forum thread numbers appear relatively stable after 2006 (Figure 2-6), after which time the collective average monthly reports specifically meeting the criteria for the extraction of bass data was 11 ±8 threads per calendar month.

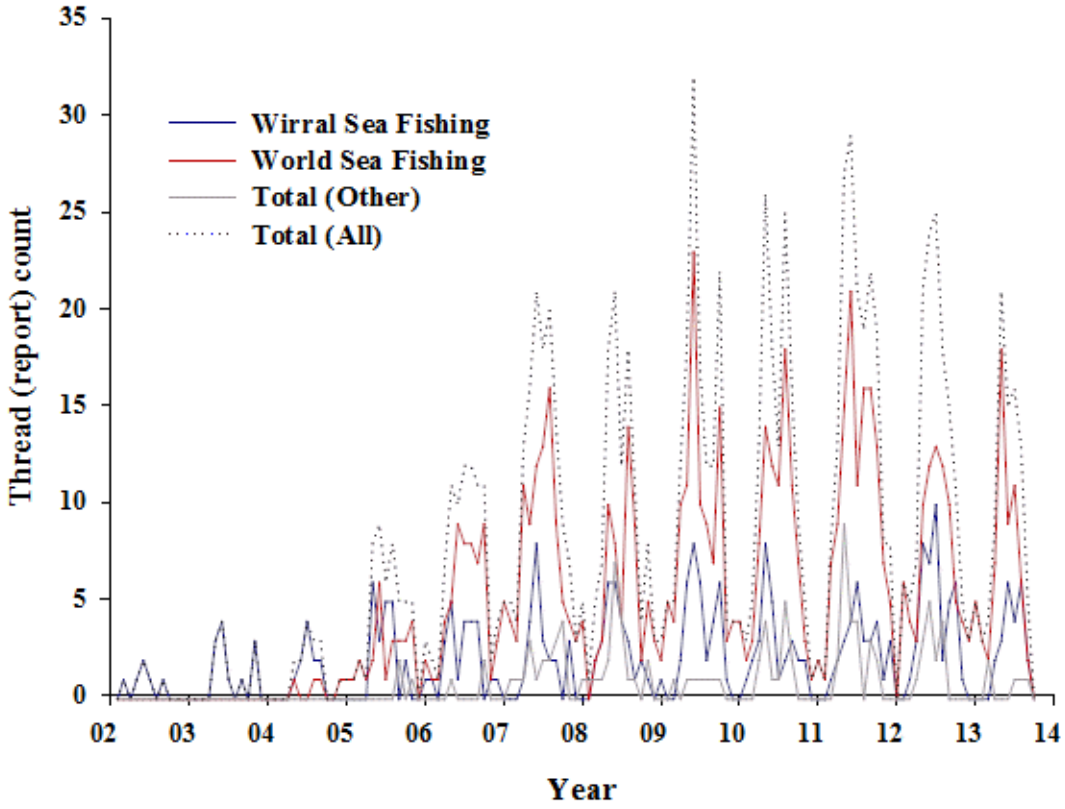



Figure 2-6. The number of threads (separate angler submitted reports) containing valid bass catch data for the two most popular forums
, Wirral Sea Fishing and World Sea Fishing. All other forum thread counts were summed and are shown as Total (Other). Total (All).is the time series for the sum of all threads.

Table 2-12. Number of catch and measure records derived from the specified data sources since the relative stability of forum thread submissions in 2007.

Ab. = catch number record, Mea. = measure.

| | Club diary | | For-Hire charter | | Forum report | | Match cards | |
|---|---|---|---|---|---|---|---|---|
| Year | Ab. | Mea. | Ab. | Mea. | Ab. | Mea. | Ab. | Mea. |
| 2007 | 1 | | | | 57 | 173 | 3 | 3 |
| 2008 | 1 | 2 | | | 40 | 119 | 5 | 48 |
| 2009 | 6 | 85 | | | 55 | 206 | 2 | 2 |
| 2010 | 4 | 115 | | | 54 | 147 | 2 | 8 |
| 2011 | 7 | 2 | 1 | | 68 | 242 | 4 | 9 |
| 2012 | 12 | 2 | 1 | | 60 | 167 | 5 | 4 |
| 2013 | | | 1 | | 26 | 119 | | 7 |

The comparative strength of the time series across data sources for the number of records of fish length and weight measures, and records of catch numbers are presented in Figure 2-7A and Figure 2-7B respectively (also see Table 2-3 for totals). A breakdown of the yearly extracted catch and measure numbers are given in Table 2-12, with forum reports providing a yearly mean of 51 ±14 separate catch number data points and 167 ±45 separate measures $yr^{-1}$. This compares favourably with the next highest record yields from club diaries at 4 ±4 and 29 ±49 for catch number and measures respectively, though it is noted that in general, forum derived data is from a larger number of individual anglers.

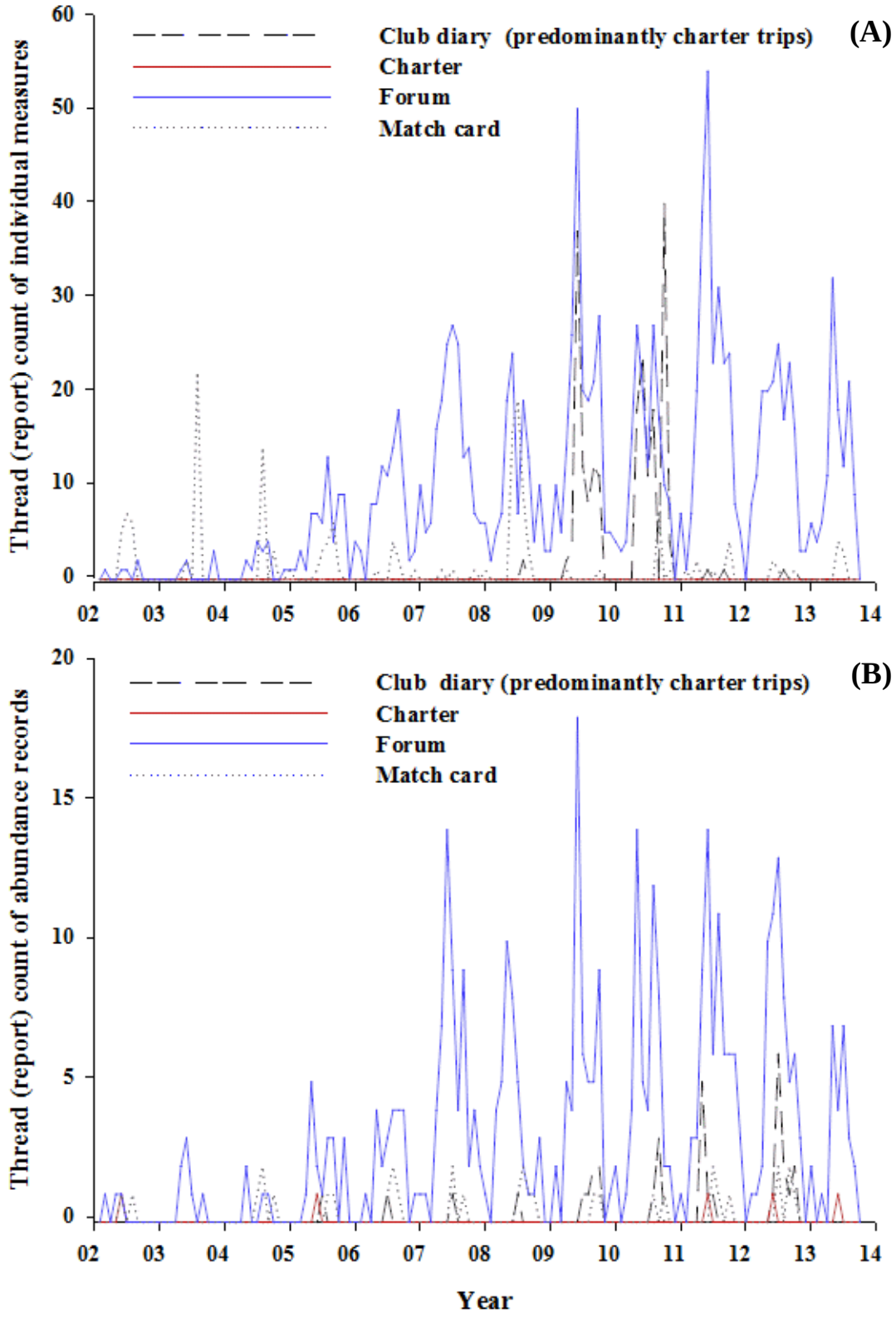



Figure 2-7. The number of unique records obtained from data source types for: (A) measure of fish weight and length, (B) numbers of fish captured. The club diary records were primarily derived from clubs who had hired a charter for an organised trip, charter records are those obtained directly from charter boat skippers. Data obtained from the single bass guide has been excluded for clarity.

The high frequency of shore based threads submitted to forums is apparent from Figure 2-8. Of the 1,110 threads with valid bass data, 973 (88%) are shore based, with charter, private boat and kayak accounting for 3%, 6% and 4% of the total respectively.

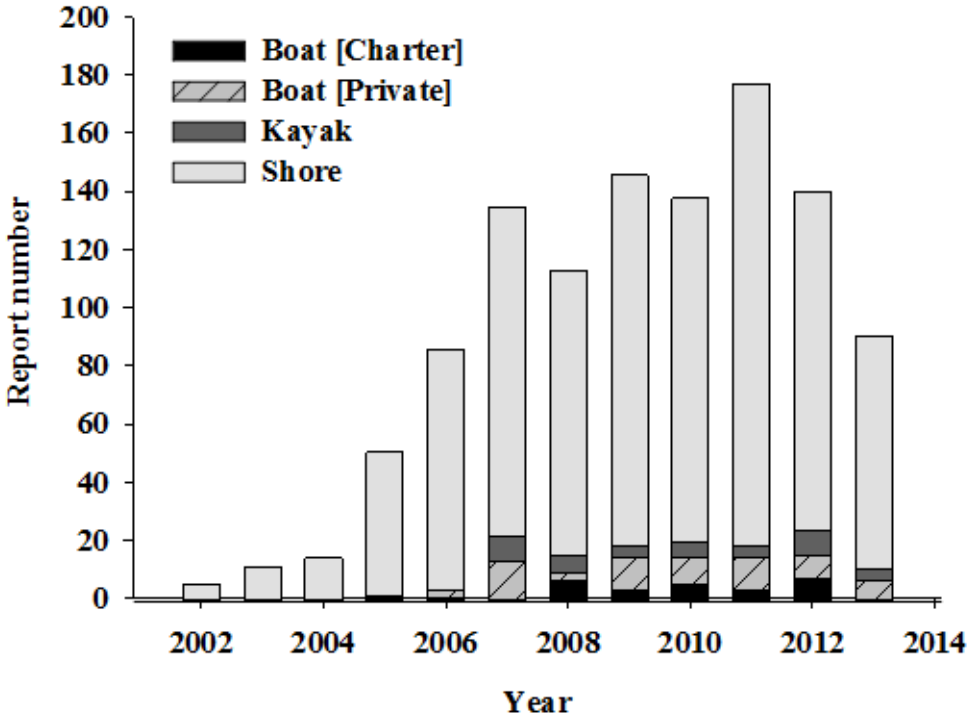



Figure 2-8. The number of reports (threads) derived from forum data split by angling platform across years.

## 2.5. Discussion

Bass in Wales are persecuted by both the commercial and recreational sector (Pickett *et al.* 1995, Pawson *et al.* 2007). The commercial fishery is dominated by small boats < 15 m which are required to declare the weights of their landings through the buyers and sellers register. Cefas also operate a voluntary logbook scheme for vessels < 10 m (Pickett *et al.* 1995) and ICES consider there to be improvement in data recording within this sector (ICES 2012f). In contrast the marine recreational fishery in the UK has been the subject of very little monitoring and there are no licensing requirements (Pawson *et al.* 2007), hence the bass recreational fishery is incompletely understood (ICES 2012f), being unable to answer the basic questions of where, when and who lands the most bass within the recreational catch. Suitably stratified estimates of effort, catch and angler number and the optimal stratifications to employ are also currently unanswered, with the last comprehensive work carried out in 1989 and 1995 (Dunn *et al.* 1989, Pickett *et al.* 1995) . This paucity of information is a concern with bass being under increasing commercial pressure (ICES 2012f) hence it is becoming critical to provide recreational catch information if bass stock status is to be properly assessed and so appropriate harvest control measure implemented if required, according to calculated biological reference points

It is critical that any recreational fishing survey is very carefully planned prior to implementation, sample designs must be based on sound statistical theory (Pollock *et al.* 1994), otherwise results are open to well founded criticism which will undermine management measures, this can occur even in well funded large scale national surveys (NFSP 1987). Consideration of complemented methods of data collection for multiphase surveys of recreational fisheries are therefore paramount, data capture methods are typically some combination of mail, telephone, door to door, internet based, access point, roving creel, aerial; and logbook, diaries and catch cards (Pollock *et al.* 1994). The first three are typically used in the early sampling phases to identify rare populations by gathering profiling data (Kish 1965) – from the UK perspective the Sea Angling 2012 and National Angling Survey collected a considerable amount of this 'high level' profiling data nationwide under a statistically robust model (Brown 2012, MMO 2013). These surveys however are incapable of providing specific effort and catch data with respect to bass angling in Wales, these data need to be provided by costly roving creel, aerial and intercept interviews and/or from alternate new and inventive low costs methods. As a minimum, it is important that low costs methods are investigated as a prelude to any on-site methods.

### 2.5.1. The scope of catch record sources in Wales

This thesis was primarily concerned with the state and availability of historical off-site data held by recreational bass fishers who prosecute the species in Welsh waters to assess whether these historical records could provide time series of biological data and recreational fishery profiling information.

In essence this type of information can be classified as logbooks, diaries and catch cards; this is data effectively reported directly by the angler hence they are comparatively cheap methods of survey data collection which may provide effort, catch, profile and biological data. They may be subject to recall and prestige bias when anglers maintain prospective diaries under request from survey programs (Campbell *et al.* 2001, Bochenek *et al.* 2012).

The extent of off-site data held by individuals was not investigated directly and charter boat and clubs were primary targets of effort but yields of data were low with only 8 charters who targeted bass maintaining a diary, and of those 8, only 2 provided a data set within the 3 month extent of the project, both of these data were aggregated by year and so lacked detailed effort and catch data.

Club diaries (primarily from private boat owners operating in the Bristol Channel) yielded 18 measures and 32 catch numbers. Match cards from clubs (sourced from both clubs and MES) yielded more records (124 measures, 157 catch number) but these numbers are limiting in the context of the temporal and geographical range of interest.

Coverage of the charter and club populations is thought to have been comprehensive, with the number of charters identified matching that of Richardson (2006) and above the 44 full time boats estimated by the CEMARE report of 1995 (Pickett *et al.* 1995).

It is difficult to estimate the angling club coverage, however comparison with returns from the cooperating clubs identified in the Welsh Pilot Surveys (Goudge *et al.* 2009, Goudge *et al.* 2010) indicate all major bodies (in terms of member number) in North Wales were identified and contacts attempted, additionally club names were taken from a list provided by WFSA who have affiliations with all major clubs operating in Wales (WFSA *Pers. Comm.*). BASS members maintain bass catch records, collected under a long running member program, extending to the collection of scales, however at this time the records have not been received.

Retrospective record yields across traditional sources therefore have been low (654 in total), however recreational anglers contacted through clubs and charters who targeted bass were both amenable to cooperating with this project with no refusals to provide data, therefore prospective engagement with these entities could yield good time series of data provided real effort is invested in a program of follow up contact surveys at intervals of no more than 3 months as recommended by the National Australian Recreational Surveys (Henry and Lyle 2003). Charter boat logbooks schemes have been particularly successful in past studies (Bochenek *et al.* 2010, Morson *et al.* 2012) though recall bias must be accounted for (Bochenek *et al.* 2012).

### 2.5.2. Modern approaches to data collection: An online angling diary

In view of the disappointing yields from retrospective sources held by bass anglers and the issues of recall bias associated with off-site contact methods (Forward and Lyle 2002, Lyle 2009, ICES 2010), the implementation of a means for anglers to record catches in-situ via a smartphone application post trip was important to investigate, though both NRW and CEFAS have considered and rejected this approach (NRW, CEFAS, *Pers. Comms.*).

The specification process was successful; both in identifying anglers' recording requirements and delivering a design agreed by 3 separate software houses, the poll response was low ($n$ = 67) and estimates are unlikely to be representative of the population. The low engagement rate however in itself provides support for the low magnitude of the final adopter estimate (24 users), this is not without precedent; a conceptually similar site commissioned by the Scottish Fisheries Coordination Centre (SFCC) for fresh water anglers to record catches has ≈ 20 active users (SFCC *Pers. Comms.*, exeGesIS 2011) and displays minimal activity despite a well developed and professional SaaS application.

Despite the apparent non-viability of the diary application at this time and within the current context of the SFP, feedback from the poll is of utility for future projects, 19.5% ±3.4 of poll respondents agreed that the application must have tide and weather integration, this impacts development cost but would enhance site usability, identified by 53% of respondents that commented as the most important factor in influencing their decision to use the application. Ideally a more extensive assessment of the feature set anglers require should be undertaken prior to the procurement of development services. This should ensure response stratification by angler activity level, necessary to better determine the feature set which high activity anglers (indicated by the survey as the most likely group to use the service) would use.

Further market research would allow application content and functionality to be tailored for users at different activity points; this could either be based on a simple response to a user sign-up profile question, or change according to the frequency of diary entries recorded. Targeted content delivery may also serve to improve retention levels, this would be critical in building an active user base.

It is clear that a well managed, designed and maintained SaaS application simply is not enough to have a successful site, and constant and regular contact with the angling community through clubs, angling forums, charter skippers, angling shops, the magazines Sea Angler and Total Sea Fishing and at organised matches, while ensuring value added content on the site is not static would all be necessary in ensuring a successful application, this however requires dedicated human resources and it would be paramount that any such project is maintained for the long term – it could be damaging to the already precarious scientist-angler relationship (NRW, *Pers Comm.*) if RSAs invested time and effort to record data only for the project to be terminated and their data were no longer available after their considerable effort in recording it.

#### *2.5.2.1. Alternative approaches*

Though under the proposed model the online diary is probably unviable, this does not rule out the online collection of angler data through a tailored site. Club anglers for example indicated that a smartphone diary application would be of utility during matches to record lengths and provide pictorial verification of catches, particularly during roving matches.

An application with less ambitious aims may be a viable substitute for traditional mail and telephone surveys, reducing costs and improving the quality of collected data obtained from charter boat skippers, clubs or individuals involved in prospective multiphase survey assessments. It is suggested that such an online application would provide the means of verifying that participants meet any agreed data recording commitments without the need for telephone calls or door to door visits which may antagonise and discourage participants and reduce participation rates. Data handling would also be reduced, improving data quality, reducing costs and making experienced personnel available for other tasks.

Another 'route to market' may be via cooperation with existing and well establish angling forums. Evidence that anglers are willing to report their catch details via form based report submissions is provided by the Wirral Sea Fishing forum (Wirral Sea Fishing 2013) and so the author suggest that the development of a plug-in for the forum angling websites and forum engines, primarily Wordpress (PHP), vBulletin (PHP), SimpleMachines (PHP) and Proboards (Perl), could offer a viable alternative. Content generation, promotion and marketing are provided implicitly by the angling forum itself and there is already an accessible target audience.

### 2.5.3. Modern approaches to data collection: Text mining of online reports

Forums began establishing themselves in 2002 and their popularity has been rising since with a total of ≈80,000 reports submitted containing the keyword bass to the present date. It is not currently clear if forum usage has reached peak membership, though even at current angler usage rates the utility of the methodology when compared with the scope of historical records is clear with 1,134 separate angler trips specifically containing bass catch records.

Forum derived data however demonstrated low report yields of charter boat (3%) and private boat owners (6%) (Figure 2-8) this is notable because it is lower than the population estimates of 26% and 13% derived from questionnaire based survey assessment by Richardson (2006), Richardson however was unable to use a sampling frame of the desired coverage and acknowledged that the estimates may be subject to a retrospectively unquantifiable degree of bias. Despite this it remains clear that forum data is likely biased to shore angling activity. It is possible that alternate forums aimed at the private boat owner exists, however this author suspects this not to be the case.

#### *2.5.3.1. Comparison with traditional off-site methods*

This trial of a novel technical approach to the extraction of recreational angling data compared well with traditional historical sources held by angling clubs and charter skippers, which after exclusion of the commercial data, accounted for 75% of extracted catch and measure records. The comparative effort involved in this extraction was not recorded, however it was equivalent to the pursuit of other sources under this project and time investment is frontloaded – once a methodology and the associated software is developed and refined, then extraction could be largely automated.

#### *2.5.3.2. Data quality*

The extracted forum data does require more careful consideration than governed sources, for example, match card results where the recordings of measures are adjudicated. This necessarily leads to subjective judgements on record inclusion and language interpretation, and forum derived data are subject to prestige bias, much the same as all other off-site survey collection methods (ICES 2010). Such prestige biases could be considerably reduced by limiting extraction to threads with photographic evidence, with measures verified with an image scaling program, exampled by ImageJ (NIH 2013). Other verification methods include the review of questionable individual posts (regular reports of large fish) or by taking a subsample of verified reports and comparing against the general forum report population. Anecdotally from this study, 15 bass were reported with lengths in excess of 70 cm, the author validated each corresponding thread and no evidence of miss-reporting was found.

The forum derived data presented here-in will be subject to inaccuracies: the scraping protocol and associated application developed by the author were completed relatively late in this project's timeline. It is certain therefore that valid data were missed, particularly with respect to the detection of fish measures and angling session durations which were dependent on identifying relevant noun forms (tide and bass for example), cardinal numbers and in the case of measures, noun forms which indicated dimensions of weight or length. Additionally whole paragraph interpretations were not attempted programmatically. During iterative testing of the application instances of catch data missed because of failure to attempt whole paragraph interpretations were observed. To example, consider the 2 sentence paragraph *'I caught a bass. It was a nice fish of 4 lbs'*, in this instance the VS2008 program would extract the sentence 'I caught a bass', correctly interpreting 'a' as 1 with the keyword bass, but then fail to record the associated weight of 4 lbs because the 'measure' sentence is separate from the bass tagged sentence. This limitation however is a surmountable technical issue which simply reduces the data yield and the author suggests it is unlikely to bias the extracted data, though further efforts to verify this should be undertaken were the methodology to be repeated.

#### *2.5.3.3. Improvements*

As a trial methodology the scope for improvements are numerous and clear and are centred on location identification, extraction yields, post processing of extracted sentences and data verification. These are discussed below:

##### 2.5.3.3.1. Location identification

Though the compiled list of 6,366 separate place names had a success rate of ≈ 75% in identifying angling locations, time restrictions meant that specific colloquial names or UKHO chart derived features were assigned to the nearest landward geographic location recognised by Google's mapping application (Google 2013). This was not a serious limitation for this work, however if for example intercept surveys were to be based on derived effort then pinpointed areas would be required. Also off-coast areas may provide important information when examining charter and private boat fishing effort distributions. This is relatively simple to correct, by extending the locations catalogue within the database itself to include latitude and longitude coordinates for all areas not identifiable in Google Maps.

#### 2.5.3.3.2. Language handling

The approach to the processing of language was rudimentary, improvements in its implementation would reduce the number of sentences identified as containing relevant data which did not (false positives), decrease the (unquantified) number of missed catch data (false negatives) and reduce the amount of manual processing on extracted sentences by intelligently extracting catch data direct from the sentence. These may all be achieved by greatly improving natural language processing of the reports, however the task is non-trivial.

The natural language processing library chosen was SharpNLP (richardn 2006), it was designed specifically for the Visual Studio.NET platform and so its basic use was familiar to the author. SharpNLP is no longer updated or maintained and so lacks many advanced features, however it is a port of the open source project OpenNLP. The adoption of OpenNLP would offer additional opportunities for the development of an advanced natural language rule set. In addition to this enhancement, additional improvements would require the training of OpenNLP in the unique lexicon used by recreational anglers when submitting reports to forums – in simple terms this involves tagging a large number of existing angler sentences, paragraphs and words using a maximum entropy model to 'tell' OpenNLP what the correct interpretation of each case is, this is reiterated until translation success rates achieve an acceptable level across repeated tests.

Following training, application development would be required to provide the higher level rules to understand the context of paragraphs and sentences if improvements in the rates of false positives, false negatives and the post processing of extracted sentences are to be realised. Take the sentence *"My friend caught a 2 pound bass last week, but today I caught a 5 pounder"*; to extract the firsthand account of the 5 lb fish the application must recognise that the first person singular pronoun is associated with the 5 pound bass and not the 2 pound bass of the friend.

#### 2.5.3.3.3. Verification

Time constraints made verification of forum derived records impractical. If time allowed then a sample of records produced from an automated (or semi automated) extraction process should be compared independently with data extracted manually from reports to estimate incorrect measures, and the rates of false positives and negatives. Additionally, investigating methods to identify falsified reports should be investigated. Many reports are also supplied with images taken by the angler, these offer a particularly accurate method of verifying reported weights and lengths and may be treated as a control group.

# 3. RECREATIONAL BASS ANGLING IN WALES: TRENDS IN SPATIAL AND TEMPORAL EFFORT WITHIN SAMPLED POPULATIONS

## 3.1. Abstract

Historical catch data gathered under the methods outlined in 2.3.1 and 2.3.3 were used to determine effort patterns in calculated gear hours within the sampled populations of charter boats, sea angling clubs, formal survey, and match card data. Where data were sufficiently numerous samples were stratified by platform, i.e. shore, private boat and charter boat. In addition, to provide an indication of coastal utilisation patterns by individual bass anglers, the number of individual trips made to coastal locations is provided.

Within the sampled data there was a clear seasonal and regional partitioning of effort, overall 53% of charters targeting bass operate within South Wales (SW) and 38 of the 47 clubs identified (81%) were also located there. The split of effort by shore and private boat anglers between the summer months of May to October across North (NW), Mid (MW) and SW was 28%, 35% and 37% respectively, with winter effort differing significantly from summer effort within the aggregated shore and private boat angler grouping (MWU, $U$ = 25,359, $P$ = 0.016). Charters were data sparse, though figures suggest a higher level of summer activity, with 73% of all gear hours season$^{-1}$ occurring between May and October in SW. Shore anglers and private boat owners again showed the greatest effort during summer in SW at 26% (NW = 20% and MW = 24%). Summer effort for shore and private boat anglers differed significantly between NW and MW (MWU, $U$ = 4,233, $P$ = 0.011). Under mapping, a complete absence of effort between Tywyn and Folly was observed, possibly attributable to forum reports being driven by anglers visiting MW on vacation.

Mean gear hours per trip and standard error for sampled shore and charter anglers were 3.8 ±0.09 and 5.3 ±0.15 respectively and the standardised monthly effort showed clear minimums from December to March, after which effort began to increase.

Unstructured interviews, primarily with charter boat skippers showed that their recalled experience of trends in bass abundance differed between charters operating to the north and south of Aberystwyth (Jonckheere-Tepstra Exact, $J\text{-}T$ = -2.313, $p$ = 0.010) with NW skippers identifying no decrease, however there was general agreement that sizes had decreased (Binomial$_{(exact)}$ test proportion = 0.5, $p$ = 0.033).

## 3.2. Introduction

Recreational angling across the UK has proved difficult to assess, the Welsh RSA community is highly diverse and bass angling in Wales occurs on open coastline, frequently at unsociable hours. During the summer months there are large influxes of tourists (who are also diverse) that must be covered by the chosen survey frames, and this makes formulation of a suitable stratification and choice of a sampling frame with suitable coverage of the target population problematic. These factors make the costs of a properly executed survey, capable of producing sound statistical estimators of low variance for total angler number, effort and catch, restrictively high and effectively impossible in terms of sustained monitoring.

There have been programs to assess RSA, notable large scale surveys employing sound designs are the Sea Angling 2012 project (ICES 2012g, MMO 2013) and that of the Angling Trust's National Angling Survey 2012 (Brown 2012), though neither make provision to identify anglers who successfully target bass nor have large coverage of Wales (NRW *Pers. Comm.*). This would render any calculation of effort and total catch of bass derived from extrapolation based on angler stratifications identified from the surveys prone to high variance. Therefore to accurately assess bass landings per unit effort (LPUE) and total landings by the recreational fisher sector, effort has to be expended in quantifying the temporal and geographic pattern of bass prosecution within Wales, and angler profiling information must be collected to make low variance estimates of total landings per unit time.

The last large scale UK assessment of bass was by Picket *et. al.* in 1995, this CEMARE study conducted 400+ intercept interviews to produce estimates of LPUE which, when extrapolated to the total UK population with data derived from a separate National Bass Angling Survey and additional postal surveys, provided total yearly landing estimates, expressed by ICES fisheries areas. Other bass centric surveys have also been undertaken (Dunn *et al.* 1989, Dunn and Potten 1994) however these cannot be used to accurately extrapolate catches at the current time and for Wales because of the variability in coastline and different fisher behaviours and methods which may be employed within the Welsh bass angling population.

There exists no study which covers country wide Welsh angling captures. The pilot study carried out by the Countryside Council for Wales (Goudge *et al.* 2009, Goudge *et al.* 2010, Blyth-Skyrme 2011, Goudge and Morris 2011) (now Natural Resources Wales) was restricted to NW and did not target bass. Additionally any accrued RSA survey data is a snapshot (as Pickett himself raised in the 1995 study) and is probably insufficient for ongoing fisheries management as fisher behaviours may change, minimally, incorporation of the survey data into fisheries models risks introducing uncertainty which may hamper the introduction of any prospective harvest control measures, or legislation amendments.

Though there have been some informal efforts to map the distribution of recreational bass fishing effort across Wales, these have been based on expert consultation (Pawson and Pickett 1987) rather than a repeatable methodology, it is therefore important for the conduct of future assessments of bass RSF to investigate where relative fishing effort is concentrated, how that effort may fluctuate within months and identify methods which may allow the continued monitoring of relative effort by location.

### 3.2.1. Aims and Objectives

- To explore the scope of data harvested under the initial exploratory data collection project phase.
  - Provide estimates of angler trip durations and per trip gear numbers within a population of anglers successfully prosecuting bass in Wales
  - To provide seasonal and spatial relative estimates of effort and trip counts within a population of anglers successfully prosecuting bass in Wales
  - To detail the processing of angler catch data obtained from identified novel data methods from the previous section.

## 3.3. Methods

### 3.3.1. Common data handling methods

#### *3.3.1.1. Report interpretation*

Primary methods of data collection are outlined in *2.3 Methods*. The language and detail noted in fishers' records were highly variable (particularly in the forum derived data), making interpretation of bass measures, gear numbers and trip durations a frequent necessity. The bass measure recording rule set, colloquial translations and the keywords used to identify sentences of interest during processing appear in Appendix IV. For www derived reports, only first hand catches were considered, accepting trips attended by multiple anglers.

With particular reference to the forum derived catch reports, multiple corrections of common spelling mistakes (including place names) and other quirks of language were executed prior to processing to reduce the rule set programmed in the VS2008 sentence handling application, for example whole word occurrences of one, two, three … were replaced with digits in all reports.

#### *3.3.1.2. Quality ranking of records and effort estimation*

During collation, the quality of the effort parameters (duration, gear number, trip number) were ranked between 1[4] and 5[5], or assigned 0 if any single parameter was absent from the trip record (this is termed the *effort quality rank*, EQR). Where the EQR was 0, the mean effort parameters for the relevant platform and gear stratifications were substituted for effort based calculations, values are given in Table 3-6 of section 0.

#### *3.3.1.3. Georeferencing and mapping of sampled effort data*

General data handling for the proceeding geospatial work was carried out as follows: Data collected from sources as outlined in 2.3.1 and 2.3.3 were collated into Excel (Microsoft 2007) and then imported into SQL Server (Microsoft 2008). Distinct geographic location names (exampled by village, town and city names) derived from the data ($n$ = 254) were extracted and imported into Google Maps (Google 2013) to georeference the textual place names. Positions were checked visually and following basic corrections the georeferenced locations were exported from Google Maps to the Google Earth Keyhole Markup Language (KML) format and subsequently imported into ArcMap 10 (ESRI 2010) using the *KML to layer tool* where they were persisted as a shapefile.

[4] Poor – effort heavily interpreted from the language for any one individual parameter
[5] Excellent – precise figures given for all effort indicators

Latitude and longitude coordinates were added to the location layer with the ArcGIS *Add XY coordinates* tool, this layer was then available for all further GIS works requiring the georeferencing of locations by linking via the common location names.

### 3.3.2. Distribution of for-hire charters and clubs in Wales

To provide an indication of the distribution of anglers across Wales the home port of charter boats and the address of recreational angling clubs (collated under 2.3.1) were mapped in ArcMap 10. During unstructured interviews, primarily of charter boat skippers, respondents were asked if they target bass, those who indicated they did are displayed on a second map for comparison.

### 3.3.3. The seasonal distribution of sampled relative annual effort

An indication of relative effort, expressed in mean gear hours per season (gh season$^{-1}$), was determined as follows; shore, kayak and private boat data were merged to a category, *"private anglers"*, then data were aggregated by private anglers and charter boat stratifications across years for the summer (May to October) and winter months (November to May) from summer 2006 onwards (corresponding with the stabilisation of the www dataset, see Figure 2-2). In addition, summer and winter mean gear hours per season were aggregated across all platforms by ICES rectangle and mapped. The 2013 summer dataset was included without a proportional adjustment to account for the absence of October from the data. Effort measure means were used where data were incomplete according to 3.3.1.2.

Charter boat data contributed by clubs were included under the assumption (partially supported under review of the raw data) that clubs exercise choice in location and skipper selection when procuring charter services, though a degree of bias was accepted as unavoidable.

Data were generally unavailable for the specific grounds where charter and private boats prosecuted bass, hence the home port, or nearest landward location was used, this was assumed reasonable as in most instances bass are pursued in inshore waters relatively close to port (fishers *Pers. Comm.*), with particular exceptions in North and Mid Wales.

Mean yearly effort for each of the 254 locations $E_{1,yr}$ were calculated according to equation [2], where *yr* = year, *g* = gear number, *t* = trip number (typically 1),*d* = duration in hours and *l* = location.

$$E_{l,yr} = \left( \sum_{yr=2006,l=1}^{yr=2013,l=254} g \times t \times d \right) \div (2013 - 2006) \qquad [2]$$

The *calculation of total gear hours per season* (winter and summer) for Table 3-3 and Figure 3-3 aggregated elements of $E_{l,yr}$ according to their platform, season and region. In this instance the mean by platform, season and region would of been an unsuitable comparator of relative effort as the mean

would make account of the location number, which differs for each partition (for example for-hire charters were only associated with 7 locations in winter).

#### *3.3.3.1. Significance testing*

Data were summed yearly by region and season between 2006 and 2013 excluding the charter platform as data were sparse. The remaining private data partitioned by season and region (NW, SW and MW) were non-parametric and a log10 transformation with the removal of outliers according to -3.29 < Z score < 3.29 failed to render the left skewed mean yearly effort data normal. The Kruskall Wallis (KW) test was therefore used to test for significant differences between the sample means for summer by NW, SW and MW and winter by NW, SW and MW, with MWU employed for pairwise post-hoc testing. Bonferroni family-wise adjustments to α were made as necessary.

#### *3.3.3.2. Data exclusions*

Preaggregated data without a trip or prosecuting entity value (e.g. boat number) were excluded from calculations because adopting the stratification averages of Table 3-6 could be inaccurate. In addition the single commercial diary, shore matches (primarily from MES) and a dataset submitted by a single charter boat skipper were not used as they would greatly inflate the effort at their locations. It is noted that the forum data includes charter boat and private boat effort in addition to shore angling records.

### 3.3.4. The seasonal distribution of sampled angling angler trips

The number of angling trips per year for each location $T_{l,yr}$ were calculated according to equation [3] where $t$ is a single trip. The methodology in 3.3.3, including data exclusions outlined in 3.3.3.2 was applied, and the aggregated data of Figure 3-5 and Table 3-5 followed the same principle as the *calculation of total gear hours per season*.

$$T_{l,yr} = \left( \sum_{yr=2006,l=1}^{yr=2013,l=254} t \right) \div (2013 - 2006) \qquad [3]$$

### 3.3.5. Estimate of mean trip effort parameters and standardised monthly effort trends

To give an insight into the relative angling effort between platform stratifications within the data series obtained for anglers who have captured bass, the mean effort in gear hours (gh) by platform across summer and winter was extracted for all cases where the assigned report EQR was > 3 and calculated by multiplying the gear number by angling trip duration. Data were processed in Sigma Plot (Systat Software 2011) for graphical display, Mann-Whitney U (MWU) tested data for significant differences. The commercial diary was omitted from the series and the kayak platform was merged with the shore stratification. Additionally means of trip duration and gear numbers by platform stratifications were calculated, the figures were used where no estimate of duration or gear number could be extracted from the anglers trip information (also see section 3.3.1.2). Note that shore calculated means excluded match card data.

The month to month trends of effort by the for-hire charter and private stratification were standardised before comparison to account for inter-year variations in effort within the sample and were calculated as follows:

Consider equation [4], $E_{p,r,m,y}$ is the matrix of standardised effort for all months where $p$ = platform, $r$ = region, $m$ = month and $y$ = year; $\bar{e}_{p,r,y}$ is the matrix of yearly effort means from trips summed at each trip location and $e_{\sigma_{p,r,y}}$ is the standard deviation of the sample with mean $\bar{e}_{p,r,y}$. $S_{p,r,m}$ in [5], the figure under scrutiny, is the standardised monthly mean across sample years 2006 to 2012 and $n$ is the number of data items in the partition for $y$ = 2006 to 2012 (i.e. a maximum of 8 singletons in a fully populated partition). Partitions with fewer than 3 mean month data points in a year ($e_{p.r.m,y}$) were excluded from all calculations and therefore from the final standardised monthly effort estimates.

$$E_{p,r,m,y} = \frac{e_{p,r,m,y} - \bar{e}_{p,r,y}}{e_{\sigma_{p,r,y}}} \quad [4]$$

$$S_{p,r,m} = \frac{\sum_{y=2006}^{y=2012} E_{p,r,m,y}}{n_{p,r,m}} \quad [5]$$

### 3.3.6. Unstructured interviews: Opinions on stock status

The entities contacted as outlined in 2.3.1 that had experience in targeting bass were encouraged to express opinions on the historical 'direction of travel' of bass abundance and size, their general comments were recorded and then later reviewed and assigned a value of -1, 0 or 1 as an indicator of decrease or increasing size and abundance (-1 = decrease, 0 = no change, 1 = increase).

Data were presented on a diverging stacked bar graph and due to the small sample numbers an Exact (Cyrus and Patel 1989) Jonckheere-Terpstra (JT) test was employed to determine if there was a significant ordered pattern of disagree, no change and agree responses from SW to NW for both size and abundance opinions. To determine if the combined NW and SW opinions on size differed from an even distribution under $P_{(\text{no change})} = 0.5$, $P_{(\text{decrease})} = 0.5$ an Exact binomial test (B) was performed. Note that the low sample number ($n$ = 18) made it necessary to reduce the regional categorisation from NW, MW and SW to NW and SW, divided at Aberystwyth.

## 3.4. Results

### 3.4.1. Distribution of for-hire charters and clubs in Wales

The distribution of clubs and on-hire boats identified in this study are given in Figure 3-1 and numerically summarised in Table 3-2. Table 3-1 lists the home ports of for-hire charters prosecuting bass in Wales.

Established sea angling clubs dominate in South Wales with 81% of the total. In contrast there are 18% more on-hire boats in North Wales (NW) than South Wales (SW), however the majority do not target bass with only 4 of 27 (15%) running trips specialising in bass, it is important to note that even those charters prosecuting bass do not do so every trip, and even within a trip may switch their target species according to client request or in response to poor catch rates (skippers, *Pers. Comms.*). Despite South Wales having fewer charters, it has the highest percentage of dedicated bass trips at 55% overall.

Table 3-1. Number of for-hire charters by home port (Apr. – Nov.) providing specialists bass angling trips.

| Region | Port | Nr. |
|---|---|---|
| North Wales | Cemaes | 1 (5%) |
| | Beaumaris | 2 (10%) |
| | Caernarfon | 1 (5%) |
| | Y Felinheli | 1 (5%) |
| Mid Wales | Aberdovey | 2 (10%) |
| | Aberystwyth | 2 (10%) |
| | Pwllheli | 1 (5%) |
| South Wales | Burry Port | 2 (10%) |
| | Llanelli | 1 (5%) |
| | Milford Haven | 3 (14%) |
| | Penarth | 3 (14%) |
| | Saundersfoot | 1 (5%) |
| | Swansea | 1 (5%) |

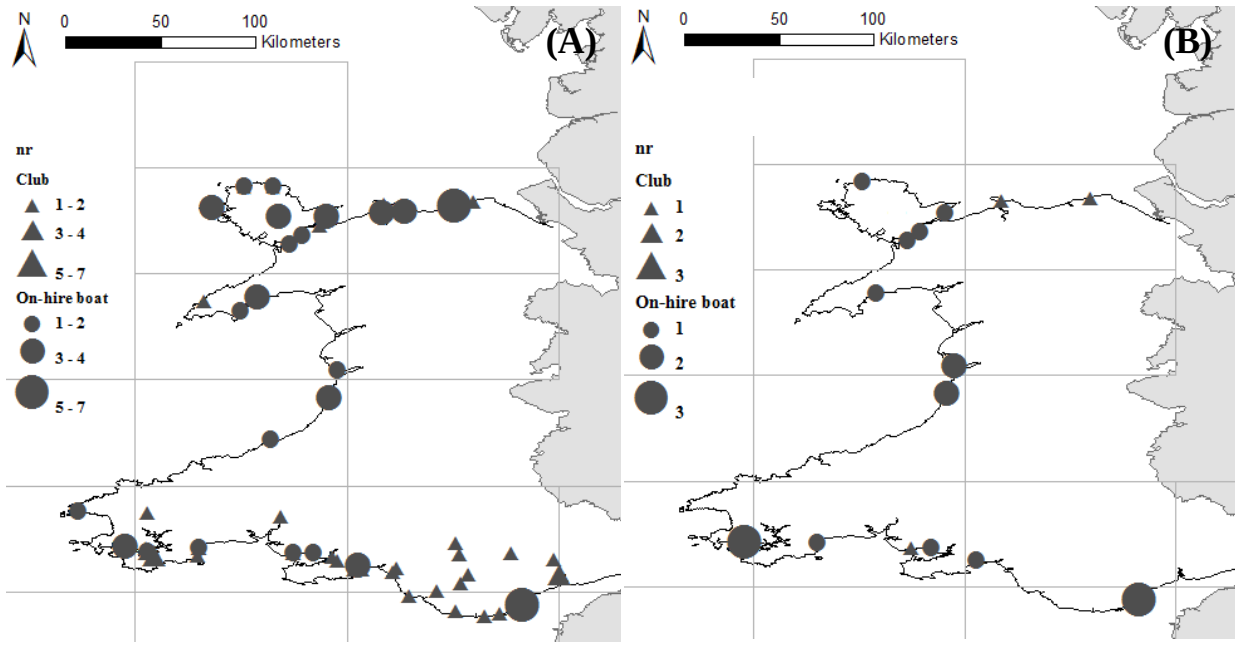



Figure 3-1. Location of for-hire charters and RSA clubs. (A), for-hire charters (circles); (B), RSA clubs (triangles). (B) shows entities who indicated under interview that they make deliberate efforts to target bass (e.g. by gear selection or fishing location). Club figures in (B) do not account for the activity of individual club members. Central Anglesey data arose from entities with no specified address on the island.

Table 3-2. Number and percent of entities (within the entity type) by location.

| Entity | Location | All entities | Entities targeting bass |
|---|---|---|---|
| Club | North Wales | 7 (15%) | n/a[6] |
| Club | Mid Wales | 2 (4%) | n/a |
| Club | South Wales | 38 (81%) | n/a |
| Guide | Mid Wales | 1 (50%) | 1 (50%) |
| Guide | South Wales | 1 (50%) | 1 (50%) |
| On-hire boat | North Wales | 27 (48%) | 4 (20%) |
| On-hire boat | Mid Wales | 12 (21%) | 5 (25%) |
| On-hire boat | South Wales | 17 (30%) | 11 (55%) |

### 3.4.2. The seasonal distribution of sampled relative annual effort

Charter boats were poorly represented across the data with only 50 records in total, particularly in North (5 records) and Mid Wales (MW) (4 records). Their data is presented but they were omitted from significance testing. Charter services in South Wales had 40 summer records, though winter bass angling activity was much reduced ($M$ = 16.0 gh season$^{-1}$) in the region.

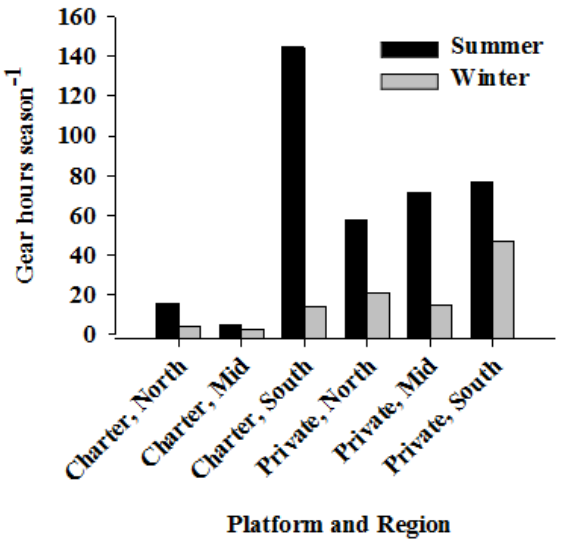



Figure 3-2. Total gear hours per season for private (boat, kayak, shore) anglers and charters boats from November to April (filled circles) and May to October (open circles) in Wales. Regions are North; ICES rectangles 35E5, 35E6: Mid; rectangles 34E5, 33E5, 33E4: South; rectangles 32E4, 32E5, 32E6, 31E6, 32E7. Period was from January 2006 to September 2013.

Private angling activity (an aggregation of boat, kayak and shore activity) had better cross regional representation and lower between site effort variance (standard deviation given in Table 3-3). A seasonal decrease in effort was also discernible in the private stratification with decreases of 82%, 82% and 59% for North, Mid and South Wales respectively. There is a decrease of mean total effort per location in MW between summer and winter of 10.5 gh season$^{-1}$, with the effort in North Wales dropping in winter by 3.0 gh season$^{-1}$ from the summer mean of 11.5 gh season$^{-1}$. Data is presented in Figure 3-2 and tabulated in Table 3-3 and maps based on IDW interpolation are given in Figure 3-3.

[6] Members within clubs certainly target bass, however no suitable criteria were developed on which to classify a club as a whole body as prosecuting the species.

Table 3-3. Total gear hours season$^{-1}$ for private (boat, kayak, shore) anglers and charter boats from November to April (winter) and May to October (summer) across Welsh regions (North; ICES rectangles 35E5, 35E6: Mid; rectangles 34E5, 33E5, 33E4; South; rectangles 32E4, 32E5, 32E6, 31E6, 32E7). SD is the standard deviation of the mean gear hours per location within the given stratification. Period is from January 2006 to October 2013. Percentages given are within platform and season. Highest percentage cell greyed.

| Season and platform | Region | Total gear hrs. per season | Season and platform | Region | Total gear hrs. per season |
|---|---|---|---|---|---|
| Summer[7] Charter (34%) | North | *M* = 18.0 (10%) *SD* = 10.7 | Winter[8] Charter (5%) | North | *M* = 6.3 (23%) *SD* = 0.0 |
| | Mid | *M* = 7.5 (4%) *SD* = 19.8 | | Mid | *M* = 5.0 (18%) *SD* = 0.0 |
| | South | *M* = 146.3 (85%) *SD* = 68.7 | | South | *M* = 16.0 (59%) *SD* = 23.9 |
| Summer Private (42%) | North | *M* = 59.8 (28%) *SD* = 12.6 | Winter Private (18%) | North | *M* = 23.2 (26%) *SD* = 4.0 |
| | Mid | *M* = 73.4 (35%) *SD* = 37.2 | | Mid | *M* = 17.1 (19%) *SD* = 6.1 |
| | South | *M* = 78.9 (37%) *SD* = 9.5 | | South | *M* = 49.2 (55%) *SD* = 7.0 |

The private summer group gave a significant difference between regions (KW, $H_{(2)} = 6.88$, $n = 365$, $P = 0.032$) under $P = 0.05$, however $\alpha = 0.025$ after Bonferroni correction, rendering the result marginal. The author considered it worth continuing with a pairwise comparison to identify significant group differences.

Pairwise MWU at the Bonferroni adjusted significance level $\alpha = 0.017$ showed that yearly summed efforts were significant by region between the North and Mid Wales regions during summer. Other pairwise comparisons were non-significant. MWU on the private group between summer and winter showed a significant effect for season (MWU, $U = 25{,}359$, $P = 0.016$).

[7]Summer charter was excluded from significance testing
[8] Winter charter was excluded from significance testing

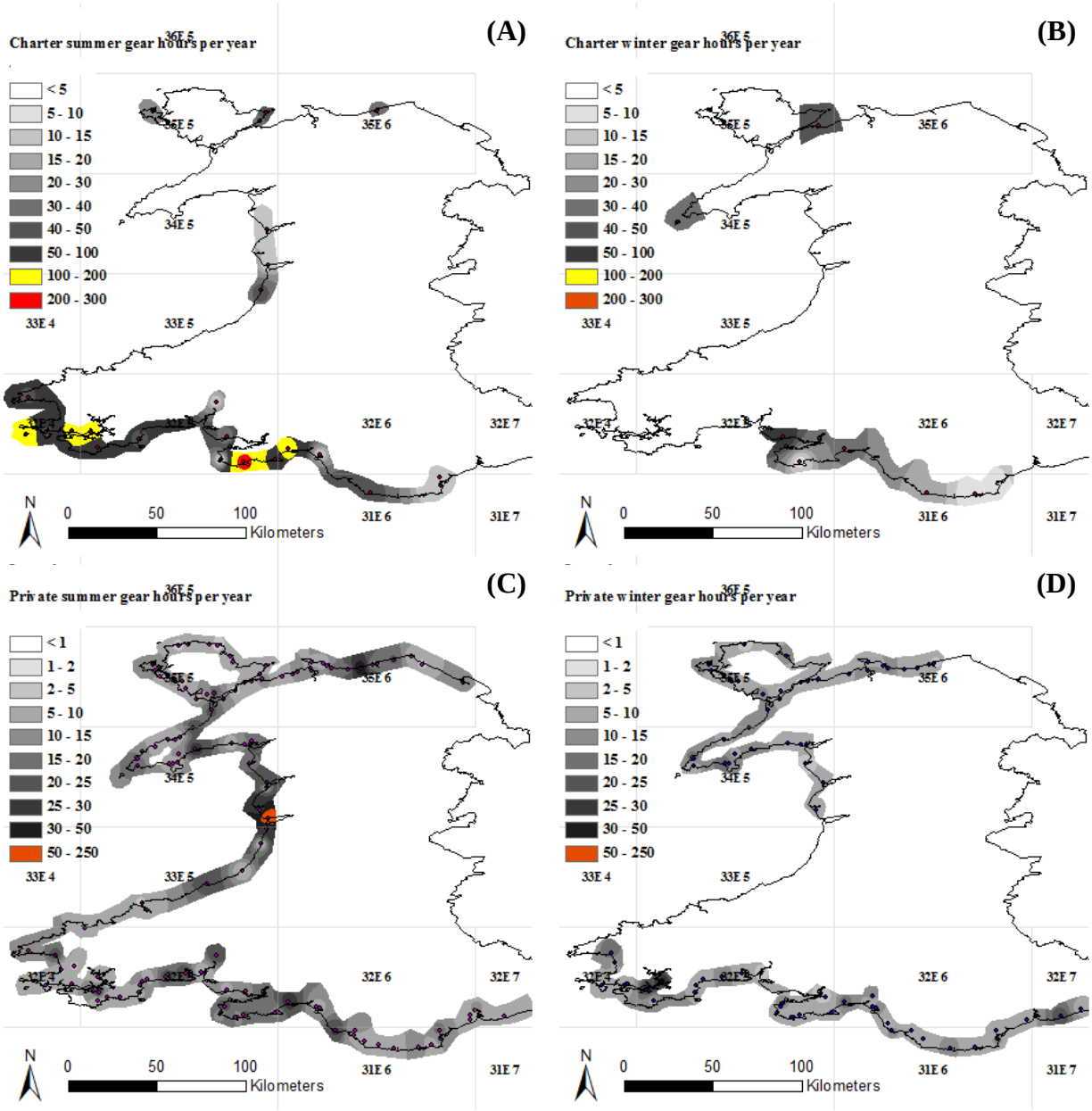



Figure 3-3. Inverse distance weighting interpolated maps of mean yearly effort in gear hours season$^{-1}$ from January 2006 to September 2013 in Wales for November to April and May to October, split by for-hire charters and private (shore, private boat, kayak) anglers. (A) Summer for-hire charter; (B) Winter for-hire charter, (C) Summer private anglers, (D) Winter private anglers.

The partition of mean total effort between summer and winter within coasts abounding ICES rectangles across the for-hire charter and private grouping is given in Table 3-4 and illustrated in Figure 3-4. The greatest effort within the sampled population is in 32E5 (the Gower and surrounding area) for both summer and winter with 32% and 27% of the total effort respectively. Percentages were calculated within season.

Table 3-4. Mean yearly effort gear hours season$^{-1}$ by ICES rectangle with number of locations (n) contributing to calculation. Period from January 2006 to September 2013 for Wales, Winter: November to April, Summer: May to October. Greyed cells highlight highest within-season total.

| Season | ICES rectangle | Mean total gh season$^{-1}$ | Season | ICES rectangle | Mean total gh season$^{-1}$ |
|---|---|---|---|---|---|
| Summer | 31E6 | *M* = 178.1 (6%) *n* = 13 | Winter | 31E6 | *M* = 85.9 (9%) *n* = 9 |
| | 32E4 | *M* = 420.4 (14%) *n* = 10 | | 32E4 | *M* = 50.8 (5%) *n* = 6 |
| | 32E5 | *M* = 963.4 (32%) *n* = 34 | | 32E5 | *M* = 252.0 (27%) *n* = 20 |
| | 32E6 | *M* = 212.7 (7%) *n* = 9 | | 32E6 | *M* = 100.5 (11%) *n* = 8 |
| | 32E7 | *M* = 21.2 (1%) *n* = 2 | | 32E7 | *M* = 30.4 (3%) *n* = 2 |
| | 33E5 | *M* = 109.7 (4%) *n* = 7 | | 33E5 | - |
| | 34E5 | *M* = 537.0 (18%) *n* = 25 | | 34E5 | *M* = 175.7 (19%) *n* = 15 |
| | 35E5 | *M* = 326.6 (11%) *n* = 27 | | 35E5 | *M* = 155.1 (17%) *n* = 14 |
| | 35E6 | *M* = 289.4 (9%) *n* = 18 | | 35E6 | *M* = 79.0 (9%) *n* = 9 |

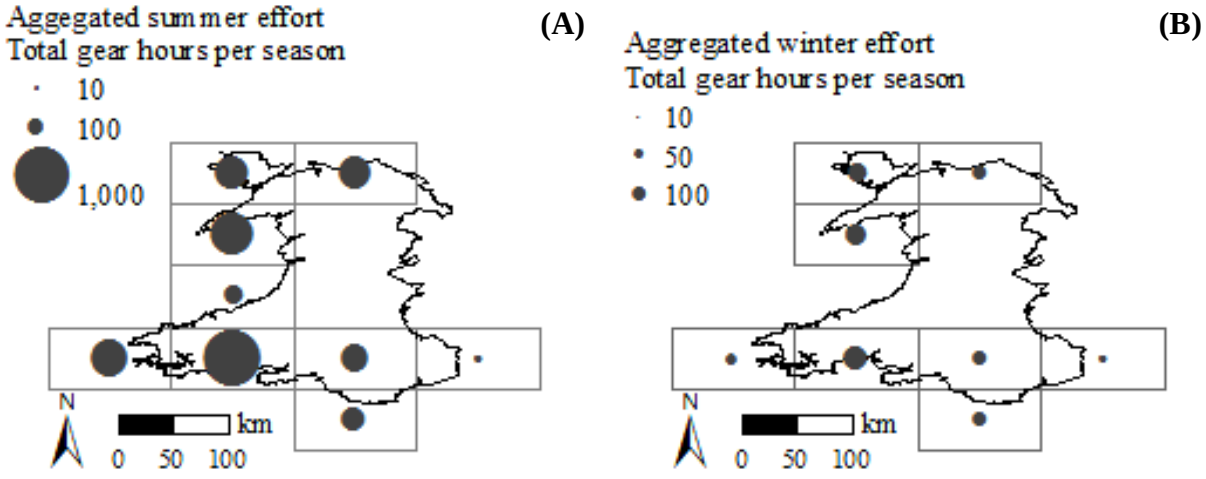



Figure 3-4. Maps of mean yearly effort gear hours season$^{-1}$ split by ICES rectangle from January 2006 to September 2013 in Wales for November to April and May to October.

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### 3.4.3. The seasonal distribution of sampled angling trips

The increased number of trip reports with bass catches during summer is evident with North, South and Mid Wales show winter trip decreases of 61%, 77% and 38% respectively, this pattern is mirrored for charters, with decreases as follows; NW, 65%; MW, 33%; SW, 89% (Figure 3-5,Table 3-5).

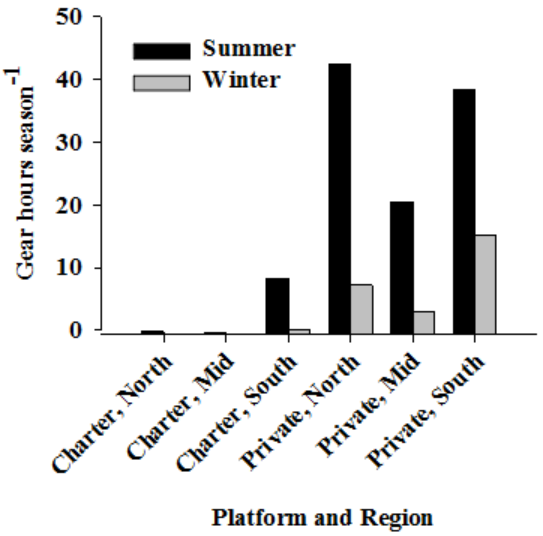



Figure 3-5. Mean trips season$^{-1}$ for private (boat, kayak, shore) anglers and charters boats from November to April (filled circles) and May to October (open circles). Regions are North; ICES rectangles 35E5, 35E6: Mid; rectangles 34E5, 33E5, 33E4: South; rectangles 32E4, 32E5, 32E6, 31E6, 32E7. Period was from January 2006 to September 2013 ($n$ = 8).

Contrasting the charter boat summer effort and trip results demonstrates the increased per trip effort of charter boats carry, attributable to the increased gears (individual anglers) on board, this is shown in Table 3-6, with the charter boat mean gear number of 8.7 ±2.5 rods, compared with the shore, kayak and private boat means of ≈ 2. The mean angling trips per season mapped across Wales are given in Figure 3-6, they visually reinforce the decrease in bass reports over the Winter in MW.

Table 3-5. Mean trips season$^{-1}$ with standard deviation and trip number range for private (boat, kayak, shore) anglers and charter boats from November to April (winter) and May to October (summer) across regions (North; ICES rectangles 35E, 35E6: Mid; rectangles 34E5, 33E5, 33E4; South; rectangles 32E4, 32E5, 32E6, 31E6, 32E7). Sample number gives the number of locations where samples were recorded. Period was from January 2006 to September 2013 ($n$ = 8). Grey cells give highest trips within season and charter group.

| Season and platform | Region | Mean and trip range year-1 | Season and platform | Region | Mean and trip range year$^{-1}$ |
|---|---|---|---|---|---|
| Summer Charter (7%) | North | *M* = 0.5 ±0.6<br>*Range* = 1 - 2 | Winter Charter (1%) | North | *M* = 0.1 ±0.0<br>*Range* = 1 |
| | Mid | *M* = 0.4 ±0.7<br>*Range* = 1 - 2 | | Mid | *M* = 0.1±0.0<br>*Range* = 1 |
| | South | *M* = 9.0 ±6.2<br>*Range* = 2 - 22 | | South | *M* = 0.7 ±0.6<br>*Range* = 1 - 2 |
| Summer Private (73%) | North | *M* = 43.0 ±15.9<br>*Range* = 25 - 64 | Winter Private (19%) | North | *M* = 7.9 ±4.4<br>*Range* = 2 - 16 |
| | Mid | *M* = 21.1 ±9.7<br>*Range* = 5 - 34 | | Mid | *M* = 3.7 ±1.1<br>Range = 2 - 5 |

| | | | |
|---|---|---|---|
| South | *M* = 38.9 ±14.9<br>*Range* = 18 - 68 | South | *M* = 15.7 ±7.4<br>*Range* = 4 - 25 |

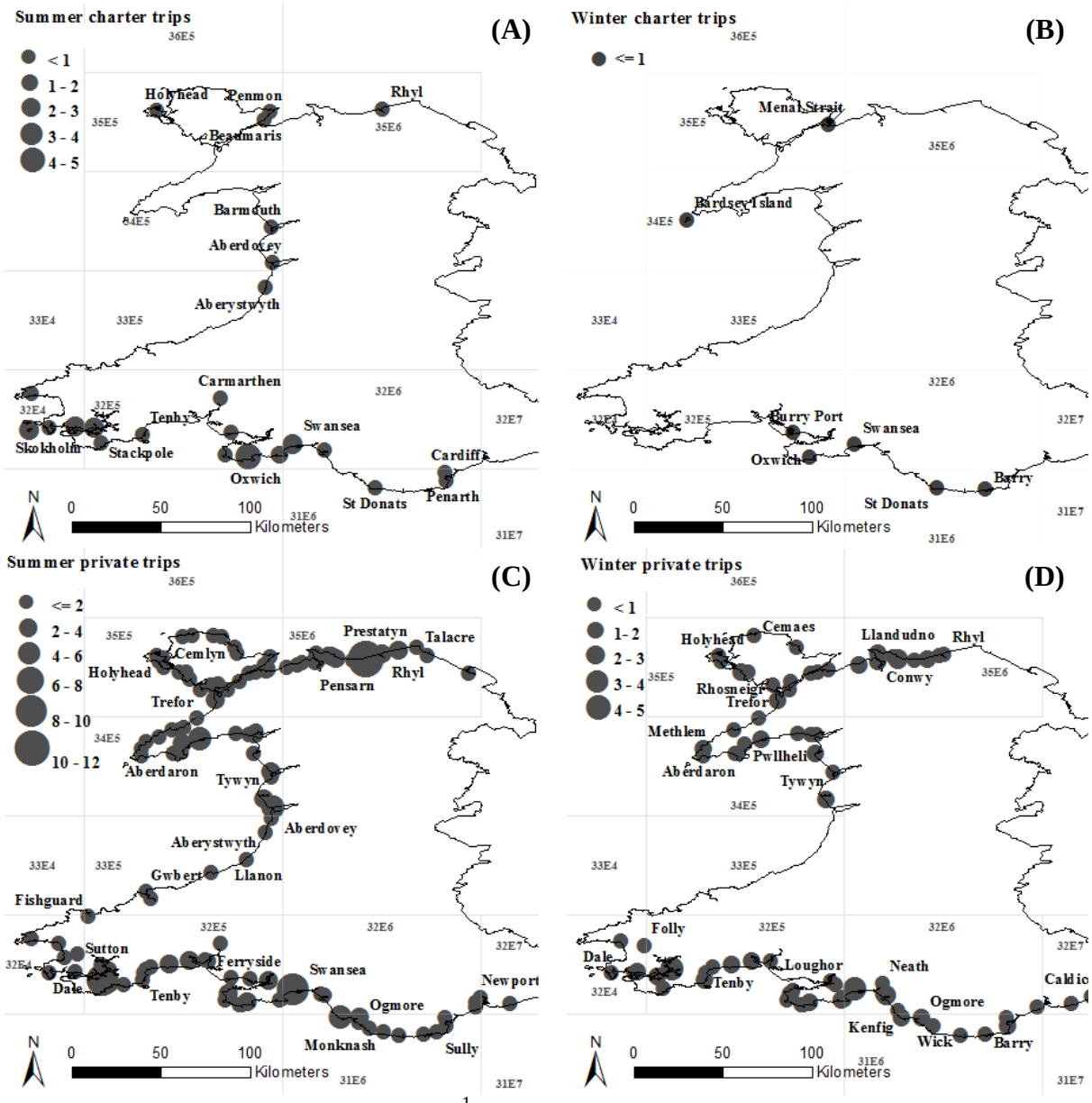



Figure 3-6. Maps of mean angling trips season$^{-1}$ where bass were landed , from January 2006 to September 2013 in Wales for November to April and May to October, split by for-hire charters and private (shore, private boat, kayak) anglers. (A) Summer for-hire charter; (B) Winter for-hire charter, (C) Summer private anglers, (D) Winter private anglers.

### 3.4.4. Estimate of mean trip effort parameters and standardised monthly effort trends

Estimates of mean gear numbers and mean trip lengths are shown in Table 3-6, on seasonal breakdown the winter charter boat, private boat and kayak platforms have insufficient data, with $n$ = 3, $n$ = 1 and $n$ = 1 respectively. The summer and winter shore gear number means differed (summer; $n$ = 336, $M$ = 1.64 gears ±0.99: winter; $n$ = 128, $M$ = 1.52 gears ±0.82) though not significantly (MWU, $U$ = 19,996, $n$ = 464, $P$ = 0.185). Similarly for trip durations (summer; $n$ = 336, $M$ = 3.87 hours ±0.1.97: winter; $n$ = 128, $M$ = 3.79 hours ±1.71), (MWU, $U$ = 21,364, $n$ =464, $P$ = 0.913)

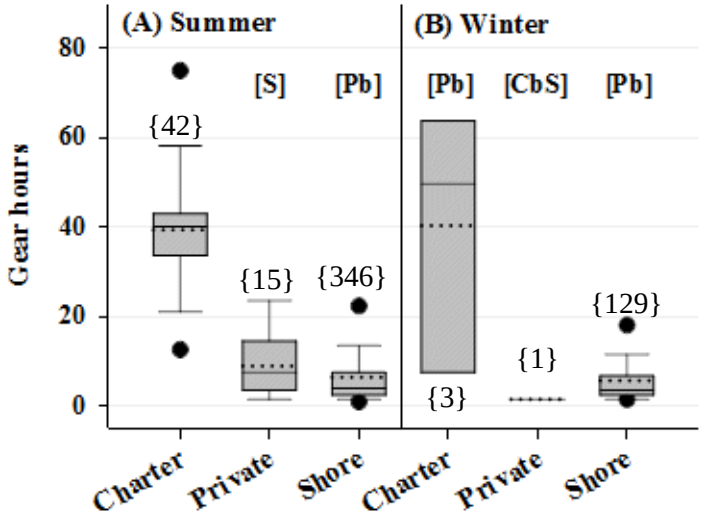
Table 3-6. Mean gear number and trip durations with standard deviation, stratified by platform and taken from data graded with an effort quality rating of > 60%. Boat [commercial] is from a single data set derived from a rod and line bass fisher, longline-30 is a 30 hook longline deployed by the same individual. Standard errors are given.

| Platform | Gear | Sample nr | Mean gear nr with SE | Mean duration (hrs trip$^{-1}$) with SE |
|---|---|---|---|---|
| Boat [Commercial] | Longline-30 | 98 | 3.3 ±0.33 | 5.0 ±0.0 |
| Boat [Charter] | Rod | 79 | 8.7 ±0.98 | 5.3 ±0.15 |
| Boat [Commercial] | Rod | 238 | 2.0 ±0.13 | 5.0 ±0.02 |
| Boat [Private] | Rod | 16 | 2.1 ±0.53 | 3.9 ±0.58 |
| Kayak | Rod | 12 | 2.0 ±0.58 | 4.8 ±1.04 |
| Shore | Rod | 494 | 1.6 ±0.07 | 3.8 ±0.09 |

Average trip length by platform stratification is presented in Figure 3-7, charter boat trip lengths differed significantly from private and shore trips in summer and shore trips differed from charter boat trips in winter (MWU $P < 0.05$). Trip lengths in hours across all stratifications showed high variance across summer and winter (summer; charter $M$ = 39.8 ±14.6, private $M$ = 9.5 ±7.5, shore $M$ = 6.9 ±6.9: winter; charter $M$ = 40.7 ±29.7, private $M$ = 2 (n = 1), shore $M$ = 6.2 ±5.7).

The trends of standardised monthly effort are presented in Figure 3-8, on the scale 1 unit represents a value 1 standard deviation from the mean of 0. After partitioning, only the 4 results presented had sufficient data. The increased angling effort within the sample over the summer months is clear, with activity minimums between November and March before increasing to June. Private effort in SW and NW has a bimodal peak, it is conjectured that the August peak could be attributable to the school summer holidays, though this is not seen in the MW trend line.

Figure 3-7. Mean and median effort in gear hours per angling trip by platform stratification. Charter and private are boat platforms. Within bar solid and dotted lines are the median and mean respectively. 25th and 75th percentiles also given. Bracketed letters give non-significant Mann-Whitney-U pair-wise comparisons ($P > 0.05$). Sample numbers given in curly brackets.



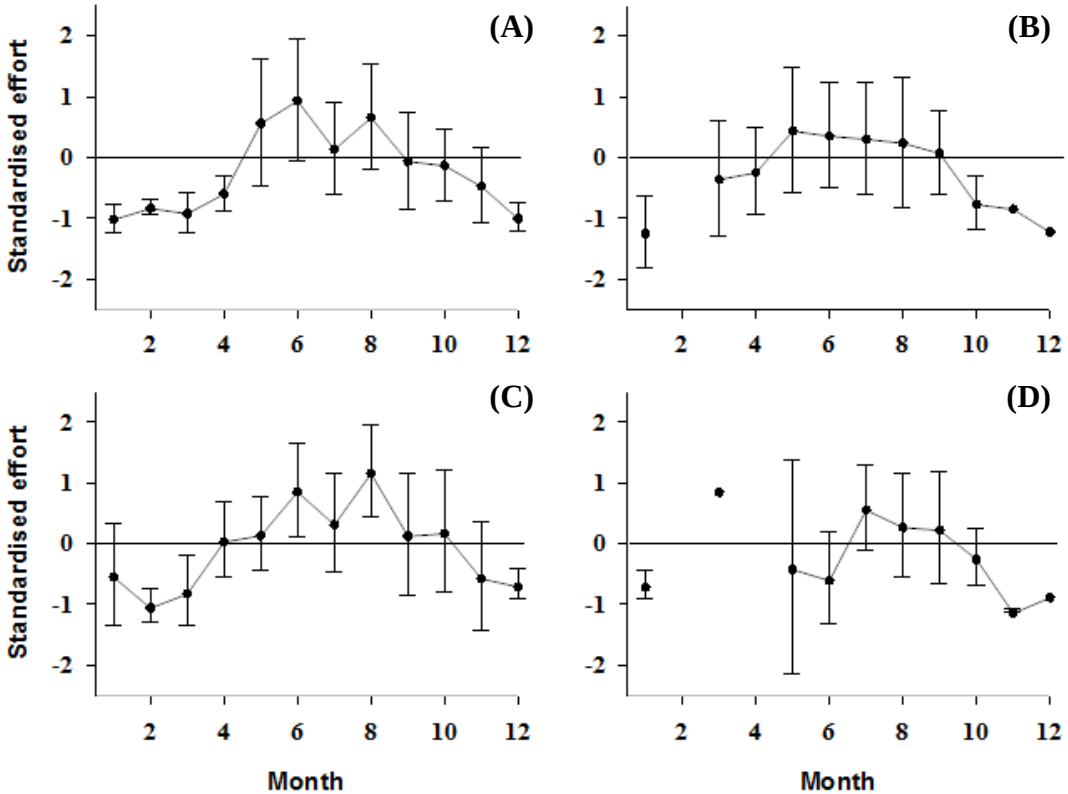




Figure 3-8. Graphs of monthly mean standardised effort with standard deviation bars across years for (A), private North Wales; (B) private Mid Wales; (C); private South Wales and (D) for-hire charters in South Wales.

### 3.4.5. Unstructured interviews: Opinions on stock status

Comments made by for-hire charters and club members under unstructured interviews are presented in Appendix V, these comments have then been classified to give an indication of the contacts' opinion on the direction of travel for bass abundance and size. The low sample number ($n$ = 17) rendered stratification by the locations defined in Appendix I unsuitable, therefore comments were split into North and South Wales (based on respondent location), with North Wales including all places inclusively north of Aberystwyth.

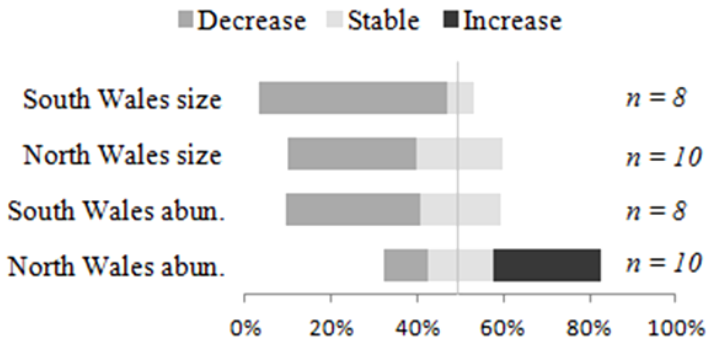



Figure 3-9. Unstructured interview response frequencies where respondents have indicated whether bass size and numbers (abun.) have changed over an (undefined) time period. North Wales includes all places inclusively north of Aberystwyth; South Wales is all places exclusively south of Aberystwyth.

Opinions on size changes within interviewees were nonsignificant between North and South Wales (Figure 3-9, $JT_{exact}$, $J\text{-}T$ = -1.26, $p$ = 0.196) but significant for abundance ($JT_{exact}$, $J\text{-}T$ = -2.313, $p$ = 0.010), indicating that size opinions on the direction of travel are the same between NW and SW, but in NW skippers do not think that abundances have decreased (Figure 3-9). NW and SW skippers agreed that sizes had decreased over time ($Binomial_{(exact)}$ test proportion = 0.5, $p$ = 0.033), this in itself should be considered a conservative test as it cannot account for the empty *'increase'* response.

## 3.5. Discussion

Unfortunately there is very little comparative data outlining the distribution of recreational fishing effort in Wales despite there being multiple Special Areas of Conservation and Special Protection Areas which recognise marine environments as areas of high conservation value at the European and national levels, therefore any data which helps understand the utilisation of coastal areas by anglers may be regarded as important, especially in light of the difficulty in assessing recreational angling activity.

It is recognised that the derived dataset is both small and potentially biased, certainly the figures for effort should only be interpreted in terms of the relative distribution of bass angling activity within the population of samples, data are currently insufficient to extrapolate results with statistical confidence to the population of forum users from which the data was primarily derived. The calculated mean gear numbers and mean trip durations by stratification given in Table 3-6 may be assumed to be an accurate measure for recreational shore anglers (mean duration $trip^{-1}$ = 3.8 ±0.09, mean gear number $trip^{-1}$ = 1.6 ±0.07, $n$ = 494), however the remaining platforms suffer from low sample numbers and 'afloat' platforms may be prone to durations which do not accurately reflect gear wet times.

### 3.5.1. Angling clubs and for-hire charter distribution

The distribution of angling club membership and relatively larger quantities of charter vessels persecuting bass in South Wales can be regarded as representative as the author considers survey coverage to be good (section 2.5.1). Both entity types are more frequent in South Wales (81% clubs, 55% charters) than elsewhere, where the frequency of organised sea angling clubs is probably attributable to the large conurbations of the southern region, this does not explain the disproportionately high numbers of charters offering specialists trips targeting bass, with North Wales having 18% more operational charters across the region. South Wales is thought to have more commercial boats targeting bass, primarily in the Bristol Channel using drift nets and rod and line, some of these may also operate as charters capable of taking anglers to high energy offshore areas subject to overfalls (Pawson *et al.* 2007).

### 3.5.2. Patterns of effort

It is unsurprising that charter boat trips were found to differ significantly from those of shore and private boats, particularly in the summer, total gear hours for a single trip are substantially higher as charters only operate when they have sufficient people on board to make the trip economically viable. It should also be noted that the results for charters and private boats were derived from a small sample set with 60% of individual trips derived from 2 clubs who arrange specialist charter trips with skippers and a further 23% from the World Sea Fishing scraped data. As the population of Welsh charters targeting bass is small ($n$ = 8) and it is likely that initial population coverage was good from

the comparison with Richardson's 2006 recorded numbers then despite the limitations of the dataset, the task of assessing charter boat landings of bass appears achievable with little investment.

Figure 10 gives an individual expert's outline of the distribution of recreation bass angling (Pawson *et al.* 1987), the mapped effort given here-in has good agreement with Pawson's paper across both summer and winter. Summer shows an additional concentration of effort on the sandy beaches between Pensarn and Rhyl, and also Pwllheli. Winter has good agreement also, though some effort is recorded in this study in the locale around Barmouth and Aberdovey which are absent in the 1987 map and no effort was reported in winter since 2006 between Tywyn and Folly. The highlighted summer differences may either represent newly exploited areas or represent a coverage gap in the 1987 map.

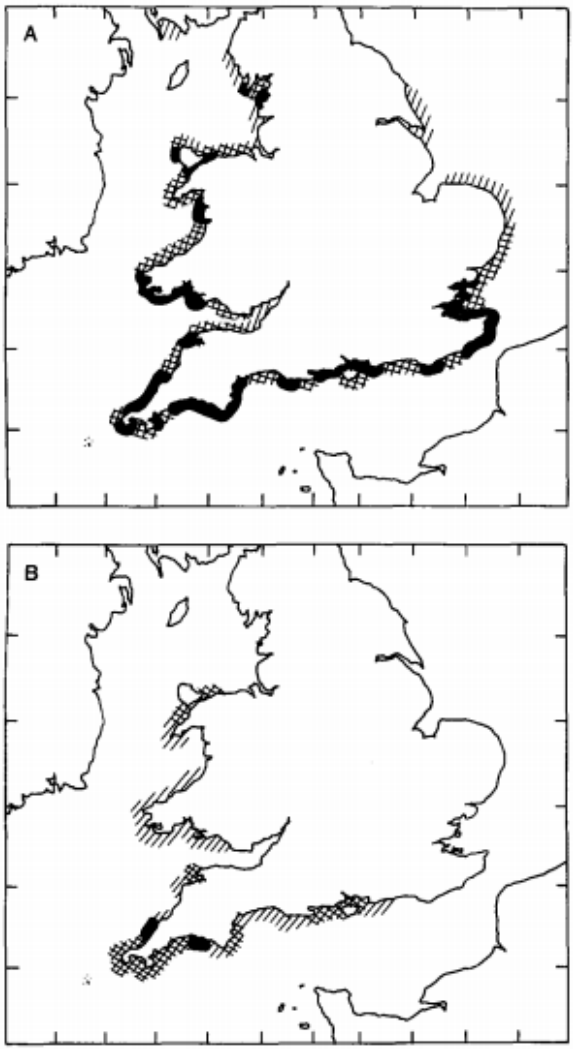



Figure 10. The distribution of distribution of bass angling activity in the U.K. (A) During summer (May-October). (B) During winter (November-April). Areas blocked denote main directed fishery; areas cross-hatched denote frequent directed fishery areas hatched denote occasional or incidental bass catches. Reproduced from Pawson *et al.* (1987)

Temporarily, the reduction in angler effort is unsurprising, mature bass begin to migrate away from their summer feed areas to winter spawning regions in November (Pickett and Pawson 1994), these results however do show that the methodology is sensitive enough to detect this change of angler activity despite the limitations in methodology and lack of a systematic analysis of error rates.

The interpolation process used in the production of the Figure 3-3 maps was primarily a visual indicator of relative effort at location, it is likely to be subject to high degrees of error when interpolating raster values between points spread far apart. In addition, it is apparent that the area to which the interpolation was restricted falls significantly outside the coastal border accessible to shore anglers. Under refinements, for example increasing the accuracy of locations as outlined in 2.5.3.3.1, improving the resolution of the interpolated area available for calculation, changing the interpolation algorithm and increasing the sample size (and all the associated improvements previously outlined for the scraping protocol) then the raster output may provide more absolutely interpretable effort data.

Despite the severe limitations in any extrapolation to estimating total effort, in excess of 1,000 separate bass records were obtained across Wales (which have been made available for analysis), and the effort parameters of mean gear use and mean trip duration should be of general applicability. The data is particularly strong in its representation of shore anglers who targeting bass, this is a rare and hard to survey group (NRW, CEFAS, Pers. Comms.) who generally fishing during the early hours of the morning or around dusk and in remote locations. These collection of data represents the largest collection of bass targeted recreational shore angling information gathered since the 1994 CEMARE study, but offers a framework for repeated measures at low cost.

### 3.5.3. Unstructured interviews: Opinions on stock status

Though a minor part of the project, the opinions of experienced fishers are important. That experienced charter boat skippers in South Wales feel there has been an overall decline in the size and numbers of bass, particularly within the Bristol Channel area has been demonstrated here-in, and provides additional confirmation of feedback provided by both commercial fishers and angling clubs on the state of the Bristol Channel fishery during a Marine Stewardship Council certification assessment of the bass trawl fishery in 2010 (Andrew and Pawson 2010), feeling was particularly strong that no resolution to the exercise of ‘grandfather’ rights by several vessels exploiting bass in the Bristol Channel had been achieved and there was some initial hostility to efforts to engage with some skippers over the lack of progress (from their personal perspective) on this issue.

# 4. CONCLUSIONS

The identification and assessment of existing recreational angler data sources with respect to bass were achieved with extensive coverage of Welsh angling clubs and charter boats. Unfortunately the extent of the data available was disappointing and is unlikely to provide a long term option for gathering retrospective data on angler activity. Both clubs and charter boat skippers targeting bass were however cooperative and receptive to the concept of a sustainable fishery and good management, it is likely that they would take part in off-site methods of data collection by recording bass catches.

It therefore appears viable that under an organised survey program very accurate assessment of charter boat CPUE and LPUE would be achievable, the whole population of charters targeting bass may be sampled and the random selection of other charters, under regional clustering can be used to generate effort estimates for the 'non-target' stratification. As charter boats necessarily have fixed launch points and launch times to coincide with favourable conditions then intercept interviews directed at anglers arriving back in port would be relatively trivial, such methods (or variations thereof) have been successful in previous studies (van Voorhees *et al.* 2002, Henry and Lyle 2003, Bochenek *et al.* 2010).

Shore based recreational anglers are more problematic, in general the group showed a mistrust of programs requiring data (for anecdotal evidence see *"Can we trust the scientists"*, World Sea Fishing (2013)). This is probably due to the general increase in sensitivity to data protection issues, 'nag' from previous surveys perceived as not producing results and concern over RSA licensing and possible harvest control rule enforcement in the future (Thrussel 2009, Goudge and Morris 2011), these were very difficult to engage as supported by the return rate from online diary survey requests.

The text mining technique was demonstrated to successfully extract recreational angling data and shore anglers were particularly well represented within this sample. Online data mining is employed widely in marketing (Berry and Linoff 2004), where it is used to build customer profiles (Adomavicius and Tuzhilin 2001) with obvious parallels with the stated requirements to help elucidate recreational angling stratifications and the geographical and temporal distribution of effort to aid in the design of comprehensive angling surveys.

The technique would be transferable to other fish species where the forums used here-in are a large repository of untapped data. There may also be a wider application across multiple aspects of local community and recreational use of the Welsh coast within the WG's Integrated Coastal Zone Management strategy. Forums and social media, in fact any suitable www accessible material can be used on an ongoing basis at low relative cost to produce data which otherwise would only be collected through sustained and organised mobilisation of personnel.

With specific reference to bass, the surveys undertaken have largely been to gather socioeconomic, profiling and general effort data (Nautilus Consultants Ltd. 2000, Drew Associates 2004, Richardson 2006, Goudge and Morris 2011, Brown 2012, MMO 2013). Where angler catch has been quantified (for example by the Welsh pilot surveys and match card assessments) bass capture rates have been very low in the measured population (1 bass per ≈500 gear hours in the match card data for example), therefore the importance of identifying anglers who specifically target bass to produce accurate low variance estimators of total CPUE is apparent. To accurately assess total bass landings, surveys must include anglers who catch bass and not anglers who say they fish for bass, Richardson for example identified that charter boat, private boat and shore RSFs listed bass in their top 3 target species in 30%, 62% and 64% of cases respectively (Richardson *et al.* 2005) and a similar pattern is seen in the MES Pilot Surveys. Any profiling questions need to align with bass angler stratifications and not just the general angler population if capture estimates are to be robust.

Any accurate assessment must also consider the catches by hobby netting and the grey area of rod and line anglers who sell their fish, it is likely that they have higher capture rates than the recreational sports fishing angler, particularly when captured from boat, yet assessment of this stratification is extremely difficult due to a reluctance to submit data. This study was unable to capture any information pertaining to the activity of hobby netters. Assessment of the recreational bass fishery must also take account of catch and release, which is practiced by a significant proportion of anglers. Release rates range between 32% and 39% according to the study by Drew Associates (2004) and Pawson *et al.* (1995) quoted rates for bass of 68% for shore anglers and 64% for boat anglers, there are however no detailed studies on survival rates of bass which partition survival by fish size and capture gear, both of which are likely to have significant effects on post catch mortality and so an accurate catch figure cannot currently be calculated.

This work concluded that the implementation of a web diary could not be justified when delivered under an isolated program of fisheries research, however the popularity of online angling forums in the recording of angling catch data has been demonstrated and they provided fertile grounds for the collection of recreational angling information, therefore they would be a logical point from which to engage in future data collection projects under an established user base. If scientists are to understand and assess recreational angling it is important to engage directly with the angling community to promote trust and relationships.

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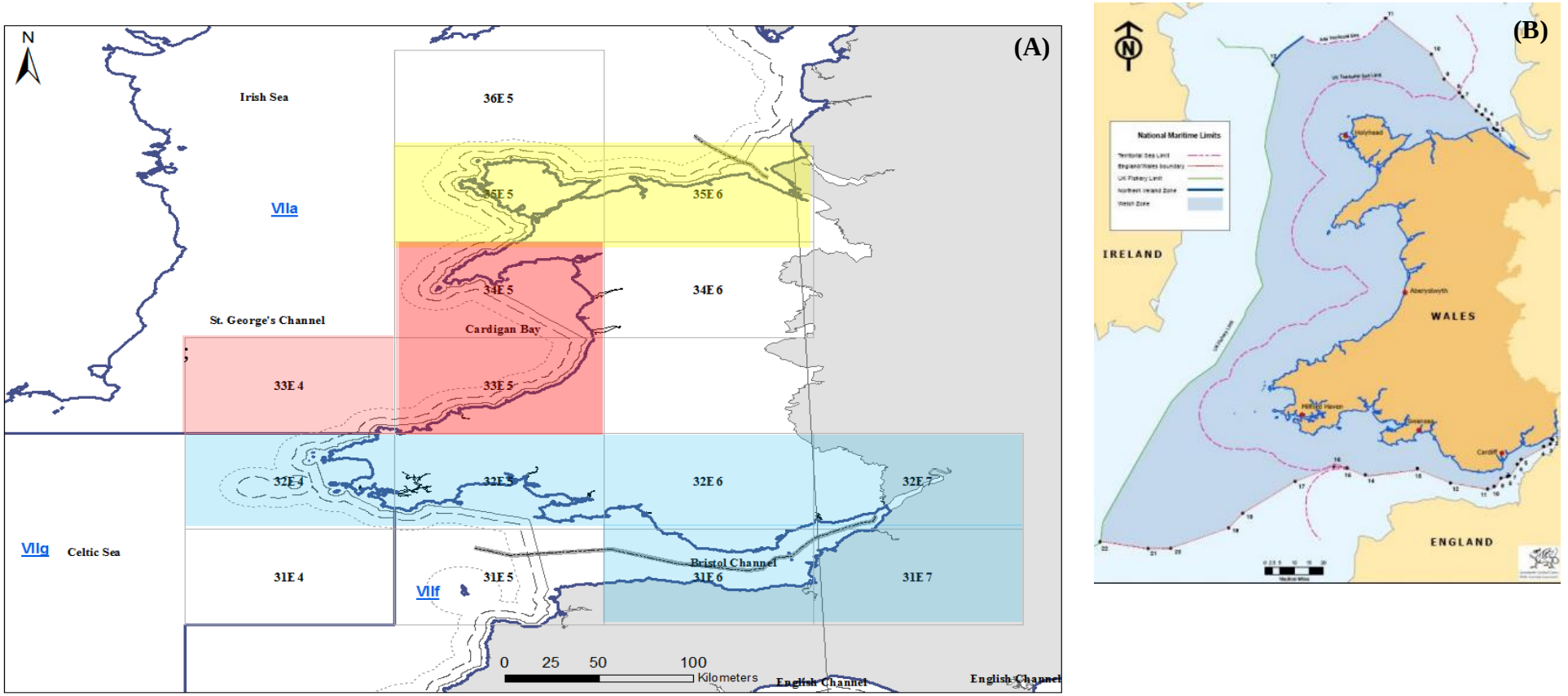
# ♦ APPENDICES

## Appendix I. Welsh waters, surrounding seas and abounding ICES rectangles




(A) Map of Wales and surrounding waters. ICES rectangles in grey are labelled with their 4 character code. ICES fisheries areas are delineated by strong blue line with corresponding underlined blue labels. Coastal lines represent limits as follows; dotted line, 12 mile UK territorial waters limit; dashed line 6 mile limit. Strong grey lines are Wales-England country boundaries. Yellow, red and blue overlays (aligned to ICES rectangles) delineate the author's definition of North Wales, Mid Wales and South Wales respectively, within the context of this thesis. (B) gives the 2010 boundary under which the Welsh Government has the competence to manage fisheries under the Boundaries and Transfer of Functions Order 2010. Reproduced from a Welsh Government source.

## Appendix II. Diary market research poll

This questionnaire aims to assess if an online diary for anglers has support and what features anglers consider important.

The online diary is part of the EFF funded project Sustainable Use of Fisheries in Welsh Waters, which will report to the Welsh Government

Would you ever record catches online? Yes | No How often do you sea fish per year? <5 | 5-19 | >20

| | disagree | slightly disagree | Neither | slightly agree | agree |
|---|---|---|---|---|---|
| I like keeping a diary of my fishing trips and catches | ☐ | ☐ | ☐ | ☐ | ☐ |
| I would like to use an online diary to record my catches | ☐ | ☐ | ☐ | ☐ | ☐ |
| I like using online angling forums | ☐ | ☐ | ☐ | ☐ | ☐ |
| I like submitting catch reports to online forums | ☐ | ☐ | ☐ | ☐ | ☐ |
| I like using social media sites (e.g. twitter and facebook) | ☐ | ☐ | ☐ | ☐ | ☐ |
| I would like to help scientists to understand my sea angling activity | ☐ | ☐ | ☐ | ☐ | ☐ |
| Note which web browsers you use _____ | | | | | |
| **The following questions seek to understand what personal profile details anglers would be prepared to provide, on a voluntary basis.** | | | | | |
| I would prefer to login through an online service (e.g. Facebook or Twitter instead of creating a new username and password) | ☐ | ☐ | ☐ | ☐ | ☐ |
| I would be comfortable providing my gender | ☐ | ☐ | ☐ | ☐ | ☐ |
| I would be comfortable providing my age | ☐ | ☐ | ☐ | ☐ | ☐ |
| I would be comfortable providing my name | ☐ | ☐ | ☐ | ☐ | ☐ |
| I would be comfortable providing my contact telephone details | ☐ | ☐ | ☐ | ☐ | ☐ |
| I would be comfortable providing my address | ☐ | ☐ | ☐ | ☐ | ☐ |
| I would be comfortable letting you know which fish I like to fish for | ☐ | ☐ | ☐ | ☐ | ☐ |
| I would be comfortable letting you know why I enjoy sea angling | ☐ | ☐ | ☐ | ☐ | ☐ |
| I would be comfortable letting you know my angling method(s) | ☐ | ☐ | ☐ | ☐ | ☐ |
| I would be comfortable recording my spend on sea angling in Wales | ☐ | ☐ | ☐ | ☐ | ☐ |
| **This section captures the information you would both like and be prepared to record.** | | | | | |
| I would like to record wind direction and speed | ☐ | ☐ | ☐ | ☐ | ☐ |
| I would like to record sea state | ☐ | ☐ | ☐ | ☐ | ☐ |
| I would like to record water clarity | ☐ | ☐ | ☐ | ☐ | ☐ |
| I would like to record how bright the day was | ☐ | ☐ | ☐ | ☐ | ☐ |
| I would like to record details of the tackle I used | ☐ | ☐ | ☐ | ☐ | ☐ |
| I would like to record the bait I used | ☐ | ☐ | ☐ | ☐ | ☐ |
| It is important to me that my fishing locations cannot be accurately pinpointed by the general public | ☐ | ☐ | ☐ | ☐ | ☐ |
| It is important to me that my fishing locations cannot be accurately pinpointed by other diary users | ☐ | ☐ | ☐ | ☐ | ☐ |
| It is important to me that my fishing locations cannot be accurately pinpointed by anyone | ☐ | ☐ | ☐ | ☐ | ☐ |
| I will only use the diary if it automatically provides weather information | ☐ | ☐ | ☐ | ☐ | ☐ |
| I will only use the diary if it automatically provides tide information | ☐ | ☐ | ☐ | ☐ | ☐ |
| My angling activity changes with the seasons | ☐ | ☐ | ☐ | ☐ | ☐ |
| I would answer questions to help understand my angling activity, e.g. how many rods I used and which fish I targeted | ☐ | ☐ | ☐ | ☐ | ☐ |

Page 1of the poll used to assess recreational angler opinion to a software as a service delivered online and smartphone diary application.

**This section captures the information you would both like and be prepared to record. (Continued)**

| | disagree | slightly disagree | Neither | slightly agree | agree |
|---|---|---|---|---|---|
| I weigh all the fish I catch | ☐ | ☐ | ☐ | ☐ | ☐ |
| I measure the length of all the fish I catch | ☐ | ☐ | ☐ | ☐ | ☐ |
| I only weigh or measure the bigger fish I catch | ☐ | ☐ | ☐ | ☐ | ☐ |
| I may use more than one fishing method during an angling session | ☐ | ☐ | ☐ | ☐ | ☐ |
| I do not mind recording if the fish I caught were kept or released | ☐ | ☐ | ☐ | ☐ | ☐ |
| I do not mind recording if I think a released fished survived | ☐ | ☐ | ☐ | ☐ | ☐ |
| I would like to see my catches summarised on a map | ☐ | ☐ | ☐ | ☐ | ☐ |

**Community features may enhance the application, encouraging anglers to use the site. These questions will help identify the community features users may wish to see.**

| | | | | | |
|---|---|---|---|---|---|
| It is important to me that the site has community features (e.g. contacting site members, sharing photographs, posting events, personal blog) | ☐ | ☐ | ☐ | ☐ | ☐ |
| I would like the diary to integrate with social media sites, for example sharing my catch pictures on facebook | ☐ | ☐ | ☐ | ☐ | ☐ |
| I would share my catches with the general public, provided the location could not pinpointed | ☐ | ☐ | ☐ | ☐ | ☐ |
| I would share my catches with other diary users only, provided the location could not pinpointed | ☐ | ☐ | ☐ | ☐ | ☐ |
| I would share my catches with friends only, provided the location could not pinpointed | ☐ | ☐ | ☐ | ☐ | ☐ |
| I would like to see other anglers catches summarised on a map | ☐ | ☐ | ☐ | ☐ | ☐ |

**In addition to the website diary we wish to know if anglers want to record and view catches on a smartphone and what broad features they would like the smartphone diary to have.**

| | | | | | |
|---|---|---|---|---|---|
| I would prefer to use a smartphone rather than a web site to record my catches | ☐ | ☐ | ☐ | ☐ | ☐ |
| I would like to use diary community features (e.g. sharing catch photos with users) on the smartphone diary | ☐ | ☐ | ☐ | ☐ | ☐ |
| I would only use the smartphone diary if it had tide and weather prediction | ☐ | ☐ | ☐ | ☐ | ☐ |
| I want to see catches on the smartphone diary that I have added to the Web site | ☐ | ☐ | ☐ | ☐ | ☐ |
| I want to see catch summaries from other users on the smartphone diary | ☐ | ☐ | ☐ | ☐ | ☐ |
| I want to record catches during my angling session | ☐ | ☐ | ☐ | ☐ | ☐ |

*What smartphone operating systems do you use? (mark on all which apply)*

Android | Asha (some Nokia) | Blackberry | iOS (Apple) | Windows Mobile 6.5 or earlier | Windows Mobile 7 or later | Do not own one | Unsure

Comments (e.g. on expected features, what would discourage/encourage you from using an online diary)

**PLEASE RETURN TO THE SURVEYOR AT THE END OF YOUR ANGLING SESSION**

Page 2 of the poll used to assess recreational angler opinion to a software as a service delivered online and smartphone diary application.

## Appendix III. Diary market research poll: Open ended answers

The following are the free text responses provided by anglers when completing the online survey.

| What features would encourage you to use this electronic diary? | Classification |
|---|---|
| If my diary helped to ensure future fish stocks were maintained | *Sustainable management* |
| simple and fast data entry | *Usability* |
| Tide tables, Weather forecast (3 day) Tide heights, Wind strength & direction, Sea state, Fish reports for all main fishing areas, i.e., good fishing, poor fishing, species being caught. | *Value added* |
| In pursuit of a sustainable fishery, I would freely participate in any sensible scheme | *Sustainable management* |
| Regular feedback would be useful, with enough detail to know that fish were showing at venues, including size and number. Size and fish species vary between years, e.g. 2011 was good for codling in Conwy. | *Value added* |
| Ease of use | *Usability* |
| A computer program that can give you a best guess as to which venue to fish if you enter weather and tide info. | *Value added* |
| Simplicity | *Usability* |
| Weather and tide. | *Value added* |
| easy to use smooth seamless various methods of recording from tides to fish | *Usability* |
| Use of API's to retrieve tide and weather conditions. Quick and easy to use - one touch to add a fish. | *Usability* |
| ease of use | *Usability* |
| If I believe it was benefiting the environment. If it was effectively a crown sourcing mechanism for seeing what was being caught where. If there was some way that we could prevent the information being used by unscrupulous netters. | *Sustainable management* |
| if it was straight forward and was secure | *Usability* |
| If it was extremely easy to use and didn't take much time up | *Usability* |
| Community forum | *Value added* |
| simplicity | *Usability* |
| Prob. None | *Would not use* |

| What features would stop you from using an electronic diary? | *Classification* |
|---|---|
| If it turned out to be too time consuming | *Poor Design* |
| slow and complex data entry | *Poor Design* |
| Too much personal information | *Poor Security* |

| | |
|---|---|
| data was not secure | *Poor Security* |
| Poor/Tacky design | *Poor Design* |
| if it was difficult and not user friendly | *Poor Design* |
| spam advertising. automatic, unauthorised posting to social media e.g. facebook | *Cross Marketing* |
| See above re netters. | *Data privacy* |
| if my marks were pin pointed as I fish a lot of out of the way rock marks | *Poor Security* |
| If it was time consuming and difficult to use | *Poor Design* |
| Complexity and time consuming - Keep it simple | *Poor Design* |
| difficulty | *Poor Design* |
| GPS | *Poor Security* |

| **Are there any features or items of diary information we have not included?** | |
|---|---|
| Communication between Fishing clubs and Forums, building up a clear picture of grass roots information and a regular basis | *Community features* |
| yes was a fish finder used or not .the depth of water fished in | *Fish finder use, Fishing depth* |
| voice recording for marks - or voice recognition for quicker data entry. | *Voice recognition* |

| **If you object to using this diary, can you please tell us why?** | |
|---|---|
| I've seen too much "confidential" information end up in open circulation. | *Data privacy* |
| I do not object, I simply fish for my own pleasure and do not feel the need to record my very small catches | *Insufficient catches* |
| I have kept a diary in the past and feel I know my patch well enough. If I ever moved, or started fishing new waters, I would keep an online diary. | *Of no personal utility* |
| I don’t want to | *Of no personal utility* |
| tbh i only keep 5-6 fish per year it’s a sport for me rather than fishing for the table | *Insufficient catches* |
| I don’t so much object ,I just wouldn’t use the diary it s not how I work. | *Of no personal utility* |
| i would pass you catch reports, but do not want the information seen on the web, or anywhere else in public view. | *Security* |
| Possible misuse by authorities to restrict angling without consultation. | *Official organisation data misuse* |
| Do not want my personal information about my fishing activity online | *Data privacy* |

## Appendix IV. Catch record and colloquial term translation and interpretation

Appendix IV. Rules for the translation of catch records from anglers reports and interpretation of common colloquialisms. The abbreviation +der means including derivations, extending to include common misspellings. Plural forms were also accounted for, but are not specified in this table.

| Case | Record treatment/interpretation | Example or common term |
|---|---|---|
| Measure specified for individual fish | Record individual measure as a sample. All lengths assumed to be total length unless otherwise specified. | Caught a fish of 3.5 pound. |
| Number of fish unspecified, smallest and/or largest measure given | Record as a maximum and/or minimum | A mixed bag of fish, to about 5 lbs. |
| Catch number given | Count only recorded. | I caught 7 bass |
| Measure for multiple bass over small measure range | Record as an individual measure for each fish with the value of the range mean. | 4 fish caught just between 10 and 12 inches. |
| Measure for single bass over a measure range | Midpoint of range recorded as an individual sample | Bass was between 0.5 and 1.0 kg |
| Adjective phrases indicating small variances from a specified figure | Adjusted measure in the implied direction of the quantifier by 0.05 kg (≈ 1 ounce), or 1 centimetre. | A little under 2 kilograms |
| Relative measure phrase with respect to minimum landing size (MLS) | Adjusted measure in implied direction as above, based on the regional MLS | One bass was a shade undersize, the other was just big enough for the table |
| Multiple anglers | Added as additional gears | |
| Interpretation of common fishing trip length duration terms | 6 hours | Fished tide in/out/down/up/a tide |
| | 8 hours | All night(er)/day/a day's fishing |
| | 4 hours | Afternoon/morning/evening |
| | 3 hours | Around low/high |
| | 3 hours | Short/quick session |

| | | |
|---|---|---|
| | 2 hours | Couple/few (hours) |
| Slang terms for bass | silver bar, silver, silver bullet, shirley (+der), bar of silver, schoolie (+der.), bassling | |
| Weights | kg, kilo, kilogram, pounder, lber, oz, ozs, ounce, lb, pound, gram | |
| Lengths | cm, “ (double quote), inch, inches, feet, foot, centimetre, centimetre, meter, metre | |
| Numbers | Lone, single, solo, solitary, final, next, another, a, couple, few, half a dozen (+der), dozen, brace, pair, basss, first (1st), second (2nd), third (3rd) …, quarter (+der), half (+der) , three quarter (+der) | |
| Kayak platform identification tags | yak, kayak, prowler, tarpon, trident, scupper, hobby, paddle, fatyak, fat yak, dorado, kaskazi, teksport, emotion | |
| Boat platform identification tags | Tub, dinghy, dingy, boat, ship, vessel | |
| Other platform identification tags | Launch (+der), skipper, inflatable, sail (+der), onboard, seasick, sea sick, drift (+der), anchor (+der), warrior, paddle (+der), row (+der) | |
| Duration candidate tag | arrived, started, fished, fishing, before low, after low, to low, after high, to high, before high, either side, around high, around low, hour, hours, p.m., a.m., flood, ebb, tide out, tide down, tide in, tide up, packed up, stopped, went home, ended, finished, left, began, begun | |

## Appendix V. Unstructured interviews

Appendix V. A record of comments from contacted entities (angling club boards and for-hire charter skippers) under informal interview between July 2013 and September 2013. The size and abundance change columns indicate the interviewee's opinion on the increase or decrease in size or numbers of bass caught as indicated by the comments. Note that the time scale over which the indicated change occurred is not formally qualified in most cases and that North Wales includes all respondents operating north (but inclusive of) Aberystwyth.

| Region | Comment | Size change | Abund. change |
|---|---|---|---|
| North Wales | There are fewer and smaller bass than 30 years ago. | ↓ | ↓ |
| | The numbers are better, but the sizes have decreased. | ↓ | ↑ |
| | Plenty of small bass but fewer bigger ones, a 7lb bass is a rarity now. | ↓ | ↑ |
| | A lot more caught recently, almost all between 33 and 43cm, generally a few caught each day. | → | ↑ |
| | Plenty of small bass around. | → | ↑ |
| | Very small now, bass over 5lbs are very rare. | ↓ | → |
| | Numbers are the same, size decreased. Averaged in the 80s and 90s was 4.5lb, now it's about 1.75lb. | ↓ | → |
| | The numbers are better, but the sizes have decreased. | ↓ | ↑ |
| | Last 10 years bass numbers have dwindled. Netting from the shore is taking a lot of bass. I can't force people to put bass back on the boat because there are no controls. Bag limits would allow me to enforce this. | → | ↓ |
| South Wales | Wouldn't say they are declining and the big ones are still around if you know where to look. | → | → |
| | Bad year, 30 under 30cm. 30% fewer bass year on year and they are smaller. Fisheries are powerless to act and the protection even for nursery areas is not enforced and does not apply to shore fishers. | ↓ | ↓ |
| | The sizes have decreased, but the numbers are ok. | ↓ | → |
| | Double figure bass have declined. | ↓ | → |

| | | |
|---|---|---|
| Huge decline in abundance and size, due to grandfather rights exercised by the Josi Grace. The bass and turbot fishery has been ruined. No protection of nursery areas. I support an MLS increase to 40 cm. It's not anglers who have affected the stocks. | ↓ | ↓ |
| Stocks much reduced. Bass nursery areas are working, but they are fewer and smaller. In Ireland bass seem to be recovering under the bag limit restrictions. Lots of small boats now fishing and there can be over 20 at a mark. | ↓ | ↓ |
| Numbers and size have decreased, 60% smaller and fewer than 10 years ago. Rod and line and netting by hobbyists who sell illegally and commercial anglers who target bass as they clump up to spawn are the main causes. A 10lb bass used to be a regular occurrence, not anymore, lucky now to catch a 5 lb bass. I no longer bass for bass as I can't guarantee a my clients will catch one. | ↓ | ↓ |
| Gradually declining in numbers and size over the last 8 years. Large numbers of small boats a fishing all day and taking a lot of undersize bass to sell to restaurants. | ↓ | ↓ |

## Appendix VI. Web application specification

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# RSA Diary Website Software: An Overview and Draft Specification

### Contents



### Introduction

Though this document is primarily concerned with the Web site specification, an overview of the high level architecture of the web and smartphone apps is given in Figure 1 and *Mobile Diary* will be briefly introduced.

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Version 2, released 14th June 2013

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*Mobile Diary*[1] smartphone application to be delivered to:

- Android
- iPhone
- Windows 7 mobile devices

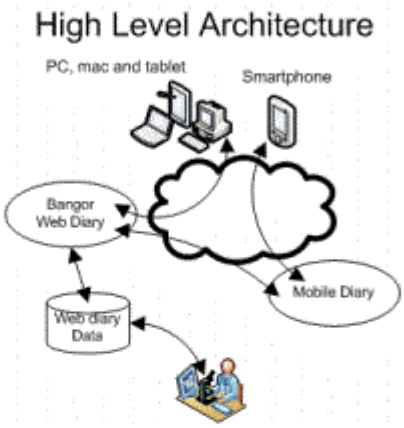


Figure 1.

*Mobile Diary* will allow an angler to enter diary information even in the absence of a GPRS signal. The captured data will be sent (via a webservice) to the centralised *Web Diary*[1] web application (running on a web server in an as yet undermined place or platform).

Data will be stored in an enterprise class database (for example SQL Server, MySQL or Oracle) which may then be accessed directly by scientists for analysis, or further publishing via dedicated reporting services or additional webservices for other (authorised) consumers to use (CEFAS, NRW etc.).

[1] Working name only, to be finalised at a later date.

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# Web Diary

## Overview

*NB: In general, terms may be used throughout this text, such as 'system administrator', these are simply to introduce concepts and terms in which we can understand the discussion, and do not indicate strict requirements or dictate and restrict final function. In addition,* ***the design and layout of the screens is not prescriptive, as it is expected the development house will be familiar with the design of web UIs and be able to show some examples of current work.***

**It is recommended that the web site development proceeds in two phases to enable data collection to start at the earliest possible opportunity.**

**Phase 1**: Develop the application core necessary to provide the diary function to anglers, this necessarily includes basic user management, security and informed consent agreement.

**Phase 2**: Develop social media and other MoSCoW [2]"Should haves" and "Could haves".

The *Web Diary* "traditional" web application provides multiple software services and **it is the main concern of this specification**[3]. Aims and justifications in brief are:

- Web based diary like data entry, functionally equivalent to the smartphone *Mobile Diary*.
- Facility for data entry from other sources (scientists, hired data inputters, RSA clubs etc.) to standardise data.
- Individual user features within a richer user interface
- Social media features within a richer user interface.
- A web presence which can be used as a tool to promote and disseminate information related to the project and the organisations involved and through which **all** stakeholders can directly see *value for money*.
- A platform for further expansion, for example it could be leveraged into a portal for professional inshore fishers to record catch data for scientific purposes, significantly reducing the effort associated with manual data capture, recoding and processing.

---

[2] MoSCoW: **M**ust have, **S**hould have, **C**ould have, **W**ould have. A useful and clear classification for software feature discussions during design and specification.
[3] The smartphone application specification is dependent on the web diary application and clarification of the business model, it naturally will follow after the web site specification has been agreed.

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- The *Web Diary* function will remain as the IP of the procurers, irrespective of the smartphone business model decided upon.

The *Web Diary* function will be developed first, it dictates the database definition (on which all else depends), will be the most rapid to develop and progress is not complicated by the business model issues of the *Mobile Diary*.

The *Web Diary* application will retain full functionality on the following browsers:

- Internet Explorer 8 or later
- Chrome
- Firefox
- Opera

**General Expectations**

These are open to discussion, however in principle the following points will greatly improve the acceptance, flexibility, utility and longevity of the application, particularly in combination with the *Customisable Lookups* option.

- Allow descriptive field labels (e.g.. Publication date: All dates ) to be configurable by a *system administrator*
- Allow a field to be associated with a customisable '*tooltip*' to provide further information on input – this may be sufficient to dispense with a formal help or support guide, at least initially.
- Allow data fields to be suppressed/hidden on the web forms.
- Allow data fields to be flagged as required.
- Every user input field should be validated and report to the user if there is an exception, highlighting the field (in some way) in the UI.
- Compulsory user fields to be visually indicated.
- Tab order for user input to be set logically.
- Website will be XHTML 1.1 compliant (to meet accessibility requirements).
- CSS will be CSS 2 compliant.
- Complies with EU "cookie laws".
- Web forms are expected to be asynchronous, using Ajax or equivalent technology, it is important that the web UI is perceived as modern.

- All data lists should support paging and the default order should be appropriate (typically alphabetic or reverse date order).
- All lists will support searching based on the main descriptive field. Auto complete of search terms is a "Could have".
- All code to be commented in a standard fashion (according to the standards of the development house) with a description of what the routine does and why it is important (not a walk-through of the code itself!).
- Database to be second normal form, unless this would significantly increase development time of a single functional area.
- Database to follow a standard naming convention (convention at the choice of the software house) and employ relationships, primary keys, indexes, unique keys and default values as appropriate, these features greatly enhance the robustness and interpretation of the underlying database structures and application business rules.
- Where there are no primary key candidates, uniqueidentifiers (GUIDS) are preferred to identities, this greatly improves synchronisation resolution and inter database data transfers.
- Reasonable measures to be taken to secure the website (for example, prevent embedded SQL scripts attacks), ensure webservices which expose user specific data are secured via user authentication with passwords not sent in clear text. It is anticipated that Bangor University[4] will procure a new domain and corresponding SSL certificate.
- Ideally, key data collection forms (trip and catch logging) should be optimised so they can be viewed on a smartphone. This will enable smartphones to be employed in a remote data collection capacity after the completion of phase 1 (accepting availability of GPRS signal).

[4] Bangor University, or Bangor is used within this document and in general refers to scientists and Bangor University School of Ocean Science EFF programme partners (or future partners).

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**Conceptual Layout**

Asynchronous web technology allows multiple pages to be combined to appear as one and greatly improves the user experience (facebook is an excellent example, you can recognise when asynchronous content has been served when the blue header bar does not reload). As such, figure 3 shows the basic web page map, though it will hide some development complexity. Note the concept of a single subscriptions page, which lists all content to which a user can subscribe to display on the users home page (format and layout to be decided).

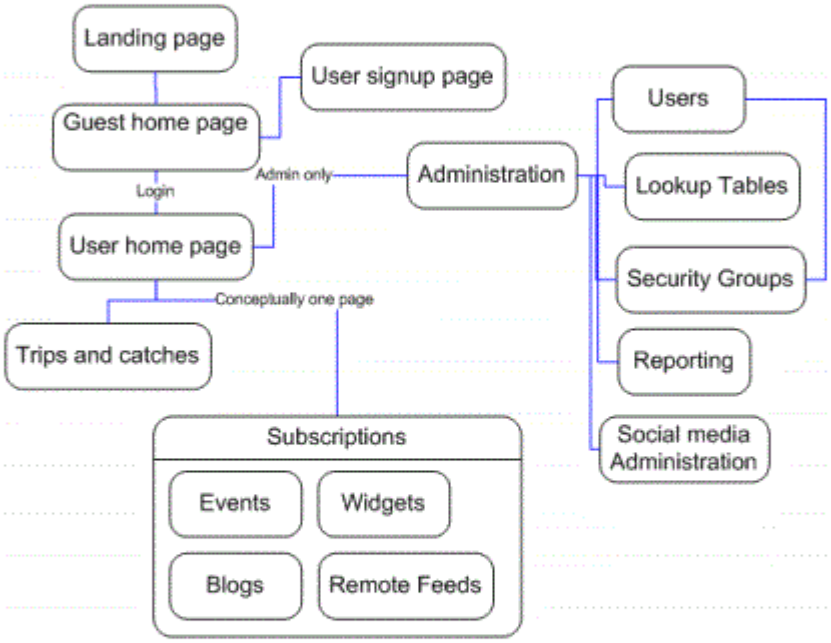


Figure 2.

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## Conceptual Structure

Structure schematic is given in Figure 3. It is not intended to be a complete coverage of each table that will be required in the database design.

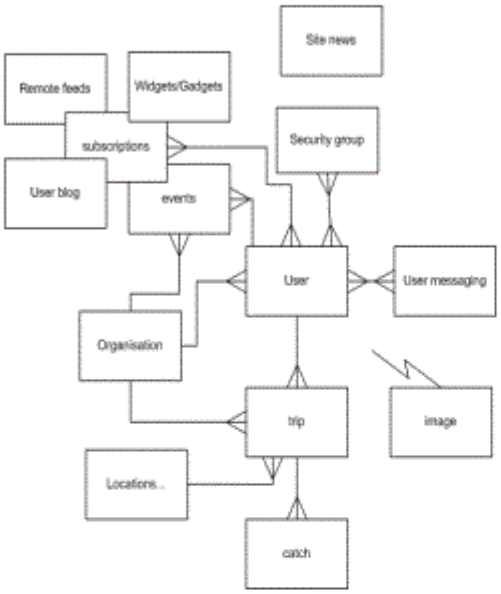


Figure 3

The core structure is **user – trip - catch**. The user contains basic information pertaining to the angler, recorded during registration and editable as required, the table ***User Entity*** lists some preliminary fields.

A user (angler, scientist etc.) can create a trip, recording necessary details, such as where it was, what species they were targeting etc.

The ***Trip*** table lists some preliminary fields. A trip may have multiple catches or none (**note it will be important to persuade anglers to record unsuccessful trips, there can be many!**).

Catches are the lowest tier in which a user records the species caught during a trip and other specifics, for example anglers can change gear and bait within a trip, hence the allocation at the catch tier.

***For key fields see the embedded document below.***

Adobe Acrobat Document

**Location** structure is currently undetermined and requires further discussion within Bangor. The issue is twofold; a) aggregating data at an acceptable geographic level to fishers and b) ensuring that when an angler (or future group if the sites use is extended) logs data without the GPS coordinates that it can be aggregated to the lowest level (most detailed) required of

the scientific analysis, while still being easy and meaningful to the user. **This determines how any mapping content will be delivered.**

### User and Security Control

CRUD[5] access per page should be assigned to security groups, a user may belong to more than one security group and *vice versa* (many to many). As additional functions are developed, these will be included under group security control, for example the ability to delete pictures (if for example an inappropriate one had been posted).

#### Key features

- Users need to agree to an informed consent form (which will include T&Cs), agreement needs to be recorded and the wording of the form should be editable by an administrator. This consent agreement should be resettable for one or multiple users, if for example the consent statement is changed.
- Users need to be able to create their own login, this needs to be verified as human with a ReCaptcha (or equivalent).
- Guest access is allowed, showing summary data, system news and public events.
- System administrators need CRUD access to any content, for example to delete offensive pictures or events and to delete or disable user accounts.
- User signup requires email validation.
- Standard features allowing administratorless verified password resets ("request a new password"), including security question(s) in the event a user's email address has changed.
- Administrators need to be able to perform password resets and email those resets.
- Password complexity to be enforced. The rules can be fixed.
- It should not be possible to lock all administrators out of the system, a single undeletable administrative user should be added.
- A log file should be kept of all table CRUD activity through the web (it is assumed *Mobile Diary* will use the same underlying webservices) and include the user executing the command. If database triggers are used to implement this feature it is important that bulk data transfers are not logged as an event per affected record.

#### Lookup table administration

Lookup tables need to be maintained (CRUD) via the web interface and access to carry this out must be under security control. It is not anticipated that permissions by specific lookup table will be required.

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[5] Create Read Update Delete – the basic actions which can be carried out on data.

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## Social Media and Value Added Content

Social media is complex and brings with it an onus on the system administrators to police the system, which of itself increases complexity as users need to be able to raise issues against any user generated content and administrators need the means to locate and censor said content. It also follows that codes of conduct and terms of conditions need to be drafted. Restricting the breadth of social media features is advised, this isn't facebook.

### Site news

A means of a system administrator posting news items which appear as a feed on guest and user landing pages, this should support html to ensure good quality presentation, ideally a WYSIWYG html editor would be incorporated so that system administrators do not require HTML coding skills.

### User messaging

A simple user to user messaging system (**not** instant) would add some utility.

### The subscriptions idea

*Subscriptions* is intended to provide the appearance of a single screen from which a user can choose to subscribe to the 4 types of available content. Note that this necessarily requires a user to be able to unsubscribe and resubscribe to feeds and also to search for feeds by feed owner (users own blogs, events are owned by users or organisations) and description. A subscription which has been subscribed to should be removed from the list of unsubscribed subscriptions and *vice versa*.

### A brief description of subscription components

- **Remote feeds:** will be added by administrators, they are RSS feeds from related sites to which a user can subscribe to
- **Widgets/Gadgets:** these are graphs and tabular content which may be fixed, or ideally should be flexibly configured by a system administrator, they provide content driven by the application data, an example would be 'The top 5 longest fish caught this year' (table) or 'The proportion of species caught in your area' (pie chart)
- **User blog:** Essentially a copy of the facebook user *Post* function, or twitter, users can subscribe to other users inanities.
- **Events:** Organisations and users can post events to which other users can subscribe, this would include matches, club meetings and even formal events by

other organisations. Users can indicate if they are attending or not. Organisations and events are analogous to facebook *Groups*.

The User home page (Figure 2) will display subscription feeds to which the user has subscribed, adding a "wow" factor and value added content.

**Pictures**

Pictures should be able to be associated with user, organisation, trip, catch, event, user blog, site news. A one to many relationship is expected (at least functionally). Pictures will drive some of the social media content, and will be expected to appear as appropriate to improve content. Details can be discussed during the next specification stage.

## Reporting

Reporting is often challenging, as a general principle system administrators (scientists and partners) need to be able to have the facility to export data without having direct access to the underlying RDMS. Several options are typical, and these should be investigated

- 3rd party reporting tool(s) outside of the application are used and maintained by Bangor (for example SQL Server Report Services, SAP Crystal Reports).
- Fixed export options from a system administration area delivering data in a 'flat' excel format corresponding to each available table (lacks flexibility, and interpretation of output will require some knowledge of database principles).
- As a general principle it would be useful for custom SQL queries to be configured by a user which can then be pushed/published to other users to provide custom datasets, without all scientists needing to understand SQL and the database structures. These would be available on a web page within *Web Diary*.
- Other solutions are open to discussion according to the practices of the software house.

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**MoSCoW Feature Summary**

| Feature | MoSCoW | Time (d) | Cost Est. |
|---|---|---|---|
| CRUD of own key parameters | M | ? | ? |
| Reasonable data validation for key collection parameters (length, weight, dates) | M | ? | ? |
| ~~Cost and economics (probably simple cost information options at *Trip* level)~~ | ~~M~~ | ~~?~~ | ~~?~~ |
| View graphical summary data from all users | M | ? | ? |
| Administrators interface for crud, querying, quality checking, deleting, grading data quality | M | ? | ? |
| Users and user profiles | M | ? | ? |
| Photograph library against trip | ~~S~~ M | ? | ? |
| Maps ... investigate possibilities by cost! | S | | |
| Page help for complex areas (search and graphics) | M | ? | ? |
| Link with time, tide and sunset information for night/day state recording and tide state from times | C | ? | ? |
| Synchronise data with smartphone via webservice | C | ? | ? |
| Build flexible 'dashboard' like graphs and queries, under administrative control which can be pushed to users | C | ? | ? |
| Custom content publishing, social media etc | C | ? | ? |

Authored by Graham George Monkman
Version 2, released 14th June 2013

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## Appendix VII. Web application list of fields

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# List of Required Fields for RSA Diary Functions

### Introduction

The RSA diary function, common to the smartphone and web application, requires the collection of key data to be of utility to anglers and scientists.

Fields are categorised by the three data tiers set out in Figure 1,

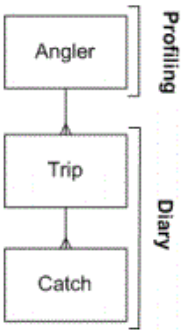


Figure 1. Logical core structure

Tiering is hierarchical:

The *Angler* tier is at the top and holds voluntarily submitted data applicable to an angler.

*Trip* holds data common to a single continuous fishing trip or session.

*Catch* holds data relevant to the capture of a fish (or fishes) the angler caught during a *trip*. Fish or fishes is used as an angler may wish to record multiple captures under a single record to decrease input effort. An example would be a mackerel fisher who catches 20 mackerel, all of 20cm length while "feathering", they could input all 20 fish in a single record.

A common data motif is the collection of 3 pieces of commonly applicable data, this is Season, Avidity and Frequency (SAF), in essence *when*; *how dedicated/keen,* and *how often*. There is a subtle but important difference between avidity and frequency, best illustrated by example: I am an avid kayak angler, investing much time researching the hobby, however the increased difficulty posed by kayak angling (weather, preparation, logistics …) means I would on average fish more frequently from the shore using a method I have less knowledge of.

Authored by Graham George Monkman
Version 1, released 1st July 2013

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# Tier Input Field Listings

## User Details

| Data | Data Description | Comment |
|---|---|---|
| **Name Details** | Multiple types | Information used to identify the angler within the system, such as email and username[1] |
| **Gender** | Fixed list | Male, female |
| **Age group** | Configurable dropdown | <16, >=16[2] |
| **Organisations** | Configurable many selectable | Angling club affiliations. User can belong to many organisations |
| **Postcode** | Text | Accept partial postcode, this is more accurate than the user inputting a text location description[2] |
| **Years actively Angling** | Integer | Would need to define "actively" to the user, for example > 5 trips pa |
| **Species SAF** | Species SAF matrix | See Figure 3 (in the appendix) and Table 1 |
| **Gear SAF** | Gear (metier) SAF matrix | See Figure 3 and Table 1 |
| **Platform SAF** | Platform SAF matrix | See Figure 3 and Table 1 |
| **Motivation Ranking** | Ranked list of motivations | Angler ranks their fishing motivations by importance. See Table 1. |
| **Location SAF** | Location SAF matrix | See Figure 3 and Table 1 |

## Trip Details

| Data | Data Description | Comment |
|---|---|---|
| **Start Time** | Time (24 hr) | Dd/mm/yyyy hh:mm |
| **End Time** | Time (24 hr) | Dd/mm/yyyy hh:mm |
| **Location** | GPS Coordinates picked from map | Angler picks location using Google maps, allowing inexact location to be chosen |
| **Location (Coordinates)** | GPS Coordinates | Two fields representing latitude and longitude |
| **Location (Anglers description)** | Text | Angler can enter their own description of location |
| **Location Experience** | Ranked dropdown | Angler's assessment of experience fishing location. A ranked customisable response (1 – 5 –low to high for example) |
| **Was Competition?** | Fixed dropdown | Yes/No |

[1] Data protection act.
[2] Aligned with Seaangling 2012 survey

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| | | |
|---|---|---|
| **Platform** | Configurable dropdown | Boat, shore etc. See Table 1 |
| **Species actively targeted** | Configurable many selectable | Will need a clear definition of "actively targeted" for the anglers |
| **Gear hours** | Custom | See Figure 2. Also introduces the new concept of *gear modifications*, expanded below. |
| **Comments** | Text | Angler comments |
| **Tide state across session** | Yes | For example **-3 LW +2** |
| **Wind Direction** | Dropdown | 8 point compass direction |
| **Wind Strength** | Beaufort strength dropdown | 0-10, with help listing equivalent wind speeds |
| **Sea State** | Dropdown of Inshore Forecast States | Smooth, Slight, Moderate, Rough with wave height indication to help |
| **Water Clarity** | Dropdown of water clarity | To discuss suitable description |
| **Weather** | Dropdown for weather (precipitation) | e.g. Dry, Occasional showers, Moderate showers, Heavy showers |
| **Cloud Cover** | Dropdown for cloud cover | e.g. *None, Some, Moderate, Complete* |

**On gear and gear hours**

Gear hours record the total effort per gear unit. To improve utility to anglers and scientists, gears selected under gear hours can have one or more gear modifications associated with them (very similar to the tags familiar to blog users). Gear modifications will be a fixed list configurable in the system. Users can add or remove gear modification tags from their gear hour records. This will add flexibility and will also be relevant to other fishers (e.g. Brown crab potters).

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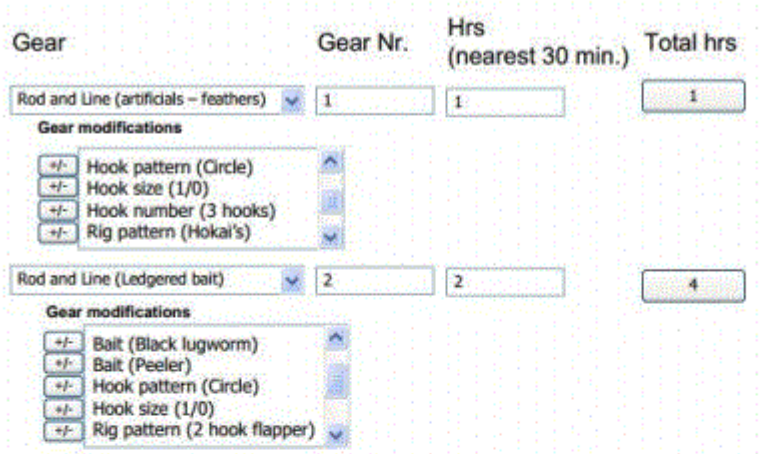


Figure 2. Example recording of gear effort and the new concept of *Gear modifications*. We can see that the 1 hour spent "feathering" was carried out with 3 circle hooks of size 1/0. Total hours are automatically calculated.

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## Catch Details

| Data | Data Description | Comment |
|---|---|---|
| **Species** | Species dropdown | Full list of species |
| **Number of fish** | Integer | |
| **Length** | Decimal | For individual fish (Number of fish▪1) |
| **Length unit** | Configurable dropdown | User to pick default units under their profile, this could then be suppressed, but internal conversion implicitly required |
| **Weight** | Decimal | |
| **Weight Unit** | Configurable dropdown | User to pick default units under their profile, this could then be suppressed, but internal conversion implicitly required. |
| **Time Caught** | Date/time hh:mm | 24 hour. Primarily of use to angler. |
| **Length Category** | Dropdown | Length category, e.g. 10-15cm, 15-20cm |
| **Weight Category** | Calculated dropdown list of categorical lengths (cm) | Weight category, e.g. 0-500g, 500-1000g |
| **Gear** | Dropdown | Pick from gear defined under gear hours from *Trip* |
| **Gear modification** | Gear modification "tag" | Allow the catch to be tagged with 1 or more gear modifications – this effectively allows association with a bait and hook size etc. Very useful for both scientists and anglers. See Figure 2 |
| **Release Status** | Configurable dropdown | Was the catch released? See Table 1. |
| **Angler comments** | Text | Free form comments on specific catch |

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# Appendix

## Season, Avidity, Frequency matrix

Below is an example of the SAF grid, capturing season, avidity and frequency score for *Gear*. SAF grids are applicable to *Gear*, *Platform*, *Location*, *Species* and *Motivation*. Data entry for this type of data is suggested in Figure 3.


Figure 3. SAF logical data entry layout using *Gear* as an example.

## Lookups

Table 1. Dropdown values. It is important to note that these lists will be configurable within the system and they are provided here to encourage feedback from a scientific viewpoint.

| Gear/Metier | Species | Platform | Organisation |
|---|---|---|---|
| Spear | *Too many to list* | Boat (on-hire) | *Too many to list* |
| Rod and line (Artificials - feathers) | | Private boat (powered) | |
| Rod and line (Artificials - plug, spinners, soft plastics) | | Private boat (unpowered) | |
| Rod and line (Float) | | Shore (beach) | |
| Rod and line (Ledgered bait) | | Shore (rock) | |
| Net | | | |
| Pot | | | |
| Other | | | |

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**Lookups- continued**

| Location (tba) | Release Status | Motivation |
|---|---|---|
| Llandudno north shore | Kept | Consumption |
| Llandudno Pigeon holes | Released (too small) | Aesthetic enjoyment of the environment |
| Etc … etc .. etc | Released (keepable) | Competition |
| | Released (other/unknown) | Goal orientated (Specimen and/or species hunting) |
| | | Relaxation |
| | | Socialisation |