Devon and Severn IFCA response

Review of Tidal Lagoons call for evidence

Potential tidal lagoon impacts on fish and fisheries: environmental and economic considerations

July 2016




Contents

1.0 Introduction

1.1 Devon and Severn IFCA

Devon and Severn Inshore Fisheries and Conservation Authority (D&S IFCA) is the statutory manager of sea fisheries from baselines out to six nautical miles. The powers and duties of the D&SIFCA are provided by the Marine and Coastal Access Act (2009). The ten regional Inshore Fisheries and Conservation Authorities (IFCAs) were set as a new type of regulator to work with stakeholder groups to achieve the long term goal and vision of healthy seas providing "ecosystem services" for the future in English Inshore waters. The IFCAs replaced the Sea Fisheries Committees with extended responsibilities not only to achieve sustainable inshore fisheries, but also to help achieve conservation objectives. The ten IFCAs have a shared vision:

"Inshore Fisheries and Conservation Authorities will lead, champion and manage a sustainable marine environment and inshore fisheries, by successfully securing the right balance between social, environmental and economic benefits to ensure healthy seas, sustainable fisheries and a viable industry."

The IFCA approach is to ensure delivery of our statutory duties and to be guided by the governments Marine Policy Statement and adherence to the High Level Marine Objectives which can be summarised as:

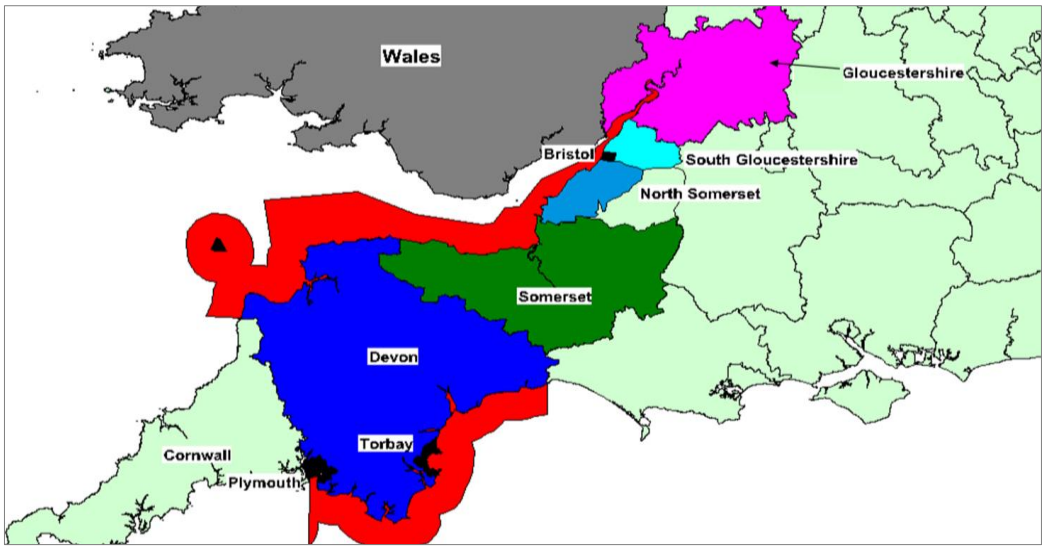
- Achieving a sustainable marine economy
- Ensuring a strong, healthy and just society
- Living within environmental limits
- Promoting good governance
- Using sound science responsibility

Devon and Severn IFCA has two sea boundaries. The southern boundary with the English Channel stretches from Lyme Regis to the border between Devon and Cornwall. The northern boundary with the Severn Estuary stretches from Countisbury Cove as far as Maisemore Weir to Chepstow and includes Lundy Island. It also includes the River Avon through Bristol and all other rivers entering the sea within the district. The district extends to sea from baselines to 6 nautical miles or the boundary with Welsh Territorial Waters in the north of the area.

Devon and Severn IFCA supports, in principle, the aim of the UK Renewable Energy Strategy (2009) to de-carbonise the energy sector in order to tackle climate change and meet agreed reductions in greenhouse gases as set out in the Climate Change Act (2008). D&SIFCA acknowledges the growing body of evidence which suggests that climate change can and is altering fish distribution and behaviour, and therefore the fisheries that depend upon them. However, D&SIFCA has specific concerns regarding the placement of a series of tidal lagoons in the Severn Estuary, the English parts of which fall into the Authorities' district.

1.2 Background

The Secretary of State for Energy and Climate Change instigated an independent review into the feasibility and practicality of tidal lagoon energy in the UK in early 2016, led by Charles Hendry. The review is currently seeking evidence and representations that will form the evidence base for the Review: https://www.gov.uk/government/news/review-of-tidal-lagoons.



Red area shows the Devon & Severn IFCA District

Whilst the key themes of the review (market and financial structure feasibility) are not necessarily of direct interest to D&S IFCA, the review is also seeking evidence on the feasibility and practicalities of a wider UK tidal lagoon programme which has to include environmental issues as they are inextricably linked to the feasibility of lagoons. The review is not targeted at any particular project but does acknowledge the existence of Swansea Bay and Tidal Lagoon Power's current work in the Severn Estuary.

1.3 Scope of response

The Devon and Severn IFCA response focuses on seafish rather than migratory fish (salmon, sea trout, river and sea lamprey, twaite and allis shad and European eel). The Environment Agency is responsible for the management of migratory fish and fisheries relating to these species. All of these species have life cycles that require movement between marine and freshwater ecosystems, and most are of specific conservation interest. Therefore, the impacts of tidal lagoons on these species may be even greater than on the seafish species, which are of more direct interest to D&S IFCA.

This report is only indicative of fishing effort on the English side of the Severn Estuary and Bristol Channel, as it is specific to areas within the Devon and Severn IFCA district. Fisheries may differ on either side of the estuary as the environmental conditions are different and there are differences between the habitats and fish behaviour relating to each side of the estuary. Information on the fish and fisheries of the Welsh waters of the Severn Estuary and Bristol Channel should therefore be sought from Welsh Government. However, an ecosystem scale perspective must be brought to bear on decisions which affect the fisheries resource in order to ensure its sustainability.

1.4 Format of response

A summary of key points is given before a technical appendix expands on the key points,
providing a literature review of the available evidence and summarising D&S IFCA officer's current knowledge.

2.0 Summary of key points

Fish and fisheries - environmental concerns relating to tidal lagoons

- Estuaries are incredibly important areas for fish, providing essential habitat for fish with commercial, functional or conservation value (*Section 3.1 and 3.2*).
- In the Severn Estuary, 111 species of fish have been recorded (*Section 3.1*.2).
- The Severn Estuary and inner Bristol Channel is an important nursery and/or spawning area for (at least) whiting, sole, plaice, dab, lemon sole, flounder, bass, thin-lipped mullet, herring, sprat, sand eel, sand gobies, sea snail, poor cod, 3-spined stickleback, common goby, river and sea lamprey, twaite and Allis shad, European eel, tope, thornback ray, blonde, small-eyed and spotted ray (*Section 3.1, pages 7 & 8*).
- We know very little about how different fish species use the Severn Estuary spatially or how fish use different habitats (*Section 3.1.4 and pages 7 & 8)*.
- Collecting adequate data on the spatial distribution of fish is extremely difficult because of difficult environmental conditions and because fish abundance is highly seasonal and fluctuates inter-annually (*Section 3.1 & page7*).
- The published literature makes premature or incorrect assumptions about some species lack of dependence on the Severn Estuary and must be treated with caution (*Page 7&8*).
- Whilst turbines damage fish and provide a barrier to migration, D&S IFCA believes that the effects of habitat change on fish could be just as detrimental (*Sections 3.1.3 and 3.1.4*).
- Damage to an important nursery area like the Severn Estuary could impact populations of commercially important species throughout the Bristol Channel and even the Celtic Sea (*Page 6 and Section 3.2.3*).
- The research needed to underpin any compensation and mitigation programmes is not well developed or doesn't exist for many habitats or fish-habitat interactions (*Section 3.1.4 and pages 8, 9 & 10*).
- Compensatory habitat rarely functions like the habitat it replaces, or takes decades or centuries to develop (*Section 3.1.4 & pages 9 &10*).

Fish and fisheries – socio-economic concerns relating to tidal lagoons

- Fisheries in the Severn Estuary are unique. Whilst smaller in scale they are often centuries old and distinct to the Severn, with great heritage value (*Section 3.2.2*).
- The Severn Estuary is incredibly important to Recreational Sea Anglers (*Section 3.2.1*) with 30 known clubs on the English side, but a national indication that less than 5% of anglers tend to be a member of a club (*Section 3.2.1)*.
- Recreational Sea Angling creates jobs and revenue in coastal communities and has positive effects on people's wellbeing (*Section 3.2.1*).
- Commercial fisheries in the Bristol Channel are larger in scale than those in the Severn Estuary and rely on many species whose nursery grounds are found in the Severn (*Section 3.2.3*)
- Changes to habitats and fish communities in the Severn Estuary may well impact commercial fisheries in the Bristol Channel and possibly even the Celtic Sea and further afield (*Section 3.2.3*).

- The first sale value of eight primary species landed into North Devon was £1.9 million and the potential value added from these species was estimates as being between £7.9 million and £16.1 million (*Section 3.2.3*).

Comparative schemes

- Decades of work on tidal power in the Bay of Fundy should be examined directly by both the Hendry Review and the UK Government (*Section 4.0*).
- A large focus of work in the Bay of Fundy has been around fish and fisheries, so there is a useful body of knowledge and evidence to draw on which has relevance to tidal power development in the UK (*Section 4.0*).
- Fishermen in the Bay of Fundy still have major concerns regarding the possible impacts of tidal energy schemes, despite years of research and developers focusing on tidal stream turbines which are likely to have fewer impacts than tidal lagoons (*Section 4.0*).

3.0 Technical Appendix

3.1 Fish and fisheries - environmental concerns relating to tidal lagoons

3.1.1 Estuaries and fish

Estuaries provide some of the most productive and dynamic aquatic environments (IFM 2015). They provide important spawning and nursery grounds for a broad range of freshwater, estuarine and marine fish species, some of which need to migrate through the estuary in order to complete their lifecycles Estuaries are also vital corridors of migration for a number of species which must move through into freshwaters to complete their life cycles in upstream (Elliot in Elliot and Hemingway 2002, IFM 2015). The ecological importance of estuary ecosystems and individual habitats to fish has been given relatively little attention in the UK and Europe compared to the US.

3.1.2 The Severn Estuary and Bristol Channel

In the Severn Estuary 111 species of fish have been recorded by power station sampling (Potts and Swaby (1993). Despite excellent data on fish abundance, seasonality and long-term trends at specific points in the estuary (Hinkley Point in the outer estuary and some data from Oldbury in the inner estuary) (Potts and Swaby 1993, Potter et al. 2001, Henderson 2007, Henderson and Bird 2010, Henderson et al. 2011) our knowledge of fishes spatial use of the estuary, and how this varies in time is extremely poor. The use of conventional fish sampling techniques in the Severn Estuary is extremely difficult because of the high tidal range and the large and inaccessible mudflats (Bird 2008). Traditional fish sampling techniques such as groundfish trawl surveys are not possible in the Severn and so the importance of this area tends to be underestimated in reviews of nursery and spawning areas (e.g. Ellis 2010). In addition, the extreme seasonal and inter-annual variations in fish abundance (Henderson and Bird 2010) and distribution will limit the conclusions drawn from even the most high-intensity sampling regimes.

The limitations of our knowledge of fish use of the Severn Estuary, despite being amplified by the difficult sampling environment, are common to many estuarine environments. Global reviews have highlighted how little is known about specific fish-habitat interactions in estuaries and have called for a need for a better understanding of the functional significance of habitats across the estuary-ocean ecotone (Able 2005).

The Severn Estuary 'notable fish assemblage' is protected as a sub-feature of the 'estuary' feature of the Severn Estuary Special Area of Conservation. In a summary of the use of the Severn Estuary by the most abundant species a number of commercial species were found to use the estuary as a nursery, including whiting, flounder, bass, thin-lipped mullet, herring, sprat and bib (Bird 2008). Several other species which are not of commercial importance but form an incredibly important part of the Severn Estuary ecosystem also use the Severn as a nursery ground including sand gobies, sea snail, poor cod, 3-spined stickleback and the common goby (Bird 2008). Additionally, species of significant conservation value are found in the estuary, including river and sea lamprey, twaite and allis shad and the European eel (Bird 2008).

However, even reviews of the best available evidence may be underestimating the true importance of the estuary to fish. Bird (2008) states that species classified as 'marine stragglers' (defined as species who normally spend their entire life at sea and only occasionally enter estuaries) probably have little impact as prey or predators on other estuarine species and will not be seriously affected

by changes in estuarine habitat. However, species such as Thornback ray, Norway pout and plaice are identified as marine stragglers. Adult thornback ray are caught by commercial fishermen and recreational anglers throughout the estuary, as far as the M48 road bridge. Commercial fishermen working around Weston-Super-Mare report catching only females, suggesting a potential specific use of the estuary by this species. Similarly, plaice have been reported to use the estuary as a nursery ground and possible spawning area. Therefore, the assumption that these species will not be affected by changes in the estuary seems premature and highlights the risks associated with attempting to apply general assumptions about fish behaviour to the Severn Estuary. RPS (2009) also found issues with knowledge gaps, reporting that sand eel populations were likely to be resident in the Bristol Channel, even though the literature reviewed failed to report nursery or spawning sites for this species. Early work by Tidal Lagoon Power has also discovered a previously undocumented intertidal herring spawning site in Swansea Bay (Tidal Lagoon Swansea Bay Environmental Statement) and commercial fishermen operating out of Minehead have suggested that a spawning site also occurs on the English side of the Severn Estuary (P.Date pers.comms). This is as yet completely undocumented.

More data is available for the Bristol Channel because the increased water depth allows for more traditional fish sampling methods (such as otter and beam trawling). Significant spawning and/ or nursery grounds have been found in the vicinity of the Bristol Channel and Severn Estuary including plaice, sole, dab, lemon sole. Whiting, cod, bass, herring, sprat, flounder and gobies as part of the Environmental Impact Assessment for the Atlantic Array Offshore wind farm (RPS 2009). Additional spawning or nursery grounds in the Bristol Channel and Severn Estuary were identified for a number of elasmobranch species including Tope, Thornback ray and Spotted ray (Ellis 2010). The area is also of significant biogeographic importance to small-eyed ray, whose centre of distribution is found in the Bristol Channel (ICES 2014).

3.1.3 Turbines and fish

Turbines can affect fish in a number of ways including direct strikes, abrasion, grinding, pressure change and shear stress. Injuries range from mucous and scale loss to damage to eyes, gills and swim bladders to spinal fractures and mortality depending on a large number of factors, including the shape and size of the fish, water velocity, turbine design and lagoon design (Turnpenny & Horsfield Associates 2014). The direct effects of turbines on fish is one of the better studied aspects of Tidal Power and advanced modelling techniques are now available and have been applied by TLP in the Environmental Statement for the Swansea Bay development. Using the Striker v4.0 model (Turnpenny & Horsfield Associates 2014) found that Clupeids are the most sensitive to damage in turbines with injury rates of herring and shad being estimated (worst case scenario) at ~50%. That is not to say 50% of all herring in the vicinity of the lagoon will be injured, rather 50% of those entering a turbine. Gadoids (e.g. cod and whiting) have a predicted injury rate of 9%, bass 4.8% and flatfish 1.86%. By combining injury rate predictions with turbine encounter modelling estimates of overall mortality have been estimated.

3.1.4 Habitat change and fish

When compared to the impact of turbines, potential effects of tidal lagoons on habitats and the fish populations they support is extremely poorly studied (Frid et al. 2012). The geomorphology of an estuarine habitat has a pronounced influence on the structure of the fish communities (Cattrijsse et

al. in Ellis and Hemmingway 2002). Factors including sediment type, degree of vegetation cover, tidal elevation, slope of the intertidal area and depth of the subtidal area will all determine the suitability of the habitat for a species or life-history stage of a species (Cattrijsse et al. in Ellis and Hemmingway 2002). Information from 14 European estuaries known to be heavily impacted by man (Forth, Humber, Mersey, Thames, Elbe, Weser, Ems, Westerschelde, Oosterschede, Somme, Seine, Loire, Guadalquivir, and the Messolongi Lagoon) has shown that land-claim, channel management and barrages/ impoundments are the processes most likely to change geomorphology of estuaries. The resulting impacts on fish communities have ranged from a decrease in species diversity to the disappearance of whole communities following a change from estuarine to freshwater conditions (Cattrijsse et al. in Ellis and Hemmingway 2002).

In the US the maintenance of Essential Fish Habitat (EFH) is a central part of fisheries management. EFH is defined as 'waters and substrate necessary for the spawning, breeding, feeding or growth to maturity' and 'necessary' means habitat required to support a sustainable fishery (Jennings et al. 2001). The loss of essential habitat could impact fish populations through a reduction in reproductive capacity measured as spawning stock biomass, numbers of eggs spawned or reduction in the numbers of recruits to the fishery per unit of spawning stock or number of eggs spawned (Cross et al. 1997). Although no final design has been put forward for the proposed Bridgwater Bay lagoon, one estimated scenario resulted in the loss that 5500ha of intertidal habitat alone (National Assembly for Wales 2010).

Unlike the Swansea Bay project, many of the subsequent lagoons planned for the Severn Estuary fall close to or inside the Severn Estuary European Marine Site. The lagoons will therefore have to comply with the Habitats Directive. This will almost inevitably require compensation measures for damage to the EMS (e.g. Sustainable Development Commission 2007, National Assembly for Wales 2010). However, for most species of fish we do not have a direct relationship between habitat and production or recruitment, limiting our ability to predict reductions in productivity or recruitment for a specific loss of a given habitat for a given species of fish. Additionally, this relationship is likely to be relatively site-specific. It should also be noted that fish sampling in estuaries has been limited due to the logistical difficulties presented by such dynamic environments. Therefore, the role of estuaries (and the Severn in particular) may be under-represented in the literature (e.g. Ellis et al. 2010).

Furthermore, the extremely dynamic nature of the protected fish assemblage will make any efforts to compensate extremely difficult, even with extensive new survey data. D&S IFCA is particularly concerned about the implications for bass nursery areas given the current concerns for this species at a stock level (Ross 2015a). Although not designated as bass nursery areas the Severn Estuary and the estuaries of many of the smaller rivers and pills which feed into it are extremely important for juvenile bass (Colclough 2012, Ross 2015a). Whilst some examples of recreation of intertidal habitats do exist, this relies upon the availability of low-quality land that can be used (Cattrijsse et al. in Ellis and Hemmingway 2002). Recreation of sub-tidal habitats is much less well understood with very few examples, and no information on how these function for fish.

Habitats that have existed for a very long time period have evolved into a complex system that is not readily replaceable by a simple revegetation or recreation (Cattrijsse et al. in Ellis and Hemmingway 2002). Newly created habitats is of low ecological value and may take decades (if not centuries) to evolve to the state of the genuine habitat (Cattrijsse et al. in Ellis and Hemmingway 2002). For

example, wetlands constructed by excavating tidal channels are likely to have very different shapes and ratios of creek sizes than those evolving over centuries (Williams and Zelder 1999).

Mitigation or compensation projects can be inadequate in replacing original habitat and conservationists or environmentalists should be aware that habitat creation or restoration seldom mitigates loss of habitat and it should be questioned whether the authentic communities can be restored (Cattrijsse et al. in Ellis and Hemmingway 2002). Critical evaluation of coastal habitat restoration efforts requires long-term, comparative research on the structure and function of sites with different alteration histories (e.g., disturbed, natural, created, and restored) over a range of physical conditions (Williams and Zelder 1999).

Studies on direct linkages between fish and specific habitats do not exist for most species, further limiting our ability to compensate directly or indirectly for fish. Perhaps the best studied species is European sea bass in intertidal areas (Claridge and Potter 1983, Kelley 1988). The obligate habitats for juvenile bass (< 4 yrs.) are intertidal areas such as estuaries, with 0+ fish penetrating deep into low salinity areas such as saltmarshes. (Kelley, 1988; Laffaille *et al,* 2001; Elliott & Hemingway, 2002; Colclough *et al,* 2002 & 2005; Pickett et al, 2004)' (in IFM 2015a). Claridge and Potter (1983) studied samples from Oldbury Power Station and concluded that 'this study has demonstrated that the Severn Estuary and inner Bristol Channel is an important nursery area for juvenile bass'. In 1976/7 almost 9000 bass were obtained from the once-weekly 24 hour samples taken at Oldbury, most of which were taken between September and December –indicating the existence of very large schools of bass entering the estuary (Claridge and Potter 1983). Additionally, they noted that findings closely parallel those recorded in similar environments such as the North and South Devon estuaries and inshore Irish coastal waters (Claridge and Potter 1986). The sampling at Oldbury was repeated 20 years after the first dataset was studied (1996-1999) and found that there were marked increases in the numbers of certain species, including bass (Potter et al. 2001) suggesting the importance of the Inner Severn Estuary as a bass nursery area has increased over time. Data from Environment Agency WFD sampling has improved our spatial knowledge of bass use of the Inner Estuary with bass clearly extending into Gloucestershire: 'Young of year bass can penetrate into low salinity areas. This is well illustrated with the strong 0+ group found each year at Arlingham Passage (Colclough 2009). Given the salinities obtained here in the late summer and autumn months, it is probable that this represents the maximal penetration of the whiting, but the juvenile bass nursery may well extend further still' (Colclough 2009). Recent research utilising stable isotope analysis has also shown that bass appear to show high site fidelity, with low site connectivity between individual salt marshes, suggesting even if new habitats are formed, they won't necessarily quickly develop the associated fish fauna (Green et al 2012).

Finally, for some habitats there may be no ability to compensate or mitigate either directly for the habitat, or for the fish species that interact with that habitat feature. In a preliminary review of possible compensation and mitigation requirements under the habitats directive for Severn tidal power options commissioned by DECC, ABPmer (2008) highlighted the fact that the presence of *Sabellaria alveolata* reefs sub-tidally in an estuarine environment is a unique feature of the Severn Estuary and any compensation package would only be able to replace these features with other types of reef feature (possibly through the designation of additional *Sabellaria spinulosa* reef habitat). The report concluded that given the difficulties in replacing the functioning and range of variation represented by these features in the Severn Estuary, confidence in the effectiveness of additional designations as a like-for-like compensatory measure for *Sabellaria alveolata* was very low. They also determined that the only available compensatory measure for subtidal sandbanks

would be the inclusion of additional sites outside the Severn Estuary and confidence in the effectiveness of this measure was assessed as low (ABPmer 2008).

3.1.5 Biodiversity and species richness

Tidal Lagoon Power have suggested that tidal lagoons will 'promote biodiversity' but the IFCA urges caution in the interpretation of biodiversity, or the assumption that increasing overall species richness at a site is positive change. The uniqueness of the Severn Estuary has led to its protected status (Natural England and Countryside Council for Wales 2009) and it is not the diversity at a site level (known as alpha diversity) which makes the site important, rather how it fits into the wider ecology of Northern Europe (known as gamma diversity) (Magurran 2013).

> Estuarine habitats are unique in that in addition to being important in their own right, they also provide links between other marine, coastal, freshwater and terrestrial areas. ***Changes within estuaries, therefore will ultimately affect the health of sea fisheries***." (Elliot and Hemmingway 2002).

3.2 Fish and fisheries – socio-economic concerns relating to tidal lagoons

3.2.1 Recreational Sea Angling

The Bristol Channel and Severn estuary provides some of the best shore fishing in the country and the region has a long and celebrated history of recreational sea angling (Food Certification International Ltd 2011). Boat and shore marks extend from the Somerset border, all the way up and along to the South Gloucestershire coastline. Major ports for charter boats exist at Minehead, Watchet with private boats also operating from these ports as well as Porlock, Burnham-on-Sea, Weston-Super-Mare and Portishead as well as many of the smaller pills throughout the estuary. The Severn Estuary provides an excellent variety of shore fishing venues for the recreational angler, depending on weather, season and target catch. Many of the 30+ clubs in the region have long and proud histories. As well as numbers of resident anglers, the proximity to the M4 / M5 means it is a very popular area for non-resident anglers coming from further afield (Food Certification International Ltd 2011). Anglers from Wales regularly travel to the English side of the Severn Estuary to attend competitions held in Minehead, Weston-Super-Mare and Severn Beach. North Devon is also an important angling destination with a number of charter boats operating out of Ilfracombe.

The government commissioned 'Sea Angling 2012' project was a nationwide study into the economic and social impacts of recreational sea angling involving Cefas, the MMO and the ten IFCAs. A project addressing Recreational Sea Angling (RSA) in England was deemed to be required "in order to help local and national policy makers make balanced, well informed decisions on the sustainable development of all forms of sea fishing". Additionally the surveys met UK obligations under European law to estimate recreational catches of several species, including bass and cod. Sea Angling 2012 therefore had several specific aims:

- To find out how many people go sea angling in England
- To estimate how much anglers catch
- To estimate how much anglers release
- To estimate the overall economic and social value of sea angling

Data was collected from over 11,000 sea anglers via a series of surveys. These included:

- An office of National Statistics telephone survey
- IFCA face to face interviews (shore & private boat)
- Catch diaries (Charter boats) led by the MMO
- Two online surveys, one regarding social and economic impacts of sea angling and a second which was essentially an online catch diary

Nationally IFCAs conducted 2030 interviews with shore anglers and 410 interviews with private boat anglers. Devon and Severn IFCA conducted a total of 143 interviews with anglers in Devon and 126 interviews with anglers in the Severn during dedicated angling surveys. In addition, Devon and Severn IFCA was an active member of the project steering group.

The economic findings of the survey highlight the great importance of recreational sea angling to coastal (including estuary) communities. There are an estimated 884,000 sea anglers in England with 2% of all adults going sea angling; however in the South West 5.6% of the population are sea anglers. Sea anglers spent £1.23 billion in 2012, equating to £831 million of direct spend (imports and taxes excluded). Sea angling in England directly supports 10,400 full-time jobs with £360 million of gross value added. Including indirect and induced effects into account, sea angling supported £2.1 billion of total spending, 23,600 jobs and £980 million GVA. Whilst figures specific data for the D&S IFCA district could not be estimated accurately, the average annual spend per angler was estimated by Sea Angling 2012 at £1394 per year (£761 trip-related costs and £633 on major items). There are over 30 sea angling clubs in the Severn Estuary alone and over 20 angling shops (Food Certification International Ltd. and D&S IFCA, unpublished data).

In addition to the economic benefits of recreational sea angling, Sea Angling 2012 identified a number of key social benefits. Six areas of wider societal benefit from sea angling were identified:

- Sport & physical activity
- Health and well being
- Environmental access and improvement
- Urban community benefit
- Rural community benefit
- Young people

Surveys showed that 70% sea anglers say that sea angling is important to their quality of life and 69% of sea anglers say that it is their main way of experiencing nature. 47% go sea angling to 'be outdoors and active'. Sea angling provides relaxation, physical exercise, and enables socialising. The majority of anglers are aged between 46-55, with the second most numerous age band being the 36-45 category. The overall average age of anglers in England is 51. Importantly, only 4.7% of participants in sea angling were members of a local sea angling club and only 2.7% were members of a national club. This means that previous estimates of anglers in the Severn Estuary area (e.g. Food Certification International Ltd 2011) almost certainly underestimated the number of resident anglers.

Crucially, Sea Angling 2012 found that recreational sea anglers believe that the most important thing to increase participation in angling would be to improve fish stocks (Sea Angling 2012). This agrees with earlier studies which revealed a close correlation between the status of stocks of fish prized by

recreational sea anglers, and their willingness to visit the area (and in so doing so support the local economy). In short recreational sea anglers will travel to where there are positive reports of good fishing. The Invest in Fish project also pointed to the strong conclusion that the size of fish caught by recreational anglers also plays an important role in determining their choice of venue. A well-managed recreational sea angling resource, may therefore expect to lead to benefits to the local economy (Food Certification International Ltd 2011).

3.2.2 Commercial and recreational netting and fisheries heritage value

In comparison to the rest of the UK inshore fisheries, a relatively small amount of catch is landed commercially from the Severn Estuary area (e.g. Food Certification International Ltd 2011). It is true that on the English side of the Severn Estuary commercial operations are small scale, with only a handful of active fishermen fishing nets from boats (home ports of Minehead and Cardiff) and netting from the shore in Bridgwater Bay. Large scale commercial trawling and netting operations are limited in the Severn because of the high tidal range and the large seasonal and inter-annual fluctuations in fish abundance and diversity. Additionally, D&S IFCA introduced a mobile gear permit byelaw which prohibits trawling and dredging on the English side of the Severn Estuary SAC to protect *Sabellaria* which is found intertidally and sub-tidally throughout the site.

However, the metrics largely used for assessing the extent and local importance of fishing operations (often MMO landings data and/ or the number of commercially registered vessels) is likely to underestimate the local importance of fisheries in the Severn Estuary. The Geography of Inshore Fishing and Sustainability (GIFS) project showed that fisheries are known to contribute to well-being benefits such as cultural identity, recreation, quality of life; heritage and social cohesion (see http://www.gifsproject.eu/en). Many fisheries in the Severn Estuary could be described as 'heritage' methods and these activities are carried out both recreationally and commercially. These fisheries are often small-scale and temporally sporadic, resulting in the exact levels being extremely hard to estimate (Ross 2015b)

Whilst the tidal range, strong currents and extensive mudflats have limited the extent of commercial fishing operations seen elsewhere, they have led to the development of fishing methods which are unique to the Severn estuary, many of which have been in existence for several centuries such as stake nets, lave nets, stone and wooden fish weirs, putcher ranks and mudhorses. Remains of wooden fish weirs exist throughout the Severn Estuary and have been the subject of detailed archaeological study with structures ranging in date from the 10th to the 20th centuries (Crowther and Dickson 2008). Lave nets and putcher ranks are regulated by the Environment Agency and as such are not covered further within this document.

Fish weirs

A fishery has existed on the sand in Minehead Bay since medieval times. It began in 1299 in the Manor of Minehead, with the installation of a 'V' shaped fish weir or 'stagna' of stone wall construction, now protected monuments that fill with water and trap fish on the flood tide. At the point of the 'V' a net is strung across a hole in the stone wall known as 'the gut' and fish are netted on the ebb tide. This fishing method produces fish, prawn and shrimp. Historically fishing rights were granted by the Dunster Estate who allowed tenants of cottages on North Hill, with no garden from which to grow food, the use of a fish weir. Fish weir structures dating back to Norman times,

range from Lynmouth in Devon to Kilve in Somerset and were constructed in such a way that they could be fished at all heights of the tide. Today only two fish weir operators are left, two commercial fishermen who were paid by the previously titled English Heritage to maintain the three main monuments.

Minehead herring stake-net fishery

In conjunction with the fish weirs, a herring stake net fishery also exists on the foreshore at Minehead. It is thought to be the only one of its kind in Great Britain and certainly the only one still in operation, albeit only a few times a year. The previously mentioned commercial fishermen are the only two remaining fishermen who fish the stakes some of which are 400 years old, by securing 3m high nets to the stakes as the tide is at slack water or about to flood. As the water ebbs the herring are picked out of the net and carried ashore. Herring congregate in Minehead Bay and are only caught on an ebb tide. The line of thirty stakes extends out along the foreshore for 250 yards but only a fraction of stakes are hung with nets, due to the ability of the two commercial fishermen to empty them during low the tides. This fishery was operated by one of the commercial fishermen's great grandfather and those before him. He holds detailed records of catches dating back to 1436 and proof of such fisheries existing in the Honour (Manor) of Dunster since 1090.

The herring that are caught in the present day are sold at the quayside in Minehead, as both fishermen have commercial licences but because of the lack of popularity of the fish, they say they often have to give the fish away for free. Jamie Oliver has recently begun a campaign championing herring as a local, sustainable food source. Such a catalyst could spark a herring revival and provide opportunity for the business to become financially viable.

Stake net fisheries

Historically stake nets have been used along a fifty mile stretch of foreshore from Minehead to Middle Hope, a headland north of Sand Bay. The fixed engines byelaw that bisects Sand Bay now prohibits stake netting upstream of the boundary line. Stakes are still in situ but limited numbers are fished due to access or conflict with anglers. Most stake netters are now recreational, continuing activities to keep the tradition alive.

At Dunster, permits to fish using stake nets from the foreshore are issued by Dunster Beach Holidays for a fee. The highest intensity of stake net fishing occurs on the traditional grounds from Watchet up as far as Lilstock. Fishing grounds are very limited due to the nature of the estuary so netters ensure they work their stakes in a traditional way so as not to impede others. Nets are mainly fished on neap tides (8m+) included gill, trammel and entangling nets, ranging from 66 yards to 150 yards long with a 4 – 5 inch mesh. Most tiers were soaked for either 6 or 8 hours a day or twice a day, targeting cod, whiting, ling and sprat in the winter and bass, mullet, smoothhound and ray in the summer.

Stake nets at Dunster Beach and a typical configuration using metal stakes elsewhere in the estuary

Stolford mudhorse fishery

At Stolford a historical stake net fishery exists using a traditional method - unique to the Severn estuary - called a mudhorse, in order to access the fishing grounds which are covered in estuarine mud. Records show 4 fishermen operating in 1851 using fyke nets to catch shrimp. Today only two commercial fishermen (a father and son: http://www.themagnificentsevern.co.uk/interviews) work these grounds frequently by wading through the mud using the mudhorse for stability and to carry the catch. Fyke nets for shrimp, gill nets and stake nets are fished and the catch is sold through their family run fish shop in Stolford. Target species vary seasonally but include shrimp, sprat, cod, whiting, thornback ray, bass, mullet and sole.

Mudhorse in use. Photograph by Nigel Phillips.

Drift netting using a Somerset Flatner

Within Bridgwater Bay National Nature Reserve and the River Parrett estuary are two recreational netters who were part of the Wessex Fishermen's Association and have been fishing for 40 years, targeting cod, whiting, mullet and sprat. They require three men onboard a specialist flat bottomed boat, called a Somerset Flatner once widely used in inshore waters of Somerset, to enable them to drift net for sprat, herring and mullet from the mouth of the Parrett to Steart Island. It is believed to be the only one of its kind still operating along this coastline. They set 3 trammel nets along Steart Island (two of which are in the mouth of the River Parrett and one is off the headland) and one across the mouth of the Huntspill River. They also set two tiers of stake nets on a large sandy area in Bridgwater Bay, known as The Gore. There were three or four fishers operating in this area, now they are the last remaining.

Fixed netting using boats

One commercial netter from Cardiff makes trips over to the Weston Super Mare in the summer months to net for bass, mullet, sole, plaice and rays. Also, members of Uphill Licenced Boatmen and

Registered Fishermen's Association use boats to set fixed nets from Burnham to Weston Bay. Again, targeting cod and whiting in winter thornbacks, bass, mullet, flounders and sole in summer. This organisation has been in existence since 1968 but ironically none of the members are commercial fishermen.

Within Weston Bay there used to be 3 or 4 gill netters fishing from Weston super Mare, now only a few remain that officers know of; a recreational gill netter for cod and bass operating to the west of Birnbeck Pier and the other is a recreational gill netter who fishes by boat outside of Weston Bay.

Stall netting

There was one survey respondent who belongs to a small group of recreational stall who fish from the shore, purely to continue the traditional fishing method. From September to January nine stall nets (also known as fyke and shrimp nets) with an aperture of 8'' x 6'' are secured alongside Birnbeck Pier. They are fished on spring tides every day for 7-8 days. Target species are sprat and shrimp.

Summary

Clearly fisheries in the Severn Estuary are small scale, but the methods used to fish and the continuation of fishing despite a lack of economic incentive, highlights the social and heritage importance of these fisheries to those involved. Devon and Severn IFCA is currently in the consultation phases of a new netting permit byelaw which would require anyone netting commercially or recreationally on the English side of the Severn Estuary (and elsewhere in the district) to hold a permit. This will provide much higher resolution information on recreational netting activities in the Severn Estuary. IFCA officers have gone to great lengths (2 pre-consultation periods and a formal consultation of twice the statutory duration) to ensure the byelaw successfully balances the conservation needs of the estuary fish assemblage, and the heritage value of these small-scale fisheries.

3.2.3 Linkages between estuary nursery areas and commercial fisheries away from lagoon sites

Although only small-scale commercial and heritage fisheries exist within the Devon and Severn IFCA portion of the Severn Estuary, significant fisheries operations exist on the Welsh coast and English ports throughout the Bristol Channel. As mentioned in previous sections, there has been very little work looking at the benefits provided by the habitats in the Severn Estuary (e.g. nursery function, feeding, spawning sites) to commercial fisheries in the Bristol Channel and Celtic Sea, even though such linkages must exist. It cannot be stressed enough that: "Estuarine habitats are unique in that in addition to being important in their own right, they also provide links between other marine, coastal, freshwater and terrestrial areas. ***Changes within estuaries, therefore will ultimately affect the health of sea fisheries***" (Elliot and Hemmingway 2002).

Northern Devon fisheries are characterised small day-boats that are limited in terms of operating range and the weather conditions in which they can go out in (ABPmer 2013). The larger trawlers can go out for a few days at a time and land larger quantities of fish. There are around 35 vessels including trawlers, potters, gill netters and scallop dredgers, with an average length of 6.2m (under-10m sector) and 12.9m (over-10m sector) (ABPmer 2013).

Landings into the Northern Devon ports of Ilfracombe, Appledore, Bideford and Clovelly have and average value of £ 2.1 million per year. The Bristol Channel is one of the few targeted skate fisheries in the UK with landings of ray from this area contributing about 20% by weight of the total skate landed by all English & Welsh fisheries (Catchpole & Enever 2007). The Bristol Channel skate fishery has an estimated annual value of between £600,000 (ABPmer 2013) and approximately £1 million (Catchpole & Enever 2007). Whelks, lobsters, squid and bass are each worth £240,000–£295,000 per year (Food Certification International Ltd 2011, ABPmer 2013). Crabs, Dover sole, sharks, turbot and other flatfish also represent an important proportion of landings value (ABPmer 2013). There is one main processor for fin fish in the region, and one processor that specialises mainly in shellfish (scallops, squid, cuttlefish, sprats), and a number of smaller wholesalers and suppliers. The first sale value of the eight species studied is £1.9 million, and the potential value added from these species could be between £7.9 million and £16.1 million, according to the value chains studied (ABPmer 2013).

Whilst direct linkages between these commercial fisheries and the nursery area in the Severn Estuary are yet to be proven, many of these species spend some part of their life cycle in the outer (blonde ray, small-eyed ray, smoothhound, dogfish) and/ or mid and inner estuary (Thornback ray, bass, sole, plaice). Devon and Severn IFCA led a partnership project 'The North Devon Skate Pilot Project' with North Devon Biosphere Reserve and North Devon Coast Area of Outstanding Natural Beauty, which received European Fisheries Fund (EFF) investment via the North Devon Fisheries Local Action Group (FLAG) which aimed to collect baseline ecological data for ray species in North Devon and highlight the importance of this fishery and the need for more data collection. Additionally, the project aimed to investigate the use of the inner Bristol Channel and Severn Estuary by placing 'Data Storage Tags' on 25 Thornback and 25 Blonde Rays. The project required tags to be returned via the re-capture of rays or by the tags being washed ashore on beaches. To date 11 tags have been re-captured (a relatively high recapture rate) and the depth and temperature information collected by them will be used to re-produce the rays' movements whilst at liberty, subject to funding to do this.

This initial project drew in interest to the area as planned and the North Devon ray fishery became a case study for the Shark By-Watch UK 2 research programme. As part of this project D&S IFCA partnered with Cefas and others to look at species aggregation and habitat use of species in North Devon (Ross et al. 2015, Hunter et al. 2015). Plans for Shark By-Watch UK 3 include a tagging programme with anglers and commercial fishermen in the Severn Estuary to further investigate linkages between North Devon and the Severn Estuary.

Whilst this report has highlighted fisheries on the English side of the Severn Estuary and North Devon, it should be noted that the majority of fisheries operating in the Severn Estuary land outside of the Severn study region, typically into Welsh ports (Food Certification International Ltd 2011). Based on a five-year average across 2006-2010, over half of the commercial fisheries active within the Severn Estuary land into Swansea with just under a quarter (22%) into Porthcawl. Food Certification International Ltd 2011). Additionally significant fisheries exist in the outer Bristol Channel and Celtic Sea, and the importance of the Severn Estuary to fish recruitment in these areas could be significant.

4.0 Comparative schemes

Evidence from the **Bay of Fundy in Canada** (which has the highest tidal range in the world) offers an insight into the behavior of estuaries with large tidal-ranges when altered through the construction of dams/causeways.

The **Acadia Center for Estuarine Research** and other academics in the region, have been studying the effect of tidal causeways and barrages on fisheries and habitats around Fundy for many decades. Much of the evidence submitted to the Energy and Climate Change Committee: A Severn Barrage?' in November 2012 (e.g. Bradshaw & Daborn) is relevant to this inquiry. In particular:

- Experience of sediment changes and its implications for habitats, fisheries, flood prevention and coastal erosion as a result of causeways built across rivers leading into the Bay of Fundy (River Avon causeway, Windsor) and the Petitcodiac River Causeway, Moncton).
- Current investigations into the feasibility of tidal stream turbines and trial deployments currently underway: tidal stream technology has come to the fore as the most favored method for harnessing tidal power after decades of investigations into how to best harness the energy from this area.

There has been large scale investment in studying the fish and fisheries of the Bay of Fundy. Despite this, the recent update to the Strategic Environmental Assessment has called for the need for more research relating to many aspects of fish behaviour, fish-habitat linkages and the possible impacts of changing sedimentary regimes (AECOM Canada Ltd and Acadia Centre for Estuarine Research 2014).

We strongly advise the Hendry Commission to consult directly with scientists working on tidal stream power deployment and tidal lagoon feasibility in other countries (particularly in Canada) to tap into this evidence and knowledge base.

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