Cyfoeth Naturiol Cymru
Natural Resources Wales

Skomer MCZ
Commercial pot fishing activity mapping 1989 to 2019

M. Burton & P. Newman

NRW Evidence Report No. 468
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We work to support Wales' economy by enabling the sustainable use of natural resources to support jobs and enterprise. We help businesses and developers to understand and consider environmental limits when they make important decisions.

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Contents

Synopsis

This report summarises all the commercial potting data collected for Skomer Marine Conservation Zone (MCZ) between 1989 and 2019. Weekly surveys of commercial fishing effort have been conducted between the months of May to September on an annual basis. The results express potting effort in terms of pots per km^2 per survey and plot the density of potting effort around the whole area of Skomer MCZ.
Average potting effort has varied annually between 20 pots/km^2/visit – 100 pots/km^2/visit with an increasing trend across the 3 decades. 85 commercial vessels have been recorded fishing in the MCZ but there is a huge variation in effort. Some boats have only fished a single pot for 1 year, others have consistently fish 250 or more pots for 24 years. The numbers of vessels using the area has stabilised around 7 to 9 in the last 10 years.

The fishing effort is not uniformly distributed across the MCZ. Areas of rocky reef are targeted the most because the provide the best habitat for crustaceans. The north coasts of Skomer Island and the Marloes Peninsula consistently have the highest fishing effort (350+ pots/km^2/visit) and the effort in these areas has increased over the last 3 decades.

Comparisons of fishing efforts are made to other areas of the UK but fishing effort varies hugely on a national and very local scale. A categorical scale of High – Low is used to compare Skomer MCZ to Lyme Bay (south England) and Northumberland (north east England). Skomer MCZ currently has a potting intensity similar to parts of Northumberland and higher than that found in Lyme Bay.

The effect of potting on the seabed is discussed with reference to recent studies elsewhere in the UK. It is not possible to discern community changes caused by potting within Skomer MCZ as there are no control areas of suitable habitat which have not been regularly potted in the last 10 – 20 years. However, concerns remain as to the effect potting has on some fragile, long-lived reef species.

Title of Report:
Skomer MCZ Commercial pot fishing activity mapping 1989 – 2019. NRW Evidence Report Number 468. Burton M. Newman P. 2020.

Crynodeb

Mae'r adroddiad hwn yn crynhoi'r data potio masnachol a gasglwyd ar gyfer Parth Cadwraeth Forol Sgomer rhwng 1989 a 2019. Mae arolygon wythnosol o'r ymdrech pysgota masnachol wedi cael eu cynnal rhwng mis Mai a mis Medi yn flynyddol. Mae'r canlyniadau'n mynegi'r ymdrech botio o ran potiau fesul km^2 ym mhob arolwg ac yn nodi dwysedd yr ymdrech botio o amgylch ardal gyfan Parth Cadwraeth Morol Sgomer.
Roedd yr ymdrech botio ar gyfartaledd yn amrywio'n flynyddol rhwng 20 o botiau/km^2/ymweliad – 100 o botiau/km^2/ymweliad gyda thuedd gynyddol ar draws y tri degawd. Cofnodwyd cyfanswm o 85 o gychod masnachol yn pysgota ym Mharth Cadwraeth Morol Sgomer ond mae yna amrywiad anferth yn yr ymdrech. Mae rhai cychod ond wedi pysgota pot unigol am flwyddyn, ac mae eraill wedi pysgota 250 o botiau neu'n fwy yn gyson am 24 o flynyddoedd. Mae nifer y cychod sy'n defnyddio'r ardal wedi sefydlogi i oddeutu 7-9 dros y 10 mlynedd diwethaf.

Nid yw'r ymdrech bysgota'n cael ei dosbarthu'n unffurf ar draws Parth Cadwraeth Morol Sgomer. Mae ardaloedd o rîff creigiog yn cael eu targedu fwyaf oherwydd dyma'r cynefinoedd gorau i gramenogion. Arfordiroedd gogleddol Ynys Sgomer a Phenrhyn Marloes sydd â'r ymdrech bysgota uchaf yn gyson (350+ o botiau/km^2/ymweliad) ac mae'r ymdrech yn yr ardaloedd hyn wedi cynyddu dros y 3 degawd diwethaf.

Caiff ymdrechion pysgota eu cymharu ag ardaloedd eraill o'r DU ond mae'r ymdrech bysgota'n amrywio'n anferthol ar raddfa genedlaethol a lleol iawn. Defnyddir graddfa gategori Uchel - Isel i gymharu Parth Cadwraeth Morol Sgomer â Lyme Bay (de Lloegr) a Northumberland (gogledd-ddwyrain Lloegr). Ar hyn o bryd, mae gan Barth Cadwraeth Morol Sgomer ddwysedd potio sy'n debyg i rannau o Northumberland ac yn uwch na Lyme Bay.

Caiff yr effaith potio ar wely'r môr ei thrafod gan gyfeirio at astudiaethau diweddar mewn rhannau eraill o'r DU. Nid yw'n bosib canfod newidiadau cymunedol a achosir gan botio ym Mharth Cadwraeth Morol Sgomer oherwydd nid oes unrhyw ardaloedd rheoledig o gynefin addas nad ydynt wedi cael eu potio'n rheolaidd yn ystod y 10-20 o flynyddoedd diwethaf. Fodd bynnag, mae pryderon yn parhau o ran yr effaith sydd gan botio ar rai rhywogaethau rîff bregus, hirhoedlog.

Teitl yr Adroddiad:
Mapio gweithgaredd pysgota potio masnachol Parth Cadwraeth Morol Sgomer 1989 – 2019. Adroddiad Tystiolaeth Cyfoeth Naturiol Cymru Rhif 468. Burton M. Newman P. 2020.

1. Introduction

Commercial fishing activities within the Skomer Marine Conservation Zone (MCZ) are controlled by Welsh Government byelaws.

The taking of scallops and the use of beam trawls and dredges are prohibited (Saved byelaw 27 and byelaw 28 prohibited area for scallop fishing of the former South Wales Sea Fisheries Committee by virtue of Article 13 of The Marine and Coastal Access Act 2009 (*Commencement No. 1, Consequential, Transitional and Savings Provisions*) (England and Wales) Order 2010)

All other commercial activities are subject to a range of measures including further saved byelaws of the former South Wales Sea Fisheries Committee, domestic statutory instruments and EU regulations.

Types of fishing activity recorded with Skomer MCZ include:
Nets: There have been occasional historic records of the use of static monofilament nets within the MCZ but a voluntary code was set up post 1990 with the then Fisherman's association which limited set nets to 600m in length and precluded the use of nets within North Haven, South Haven, the Wick and within 50m of the shore.
Hook and line: There were 2 records of commercial vessels using" jigging" systems in 2008 and the area continues to be used for recreational angling, both from vessels and from the shore.

Potting: By far the most recorded commercial fishing method. The use of static traps (pots) to catch crustaceans. brown Crab (*Cancer pagurus*), lobster (*Homarus* g*ammarus*) and spider crab (*Maja brachydactyla*) being main target species. Other target species include velvet swimmer crab (*Necora puber*) and occasionally spiny lobster (*Palinurus elephas*).
The whelk (*Buccinum undatum*) fishery has increased in the local area in last 10 years and there have been reports of whelk pots in the deeper, sediment areas of the MCZ to the north.

The Skomer MCZ team are on the water from March to November each year and whilst on the water they record the type and location of recreational or commercial fishing activity. These records began in 1989. During the main field season (May to Sep) dedicated weekend patrols are run to help advise visitors, guide behaviour and to record human activity. Commercial fishing effort is recorded during these patrols.

In 2002 a report was produced which summarised the data for commercial fishing effort from 1989 to 2002. This current report is an update to that 2002 report. The methods of data collection have not changed and all the data is still comparable.

Commercial potting has several direct and possible indirect effects on the features within the Skomer MCZ.
Direct effects:

- Removal of both target and non-target species;
- Transfer of non-target species from reef area to somewhere else;
- A shift in population structure (size, age class) of target species;
- Increase in the availability of food for other species through discarded catch, and damage to biota in the path of the gear.

- Lost gear has been shown to persist on the seabed and to continue “ghost fishing” (Bullimore *et al*. 2000).

Impacts on seabed communities:
Compared to mobile fishing techniques, pots are considered to be a relatively sustainable fishing method as their impact on non-target species and the seabed is thought to be minimal (e.g. Walmsley et al 2015, Coleman et al. 2013; Eno et al. 2001; Kinnear et al. 1996). But further quantification is needed to determine the impact of potting on areas of fragile long lived sessile epifauna such as rocky reefs (Langmead *et.al*. 2010, as static gear commonly targets these areas. Damage to benthic communities can occur through direct contact with the gear or the weight system and abrasion from gear movement in periods in adverse weather or strong tidal currents (Eno et al.; Lewis et al; Gall, 2016; Stephenson *et al*., 2015). Gall *et.al.* 2020 is the first study in the UK to record “damage” to sessile fauna while a pot is deployed and recovered from the seabed. The study put video cameras onto pots and recorded the interaction with the sessile fauna. Gall looked at (a) benthic condition of rocky reefs, (b) mechanisms of potting interaction and (c) true footprint of potting. Assemblages in static gear areas were more indicative of a healthy reef than those in mixed gear areas. Damage was recorded during pot hauling, but the area of damage was not the entire pot haul path. 25–30% of individuals were damaged (commonly through tissue abrasion) or removed. Notably, damage occurred to some long-lived, slow growing taxa raising concerns over impacts. The likelihood of potential impacts to long lived sessile epifaunal communities will be proportional to the intensity of fishing effort, low levels of pots on the ground will have a smaller chance of causing community changes over time.

There are no restrictions on the number of boats nor on the number of pots fished within the MCZ. This is in line with the rest of the Welsh waters. There are no voluntary agreements in place which would limit the access to the area or the intensity of pot fishing effort.

Other MPAs (Marine Protected Areas) in the UK have used various methods to control fishing effort and increase gear sustainability. Rees et al 2019 give an example of a voluntary code in Lyme Bay and Torbay SAC which limits:

- Numbers of pots per boat;
- Number of pots on a string;
- Escape hatches in all pots to limit the by-catch of undersized or non-target species;
- V – Notching scheme of berried (egg carrying) or undersized female lobsters.

The effectiveness of these measures can be debated but it does demonstrate that, as a technique, pot fishing is a very manageable fishery and, if well managed, should be one of the most sustainable methods of commercial fishing.

2. Aims of report

1. Collate and summarise the data collected on commercial potting from 1989 to 2019.
2. Chart changes in potting effort over time and area.
3. Identify any areas which are not potted (or very infrequently) which may be useful as control areas.
4. Compare the potting effort within the MCZ to other studies around the UK.

3. Methods

3.1. Field Recording

Weekly patrols are carried out by MCZ staff between May to September using a commercially coded RIB equipped with a GPS system.

Pot buoy positions are marked onto a template map of the MCZ photocopied on waterproof paper and the GPS accurately records pot buoy positions as waypoints to 10m using Lat/long (WGS84). However, the waterproof map has remained useful for recording field notes and providing a hard copy as a backup. Each pot position is labelled with the GPS waypoint and name and number of the fishing boat.

The whole MCZ is surveyed by boat over a period of 4 to 5 hrs on a single day, weather permitting. Areas of the MCZ not surveyed are recorded on the map.

Annual sampling effort by MCZ staff has been consistent at 16 to 20+ surveys per year apart from 1991/2 (low staff availability) and 1996 when a fishing ban was imposed after the Sea Empress oil spill (Table 3.1).

Table 3.1. Number of pot map surveys per year 1989 to 2019

Year	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Number of surveys	10	21	8	2	16	19	13	0*	17	15	17	17	16	18
Year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Number of surveys	15	18	19	18	16	18	21	19	22	19	21	16	16	19
Year	**2017**	**2018**	**2019**											
Number of surveys	18	16	15											

3.2. Data analysis

The waypoints are downloaded from the GPS, labelled with the metadata and then transferred to a GIS package (different GIS packages have been used over time). See Appendix 1 for details of the method.

The waypoints are plotted onto a gridded map of the Reserve. Lines representing the strings of pots are added in the GIS tool using the “polylines” tool. This allows points to be plotted along the length of the polylines to represent pots on the seabed. Each point is labelled with a date and a vessel number.

The spacing of actual pots along strings varies according to boat and has probably varied over time as fishing techniques have developed.

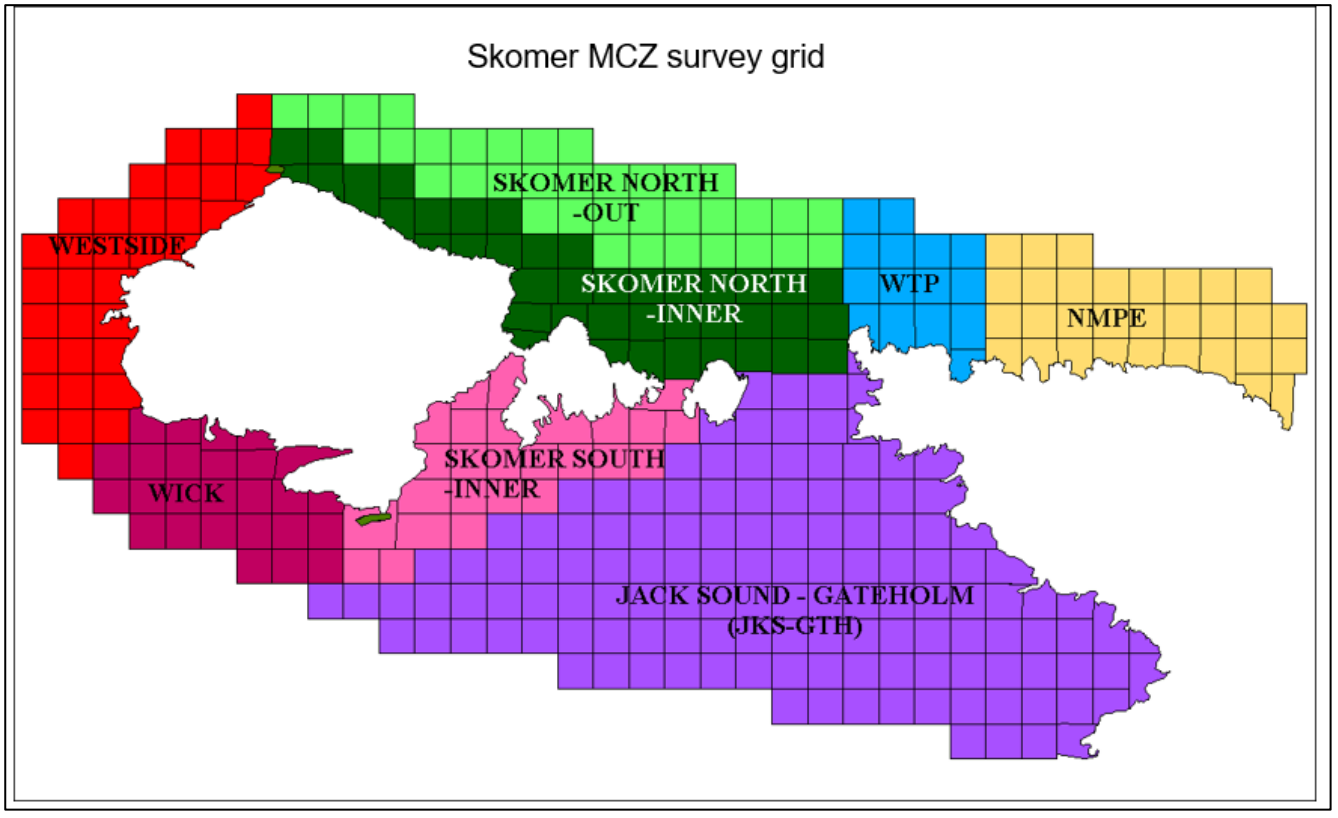
When creating the points in the GIS tool, for the sake of consistency across the whole data set, it is assumed that the number of pots on the line increases with string length and the pots are spaced equally along the lines. Information on the number of pots on a string, supplied by commercial fishermen in 2002, resulted in an approximate distance between pots of 13 m (45 feet) and this arbitrary value has been applied to the whole data set. This means the number of pots counted by the GIS software does not take into account different set ups for different vessels.
By applying the same spacing across the whole data set we create a consistent, relative measure of how many pots are being used in the MCZ. More ground truthing would refine this figure but it will always be an estimate or a relative measure rather than an actual count.

The other important consideration is that, because sampling only takes place once per week and only for part of the year, this project will underestimate how much actual fishing effort is taking place. However, by measuring the survey effort and keeping that as consistent as field conditions allow, it offers a good relative measure to show changes in potting effort over time even if the actual number of pots on the ground is an estimate with untested confidence limits.

An annual summary of all the surveys collates all the GIS data for that year and plots it onto a sample grid, with an individual grid size of approximately 0.04km^2 (250m x 250m).
For each grid square on the map the number of pots within is counted and summed over the whole year, then divided by the area of the grid to give the density of pots per km^2.
Finally, to standardise the data for any variable recording effort across different areas with the MCZ, the density of pots for each grid square was divided by the number of visits recorded for that grid square.

The units “pots per km^2 per visit” are used to plot the potting density map for each year.
Data from the GIS table is then exported into an Excel spreadsheet for further analysis.

Figure 3.1 Survey grid used to commercial potting effort across the MCZ.



4. Results

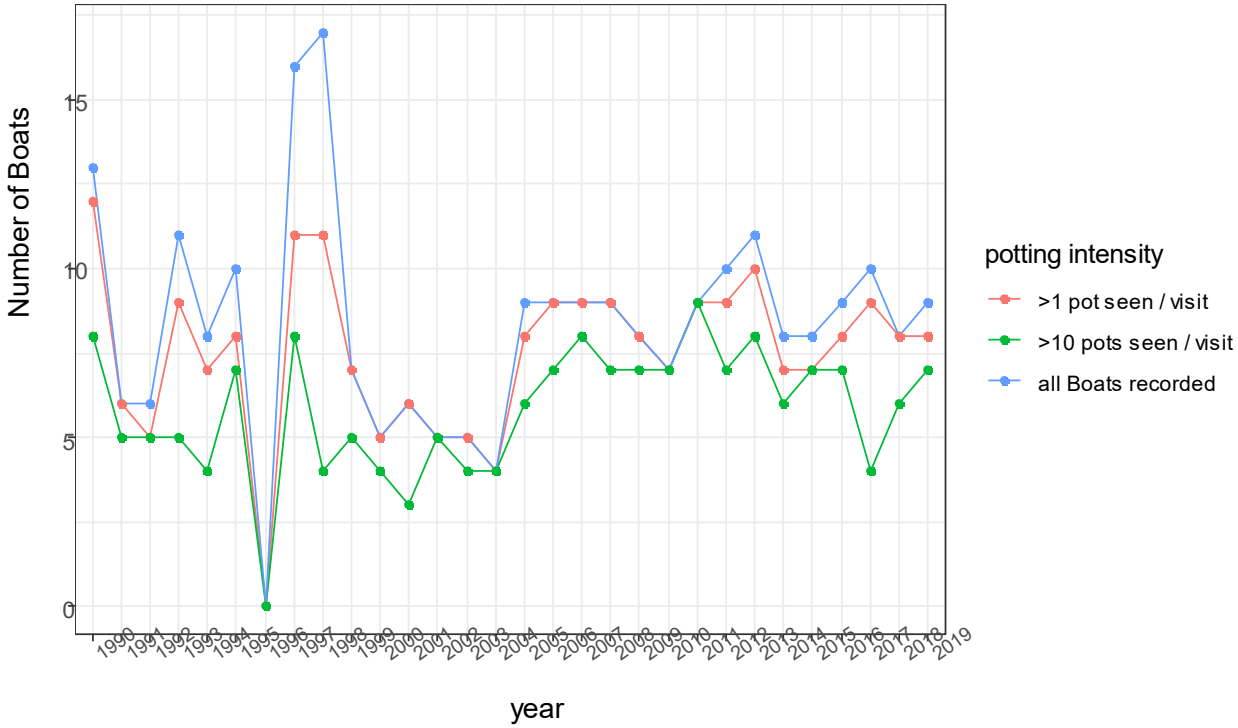
4.1. Summary of data 1989 to 2019

A total of 454 potting effort surveys were completed between 1989 to 2019, the vast majority between the months of May – September. There were no surveys conducted in December through to February and only a hand full of surveys in March and April. Land based records of commercial vessels using the area are taken all year round. The data in this report represents the fishing effort conducted during the spring, summer and autumn seasons when the most amount of gear is deployed, and the greatest number of vessels are out fishing. The winter period sees a reduced number of boats recorded fishing within the MCZ and early season surveys find a reduced amount of gear in the water.

Fishing vessels have been recorded as present and working gear within the MCZ during the winter period but there is no data on the fishing effort during the winter period.

The Number of boats potting within the MCZ is shown in Figure 4.1.

Figure 4.1. Number of commercial vessels recorded in Skomer MCZ 1990 to 2019



Some boats have just a single record of a buoy in the whole survey period, some boats just have 1 buoy seen per survey. Others consistently have a string (10+ pots) seen per survey.

The green line shows the number of vessels actively working the area with at least 1 string of pots each survey.

In 1996 the whole of the Welsh fishery around the Milford haven area was closed due to the Sea Empress oil spill (hence no commercial vessels recorded that year). In 1997 and 1998 there was an influx of vessels prospecting for ground and putting in very small numbers of pots for short periods. The core number of boats using the area only increased from 7 in 1995 to 8 in 1997 but 17 vessels did put some gear into the MCZ.

A total of 85 different commercial vessels have been record between 1990 to 2019 (no records of boat names in 1989).

41 of those were only seen potting for 1 season.

24 vessels potted within the MCZ for 2 to 4 years.

8 vessels potted within the MCZ for 5 to 9 years.

7 owners have potted within the MCZ for 10 or more years. Over this longer time period many of the owners have changed boats so 12 different vessels have been recorded.

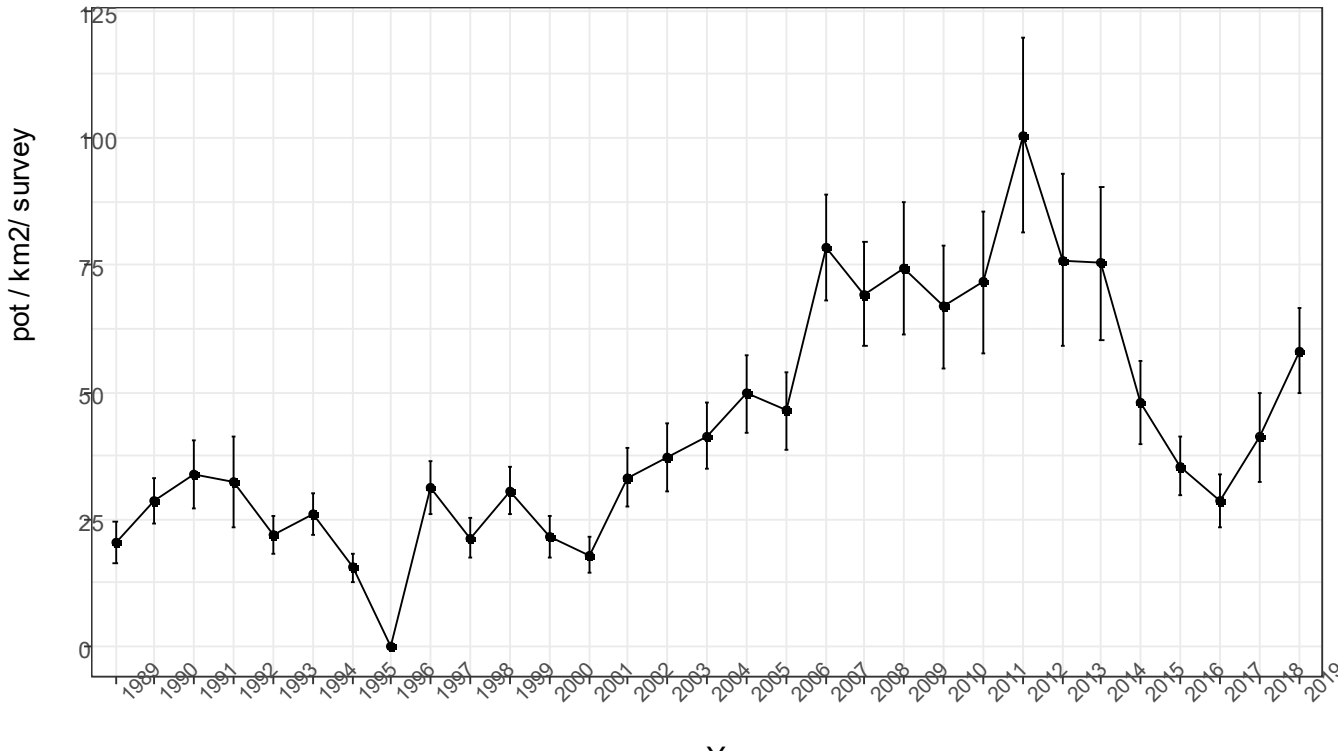
Table 4.1. Potting vessels with consistent effort with Skomer MCZ 1990 – 2019

Vessel	Average Effort pots/km 2/visit	Max effort pots/km 2/visit	Number of Years Fished	Start Year	End Year
Boat_1 & 2	251.1	655.6	24	1990	2014
Boat_3	42.5	72.7	19	1995	2014
Boat_3 & 4	139.4	336.5	15	2005	2019
Boat_5 & 6	106.4	336.7	15	2001	2017
Boat_7 & 8	66.2	142.5	11	2007	2018
Boat_9	21.1	61	11	1990	2004
Boat_10	57.3	187.1	10	2007	2018
Boat_11	97.8	189.1	9	2006	2017
Boat_12	48.2	90.5	8	2007	2014
unknown	34.6	63.8	7	2013	2019
Boat_13	30	61.2	7	1992	1999
Boat_14	79.9	154.8	5	1990	1995
Boat_15	64.6	142.9	5	2015	2019
Boat_16	59.6	89.1	5	1990	2019
Private	1.1	1.6	4	2015	2019
Boat_17	107.1	142.3	3	1997	1999
Boat_18	71	177.7	3	1993	1995

“Private” pot buoys are non-commercial pots set by (multiple) recreational users, often single pots.
“Unknown” buoys represent gear which was not marked with a legible vessel number – assumed to be commercial but not attributable to a specific vessel.

4.2. Changes in potting effort within Skomer MCZ over time and area.

Fig 4.2. Mean potting effort (pots / km^2 / visit, with 95% CI) across the whole MCZ 1989 to 2019



There was no potting effort in 1996 due to the closure of the fishery during and after the Sea Empress oil spill.

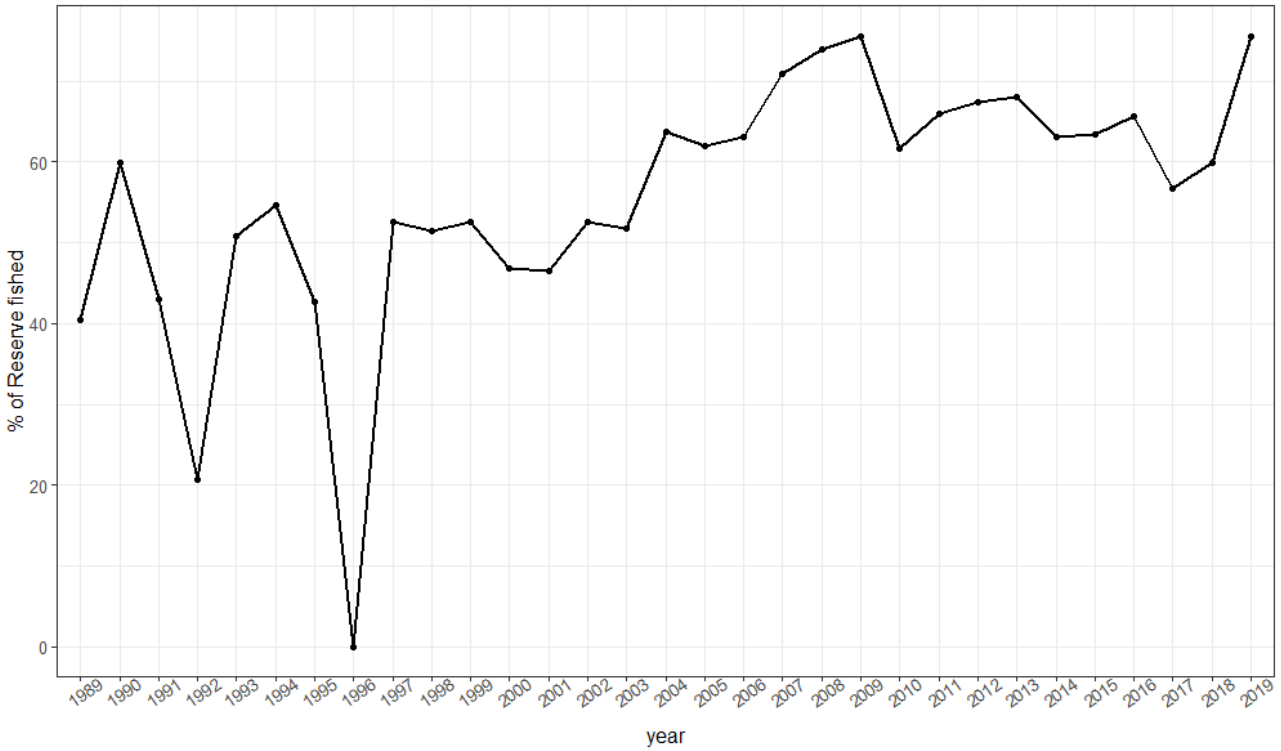
The jump in effort in 2007 is thought to be a result of a single owner replacing a smaller vessel (fishing 250 to 300 pots) with a larger vessel (650 pots/visit). However, number of pots then settled at ~ 500 pots / visit in 2008 to 2010. The owner then started to retire from the industry and the number of pots / visit steadily dropped until he finished in 2014. During that period other vessels moved into the ground left vacated.

The decline in effort from 2014 to 2017 was partly due to a reduction in the numbers of vessels actively potting within the MCZ (see figure 4.1) but also coincided with a shift in fishing patterns from targeting crustaceans inside the MCZ, to an increase in potting for whelks, much of which was outside the MCZ. Fewer crustacean pots were being worked within the MCZ as the same vessels set more whelk pots outside the MCZ (*pers. comm* with local commercial fishermen).

2018 and 2019 has seen the effort increase.

4.2.1. Area of MCZ potted commercially.

Figure 4.3. Area within the MCZ where commercial potting has been recorded (%).



Up until 2002 about 50% of the MCZ was fished commercially this then climbed to 75% in 2008 and stabilized around 65%. 2019 saw a jump back up to 75%.

The effort is not evenly distributed across the MCZ. Potting for crustaceans is concentrated over areas of rocky reef or mixed ground and tends to avoid the deeper, sediment areas of seabed. Shelter from the stronger winds / waves also effects where pots are set. The north coasts of the MCZ offer workable areas of good ground even in strong south-westerly winds so these areas are more intensively potted.

Figure 3.3 divides the MCZ into sectors and figure 4.4 shows how potting effort has changed in each sector over time.

“NMPE” (North Marloes peninsula), “WTP” (Wooltack Point) and “SKM_N_in” (Skomer north inner) are the north facing shores and consistently have the highest potting effort. They show an increase in effort from 2002 to 2015.

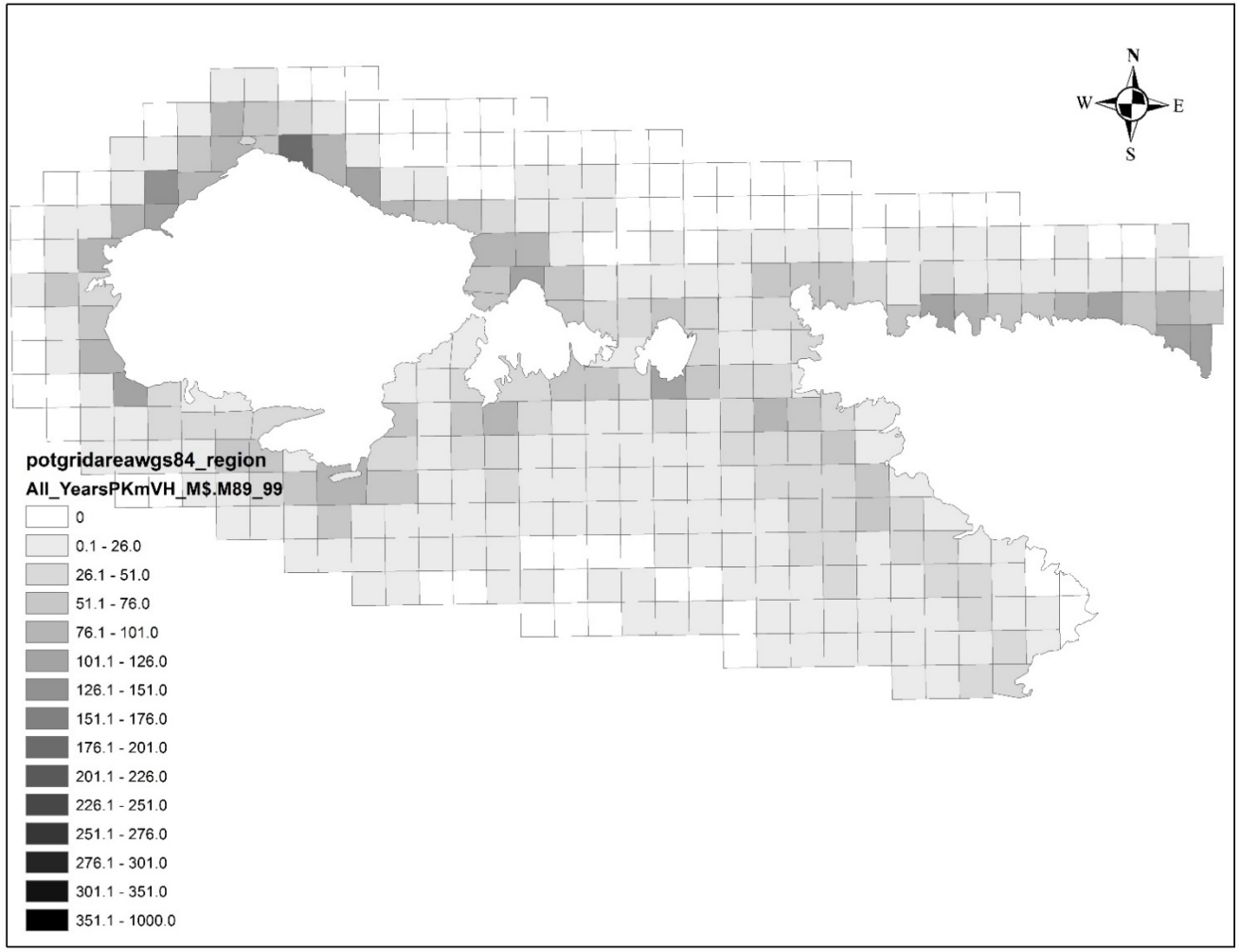
“Skm_N_out” (Skomer north outer) is an area of deep, soft sediment seabed and not good ground for the crustacean fishery. The small increase in effort between 2013 to 2015 could be due to the deployment of whelk pots.

Figure 4.4. Potting effort (pots / km^2 / visit) in each sector of Skomer MCZ 1989 to 2019

Abbreviations used: JKS_GTH = Jack sound to Gateholm, NMPE = North Marloes peninsula, SKM_N_in = Skomer north inner, SKM_S_in = Skomer south inner, SKM_N_out = Skomer north outer, WTP = Wooltack point. See figure 3.1 for locations.

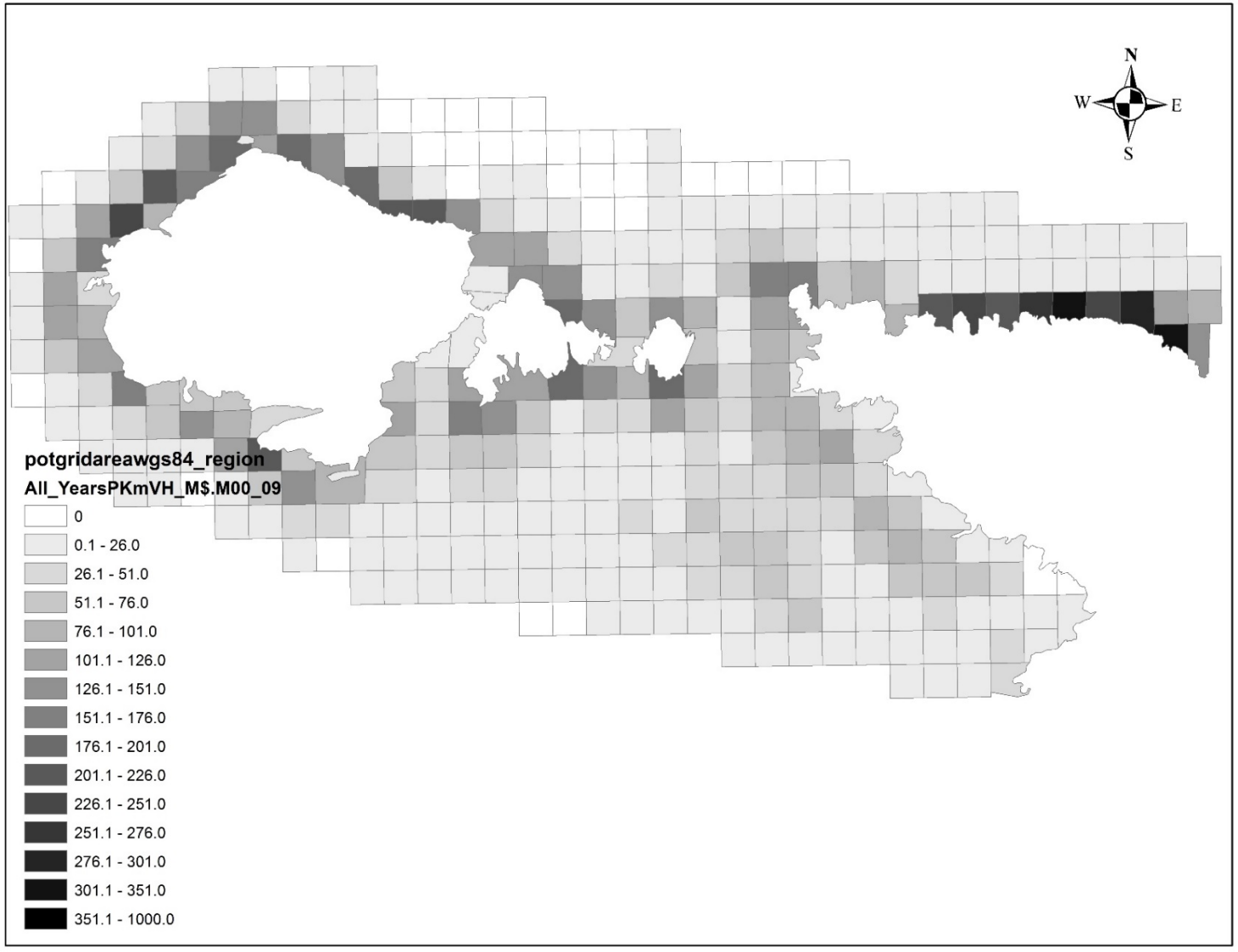
For finer detail in how effort varies within the MCZ each grid square can be mapped with an effort figure of pots / km^2 / visit. These have been produced annually and included in the Skomer MNR / MCZ annual reports. To summarise the data set 1989 to 2019 figure 4.5, 4.6 and 4.7 below separate the data into 3 decades (1989 to 1999, 2000 to 2009 and 2010 to 2019) each grid square is shaded with estimated potting effort averaged for that square across the 10 years of data for that time period. The same shading scale has been used for all 3 maps.

Figure 4.5. Potting intensity averaged for the period 1989 to 1999 Skomer MCZ



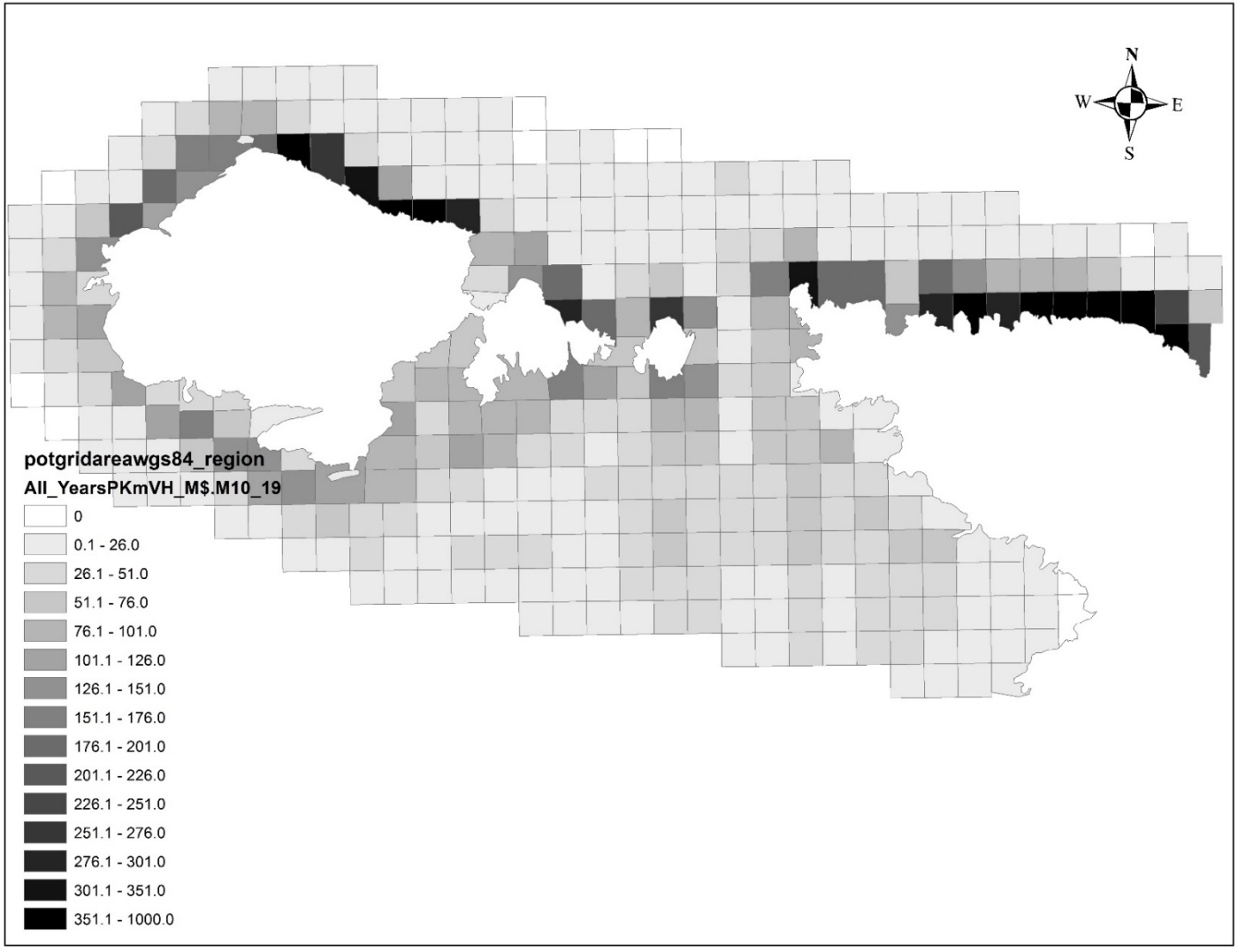
Even distribution of effort with the grids close to shore having a slighty higher density of pots.

Figure 4.6. Potting intensity averaged for the period 2000 to 2009 Skomer MCZ



In the 2000s potting effort increased especially along the North Marloes Peninsula.

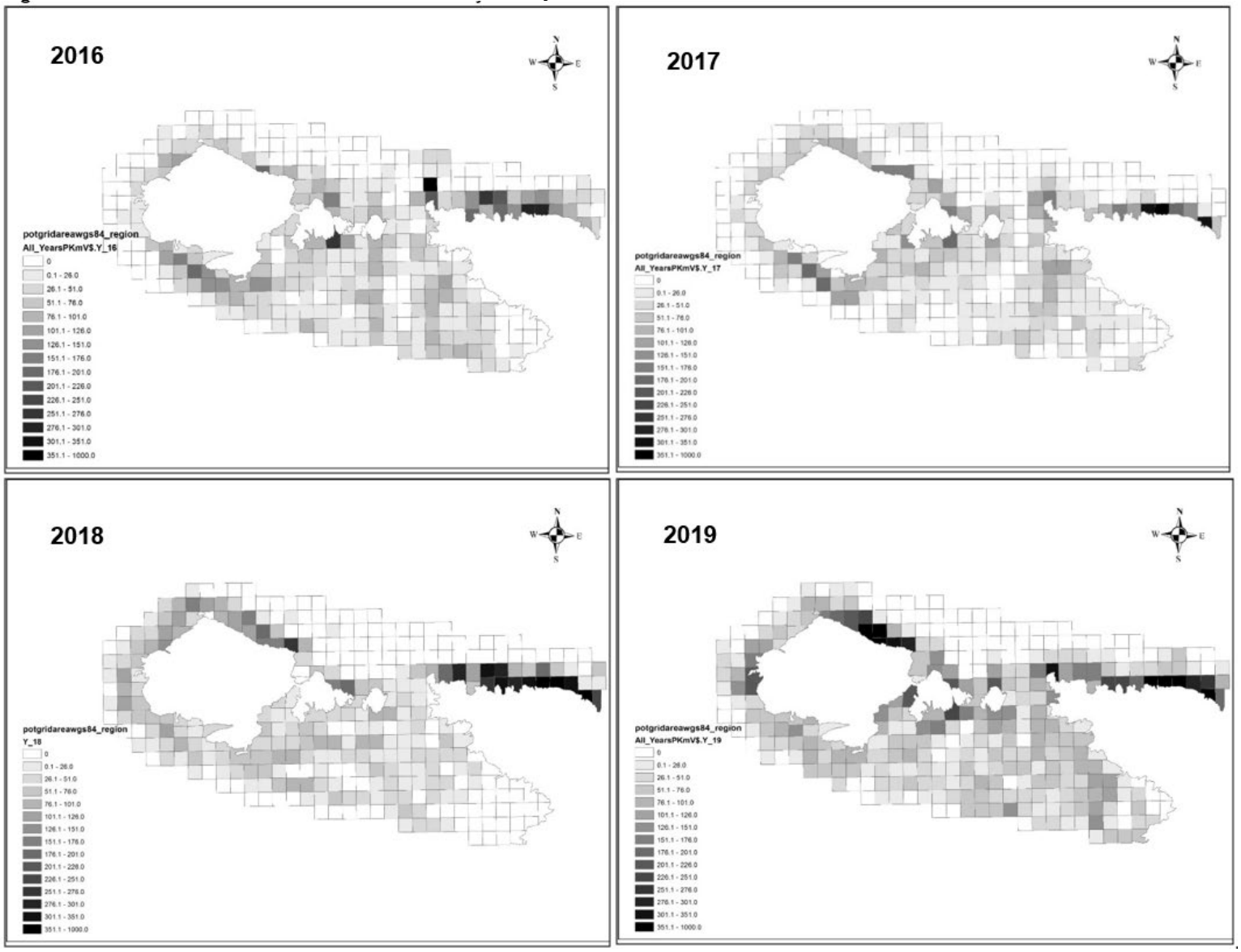
Figure 4.7. Potting intensity averaged for the period 2010 to 2019 Skomer MCZ



Further increase in potting effort seen from 2010 onwards concentrating on the north coasts of Skomer and Marloes.

Each year can be plotted separately to show inter annual change, see figure 4.8

Figure 4.8. Pots / km2 /visit for the last 4 individual years 2016 to 2019

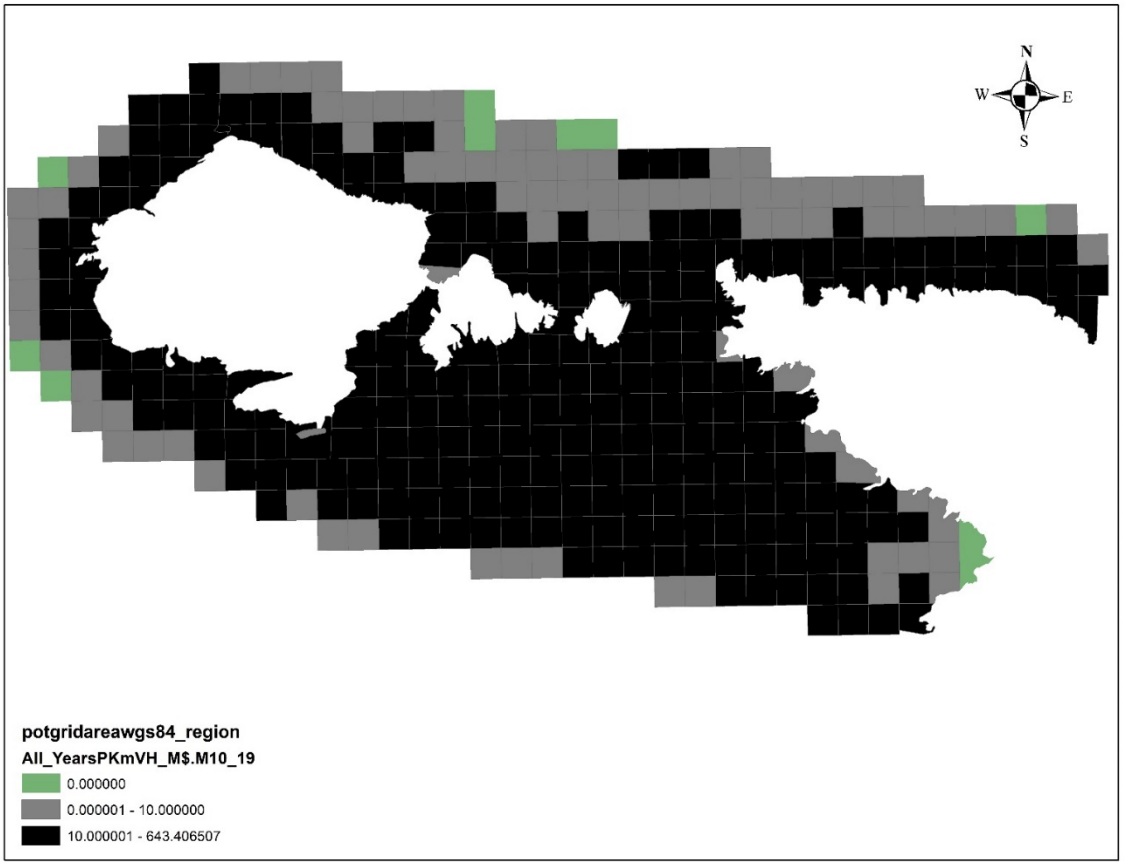


4.3. Areas of zero or very low potting effort.
Control sites to assess the possible changes caused to the benthic communities from pot fishing would require areas of suitable habitat which haven't been potted at all for several years. The next best scenario would be areas of suitable habitat which have only been potted at very low levels.

Over the last 10 years (2010 to 2019) the values in each grid square for pots / km^2 / visit can be summarised:
Minimum = 0.00
1st Quartile (25%) = 0.00
Median = 20.55
Mean = 60.17
3rd Quartile (75%) = 67.00
Max = 1240.00

The mean of 60 pots / km^2 / visit is a lot higher than the median suggesting very skewed data. There are a lot of squares with very low numbers of pots but, in the squares where potting does occur, it occurs at quite high intensities. To choose areas of low intensity potting we could choose the lower quartile, but as this is zero, we have chosen areas ½ way between the lower quartile and the median – 10 pots / km^2 / visit. This would equate to counting an average of 1 pot on the seabed within a grid square.
Using the data averaged for 2010 to 2019 grid squares which have no recorded pots were identified (green) and the areas which, on average over the 10 year period, only had 10 pots /km^2/ visit were also identified (Grey).

Figure 4.9 Areas of no or low potting effort 2010 to 2019



There are some areas of no potting effort (green) but these are at the very edges of the MCZ.

Areas of “low potting effort” (10 pots / km^2 / visit or less) are also distributed in the boundary areas or very close to shore. The black areas have a consistent level of potting effort greater than 10 pots/ km^2/ visit.

A less conservative estimate of “low” potting effort would be to choose a value between the median and the mean – 40 pots / km^2 / visit. This would equate to an average of 2 to 3 pots counted on the seabed within the grid square per visit.

Figure 4.10. Areas of no or low potting effort 2010 to 2019, low effort defined as 40 pots / km^2 / visit.

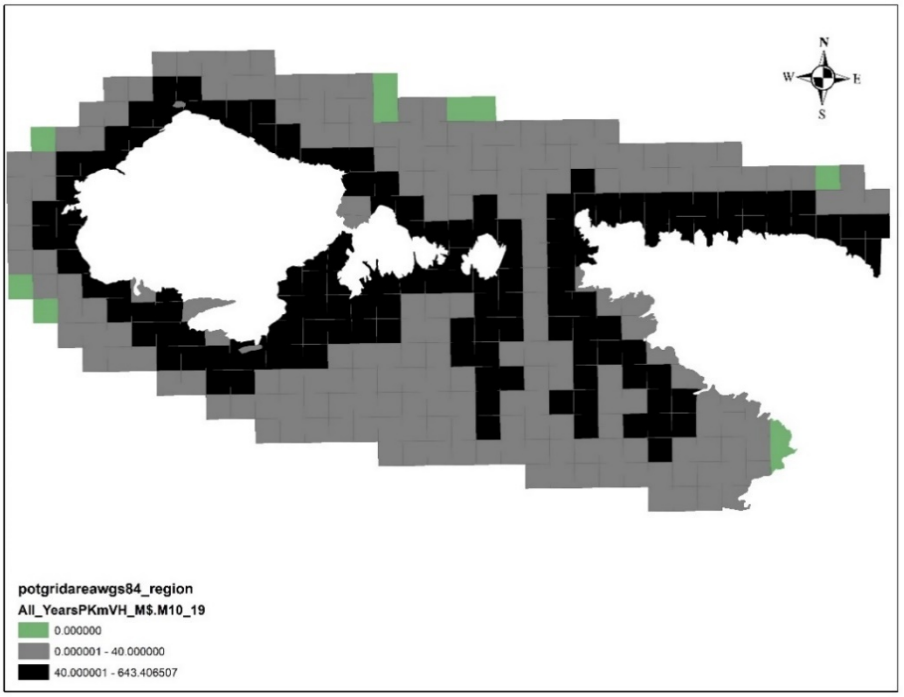
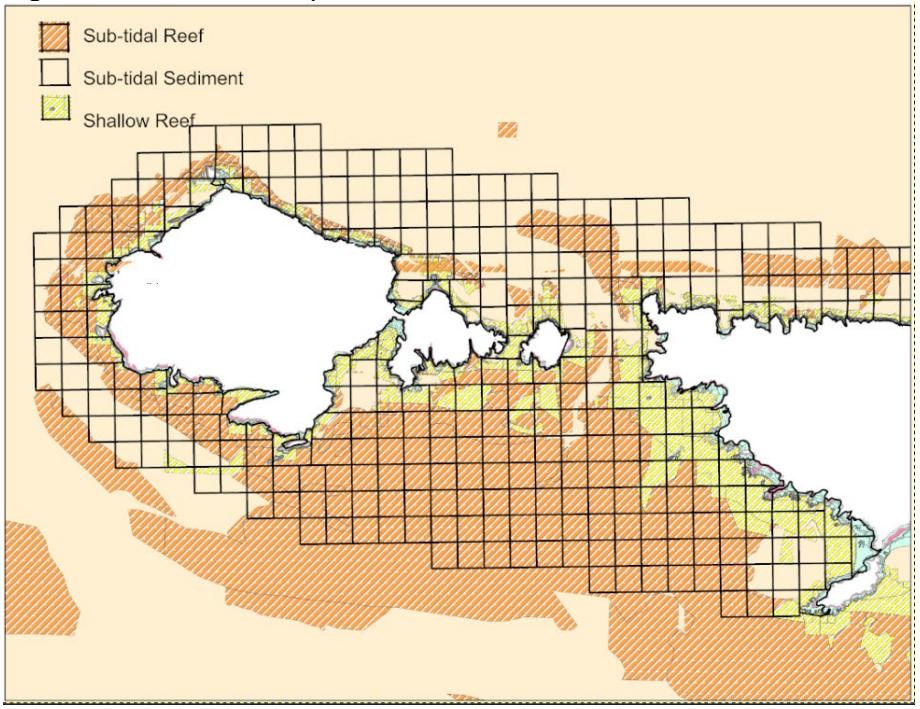
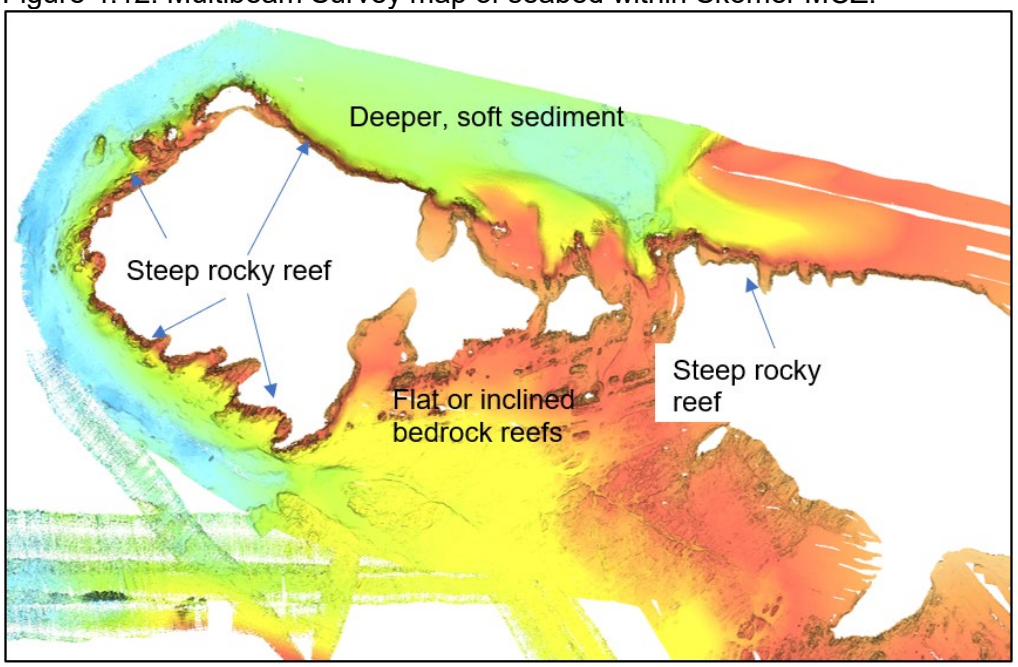


Figure 4.11. Habitat map of the seabed within Skomer MCZ labelled with seabed types



The map in figure 4.11 uses survey data, where available, and predicts the habitat where there is no survey data. The multibeam map below (figure 4.12) gives a more accurate representation of the physical nature of the seabed.

Figure 4.12. Multibeam Survey map of seabed within Skomer MCZ.



The Multibeam map in figure 4.12 is accurate to 5m and gives a visual representation of the seabed surface. It is colour coded for depth; Brown = 25m, yellow 25 to 30m, Green 30 to 40m and blue deeper than 40m (all Below Chat datum).

The Multibeam map will be more accurate and some of the reef areas in the predicted habitat map are shown as sediment on the multibeam survey map. The predicted habitat map over estimates the area of rocky reef.

Comparing the seabed maps with the potting intensity maps, all the rocky reef areas have been regularly potted over the last 10 years.

5. Discussion

5.1. Comparison of potting effort in Skomer MCZ with other areas in the UK.

There have been a few recent studies around the UK on the effect of potting intensity on benthic communities:

1. Eno, N.C., Frid, C.L.J., Hall, K., Ramsay, I.K., Sharp, R.A.M., Brazier, D.P., Hearn, S., Dernie, K.M., Robinson, K.A., Paramor, O.A.L. & Robinson, L.A. 2013. Assessing the sensitivity of habitats to fishing: from seabed maps to sensitivity maps. *Journal of Fish Biology*, **83**, 826-846.

2. Rees, A., Sheehan, E. V., Attrill, M. J. (2018). The Lyme Bay experimental potting study: A collaborative programme to assess the ecological effects of increasing potting density in the Lyme Bay Marine Protected Area. A report to the Blue Marine Foundation and Defra, by the Marine Institute at the University of Plymouth.

3. Turner, R.A., Polunin, N.V.C & Stead, S.M. (2015). Mapping inshore fisheries: Comparing observed and perceived distributions of pot fishing activity in Northumberland. Marine Policy. 51.173–181.

4. Stephenson, F., Polunin, N.V.C., Mill, A.C., Scott, C., Lightfoot, P. & Fitzsimmons, C. (2017). Spatial and temporal changes in pot fishing effort and habitat use. ICES Journal of Marine Science. 74 (4), 2201–2212.

These studies factor in how many times the pots are hauled per month as well as how many pots are being set in a unit area. Each study uses a different way of measuring effort. A meta-analysis of the 4 reports has been conducted to combine the 3 methods and establish a categorical scale of “Low”, “Medium” and “High” potting effort (Hauls / month /km^2) which is applicable to Skomer MCZ and comparable to the findings of the 3 recent studies.

Eno et al 2013 assess different seabed habitats within Wales and their sensitivity to various fishing techniques. The report reviews the published evidence available at the time and defines a scale for high – low potting intensity. Eno et al 2013 uses pots hauled / km^2 / year and assumes the pots are hauled 365 days a year. These figures have been converted to pots hauled / km^2 / month and in this report we assume 12 hauls per month averaged across the whole year.

Rees et al 2019 describes an investigation into the effect of the intensity of potting effort on the seabed benthic communities of Lyme Bay SAC. It is a comprehensive study that defines its own values for low, medium and high fishing intensity in terms of pots per 0.25km^2 hauled 3 times a week in good weather and once a week in poor weather. It also included a control area with no fishing effort during the 3 year period of the study.

Table 5.1 fishing effort as defined in Rees *et al* 2019:

Potting intensity pots / 0.25km^2	Potting intensity (max): Pots /km^2 / month ~ (12 hauls / month)
Low effort = 5 – 10	480
Medium effort = 15-25	1200
High effort = 30+	(36pots*) ~ 1728

*Note, 36 pots per 0.25 km^2 (144 pots per km^2) was deemed to be the maximum number of pots that can be viable and economical (D&SIFCA *pers. comm*.) Rees et al 2019.

Turner, R.A., Polunin, N.V.C & Stead, S.M. (2015). This study just looked at fishing effort and did not include studies of impacts on the benthic communities. It did not specifically apply a categorical scale to potting intensity but it is a comprehensive review of the variability in potting intensity in the north east of England.

Current levels of pot fishing were estimated based on comprehensively sampled fisher interviews (with effort mapping), cross-referenced with IFCA sightings data and mapped using GIS. Fishing towns were the sample areas and included: Blythe, Amble, Seahouses and Holy Island. Number of potting vessels, average pots per boat, average number of months fished and areas fished were used to calculate pot density expressed as Pot months per km^2 per year. These have been interpreted as the number of pots on the ground, being fished that month. By applying the same scaler (12 hauls per month) and taking the average across all the sites we can get these values in the same units as Rees *et.al* 2019.
It should be noted this is not how Turner *et al* presented these results, in this report we have used the range of intensities reported and selected the low, middle and high values from that range. This study did not relate fishing intensity to effects on benthic communities.

Table 5.2 Potting effort converted to Low, medium & high categories from Turner *et al* 2015

Pot months per km^2 per year	**Mean**	**Pot hauls per month (12 hauls/ month in summer)**
lowest	1-13	12 - 156
Medium	80-178	9 - 2136
Highest	634-1098	7608 - 13,176

Stephenson, F., Polunin, N.V.C., Mill, A.C., Scott, C., Lightfoot, P. & Fitzsimmons, C. *(2017).* One year, summer study: Potting intensity on rocky areas of two common Northumberland biotopes (habitats). Fishing effort was divided in three categories:

low (0–139 pots in the sea $month^{-1}.km^{-2}$),

medium (140–187 pots in the sea $month^{-1}.km^{-2}$),

high (188–265 pots in the sea $month^{-1}.km^{-2}$).

Using the same assumption of 12 hauls per month these can be converted into similar units as the previous 2 studies.

Table 5.3. Potting effort converted to Low, medium & high categories from Stephenson et al 2017

Effort Category	Experimental Pots in the sea per month per km2	Number of pots hauled per month per km2 (12 hauls / month)
Low	0–139	0 - 1668
Medium	140–187	1680 - 2244
High	188–265	2256 - 3180

5.1.1. Overall comparison of the 4 studies.

Table 5.4. Comparison of the 4 studies potting effort categories.

Potting intensity category	Rees et al 2019 Lyme Bay Pots hauled / month km^{-2}	Turner et al 2015 Northumberland Pots hauled / month km^{-2}	Stephenson et al 2017 Northumberland Pots hauled / month km^{-2}	Eno et al 2013 Converted to Pots hauled / month km^{-2}	Mean Across the 3 studies Pots hauled / month km^{-2}
Low effort	48 -480	12 -156	1 - 668	1 -2400	16 -1170
Medium effort	720 -1200	960 - 2136	1680 - 2244	2400 - 6000	1300 - 2890
High effort	1248 -1728	7608 - 13,176	2256 - 3180	6000+	3700 - 6020

The Lyme bay study (*Rees et al*) has a much lower effort of pots hauled / month / km^2 compared to the two Northumberland studies. What Rees 2019 quotes as economically unsustainable (1728 hauls/month/km^2) is only “moderate” in the other studies.
The Lyme bay area does have a lot of management measures in place to keep this effort low but this does highlight how different areas of the UK have very different levels of fishing activity.

5.2. Skomer MCZ fishing effort pots hauled / month / km^2

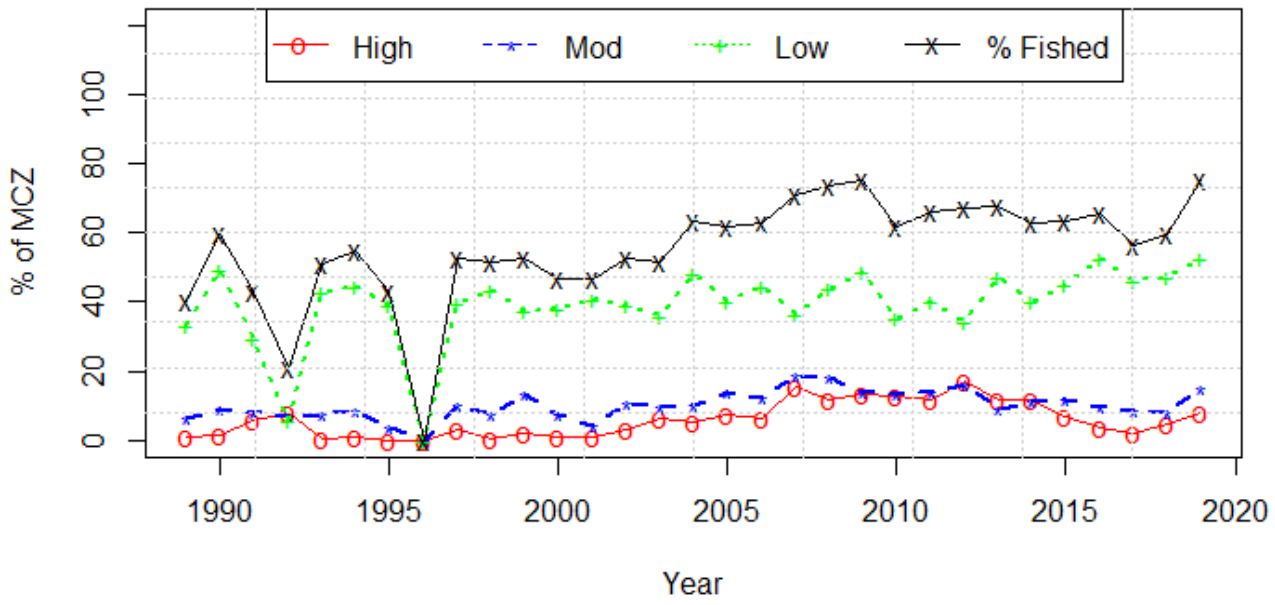
To compare the Skomer MCZ data to the same categorical scale the following values were used:

Table 5.5. Final Category values for potting intensity.

Potting Intensity Category	pots hauled / month / km^2
Low	1 - 1000
Moderate	1001 - 2000
High	2001+

The values for pots / km^2 / visit presented previously in this report for the Skomer MCZ have been scaled up by 12 hauls per month to give values of pots hauled / month / km^2 and to allow comparisons with the other potting effort studies mentioned previously.
A value of 12 hauls / month (3 times a week) has been judged as a good average of the number of times gear is worked in the MCZ based on the sightings of vessels in the area by MCZ staff. In good weather some gear will be hauled daily but in periods of poor weather it may not be visited for over a week.

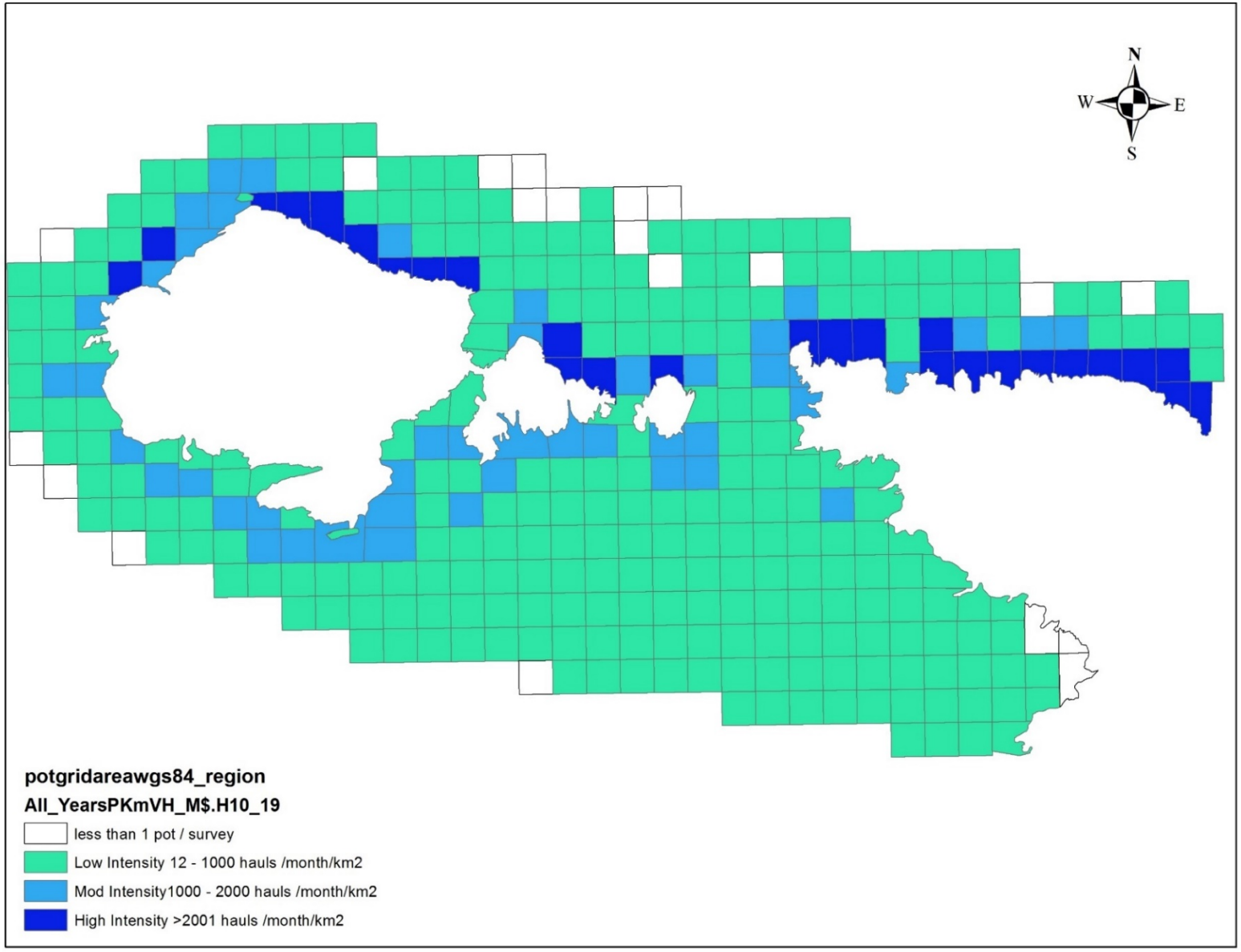
Figure 5.1. Estimated % of MCZ fished at different intensity levels – High, Mod, Low (as defined in table 5.5) and the total % of area the MCZ with some fishing effort (black line)



Of the total area (approx. 15km^2) of the MCZ between 60 to70% has been used for potting in the last 15 years. The 30 to 40% that is unused for potting will be unsuitable habitat (see figure 4.10).
Between 20 to 30% of the of the MCZ is potted at moderate or high intensity. Referring to the habitat maps (figures 4.11 & 4.12) and the potting maps figure 4.8 and figure 5.2; these show that potting is concentrated in certain areas which coincide with rocky reef. The rest of the MCZ, which does not have suitable potting habitat, is infrequently used for pot fishing. This graph suggests that where potting does occur within the MCZ it does so at moderate or high intensities.

Figure 5.2 maps the intensity levels of potting across the MCZ, averaged over the last 10 years. This gives a visual representation of where the moderate and high potting intensities occur.

Figure 5.2. Estimated Fishing effort intensity map averaged for 2010 to 2019 Skomer MCZ. Labelled with Low, Moderate and High fishing effort.



To look at the fishing intensity within the area of Skomer MCZ which has suitable habitat for pot fishing we can use the grid selection in figure 4.7. Selecting the squares which have an average of >10 pots / km^2 / visit between 2010 – 2019 will show the intensity over the regularly fish ground in the last decade (black squares in fig 4.7).

Table 5.7 Estimated Skomer MCZ potting intensity summary 2010 – 2019, grid squares which show regular fishing activity.

Sector name	**mean** (pots / km^2/ visit)	**C.I. - 95%** (pots / km^2/ visit)	**mean** (Hauls / month/ km^2)	**C.I. - 95%** (Hauls / month/ km^2)	**Potting intensity**
JKS_GTH	52.2	3.2	626.1	37.8	Low
NMPE	275.3	39.6	3303.3	474.8	High
SKM_N_in	167.7	21.7	2012.7	260.4	High
SKM_S_in	87.3	8.1	1047.9	96.9	Mod
SKN_N_out	50.1	19.2	601.4	229.9	Low
Westside	98.5	13.1	1182.4	156.9	Mod
WICK	82.7	11.3	992.4	135.3	Low
WTP	147.4	33.9	1768.7	406.6	Mod

Selecting for areas of suitable potting habitat, North Marloes peninsula (NMPE) and Skomer north Inner (SK_N_in) both have “High” potting intensity with Skomer south inner (SKM_S_in), Westside and Wooltack Point (WTP) having moderate intensity over the last decade.

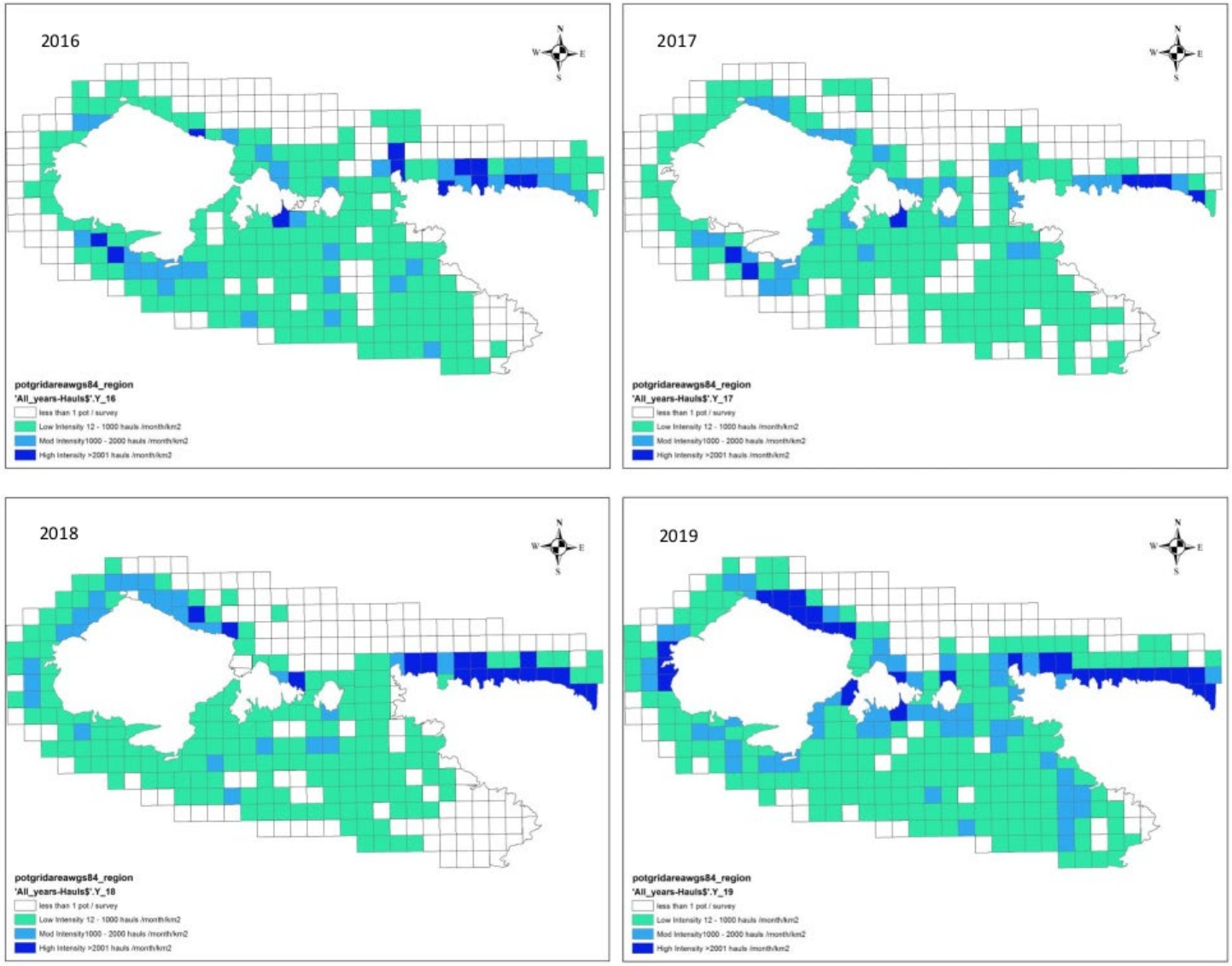
Figure 5.3 shows how the intensity changes over time (1989 to 2019) for these regularly fished areas, separated out into the 8 survey sectors. These values represent fishing intensity calculated just from the grid squares which are consistently recorded as having at least 1 pot present in each grid square per survey visit (see figure 4.7 black squares).

Figure 5.3. Estimated Hauls / month/ km2 (with 95% C.I.) by each sector 1989 – 2019. Just the grid squares which show regular fishing activity > 10 pots / km2/ visit. Green line = “Low” intensity boundary. Red line = “High” intensity boundary, between the 2 lines = “Moderate” intensity

Abbreviations used: JKS_GTH = Jack sound to Gateholm, NMPE = North Marloes peninsula, SKM_N_in = Skomer north inner, SKM_S_in = Skomer south inner, SKM_N_out = Skomer north outer, WTP = Wooltack point. See figure 3.1 for locations.

The estimated potting intensity is highest in the NMPE sector. It was consistently high from 2002 onwards

Figure 5.4. Annual potting intensity maps hauls / month / km^2. 2016 to 2019.



The highest estimated potting intensity occurs consistently on the north coasts of Skomer and the North Marloes peninsula. Most of the areas of rocky reef habitat are potted at moderate or high intensity. The rest of the MCZ is regularly potted but at low intensity (< 1000 pots hauled / month / km^2).

Over time (1989 to 2019) intensity has changed with the highest intensities seen in the period 2007 to 2013.
Comparing with other studies and using the scale Pots hauled / month/ km2 may be useful if comparing to the impact studies on benthic communities included in Rees et al 2019 and Stephenson et al 2017.

Neither Eno, Rees nor Stephenson showed any significant impact of potting on benthic communities as a whole.

Stephenson 2017 looked at 2 biotopes:

1. Faunal and algal crusts on exposed to moderately wave exposed circalittoral rock' (FaAlCr)
2. *Laminaria hyperborea* park with foliose red seaweeds on moderately exposed lower infralittoral rock' (Lhyp.Pk).

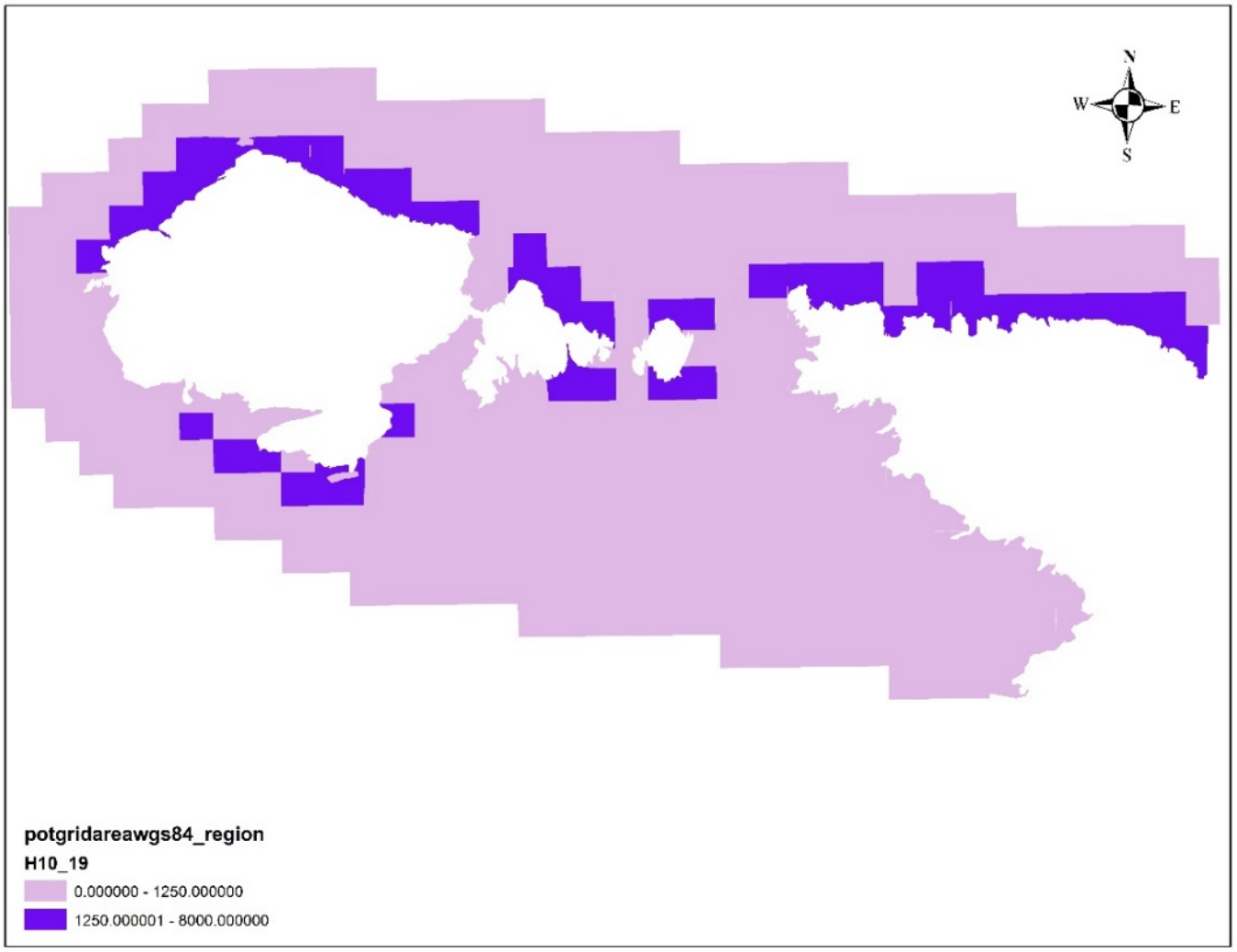
These are 2 common habitats on the north east coast of England, but they are not well represented in Skomer MCZ. Within Skomer MCZ the exposed to moderately exposed circalittoral rock habitat have more erect species present. The Laminaria park habitat is similar but it covers a very small area within Skomer MCZ due to the steeply inclined nature of the rocky reef habitats.

The habitats studied in Rees et al 2019 are much more comparable to the communities found in Skomer MCZ and it is encouraging that this study looked at specific species which are of conservation concern within Skomer MCZ and only found a significant impact from potting on 2 species; Neptune's Heart Sea squirt *Phallusia mammillata* and Ross Corals *Pentapora foliacea*.

P. mammillata has not been recorded within Skomer MCZ. Ross corals are a feature of Skomer MCZ and often found in the same area as potting occurs. There is an MCZ monitoring project for Ross Corals and it has shown a lot of variability in abundance over the years (Burton et.al. 2019), but there isn't a control site used in the project to assess if that variability is "natural" or a result of human activity.

It must be noted that the potting intensities found with Skomer MCZ are much higher than those studied in Rees et al 2019. Rees did not fish areas harder than 1248 pots hauled/ km^2/ month, whereas most of the rocky reef habitat in Skomer MCZ is estimated to be fished at a higher intensity than this (see figure 5.5). It is possible that higher intensities of potting effort seen on the north facing coast within the MCZ (3000 to 4200 hauls / month / km^2) could be having an effect on the more fragile habitats and erect species present in the Skomer MCZ.

Figure 5.5. Area of Skomer MCZ potted at an estimated intensity greater than 1250 pots hauled / km2 / month (blue). Averaged over the period 2010 to 2019.



Gall *et al* 2020 states that "*Potting is more destructive than previously thought and managers must balance ecology with social and economic considerations to determine what level of impact is acceptable."* Defining the "impact" is difficult without a reference area where there is no fishing. Even where damage to individuals can be evidenced it doesn't necessarily mean that the community is degraded. The presence of the long-lived species such as *Eunicella verrucosa* around Skomer MCZ implies that previous intensities of potting still allowed for this species to co-exist. It is the point at which the increase in the intensity of potting will have lasting effect on the population and associated community that is unknown.

6. Overall conclusions.

Potting intensity has varied a lot over the last 30 years (20 pots/km^2/visit to 100 pots/km^2/visit), with an increasing trend up until 2013.

The number of vessels potting within the MCZ and the area of the MCZ used for potting has remained fairly consistent for the last 15 years. Most of the large changes in intensity have been down to local changes of specific boats / owners changing how many pots they are working within the MCZ and are not thought to be indicative of a change in the whole of the pot fishing industry across Pembrokeshire.

The decrease in potting intensity from 2014 to 2018 may be due, in part, to a general shift in the Pembrokeshire fishery towards whelks and away from crab and lobster.

The areas of the MCZ which have the highest potting intensity are associated with the rocky reef habitats, this is the best ground for the crustacean fishery. The North coasts are also consistently fished, thought to be due to a combination of reasons: a) the seabed habitat is a good crustacean fishing ground; and b) the northside of Skomer Island and the north Marloes Peninsula both offer protection from the prevailing south westerly winds and swell. This offers protection from damage & loss for the gear on the ground and allows the gear to be worked in rougher weather.

In the last 10 years there have been several studies into the potential impacts of static gear (e.g. crab pots) on benthic communities. The overall conclusion from these studies is that potting is one of the least damaging fishing methods and no significant impacts have been demonstrated on the typical benthic communities found in the UK. These studies factor in how often the gear is hauled as well as how many pots are being worked in a unit area. Comparing these levels of hauls / month / km^2 across the UK shows great variation in what is considered high or low intensity and is probably quite subjective depending on the recent history of fishing effort and what management tools are currently active within the specific area.

The recent literature demonstrates how variable potting intensity is around the UK and how difficult it is to make comparisons to other areas in the UK.

The fishing intensities estimated for the Skomer MCZ rocky reefs (2000 – 5000 hauls / month / km^2) are of the higher order compared to high potting intensities reported for Lyme bay (Rees *et al* 2019 and the communities on Skomer's reefs comprise of more fragile, long lived species, than reported in other potting impact studies in the north east of England. There are no "non-fished" areas of comparable habitat within the MCZ so it is not possible to determine from data currently collected within the MCZ, if there has been any effect of potting on the MCZ benthic communities.

One species of concern is the Pink Sea Fan (*Eunicella verrucosa*). This is a fragile long-lived erect species with a very slow reproductive rate within the MCZ. There have been several individual Sea Fans lost from rocky reef habitat in the MCZ during the last 10 years, although it is thought some of these losses were a result of physical impact or abrasion, it has not been possible to conclude the cause or causes of these losses (Newman et al 2018 and 2019).

There are no areas of rocky reef within the MCZ which have a history of low or no potting activity so there is no obvious site to use as a control site for investigating the pros and cons of different fishing techniques on seabed communities. To set up such a control site would, ideally, involve not having any seabed impacts (fishing, anchoring, diving etc.) within the area for more than ten years. Walmsley et al 2015 states that one of the consistent problems with the current studies into the benthic effects of fishing techniques is that the ground used has already been fished for many years. Even when “no-take” areas have been set up (e.g. Lundy and Lyme bay) they have been recently fished before the studies began.

7. Recommendations

1. Continue with the current methods and aim to achieve 16 or more surveys per year between the months of May to September.

2. To improve the estimate of number of pots fishing within Skomer MCZ it would be necessary to apply a unique spacing of pots along a string to each individual boat using the MCZ. This would decrease the comparability of data to previous years but it would increase the estimate of potting intensity. A survey of the local fishing boats combined with measurements by divers could get an accurate spacing for pots on each string – specific to each vessel's set up.

3. To study the possible effects on any sea bed impacting activity would require a control site. As stated by Walmsley 2015 this would have to be set up and left unimpacted for a reasonable period of time before it could act as a bench mark to compare with impacted sites. If such an area were to be set up it would need to be free of all potential sea bed impacting activities including anchoring, diving, and angling as well as commercial fishing (nets and pots).

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Appendix 1. Commercial potting activity GIS method summary 2020

DATA COLLECTION:
Data points are collected on a GPS unit in the field. Uses wgs84
WayPoints are entered at every pot buoy and the vessel name recorded onto a field map & notebook.
GPS files are downloaded into Garmin Homeport software, points are exported as csv files and then meta data is added in an Excel file.
Access Database holds all the data – excel points are transferred to the Access Database – as a file with date. This file can be accessed by ARC GIS and is used as a personal geodatabase.

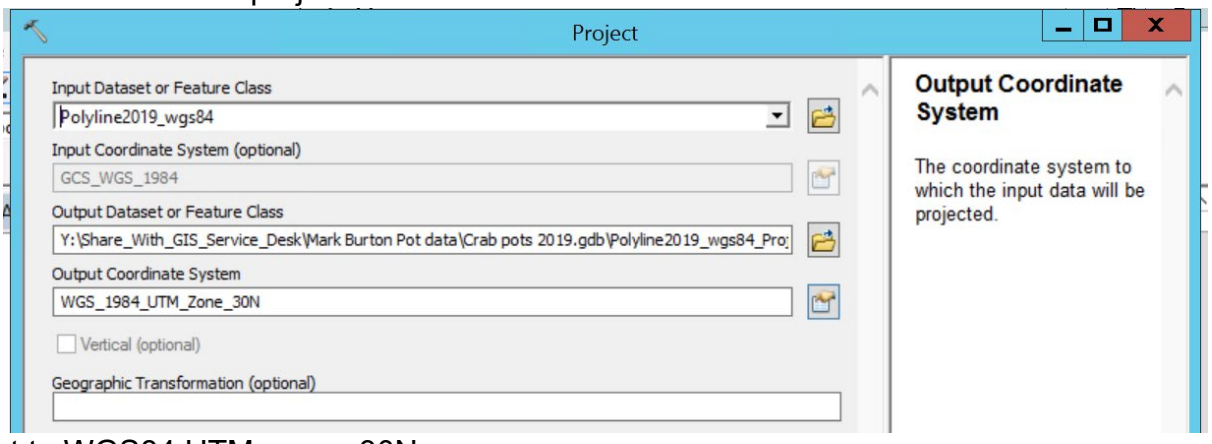
ARC Method:
In Arc create a point feature class from the XY table date file in the database

- Plot the point feature class and display the vessel name, using wgs84 projection.
- Create a polyline feature class –name as the date file for points. Use a template
- In the new polyline feature class -Create lines to represent strings of pots – label these with the date and the vessel name
- Add points to an overall year point file – using Tool – General – Append tool
- Add polylines to a Year line file– using Tool – General – Append tool

AT THE END OF THE SURVEY YEAR
1 – All Points table (point feature class with all survey points for the year)
2 – All polylines table (all polylines in 1 polyline feature class)
3 – potgrid area – shape file of count grids

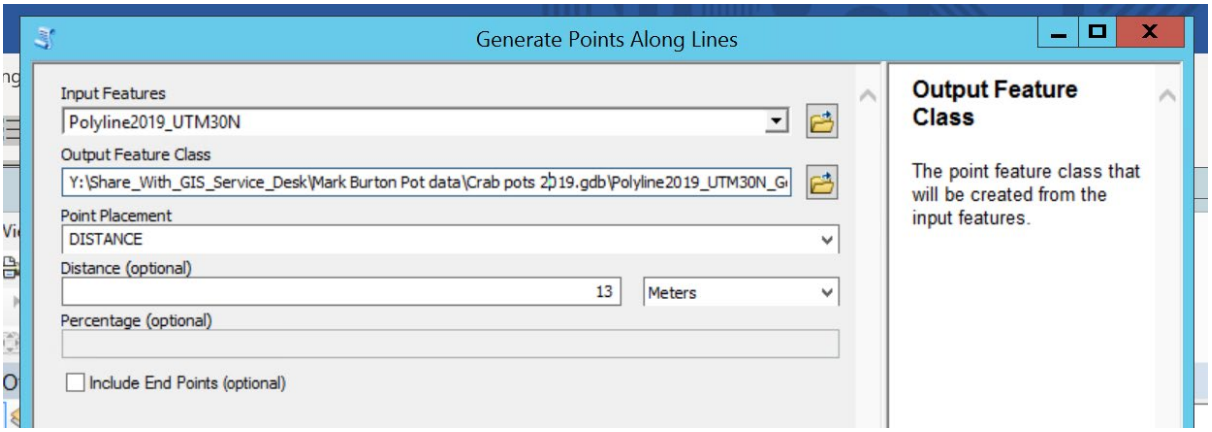
CREATE POINTS ALONG THE POLYLINES TO REPRESENT POTS ON THE SEAFLOOR

1. Convert polyline line to UTM 30N – Use TOOL = data management / projections and transformations / project



Convert to WGS84 UTM_zone_30N

- Use the UTM_30N table to run the next tool – (allows measurements in m not degrees)
- TOOL – “Generate points along a line”

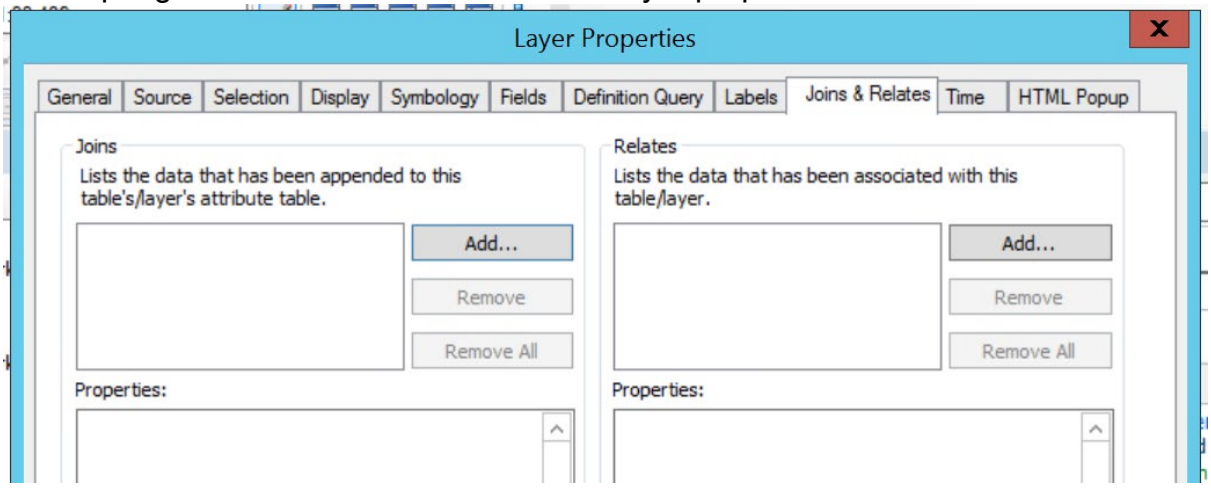


By converting to UTM_30N metres can be used instead of degrees
Set distance to 13M
DO NOT include end points

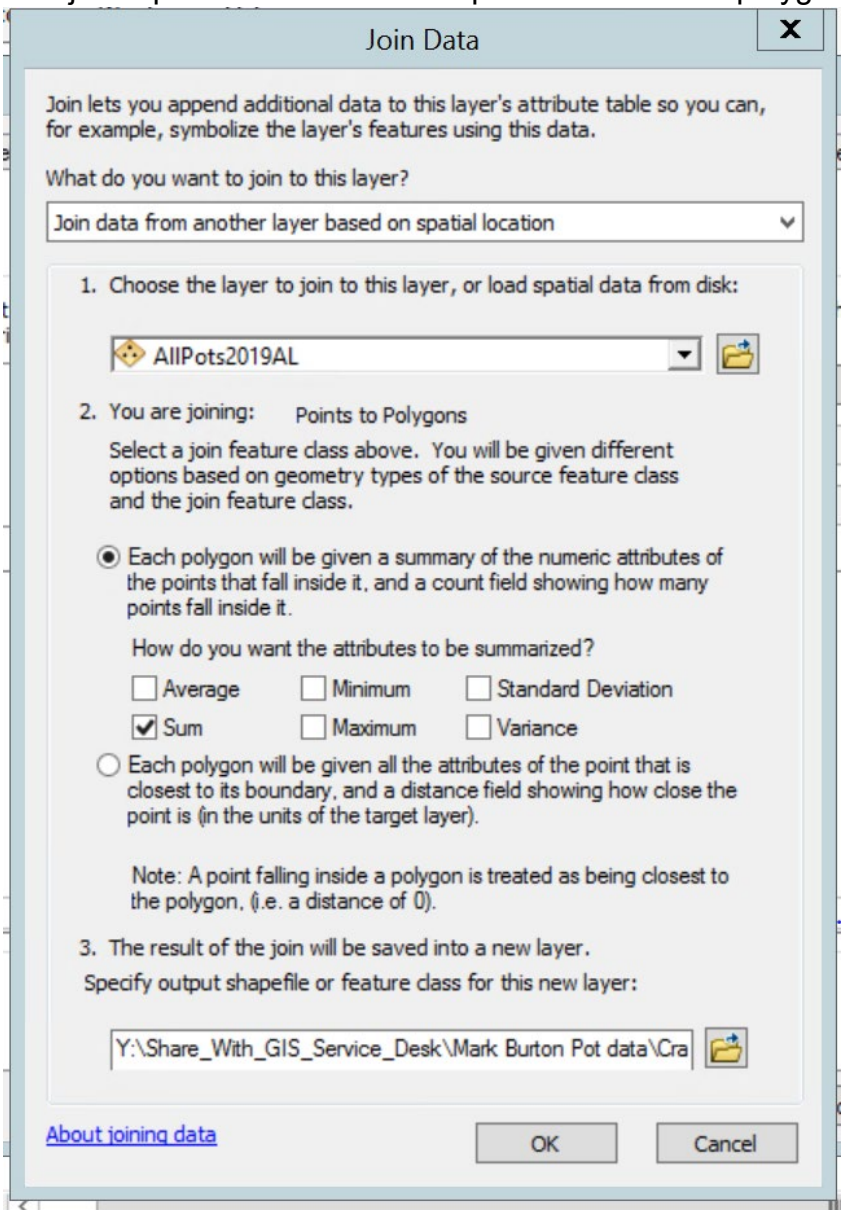
- Now “Append” the generated points to the All points table for that year.
  In the append dialogue box you need to select NO TEST – as the table structures do not match.

DENSITY COUNTS WITHIN EACH GRID SQUARE – JOIN

- Select pot grid area table – double click for layer properties



- Add join: spatial location – count points inside each polygon



- This will create a join layer with counts of pots in each grid square.
- Need to add in the number of visits for each area
- Use tool – Data Management / Field / Calculate Field:
  Pot / km2 = count_ / Area

  Pot / km^2/ visit = "pot/km^2" / No Visits

- Export join file as an excel table – USE TOOL conversions / Excel / table to excel

The rest can be done in Excel – copy data into POT SUMMARY spreadsheet
All years pots/km^2/visit data is saved in 1 excel file - W:\Potting Data \ All Years P_KM_V.xlsx

This is a simple sheet with:

idnumber	Sector_name	Y_89	Y_90	Y_91	Y_92
1	Westside	0	0	0	0
2	Westside	0	0	0	0

Rows continue with all the grid squares and idnumbers to Y_19.

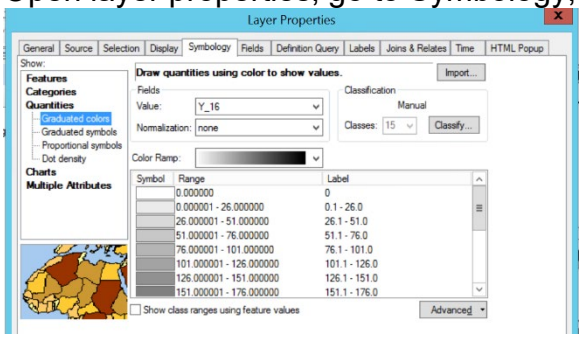
This spreadsheet can be used in ArcGIS as a layer and then “JOIN” to potgridarea layer using Idnumber as a join attribute.
This now allows a density map of any years data to be plotted.
Standard format for potting density maps:
Using a .lyr file the classification for a standard potmap can be saved.
Symbology – Graduated colours – white – black. Manual classifictaion 15 intervals:
This is what has been used so far

potgridareawgs84_region

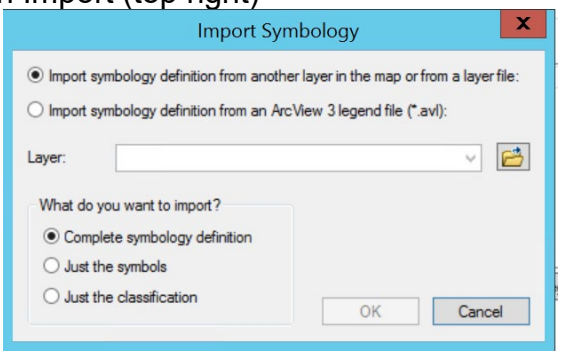
All_YearsPKmV$.Y_16

- 0
- 0.1 - 26.0
- 26.1 - 51.0
- 51.1 - 76.0
- 76.1 - 101.0
- 101.1 - 126.0
- 126.1 - 151.0
- 151.1 - 176.0
- 176.1 - 201.0
- 201.1 - 226.0
- 226.1 - 251.0
- 251.1 - 276.0
- 276.1 - 301.0
- 301.1 - 351.0
- 351.1 - 1000.0

If this needs to be changed in the future; set up a new classification system, click OK then right click on the layer and choose “Save as layer file”.
This file will store the classification setting.
To bring in the layer file:
Open layer properties, go to Symbology,



click on Import (top right)



choose the layer file from the Browser and then click on “Just the classification”
It will then prompt you to chose which data set you want to apply the classification to i.e. which years set.

W:\Potting Data \ All Years P_KM_V.xlsx will need updating with a new set of data at the end of each year.
This will need reattaching to the .MXD file – the link to the spreadsheet is not live.

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