EARLY EVIDENCE OF THE IMPACT OF PREINDUSTRIAL FISHING ON FISH STOCKS FROM THE MID-WEST AND SOUTH EAST COASTAL FISHERIES OF SCOTLAND IN THE NINETEENTH CENTURY

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Introduction

There is a growing demand in environmental and fisheries sciences for quantitative and qualitative data relating to the long-term impact of anthropogenic influence on coastal marine ecosystems (McLenachan *et al*., 2012; Lotze and McLenachan, 2014; Schwedtner Máñez *et al*., 2014; Pitcher and Lam, 2015). It is a demand which can be said to have begun with Daniel Pauly's now famous intervention in 1995, when he described the "shifting baseline syndrome" affecting fisheries science (Pauly, 1995). In essence, Pauly pointed to a tendency among fisheries scientists and ecologists to estimate changes in species abundance according to the limits of their own experience, rather than taking account of the fact that commercial species may have been subject to considerable human exploitation for many decades, or even centuries, prior to the start of their careers. Pauly's article led to a raft of new scholarly work on shifting baselines in marine science (e.g. Jackson *et al*., 2001; Zeller *et al*., 2005; Pinnegar, 2008; Jackson *et al*., 2011), and contributed to the establishment of a new discipline, "marine historical ecology" (Lotze and McLenachan, 2014). One important aspect of this new discipline has been the interrogation of early (pre-twentieth century) data relating to well-established fisheries in

Europe and the North Atlantic. Work on the North and Baltic Seas (e.g. Eero *et al*., 2007; Lotze, 2007; Lajus *et al*., 2007; Robinson and Frid, 2008; Eero *et al*., 2011; McKenzie *et al*., 2011; Kerby *et al*., 2012; Lajus *et al*., 2013), and the north-east Atlantic cod fisheries (e.g. Myers, 2001; Rosenberg *et al*., 2005; Alexander, 2009; Alexander *et al*., 2009; Bolster *et al*., 2011) has led historians and scientists to question some well-established beliefs about the timescale for the serious impact of fishing on commercial stock levels. Nonetheless, more work needs to be done to fill the significant gaps in our understanding of early fishing effort on coastal ecosystems, and nowhere is this truer than around Britain's coastline.

In 2013 a team from York University noted that bottom trawling "spread around the British Isles from the 1820s, yet the collection of national fisheries statistics did not begin until 1886" and that, as a result:

> analysis of the impacts of trawling on fish stocks and habitats during this early period is difficult, yet without this information, we risk underestimating the extent of changes that have occurred as a result of trawling activities (Thurstan *et al.*, 2013).

In order to compensate for what they viewed as a lack of statistical evidence prior to 1886, the article's authors analysed the evidence of fishermen to two parliamentary commissions appointed to inquire into the state of Britain's sea fisheries, in 1863 and 1883 (Report on Sea Fisheries, 1866; Report on Trawl Net and Beam Trawl Fishing, 1885). The conclusion they came to is that, as early as the publication of the first report in 1866, fishermen had begun to bemoan the depletion of inshore stocks of whitefish, while by the time of the emergence of the second report in 1885 there was a broad consensus that it was bottom trawling that was largely to blame for that depletion.

Thurstan *et al.'s* article is one of a number of recent contributions to the debate concerning the historical impact of industrial fishing in Britain's coastal waters, and which have stimulated a lively exchange of views (Thurstan *et al.*, 2010; Thurstan and Roberts, 2010; Heath and Speirs, 2012). The present article covers similar ground to that of Thurstan *et al.* in that we include anecdotal evidence of fishermen alongside landings data from the nineteenth century to estimate the impact of historic fisheries development on stocks in the coastal fisheries of mid-west and south east Scotland. We reaffirm their conclusion that commercially-exploited whitefish appear to have been in decline in some areas by the 1860s, but we go further: on the one hand, we suggest that that depletion began a decade earlier, in the 1850s, and on the other, we question the view that it was bottom trawling that was solely, or even primarily, to blame in these regions for this decline. We also takes issue with the assertion that "the collection of national fisheries statistics did not begin until 1886": in fact, the United Kingdom Fishery Board published a range of statistics in its annual reports from its inception in 1809 (the Board's official title was originally the Commission for the Herring Fishery, later changed to the Commission for the British Fisheries). True, most of these statistics relate to Scotland, for which there is complete geographical coverage; but it is also likely that Thurstan *et al.* meant to signify that *total* landings were not recorded until the 1880s, and this is certainly the case (though they actually began in 1883, not 1886 as stated). Prior to this, only landings of fish intended for cure (that is, to be salted and stored for later consumption) were recorded by the Fishery Board: cured herring landings were recorded from 1809 onwards, and cured "whitefish" landings (which in practice meant the commercially important demersal species of cod and ling) were recorded from 1821.

The aim of the this study is to demonstrate that, with careful handling, not only can these extensive statistics be used to push back our understanding of the scale of change in

Scottish fisheries over the nineteenth century, but that when placed alongside other Fishery Board data they can be used to offer a rudimentary calculation of changes in the abundance of Scottish fish stocks for the period between 1845 to 1886. For herring this is achieved by dividing landings (hundredweight) by the total area (square yards) of drift net used to catch them. For commercial whitefish (mostly cod and ling) we divide landings (hundredweight) by the total length (yards) of hand lines and long lines used in the fishery. Assuming that discarding was negligible and that the total yardages of nets and lines represent a rough measure of effort, these ratios then give estimates of catch per unit effort (CPUE). The standard approximation of catch being proportional to the product of effort and stock size (e.g. Haddon 2001) implies that our rough estimates of CPUE are plausible indices of stock abundance.

Datasets based on the Fishery Board's historic statistics are not unproblematic, and some rely on extrapolated estimates. Nonetheless, they are of sufficient quality to provide viable estimates of herring and whitefish landings for Scotland from 1809 and 1821 respectively, as well as broad estimates of change from around the middle of the nineteenth century, both of which chime remarkably well with the direct evidence of fishermen to the national commissions of inquiry, and challenge the existing view of the impact of commercial fishing around Scotland's shores before the twentieth century.

In the sections that follow we first introduce the historical background to the main commercial fisheries around the coast of Scotland in the eighteenth and early-nineteenth centuries, and then move on to a general discussion of the trajectory of these fisheries in the relatively highly populated regions of the mid-west and south east between 1809 and 1886. Following on from this, we offer a short analysis of the quantitative and qualitative evidence relating to catch rates in these two regions from the mid-1840s onwards, concluding that for commercial whitefish (that is, cod and ling) they declined significantly

from around 1850 and failed to recover thereafter. Finally, we briefly discuss the implications of this decline, taking into account that it began before the widespread adoption of beam trawling and therefore predates the onset of "industrial" fishing by some decades.

The Development of Scotland's Commercial Fisheries, 1809-1886

There already exists an extensive, though far from complete, literature relating to the early development of Scotland's commercial fisheries (e.g. Elder, 1912; Dunlop, 1978; Gray, 1978; Coull, 1996; Harris, 1999; Harris, 2000; Rorke, 2005; Coull *et al.*, 2008). We know, for example, that despite the fact that exports of cured Scottish herring had been growing steadily from as early as the mid-fifteenth century, serious political efforts were made to develop fisheries, particularly in the north west and Outer Hebrides, on a much larger scale from the seventeenth century onwards (Rorke, 2005). Until the later-eighteenth century, these efforts took the form of a series of joint stock companies intended to encourage investment in both the local and national infrastructure for catching, curing and exporting herring to lucrative markets in Ireland, the West Indies and the Continent (Scott, 1912; Elder, 1912; Dunlop, 1978; Harris, 2000). Despite the best efforts of protagonists, these companies are generally held to have failed. The reasons for this failure are complex, but arose principally from a failure to take account of the local social and economic conditions faced by Scottish fishermen, and an overzealous adherence to a centralized model similar to the Dutch "buss" fishery of the preceding two centuries (Coull, 2001; Harris, 2000). This system used decked vessels, known as busses, that were large enough to reach remote fishing grounds and to catch and cure herring for the entire fishing season.

In the mid-eighteenth century, the focus shifted towards the payment of cash bounties from public money to encourage so-called "adventurer merchants" to invest in

these large-scale fishing vessels on the Dutch model. From 1750 onwards, bounties were paid according to the tonnage of vessels engaged in the herring fishery, something that caused great controversy at the time (Leazer, 2013). Tonnage bounties took no account of the quantity of herring caught; they were simply paid at a rate of thirty shillings per ton (later raised to fifty shillings) for all vessels over twenty tons which fulfilled a number of strict rules relating to where, when and how they engaged in the fishing. Proponents of the tonnage bounty claimed that the use of busses, able to carry provisions, salt, and barrels for curing fish on board for the entire fishing season in the remote seas of the north-west Highlands were the only way to develop the British herring fishery to its full potential. But it is also clear that they had other ends in mind, not least the training of sufficient numbers of able seamen for the growing British navy at a time of great tension between Europe's maritime nations (Coull, 2001).

By the beginning of the nineteenth century there was a hard won recognition that the way forward for Scotland's fisheries was no longer investment in large capital projects, but the encouragement of existing small-scale boat fishing which had always provided its backbone (Coull, 2001). As a result, bounty payments which had been paid to large vessel owners were gradually superseded by a bounty of two shillings for each barrel of herring cured according to strictly enforced standards, which was payable to all fishermen regardless of the size and scale of their fishing operation. The barrel bounty had been established as early as 1785 but it gained renewed momentum with the creation of the Fishery Board in 1809. In 1815, an export bounty on cured herring was also scrapped in favour of an enhanced bounty of four shillings per barrel on approved cured landings, and in an attempt to develop other fisheries this was extended to cured whitefish in 1820. In James Coull's words, the generous barrel bounty, payable to all, had the effect of "pump-priming...a substantial boat fishery" in the first third of the nineteenth century (Coull,

1996). From its inception, the Fishery Board's efforts to develop Scotland's home-grown fisheries were hailed as a success, and this is borne out by their own statistics for landings of herring from 1809 and whitefish from 1821. Figures 1 and 2 represent, not only the actual landings of shore-cured fish, but also estimates made by local Fishery Board officers for landings of fish sent fresh to market for the period 1843-57 (represented by the black lines for this period). In addition, the actual recorded landings of fresh fish have been included for the period 1883-86 (also represented by black lines) for comparison, and the relationship between estimated total landings in the earlier period and actual total landings between 1883-86 is sufficiently similar to be useful for indicating trends. Figure 1 clearly

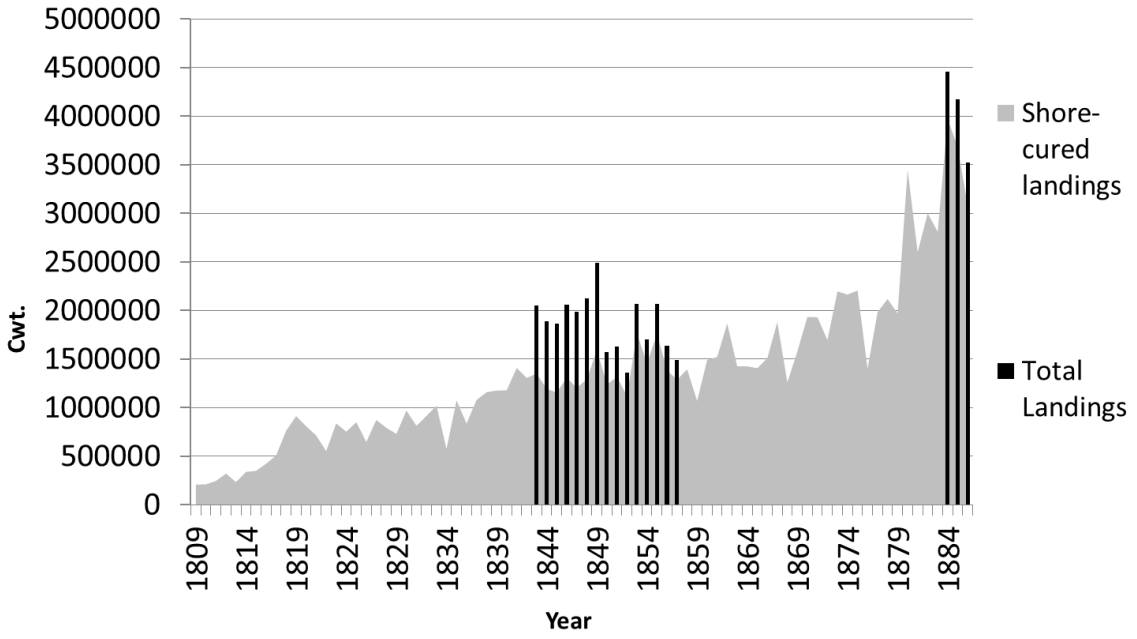

Figure 1. Herring Landings at All Scottish Ports (Cwt.) 1821-1886 (N.B. The sources for all figures and tables, except Figure 3, are the Annual Reports of the Fishery Board, 1809-1886, held at the National Records of Scotland, Edinburgh)

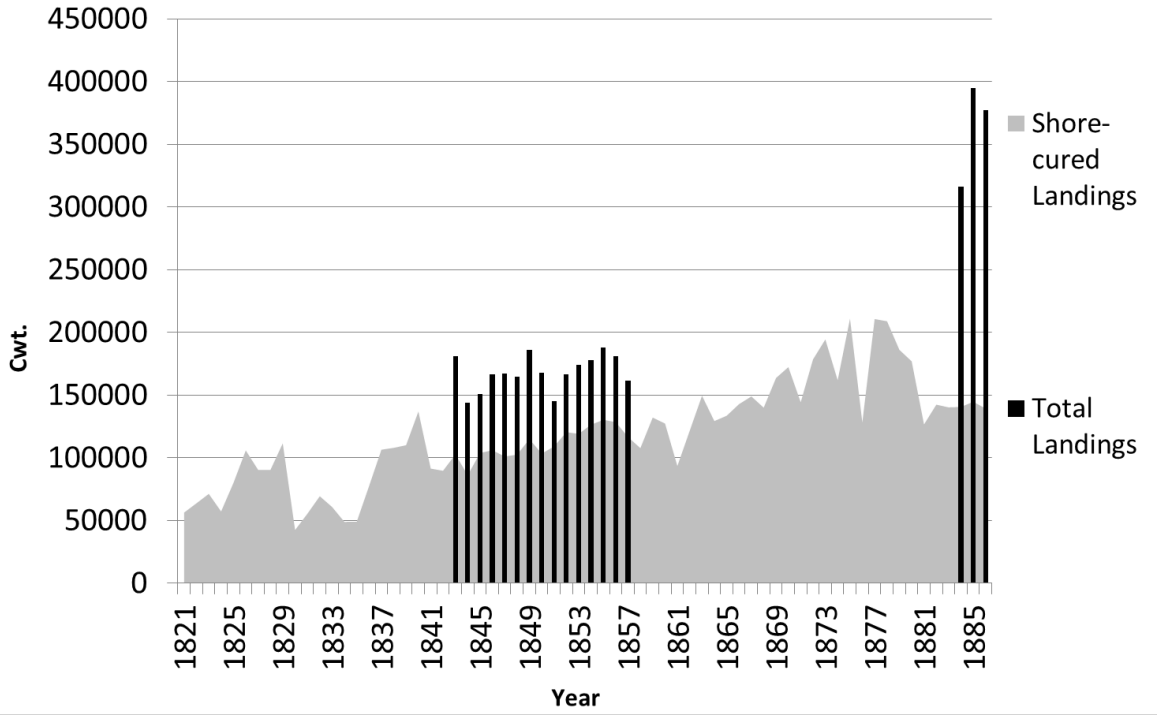

Figure 2. Whitefish Landings at All Scottish Ports (Cwt.) 1821-1886

demonstrates what we already know about the rise of the herring fishery in and beyond the nineteenth century (Gray, 1978; Coull, 1996). Estimated and actual total landings (for 1843-57 and 1883-86) also bear out the supposition that it was cured herring, mostly for export, which dominated landings, even beyond the likely development of significant markets for fresh fish. In terms of whitefish, it is clear from Figure 2 that the market for fresh fish grew substantially in the latter part of the century, and this appears to have had a significant impact on the amount of whitefish available for cure somewhere around 1880. This shifting balance between cured and fresh whitefish is unsurprising given the improvements in rail and steamship communications which took place from the middle of the nineteenth century onwards, particularly relating to the increasingly productive fisheries of the east and north east of Scotland (Report on Sea Fisheries, 1866; House of Commons Returns, 1891; Knauss, 2007). These improvements helped to serve, and to

develop, new domestic markets for fresh whitefish which had previously been inaccessible to most of Scotland's coastal fisheries before the mid- to late-nineteenth century.

With the increasing importance of *laissez-faire* capitalism in eighteenth century Britain, the generous bounties which were paid to fishermen for cured fish inevitably drew fierce criticism. As early as the 1770s, Adam Smith had mounted an attack on the buss bounty system, by then only 20 years old, for compromising the potential success of small boat fisheries and distorting the markets (Leazer, 2013). By the 1820s, the barrel bounty was also under fire for interfering with market forces and subsidising inefficient fishing practices, and as a result all bounties for cured herring and whitefish finally ended in 1830 (Coull, 1996). According to the Fishery Board, this had a significant impact on the whitefish fisheries on the west coast of Scotland, which went into immediate decline (Fishery Board Annual Report, 1831). It is highly likely that the cessation of bounty payments accounts for the dip in cured whitefish landings in 1830 (visible in Figure 2, above); but it is also obvious that for Scotland as a whole this reversal in fortunes was short-lived, for by 1837 landings had bounced back stronger than ever. In terms of the herring fishery, the scrapping of the barrel bounty appears to have had little or no effect on landings, and the overall picture is one of steady growth for Scotland's fisheries across the whole of the nineteenth century. This brief analysis is generally consistent with what we already know about the growth of Scottish fisheries from the existing literature. What it does not tell us is how that growth varied from region to region, and the impact of this considerable early growth on the short-term prospects of local fisheries.

Fluctuations in the Regional Fisheries of Mid-West and South East Scotland, 1809-86

The great advantage of the Fishery Board statistics is that they were collected and presented by individual fishing station (that is, the largest fishing port in each relatively small coastal area). On the one hand, this means that the Board's officers were, by-and-large, very familiar with the fishing in their own locality; on the other, it enables us to analyse the statistics region-by-region, rather than simply at an aggregate level. Surprisingly little research has been done on Scotland's regional fisheries, especially given their uneven growth during this period. Notwithstanding the fastidious work of Malcolm Grey and James Coull in detailing the broad trends in fisheries development over the nineteenth century (particularly on the east coast) we still lack a deep understanding of the quantitative and qualitative growth and demise of specific fisheries in particular localities (Gray, 1978; Coull, 1996). The following analysis aims to address this gap with particular reference to the fisheries of the mid-west of Scotland, including the Firth of Clyde, and the south east of Scotland, including and immediately surrounding the Firth of Forth (Figure 3).

The precise geographical delimitation of these two regions is determined by the Fishery Board's own administrative boundaries.[1] On the south east coast, landings from Montrose and Eyemouth were at times included in the overall figures for either Leith or Anstruther. In the mid-west, landings from the outer-Argyll and Inner Hebridean fisheries were similarly included in the figures for the Clyde ports of Campbeltown, Inveraray or Rothesay. The Board's reasons for including the statistics of what might be described as "outlying" fisheries along with those for stations within the two firths was far from arbitrary. Progressively, over the nineteenth century (and especially during the period 1830

[1] The fisheries stations covered by the two regions here are as follows :

South East and Forth: Anstruther, Burntisland, Eyemouth, Leith and Montrose

West Coast and Clyde: Ayr, Ballantrae, Campbeltown, Fort William, Glasgow, Greenock, Inveraray, Islay, Lochgilphead, Rothesay and Stranraer

Not all of these were operational throughout the entire period, and at various times the stations at Eyemouth, Montrose, Fort William and Islay were merged with larger stations nearby.

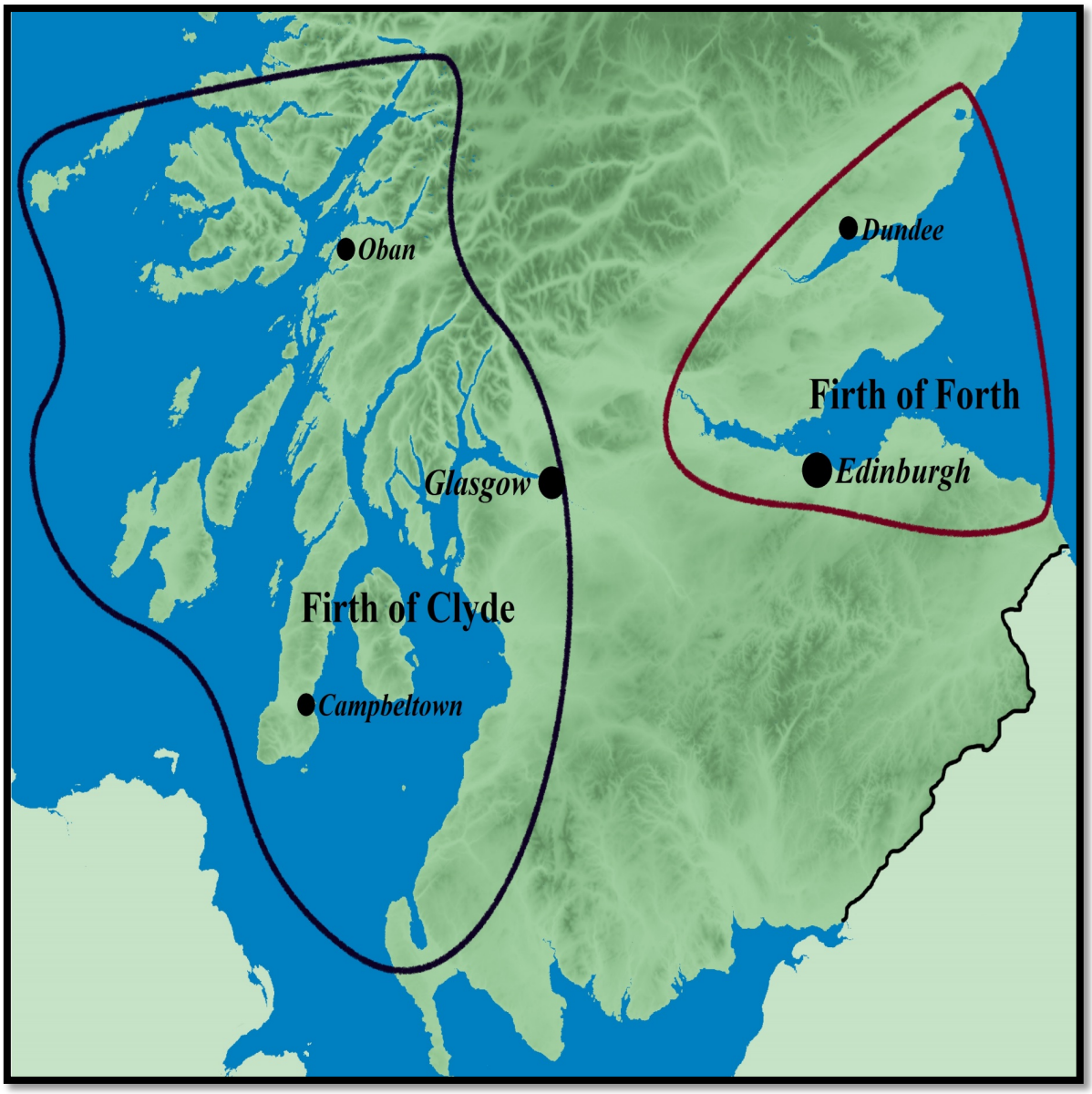

Figure 3. Map of the coastal fisheries of central Scotland (map source: NASA SRTM image, and U.S. Geological Survey's GTOPO30 data series)

to 1850) smaller fisheries stations around the Scottish coast were amalgamated with larger ones in order to save costs (Fishery Board Annual Reports, 1836, 1837, 1845). In addition, it also reflected the practicalities of fishing in these regions over time. On the west coast, for example, the major ports of the Clyde had always maintained strong links with the fisheries on the other side of the Kintyre peninsula. Campbeltown and Greenock, for example, were at the forefront of the herring buss fishery which sailed annually to the

north-west Highlands in the eighteenth century (Coull, 2001). The opening of Crinan Canal in 1801, and its improvement as a navigable channel in the 1830s, had the effect of making the western coastal waters an even more viable destination for the Clyde fishing fleet, and also of making the markets and ports of the Clyde far more accessible to the fishermen of these outlying areas (New Statistical Account, 1845). On the east coast, the ports of Leith and Anstruther dominated the greater-Forth region throughout the nineteenth century, the former being Edinburgh's hub for all coastal commerce and the latter being the largest settlement in the long-established fishing nucleus of the Neuk of Fife. Anstruther's importance as a centre for the surrounding fisheries increased considerably with the building of the Union Harbour in the 1860s and 1870s (Coull, 1996).

It is generally acknowledged that the seas around the central belt saw the earliest development of commercial fishing in Scotland, which is understandable given that they offered relatively sheltered waters for safe fishing, were close to the main urban centres, and had well-developed routes for conveying fish to market (Coull, 1996; Rorke, 2005). One by-product of this early development is that by the beginning of the nineteenth century these coastal waters had been subject to relatively intensive fishing for many decades, and, in some places, even centuries. As a result, one might expect to see some evidence of the impact of fishing activity on commercial catches in these regions during the nineteenth century. The picture is complex and requires careful examination but, in fact, this is precisely what the Fishery Board statistics seem to tell us.

In terms of the raw landings of fish, the mid-west and south east respectively fared quite differently across the nineteenth century. The data represented in Figures 4 and 5 are for locally caught herring only and, as for Tables 1 and 2, the black bars represent estimated total landings – that is, cured and fresh fish combined – for the earlier period, and actual total landings between 1883 and 1886. It is clear that, in the mid-west, the

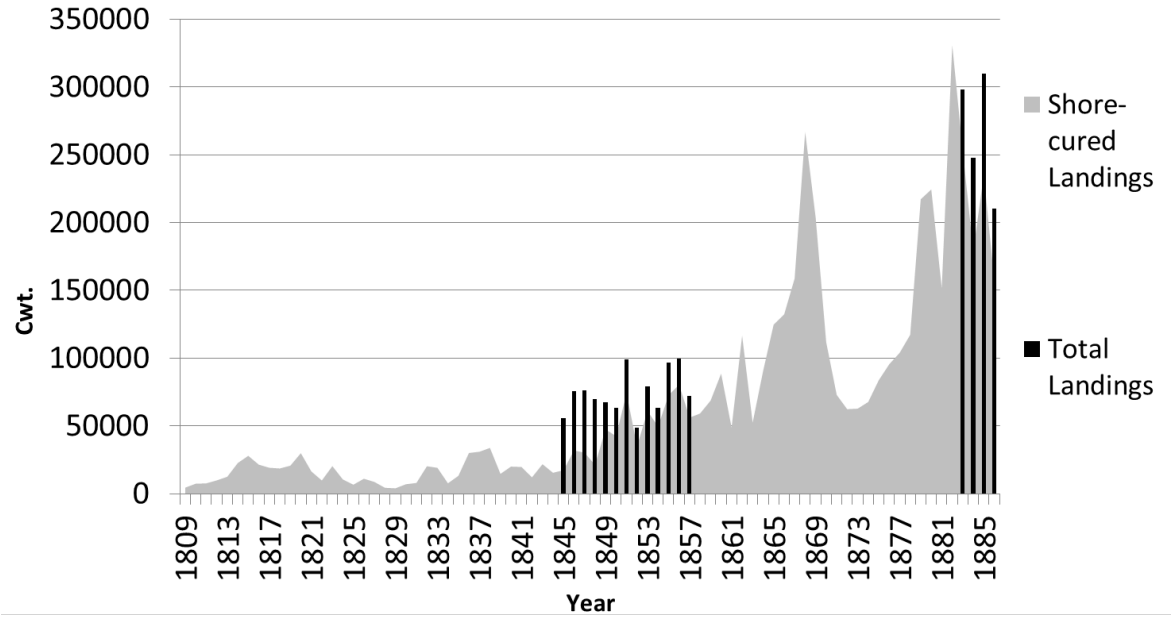

Figure 4. Herring Landings in the Mid-West of Scotland (Cwt.) 1809-1886

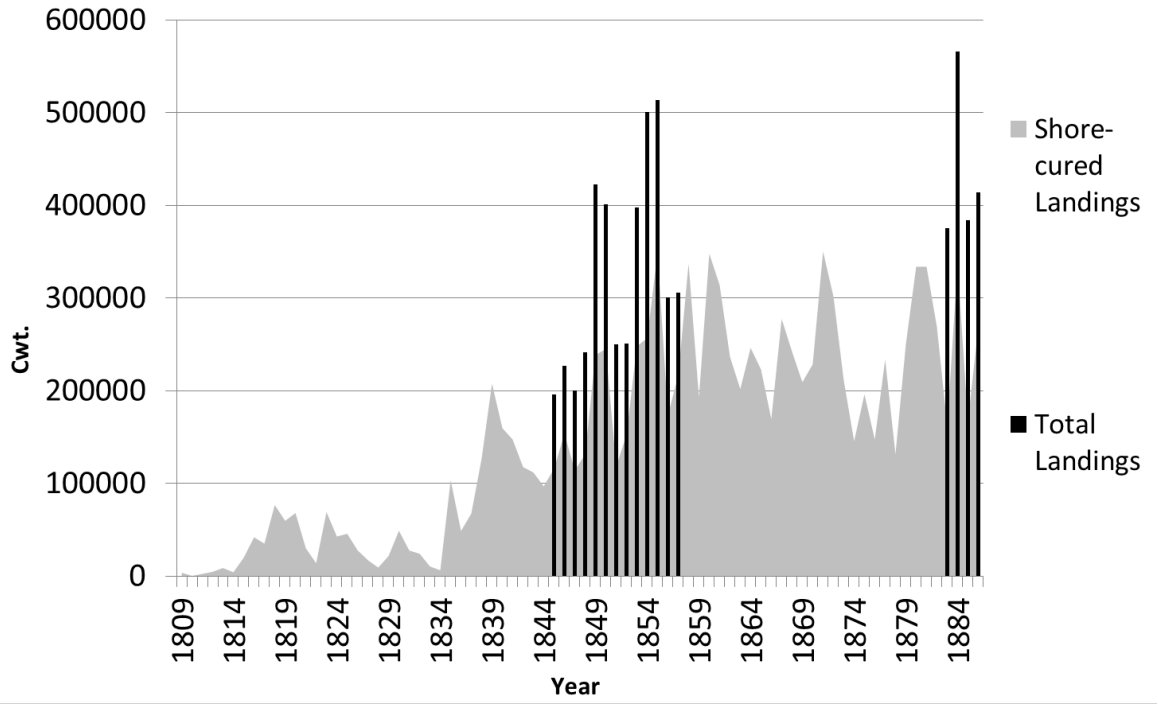

Figure 5. Herring Landings in the South-East of Scotland (Cwt.) 1809-1886

picture is one of substantial, if erratic, increases in landings, particularly from around the middle of the century, whereas the south east tended to see a significant decrease in landings of cured fish and a flattening out of herring landings overall. Once again, this is

consistent with the written accounts given in the Fishery Board's annual reports. It is notable, though, that fishermen themselves put this difference down to the use of two very different, but equally contentious, deviations from the customary gear for catching herring. In Loch Fyne – which was the focus of the herring fishery in the mid-west region throughout the period – adherents to drift netting vehemently opposed the use of the seine, or ring, net which became popular from the 1830s onwards (Martin, 2008). It was considered by drift netters, not only to be overly efficient, sweeping up entire shoals of herring to the detriment of fishermen as a whole, but also to be a highly destructive method of fishing because it caught undersized fish indiscriminately and, they believed, destroyed the spawn of both herring and whitefish. As a result, ring netting (often described as "trawling for herring") was outlawed in 1851, although in the event no official consensus was reached and the ban on ring netting was repealed in 1867 (Martin, 2008).

In the Greater Forth, another contested type of net was blamed, this time for diminishing landings. From its inception, the Fishery Board was empowered to take action against any herring fisherman who had nets of a mesh size "less than one inch from knot to knot, or any false or double-bottom, cod, or pouch". In such cases, officers seized such nets and offenders were prosecuted "for the penalty of forty Pounds" (Fishery Board Annual Report, 1809). In practice, the use of these illegal nets was only ever a significant issue with the Forth fishermen, who traditionally used a smaller meshed net to catch sprats, known locally as "garvies" (Fishery Board Annual Reports, 1810, 1812, 1826, 1861). It is notable, then, that two types of customarily problematic gear were blamed by contemporaries for having a detrimental effect on herring stocks in the two firths: in the Forth, small meshed nets were seen as the cause of the demise of herring catches, whereas in the Clyde ring nets were blamed for taking too many herring at once and, hence, endangering the long-term health of the stocks for all.

When we look at the raw landings of whitefish, the picture is once again quite different in the two regions (Figures 6 and 7). This time, despite a highly uneven pattern of development, both shore-cured and fresh whitefish landings in the mid-west appear to

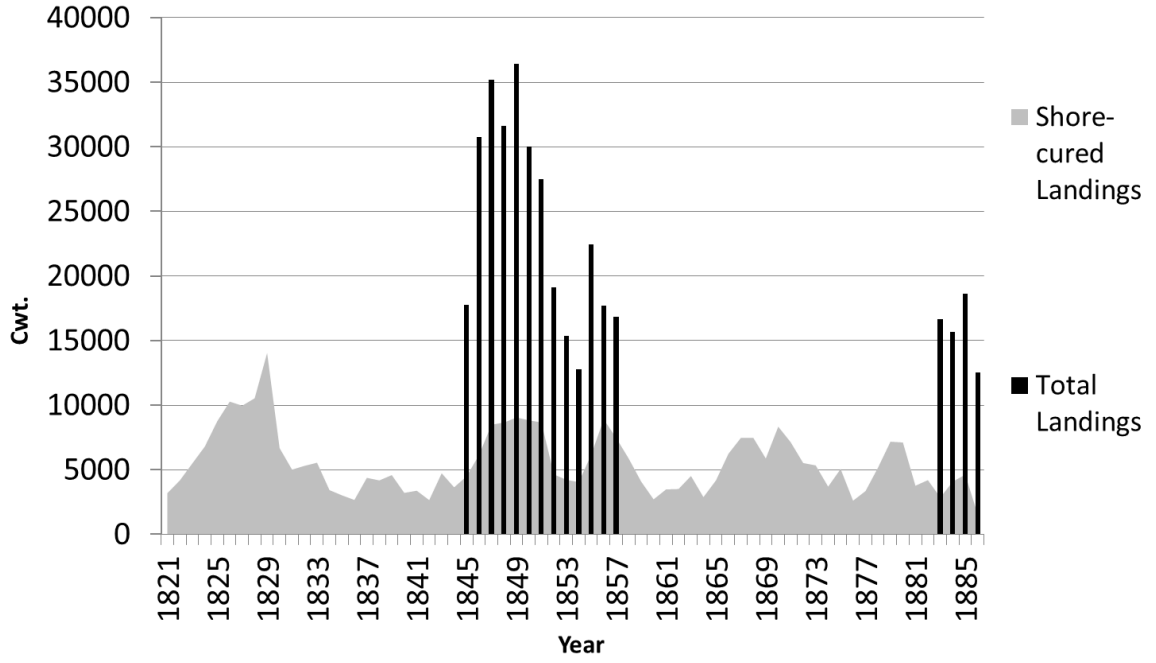

Figure 6. Whitefish Landings in the Mid-West of Scotland (Cwt.) 1821-86

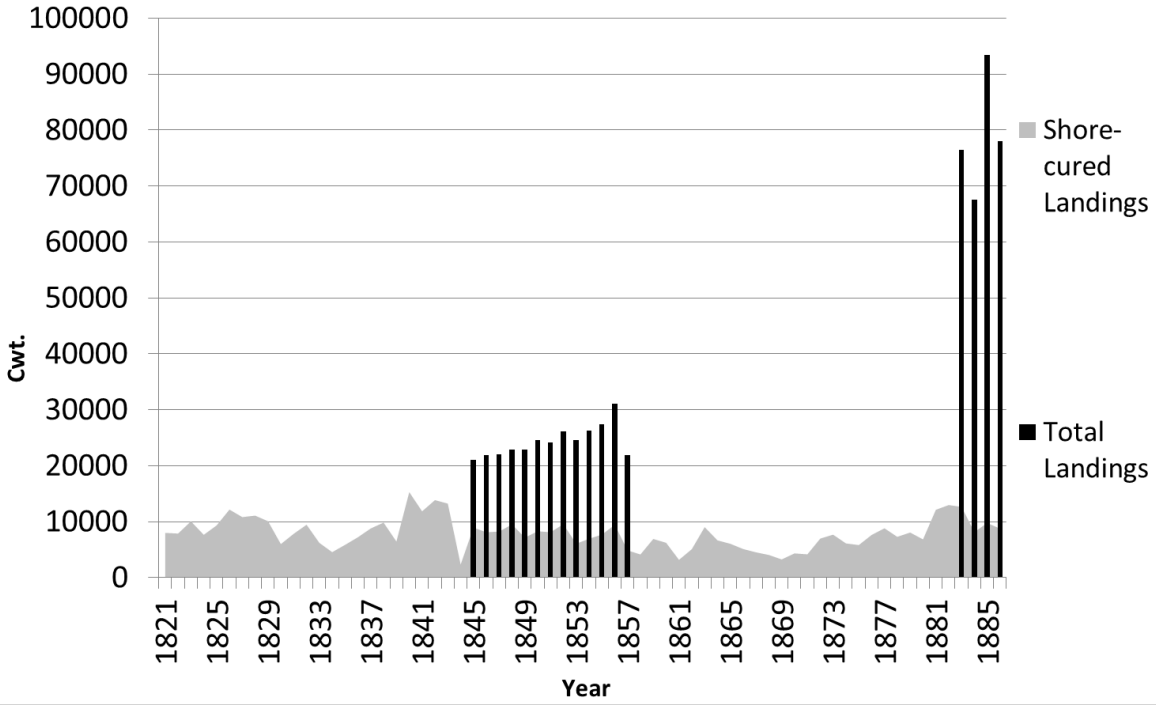

Figure 7. Whitefish Landings in the South-East of Scotland (Cwt.) 1821-86

demonstrate a long-term decline over the nineteenth century, whereas in the south east the proportion of cured whitefish declined significantly towards the end of the period in favour of fish caught fresh for market, landings of which rose to unprecedented levels. Again, there are a number of reasons why this should be the case. On the one hand, there is considerable evidence that, as the fisheries developed across the nineteenth century, the Forth ports of Leith and Anstruther became increasingly important as major landing stations for fish caught from the extensive and well-established fisheries further up the east coast, from the Neuk of Fife to Aberdeen, even as their own fisheries were declining (Gray, 1978; Coull, 1996). Thus, although they are necessarily included by the Fishery Board as greater Forth fishing stations, landings from beyond the Forth itself almost certainly have the effect of skewing the figures somewhat. On the other hand, slowly declining whitefish landings in the mid-west may demonstrate a shift of emphasis as the herring fishery, particularly in Loch Fyne and the Kilbrannan Sound, became increasingly important after the 1860s. Whatever the real reasons for these shifts in landings in the south east and mid-west of Scotland, the raw data can only give us a rough outline of the progress of the fisheries during this period. Beneath these figures lie much more profound stories of change, and in order to uncover these we need to dig much deeper into the available evidence.

Short- and Medium-Term Impacts of Fisheries Growth in the Mid-West and South East of Scotland, 1845-86

In evidence to the 1866 Commission on Sea Fisheries, Robert Smith of Dunbar was adamant that the supply of cod thereabouts was "diminishing greatly", so that:

> I remember one winter season 15 years ago when we got eight or 10 score on our small hooks, and now we will not get five in the winter season on all the length

> of lines we have, and yet we are going 20 miles distance from here after them (Report on Sea Fisheries, 1866).

Smith was not alone in this belief. Almost unanimously, fisherman, fish curers and merchants from both the mid-west and the south east regions bemoaned a recent decline of whitefish, and fishermen in the south east stated again and again that they had to go further out to sea to catch them. As Thurstan *et al.* describe for the U.K. as a whole, some of the witnesses on the east coast of Scotland blamed beam-trawling for the recent demise of whitefish stocks (Thurstan *et al.*, 2013). But they were by no means unanimous in this, and their evidence demonstrates that it was not beam-trawling alone which concerned them. In the Clyde, in particular, they claimed that not only did the ring-net (described above) damage the prospects of herring fishermen, but that it was just as destructive to the spawn and fry of whitefish as the beam-trawl. William McCullogh, a Glasgow fish-curer, considered that "we have never seen the quantity of white fish come into the market since [ring-net] trawling was allowed" (Report on Sea Fisheries, 1866). In the south east, reasons given for the apparent decline in whitefish ranged from moss being washed into the Firth of Forth from cleared land upstream, to the persistent bad weather over several seasons, and the destruction of small fish for bait; though there is no doubt that many more south-eastern fishermen blamed the beam-trawl than did those on the west (Report on Sea Fisheries, 1866).

Up to now, it has been all-but impossible to corroborate these early reports of whitefish demise; which is, perhaps, why historians and fisheries scientists have largely ignored the evidence of the parliamentary commissions (Thurstan *et al.*, 2013, excepted). On its own, anecdotal accounts such as these are questionable, particularly when they come from a body such as coastal fishermen whose livelihood has always been precarious and who, as a result, have traditionally been quick to defend their interests from what they

consider to be outside interference and unfair practices. The authors of the 1866 Report rather waspishly noted this themselves:

> fishermen as a class are, exceedingly unobservant of anything about fish which is not absolutely forced upon them by their daily avocations; and they are, consequently, not only prone to adopt every belief, however ill-founded, which seems to tell in their own favour, but they are disposed to depreciate the present in comparison with the past (Report on Sea Fisheries, 1866).

In the event, though, it seems that the commissioners were wrong to dismiss the concerns of local fishermen quite so readily.

By placing landings figures alongside other statistics gathered by the Fishery Board, it is possible for the first time to suggest a rough estimation of catch per unit effort (CPUE) for Scotland's fisheries for the second half of the nineteenth century. From 1845, the Board's local officers estimated the total quantity and financial value of all herring nets, and whitefish handlines and longlines, used by boat fishermen within their catchment area. From 1857, they stopped estimating the total quantity, but continued to record the likely financial value of nets and lines. In order to arrive at a relatively consistent estimate of the quantity of nets and lines used from 1858 to 1886, the mean value per square yard of net, and per yard of line, has been calculated for the earlier period (between 1845 and 1857) for each region, and this has then been applied to the estimated total value of nets and lines given by fisheries officers from 1858 onwards. For the mid-west region, the mean value per square yard of herring net was estimated at 0.00403 of a pound sterling between 1845 and 1857, and for the south east it was 0.00425. The mean value per yard of handline and longline was 0.0017 in the mid-west, and 0.0023 for the south east. These values have then been used to provide estimated CPUE values for the fisheries in both regions by dividing landings (converted for comparability to hundredweight, the standard

measure for whitefish at the time) by estimated total quantities of herring nets and whitefish lines.

These extrapolations are clearly not unproblematic. In the first place, from the data presented by the Fishery Board it is impossible to disaggregate the relative amounts of handline and longline used by whitefish fishermen over the period under investigation. As a result, it has been necessary to assume a crude equivalence in the fishing power of the these two fishing methods in the absence of evidence to the contrary. Secondly, as the discussion above makes clear the yardages of nets and lines from 1857 to 1886 have been calculated on the basis of their mean financial values for the period 1845 to 1857. However, on this point it is important to note that these are likely to represent *under*estimations of the actual quantities of nets and lines used by fishermen after 1858. The reason for this is that, as mass-produced cotton yarn increasingly took over from hemp and linen as the material of choice for both nets and lines, basic costs were almost certainly driven down (Report on Trawling for Herring, 1863; Holdsworth, 1874: Wright, 1974). In other words, although it has to be acknowledged that the calculations behind the following illustrations are subject to uncertain margins of error, those margins are, if anything, likely to *over* rather than underestimate stock levels as reflected in changing CPUE.

What is immediately obvious from Figures 8 and 9 is that the different trajectories of CPUE for herring in the mid-west and south east of Scotland are, if anything, even more marked than those for raw landings. Despite a significant dip in productivity in the 1870s, the picture for the mid-west fishermen was of significant increases in CPUE across the second half of the century as a whole. Again, this is entirely consistent with accounts given in the Fishery Board annual reports, which detail both the sudden dropping-off of herring in Loch Fyne in the 1860s and 1870s (along with the grumblings of many local fishermen, who continued to blame the recently legalised ring nets for this demise) and the

Figure 8. Herring Fishing CPUE in the Mid-West of Scotland (Cwt. / Sq. Yd. Net) 1845-86

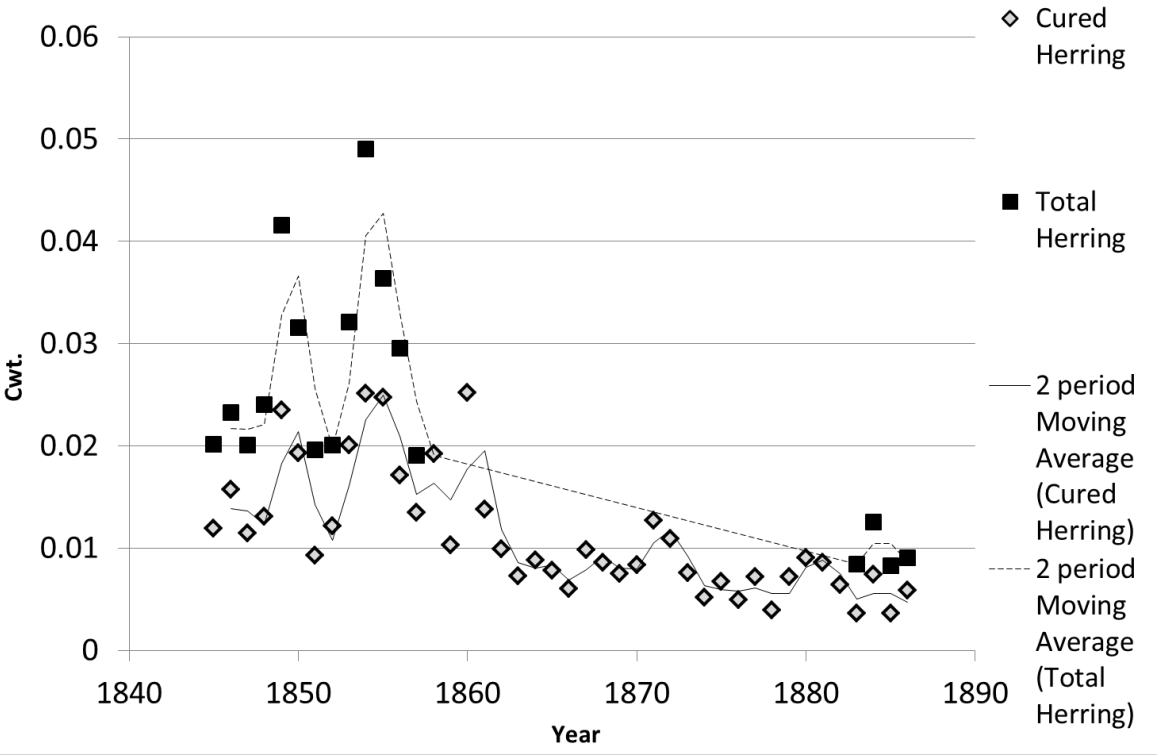

Figure 9. Herring Fishing CPUE in the South East of Scotland (Cwt. / Sq. Yd. Net) 1845-86

unprecedented catches which were once again being made by the early-1880s (Fishery Board Annual Reports, 1875, 1882). It is also consistent with the evidence given by fishermen to the 1866 enquiry, who, despite the impression that whitefish were leaving the region, consistently spoke of improvements in the herring fishing, particularly in Loch Fyne and the Kilbrannan Sound (Report on Sea Fisheries, 1866). In contrast, the south-eastern fishermen spoke of herring in very similar terms to whitefish, in that they consistently bemoaned the demise of both. William Bisset spoke for many when he said: "the number of boats engaged in fishing [for herring] is increasing, but the number of fish to each boat has not been as good as it was some years back; taking the average of six years back, there has been a falling off"(Report on Sea Fisheries, 1866). This is graphically illustrated by Figure 9 above, which shows a highly erratic picture of herring CPUE up to 1860, and then a consistent fall from then onwards, precisely the time identified by Bisset as the start of the decline.

In terms of whitefish, CPUE for the two regions is more consistent (Figures 10 and 11). In fact, given the apparently different fates of whitefish *landings* in the mid-west and south east over this period illustrated in Figures 6 and 7 above, the closer correspondence of CPUE is important in that it goes some way towards explaining the eyewitness accounts of south-eastern fishermen to the 1866 Committee. If we were to look at the findings for raw landings alone, we would have to note the apparent discrepancy between what is indicated by the Fishery Board's figures – that landings increased considerably in the south east towards the end of our period – and what the fishermen themselves clearly felt was the case in 1866 – that the fish were becoming scarcer and harder to catch. What Figure 11 clearly demonstrates is that, despite overall increases in landings of whitefish in the 1880s, and despite the complications of fish being landed in the Forth ports from other areas, CPUE in the south east region never came close to recovering its pre-1852 levels.

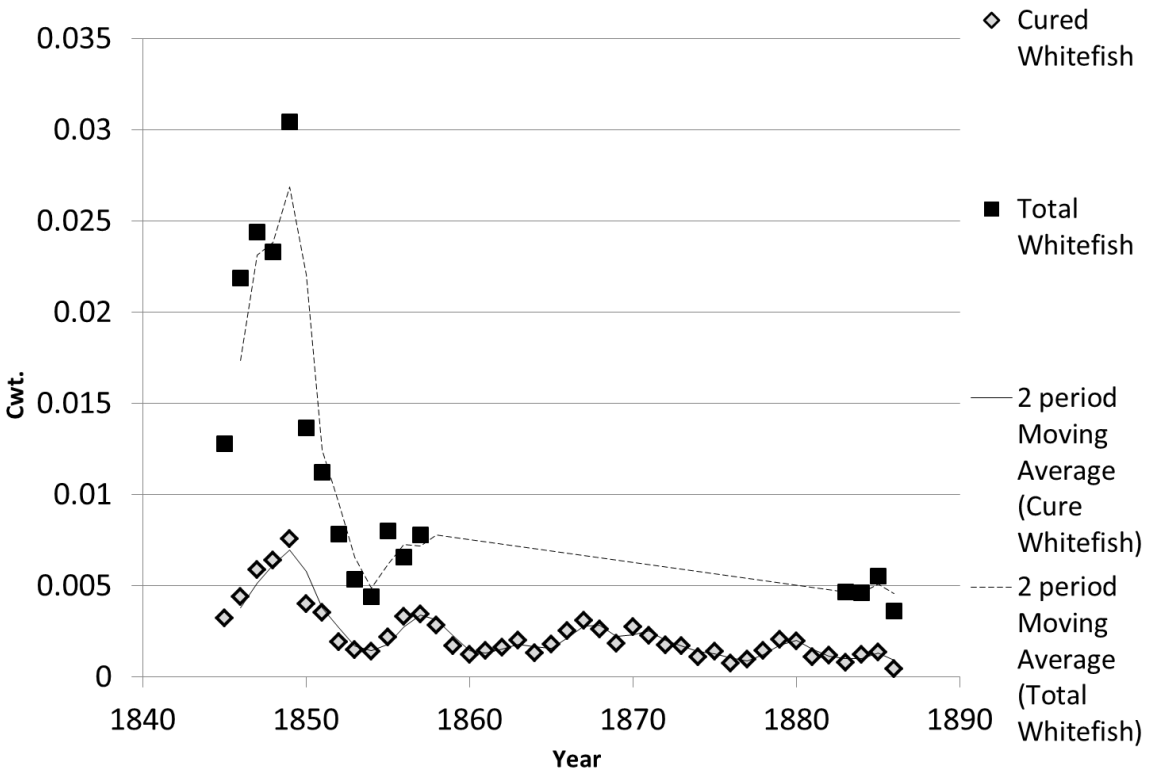

Figure 10. Whitefish Fishing CPUE in the Mid-West of Scotland (Cwt. / Yd. Line) 1845-86

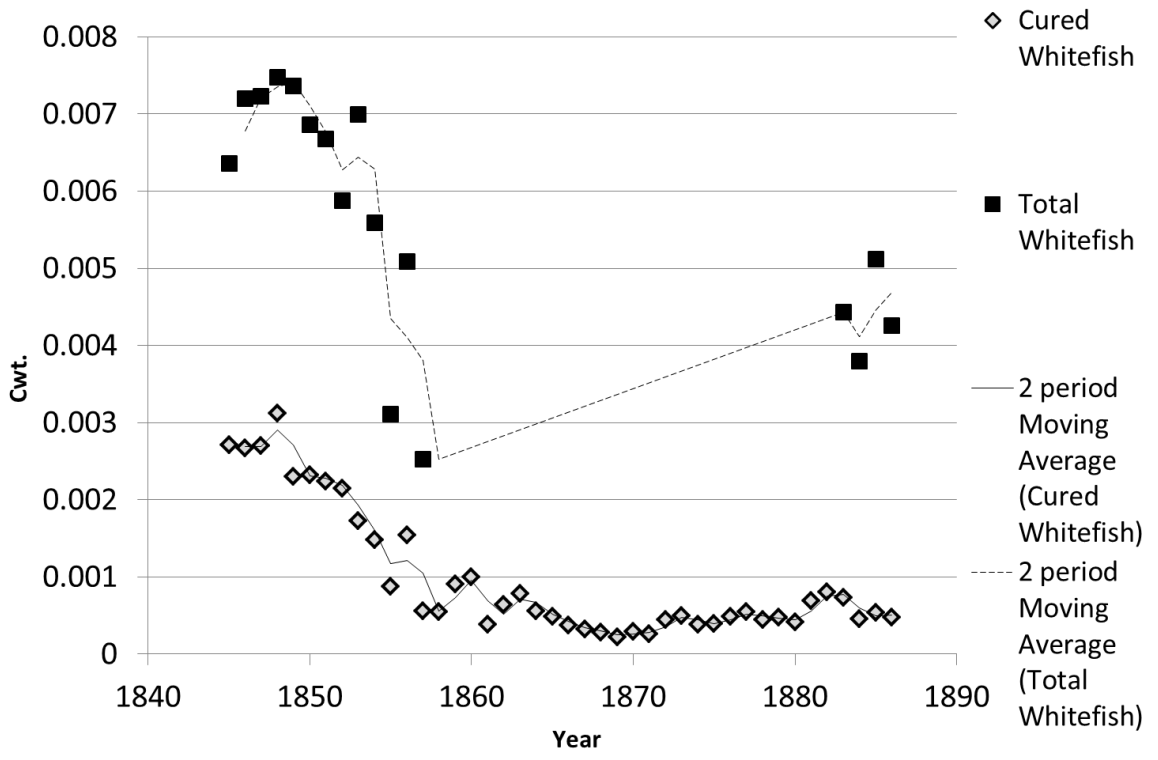

Figure 11. Whitefish Fishing CPUE in the South East of Scotland (Cwt. / Yd. Line) 1845-86

Nonetheless, despite the overall decline in CPUE from the apparent highs of the 1840s and early-1850s, there does seem to be some indication that in the south east it increased from its lowest point towards the end of our period. Once again, it is possible to account for this apparent anomaly by pointing to the fact that by the early-1880s, when the Fishery Board first began recording actual total landings, Leith and Anstruther were clearly taking in large amounts of whitefish from elsewhere on the east coast. These landings were being caught, not by small boats, but by large steam-driven beam-trawlers fishing far out at sea. According to the Commissioners' *Report on Trawl Net and Beam Trawl Fishing*, these two ports had a total of 20 steam trawlers registered to them by 1885 out of only 35 such trawlers along the whole of the east coast of Scotland; and these trawlers, though operating out of the Forth ports, were fishing from 40 to 50 miles offshore (Report on Trawl Net and Beam Trawl Fishing, 1885). In other words, even though these large steam vessels formed only a fraction of the total number of boats operating from the Greater Forth ports (1,540 in 1885), they must have accounted for a greatly disproportionate quantity of whitefish landings; whitefish that cannot be disaggregated from the total landings for the Greater Forth region and which, importantly, were caught, not by handlines, but by trawl nets *and which therefore do not appear in the estimated quantities of whitefish fishing gear recorded by the Board*. In other words, without the landings from these steam-trawlers, it is almost certain that the CPUE figures for the Greater Forth region for actual whitefish landings in the 1880s would be much lower than shown in Figure 11. Having reintroduced the subject of beam-trawling, it is now time to look in more detail at the possible causes for the trends suggested above.

Consequences of Declining CPUE in the Mid-West and South East of Scotland, 1845-86

Despite the evidence of many east-coast fishermen to the 1866 Commission, it is actually very difficult to ascertain exactly how far beam-trawling was a significant factor in any of Scotland's fisheries for most of the nineteenth century. Malcolm Grey suggests only that "[o]ne or two of the East Coast settlements...[equipped] their sailing boats for some seasonal trawling activities" before the 1880s, and James Coull is just as equivocal when he states that "there was some trawling off the coasts of southern Scotland from the 1860s" (Grey, 1978; Coull, 2008). On the other hand, evidence from contemporaries suggests that by the late-1850s beam-trawling by sail had taken hold in a few specific locations around the Firth of Forth. For example, in 1860, as a result of the fact that "[i]t has been the practice, for several years past, of a few fishermen...to Trawl for White-fish on the valuable Herring Fishery Ground near Pittenweem", an Act was passed outlawing the use of:

> Trawl, Drag, or Beam Nets...opposite the parishes of Kilrenny, Anstruther Easter, Anstruther Wester, Pittenweem, and St. Monance, and from one to four miles to seaward (Fishery Board Annual Report, 1860).

In the mid-west, there is no evidence at all that it was a widespread practice for most of the century; but there does seem to have been some small-scale beam-trawling by fishing smacks in the Clyde from relatively early on, particularly around Campbeltown. By the time of the 1866 Commission this activity seems to have declined in importance, so that William Gallacher, a Greenock fish curer, gave evidence that "[t]here are not two [beam] trawlers in Campbeltown...now where there used to be eight or nine". Captain Samuel Macdonald, Commander of the Fishery Board Cutter, "Princess Royal", was adamant that trawling was "very little practised on the east coast of Scotland", and that, what trawling there was, "only commenced within very recent years" (Report on Sea Fisheries, 1866). When the second commission heard the evidence which led to the 1885 Report, beam

trawling on the west coast was considered to be so negligible that the commissioners did not even deem it necessary to visit any ports or fishing stations on that side of Scotland at all; and this consideration was strengthened by written submissions from those based in the mid-west and Firth of Clyde region. The lack of any significant beam trawling around Scotland was also implied in the Report's conclusions, where it was stated that "the trawlers and the line fishermen work, on or near the same ground...on the north, east, and south coasts of England, and the east coast of Ireland", whereas Scotland was not mentioned in this context at all (Report on Trawl Net and Beam Trawl Fishing, 1885).

In addition, despite the complaints of witnesses in both regions of its detrimental impact on the fishing, early beam-trawling by sail was necessarily a relatively restricted practice. Sailing trawlers could only operate if wind and tide were favourable, and they did not have sufficient power to operate the beam over anything but the most featureless ground (Coull, 1994; Roberts, 2007). As a result, in 1872 the Fishery Board reported that:

> disagreements have been rife between the Line and Net Fishermen and the Beam Trawlers...not so much from the objection to the Beam Trawl Net upon allegation of its being destructive to the fishing grounds, although that opinion is held by many, but because this Net with its heavy beam comes in contact with and injures the Lines and Nets of the Line and Net Fishermen (Fishery Board Annual Report, 1872).

In other words, the evidence of the Board's enquiries, as well as the anecdotal evidence to the 1866 Commission, suggest that while there was a growing body of opinion among fishermen that early beam-trawling was not good for the fisheries, this was far from universal, and their objections stemmed at least as much from a fear of damage to their gear. On the other hand, we do know that by the early-1880s beam-trawling by steamers was gathering considerable pace along the east coast of Scotland, and there is no doubt at

all that this was blamed for falling catches of both herring and whitefish by many, if not most, non-trawling fishermen, not least in the Greater Forth region. It was, after all, the explicit reason for setting-up a second national inquiry into sea fishing less than twenty years after the first. Unlike the first report, evidence from the east coast to the 1885 Commission unanimously and overwhelmingly linked diminishing supplies of fish to beam-trawling and ultimately led to new powers for the Fishery Board to ban trawling in local inshore areas – which is, in fact, what happened in the Firth of Forth in 1885 and in the Clyde in 1892 (Coull, 1994).

In 1882, the Fishery Board reported that "[b]eam trawling by steamers, which has been more recently adopted, has greatly increased within the last two or three years", and that "[t]he number of steam trawlers employed in Scotland varies; but the average may be stated as about twenty-five" (Fishery Board Annual Report, 1882). As we have seen, these were concentrated on the east coast, and they operated mostly out of Aberdeen. By the time of the publication of the 1885 Report there were 45 trawlers registered on the east coast, by now operating out of Leith as well as Aberdeen (Report on Trawl Net and Beam Trawl Fishing, 1885). For the purposes of this discussion, it is important to note that these were all steam trawlers, and that no sailing trawlers were by now registered on the east coast of Scotland at all (Report on Trawl Net and Beam Trawl Fishing, 1885). According to the Fishery Board's annual reports, the following numbers of beam-trawlers were registered in the mid-west (all of which were actually registered to Clyde ports) and the south east regions from 1883 (when systematic records began) to 1886 (Table 1). Apart

	1883	**1884**	**1885**	**1886**
Mid-West	***9***	***15***	***60***	***75***
South East	***22***	***29***	***30***	***23***

Table 1. Number of Beam-Trawlers Registered in the Mid-West and South East Regions of Scotland, 1883-86

from at Aberdeen, none was registered outside of these regions. The number of beam trawlers operating in the mid-west at the beginning of this period was quite small; but it soon increased, so that by 1886 more than four times the number of beam-trawlers were registered in the mid-west than in the south east (no doubt largely accounted for by the early ban on trawling in the Forth). But when we look at the average tonnage of beam-trawlers in both regions it becomes clear that the mid-western trawlers were much smaller than those in the south east (Table 2). This strongly suggests that, whereas the Forth

	1883	1884	1885	1886
Mid-West	***8***	***10.4***	***7.25***	***8.07***
South East	***34.27***	***29.93***	***33.23***	***54.96***

Table 2. Average Tonnage of Beam-Trawlers Registered in the Mid-West and South East Regions of Scotland, 1883-86

trawlers were fishing far out at sea (as they would have had to have been, given the 1885 ban on trawling within the Firth), the Clyde-based vessels were fishing much closer inshore, most likely in the Firth of Clyde itself. As a result, from the mid-1880s, it is possible that landings from beam-trawlers in the mid-west will once again have had the effect of artificially inflating the whitefish CPUE findings in Figure 10 above. Yet, it is also obvious that CPUE continued on a long-term downward trend. The only conclusion to be drawn from this is that whitefish CPUE in the mid-west region for the final years covered in this study would have been even worse without the artificial effect of including trawled landings.

Overall, then, the evidence seems to suggest that beam-trawling had, at best, a negligible impact on CPUE and landings in the mid-west of Scotland for the majority of our period, and very little (except in the contested area around Pittenweem) in the south east region until the 1870s and 1880s. Yet, as we have seen from the figures presented here, and the evidence given by fishermen to the 1866 Commission, there seems little doubt that whitefish CPUE showed a significant decline in both regions from around 1850 onwards. This raises the question: what was the cause of this apparent decline in whitefish stocks in the mid-west and south east of Scotland? The evidence from the Board's own figures suggest that the total quantity of handline and longline used to catch whitefish in the mid-west region more than doubled between 1845 and 1855, from around 1.4 to 3 million yards, and rose again to around 3.5 million yards by the 1880s. In the south east region, the numbers are even more impressive: here, the estimated total of handline and longline rose from around 3.3 million to 8.8 million yards between 1845 and 1855, and reached 18 million yards by the early-1880s (Fishery Board Annual Reports, 1845-1886). It seems very likely that it was this simple increase in traditional fishing effort from the beginning of the nineteenth century, when brought to bear on what were already long-exploited whitefish stocks, that was at the heart of the apparent decline in the quantity of commercially available whitefish to fishermen in both regions from the mid-century onwards.

The situation with regard to herring landings and productivity is more problematic. It has long been acknowledged that herring abundance is affected by many different factors, environmental as well as anthropogenic, so teasing out the precise impact of human-related activity, in particular intensive fishing, on herring stocks in any particular area is a very complex task (e.g. Southwood *et al.*, 1988; Poulson, 2008). Given their migratory nature, there may be a case for suggesting that the collapse of herring stocks in

the Greater Forth region during our period was related to the intensification of local fishing activity over many decades (and even centuries) alongside the huge growth of the east coast herring industry as a whole (Coull, 1996). This was certainly the opinion of John Cleghorn, who is widely acknowledged to have coined the phrase "overfishing" to describe the process of unsustainable fishing practices for herring in precisely this region of Scotland (Cleghorn, 1855; Goethel *et al.*, 2012). From his statistical studies, Cleghorn believed vehemently that stocks of herring in the Forth had been overfished to the point of extinction, and he told the Commissioners this in 1866 in no uncertain terms (Report on Sea Fisheries, 1866). But overall, it would be unwise to draw too many conclusions about the state of herring stocks (especially given the very different experiences of the two regions) from this evidence alone. When it comes to the decline of whitefish in both regions, though, we are on far more certain ground. From the Fishery Board's own data there appears to have been a significant decline in overall stocks of commercial whitefish in both regions from the middle of the nineteenth century onwards, measured by substantial increases in the amount of fishing effort required to catch them. It is unlikely that, in either region, beam-trawling was primarily the cause of this early decline; far more likely is that a straightforward increase in fishing effort, measured by the number of boats and fishermen, and the quantities of handlines, longlines and hooks employed by them, was enough to provide a tipping point in these vulnerable whitefish communities.

CONCLUSION

In a recent chapter on the Nova Scotian Shelf fisheries in the nineteenth century, W. Jeremy Bolster and his co-authors noted that, "[n]either historians nor biologists believed that primitive hook-and-line technology could affect the legendary abundance of species like cod" (Bolster *et al.*, 2011). Yet, as they ably demonstrate, not only could these

"primitive" technologies affect that abundance; they undoubtedly did. The present study indicates that something similar occurred in southern Scotland's inshore waters at about the same time. These findings are, perhaps, some vindication for John Cleghorn's early warnings about the impact of the huge increases he observed in traditional fishing effort on the east coast of Scotland (Cleghorn, 1855). Yet, surprisingly, Cleghorn was not the first to make this connection in a Scottish context. In fact, five years previously, the Fishery Board, in its Annual Report, had written that:

> By the statements of Fishermen generally, it appears that the Boats are almost everywhere obliged to go further from land then formerly before they find [cod and ling]; and hence it is assumed either that the Fish have changed their runs on account of the Fishing that has been carried on, or that the Fishing grounds near the shore have been over-fished. (Fishery Board Annual Report, 1850).

In the event, the Board was either unable or unwilling to act on its own evidence, and Cleghorn was widely vilified for his views in his native Wick.

Notwithstanding the fact that it has taken a further century and a half, our understanding of the impact of what might be described as relatively small-scale, or pre-industrial, fishing on vulnerable marine ecosystems has improved immeasurably in the past two decades. In 1997, Jeremy Jackson wrote of the Caribbean, that "[s]ubsistence over-fishing...[had] decimated reef fish populations" by the turn of the twentieth century (Jackson, 1997). By 2008, John Pinnegar and Georg Engelhard were able to extend this analysis, suggesting more generally that "ecosystems were not pristine before the onset of industrial fishing", and that they "may have been subject to moderate or even high levels of fishing mortality for centuries" (Pinnegar and Englehard, 2008). Clearly, this long-term perspective on the ecological impact of "traditional" fishing is gaining ground among fisheries scientists and ecologists. Nonetheless, there is still much work to be done. What

Daniel Pauly described twenty years ago as the shifting baseline syndrome in fisheries science is a stubborn adversary, and it requires many more local and regional studies, founded wherever possible on hard data as well as historical anecdote or archaeological evidence, to demonstrate that the global phenomenon of overfishing reaches much further back than has previously been recognised. The findings in this paper relate only to the mid-west and south east of Scotland, both of which might be described as partially enclosed (or, perhaps, geographically delimited) seas which were subject to relatively intensive fishing activity for decades, and even centuries, before the onset of the "industrial" era of steam power and beam trawls. But they clearly demonstrate that, while this new era (beginning around 1880) undoubtedly saw the greatest gains in terms of raw landings – unsustainable gains which would eventually lead to the collapse of many of Scotland's fisheries a century later – pressure on whitefish from the intensification of "traditional" fishing techniques may have already reached critical levels in some places by the 1850s.

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