PRIFYSGOL BANGOR UNIVERSITY

Isle of Man king scallop (*Pecten maximus*) stock advice:

A data-limited approach for setting a total allowable catch for the 2018/2019 fishing season and a preliminary quantitative stock assessment for the Isle of Man Territorial Sea

Preliminary Report

August 2018

I.S.M. Bloor

Contact. i.bloor@bangor.ac.uk

Executive Summary

King scallops (*Pecten maximus*) in ICES Rectangles 36E5, 37E5 and 38E5 (Isle of Man territorial sea)

Stock advice (2018/2019)

Applying the precautionary, ICES data limited Category 3 stock approach it is advised that catch in 2018/2019 from within the territorial sea should be no more than 2562 t.

Stock development over time

The length based abundance indices for recruits (< 110 mm) and post-recruits (>110 mm) are in continued decline (Figure I). The commercial catch (ICES Rectangles 36E5, 37E5 and 38E5) decreased in 2017 alongside the introduction of a TAC within the Isle of Man's territorial sea (Figure I). There was a decrease in the overall abundance index (all size scallops) in 2018 which is also observed in the estimates of stock biomass in the latest year (2017; i.e. Biomass as of 31st October 2018) from an age based stock assessments (Figure I).
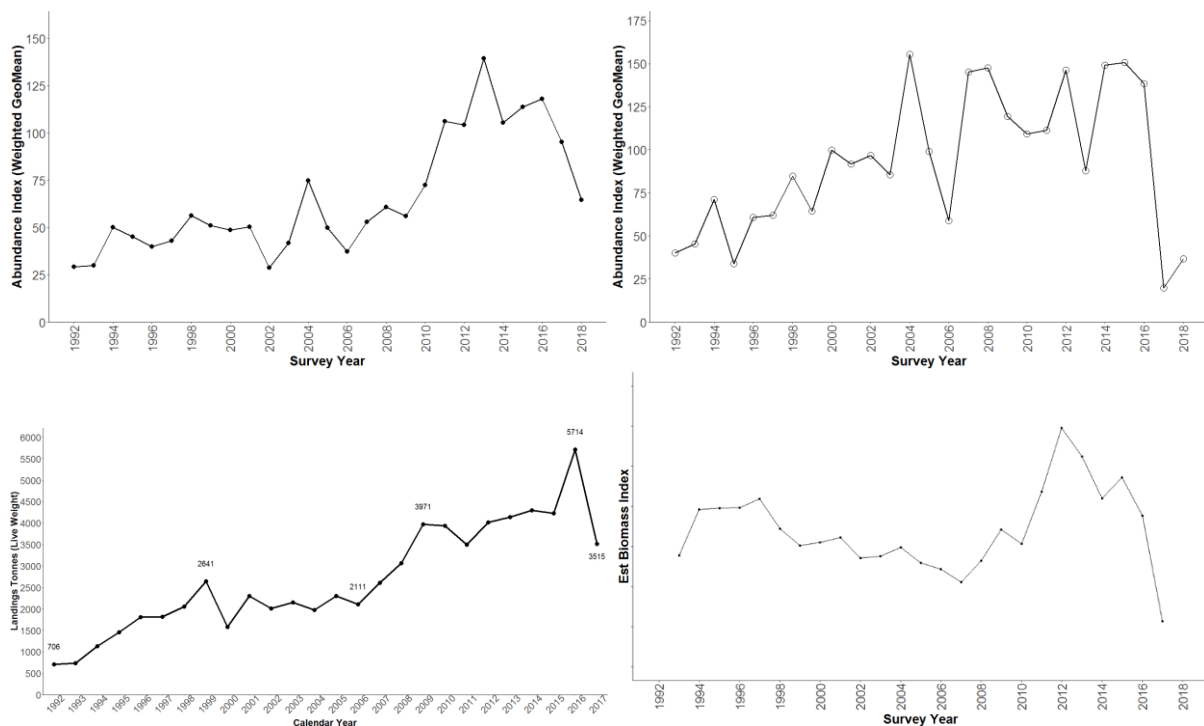
Figure I: King scallops in ICES Rectangles 36E5, 37E5 and 38E5. Upper left, Post-Recruit abundance index from survey; Upper right, Recruit abundance index from survey; Lower left, landings from ICES Rectangles 36E5, 37E5 and 38E5 by calendar year; Lower right, Estimated stock biomass calculated using age based stock assessment methods (a4a/FLR).

Catch options

The ICES framework for category 3 stocks was applied (ICES, 2012). The spring scallop dredge survey abundance index (queen scallop dredge data) was used as an index of stock development. The advice is based on a comparison of the latest two index values (index A) with the three preceding index values (index B), multiplied by a proxy for recent advised catch. The abundance index is estimated to have decreased by 44% and thus the uncertainty cap (a +/- 20% cap on inter annual changes to account for the level of uncertainty contained in a survey index) was applied. The stock status relative to candidate

reference points is unknown. Since there is evidence of recruitment impairment and high fishing mortality (F), a precautionary buffer (an additional 20% reduction in catch to safeguard against significant biomass declines) could also be applied (Table 1).

Table I: King scallops in the Isle of Man's territorial sea. The basis for catch options. Index A is the average of the last two year's index (2017 – 2018); Index B is the average of the three preceding year's index (2014 – 2016); Index Ratio is a ratio of Index A divided by Index B. Survey indices can contain a level of noise within the data, as such a +/- 20% cap (Uncertainty Cap) on inter annual changes to the TAC from the Index Ratio is advised (ICES, 2012). These methods are designed to be precautionary and so where there is uncertainty due to a deficiency of information (i.e. stock status relative to references points or exploitation is unknown) a 'Precautionary Buffer' of a 20% reduction in catch is advised unless expert knowledge or evidence indicates that the stock is not reproductively impaired or that stock size is increasing (ICES, 2012).

	I	II
Index A (2017 - 2018)	135	135
Index B (2014 - 2016)	304	304
Index Ratio (A/B)	0.44	0.44
Uncertainty cap	0.80	0.80
TAC from 2017/2018 season	3203	3203
Discard rate	-	-
Precautionary buffer	NA	NA
Catch advice for 2018/2019**	2562	2050

** For Scenario I: TAC for 2017/2018 x Uncertainty Cap;
**For Scenario II: (TAC for 2017/2018 x Uncertainty Cap) x Precautionary Buffer

Basis of the advice

Table II: King scallops in ICES Rectangles 36E5, 37E5 and 38E5. The basis of advice.

Advice basis	Precautionary approach
Management plan	There is no management plan for the stock

Quality of the assessment

The advice is currently based on abundance index estimates from a dredge survey, available for 1992 – 2018. A preliminary quantitative stock assessment has been developed (See 3 Main Report) the estimated stock biomass index obtained from age based stock assessment estimates a similar decrease in the index ratio (0.64). As there is a 20% cap in place then this therefore produces the same TAC calculation. Once the stock assessment methods are finalised and peer-reviewed the calculation of the index ratio change for future king scallop fishing seasons will be based solely on the stock assessment biomass index.

The stock structure of king scallops within the Irish Sea (Area VIIa) has not been formally delimited. The current dredge survey covers only part of the potential distribution of this stock (Isle of Man's territorial sea/ 36E5, 37E5 and 38E5) and not the whole of Area VIIa. An extension to the survey and assessment will be required to assess this stock at its full biological extent.

Issues relevant for the advice

The absence of strong recruitment in recent years raises concerns about the short-term future productivity of the stock.

Reference points

No reference points (e.g. F_{msy}, B_{pa} etc.) are defined for this stock.

Conclusions

- A TAC for the 2018/2019 Isle of Man's king scallop fishery was defined on the basis of ICES protocol for Category 3 stocks (Method 3.2).
- For the 2018/2019 king scallop fishing season the TAC calculation continues to be based on a survey abundance index pending the peer review of the quantitative stock assessment methods.
- Method 3.2 outlined by ICES compares the values from the two most recent years of the abundance index with the values from the three preceding years. The TAC is then adjusted by the percentage difference of these two values (44% reduction calculated from survey abundance index) taking into account the 20% uncertainty cap. As there is evidence of recruitment impairment and high fishing mortality (F) an additional 20% precautionary buffer could also be applied.
- The provisional catch advice for 2018/2019 king scallop fishery within the territorial sea is 2562 t.
- Should the TAC be adopted without the application of an additional precautionary buffer it is recommended that a review of the fishery is undertaken following the first month of the season with the option to revisit the application of the Precautionary Buffer.
- The Irish Sea king scallop fishery should be managed at the appropriate spatial scale. Unpublished genetic and oceanographic research indicates that the northern Irish Sea may be the most appropriate management unit for the fishery surrounding the Isle of Man. It is therefore vital that work continues towards achieving a collaborative management approach for king scallop stocks within the different regions of the Irish Sea.

Sources and references

ICES. 2012. ICES Implementation of Advice for Data-limited Stocks in 2012 in its 2012 Advice. ICES CM 2012/ACOM: 68. 42pp.

1. Isle of Man king scallop stock advice

1.1 Background

Bangor University was requested to provide scientific advice for the Isle of Man's king scallop stocks. This report represents the advice provided by Bangor University for this stock. The first section of this report provides a background to the king scallop fishery within the Irish Sea (particularly within the Isle of Man's territorial sea). The second section of the report outlines the International Council for Exploration of the Seas (ICES) methods to assess data limited (Category 3) stocks for which a biomass index is not available. Using this method an index-adjusted total allowable catch (TAC) harvest control rule was used to determine a TAC for the Isle of Man's king scallop fishery for the 2017/2018 fishing season. The final section of this report presents a preliminary quantitative stock assessment for king scallops in ICES Rectangles 36E5, 37E5 and 38E5.

1.2 The fishery

A fishery for king scallops, *Pecten maximus*, has been prosecuted in and around the Isle of Man's territorial sea since 1937 and developed rapidly in the 1960s as more and larger boats joined the fishery (Duncan et al., 2016). The Isle of Man's king scallop fishery is prosecuted from 1st November to 31st May by vessels using toothed, Newhaven, dredges. Management of the fishery differs between an inner 0 to 3 nautical mile zone, and an outer 3 to 12 nautical mile zone, with more stringent regulations in the inner zone. A total of 90 vessels from the Isle of Man, Wales, Scotland, England and Northern Ireland have licences to fish for king scallops in the Isle of Man's territorial sea 3- 12 nm limit and of those 42 vessels also have permits to fish for king scallops within the 0- 3 nm limit. For the 2017/2018 fishing season the management measures that governed the fishery included:

- TAC of 3203 tonnes
- A daily catch limit of 700 kg
- Daily curfew (18:00 – 06:00) [0 – 12 nm zone]
- Closed season: 01/06 to 31/10 [0 – 12 nm zone]
- ≤ 15.24 m vessel registered length [0 – 3 nm]
- Under 221 kw [0 -12 nm; excluding Grandfather rights vessels]
- Closed areas
- VMS required [0 – 12 nm zone]
- Minimum landing size (110 mm)
- Maximum of 9 teeth per dredge
- Minimum tooth spacing of 75 mm [0 – 12 nm zone]
- Aggregate dredge width of 762 cm [0 – 3 nm zone]
- Aggregate dredge width of 1067 cm [3 – 12 nm zone]
- Maximum tow bar diameter of 185 mm [0 – 12 nm]
- Minimum belly ring diameter of 75 mm & Minimum dredge net mesh of 100 mm

These management measures were covered by the Fisheries Act 2012 and through restrictive licencing conditions.

Of the 90 vessels licenced to fish for queen scallops during the 2017/18 fishing season 82 vessels reported landings of king scallops from within the Isle of Man's territorial sea.
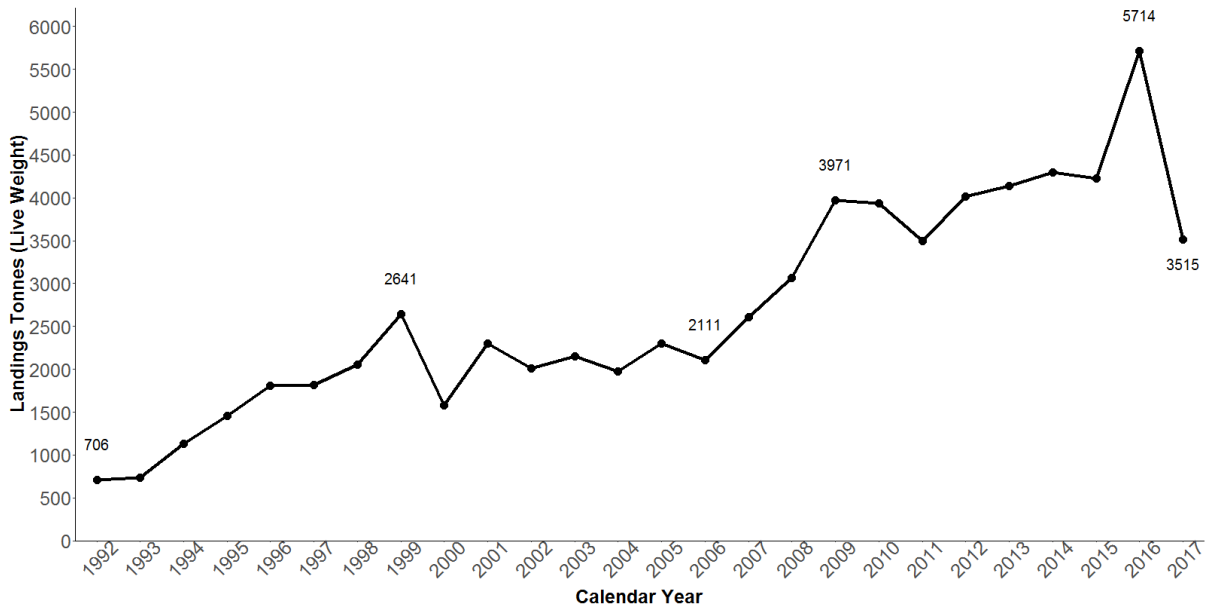
1.3 Landings

The annual landings of king scallops from the Irish Sea (Area VIIa) over the period 1950 – 2016 are shown in Figure 1 (ICES 2018a,b). Since 2006 landings have increased rapidly with peaks in 2009 and 2012 at ~ 9500 t and maximum landings to date in 2016 at > 11000 t. In the early part of the Irish Sea fishery (1950 – 1975), boats from the Isle of Man took the majority of the catch (80%), but between 2006 and 2016 the average annual Manx share has declined to around 18%, with landings from United Kingdom vessels (Scotland, England, Wales and Northern Ireland) landing around 66% (the remainder was taken by vessels from Belgium and the Republic of Ireland). Whilst there are some management measures in place within Area VIIa (i.e. a closed season for *P. maximus* which runs from 1st June to 31st October (inclusive) and a Minimum Landing Size of 110 mm shell length), the current quantity of landings from the Irish Sea (VIIa) are unprecedented (Figure1) and of concern, given the general lack of knowledge and management of the stock at these high fishing levels (Duncan et al., 2016).
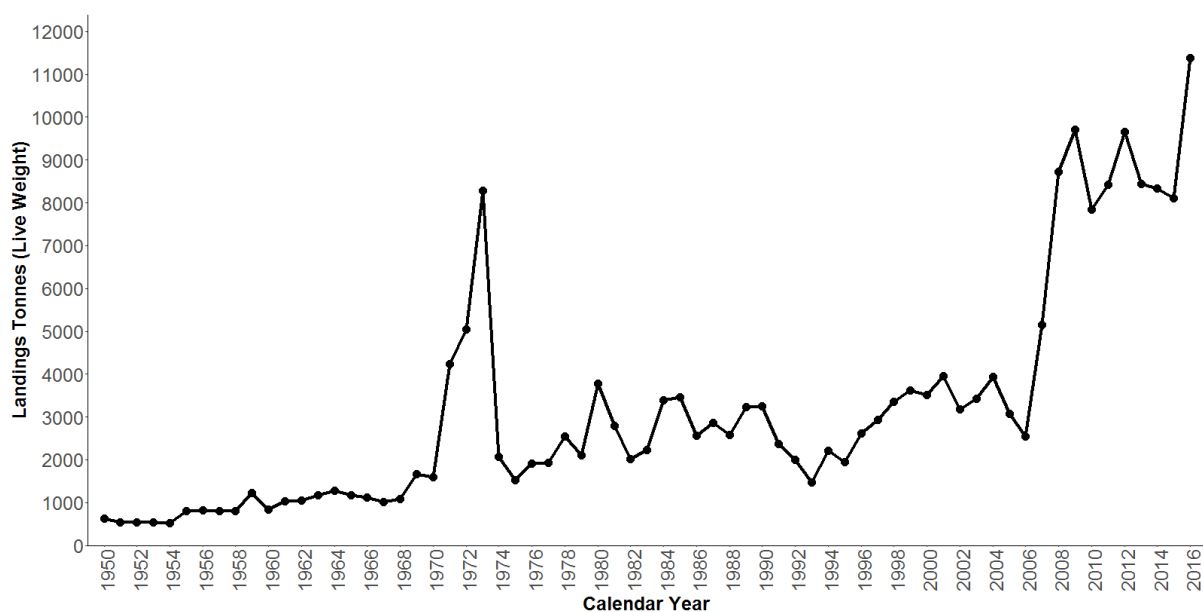
Figure 1: Annual King Scallop landings (t) from ICES Area VIIa for 1950 to 2016 using scallop landings from species Great Atlantic Scallop (SCE) and Scallop Nei (ICES 2018a; ICES 2018b).

The annual landings of king scallops from the ICES Rectangles 36E5, 37E5 and 38E5, which cover the main extent of the Isle of Man's territorial sea, show a very similar pattern of landings to those from the wider Irish Sea (Area VIIa) over the period 1992 – 2016 (Figure 2). Landings increased rapidly from 2006 to 2009 almost doubling during that period from 2111t to 3971t. Annual landings have continued to increase since 2009 with an annual average of 4020t from 2010 – 2015 and a peak in 2016 of 5714t. Landings from ICES Rectangles 36E5, 37E5 and 38E5 decreased in 2017 following the introduction of a TAC (3203 t) within the Isle of Man's territorial sea; however landings continue to exceed pre-2006 values.

Figure 2: Annual King Scallop landings (t) from ICES Rectangles 36E5, 37E5 and 38E5 (Source: Logbook data DEFA, Marine Scotland, MMO). For information the landings (t) values from key years are annotated on the graph.

Seasonal landings of king scallops (1st November $Year^n$ – 31st May $Year^{n+1}$) from ICES statistical rectangles 36E5, 37E5 and 38E5 have been relatively stable over the last six seasons (average 4298 t), although the 2016/2017 saw an increase to 5129 t (Figure 3).

In addition to the increase in overall landings the temporal pattern of landings within the 2016/2017 season differed from other seasons with a large spike in landings (> 2000t) during the first month of the fishery while previous fishing seasons were more stable at ~1000t or less (Figure 4).
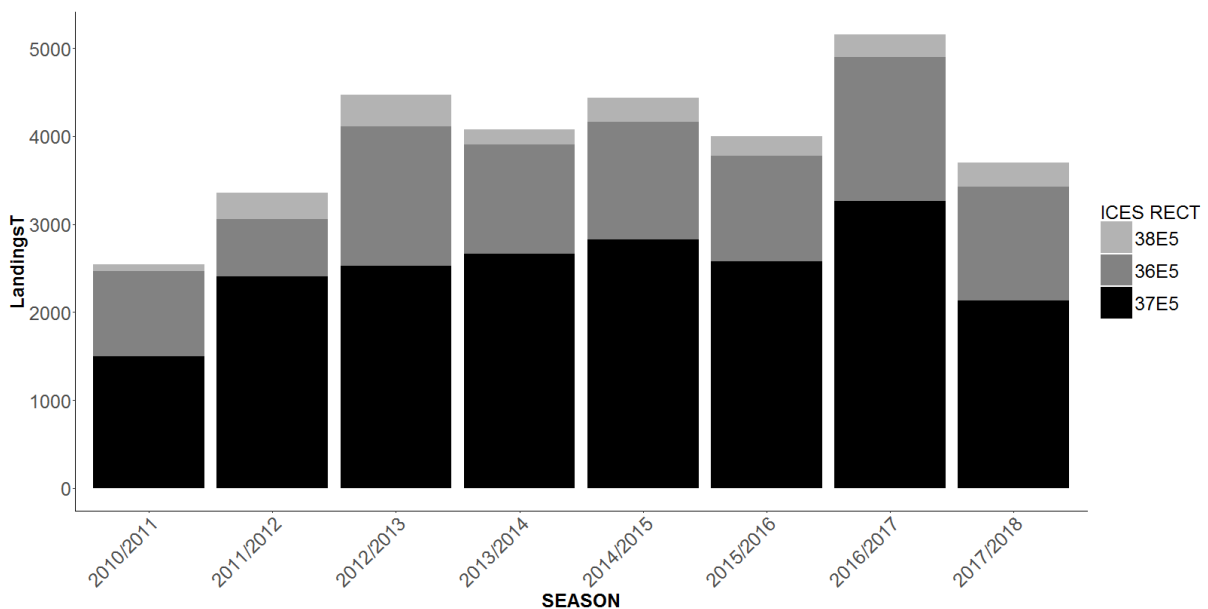
Figure 3: Seasonal landings (t) of king scallops from ICES Rectangles 36E5, 37E5 and 38E5. Data source: EU Logbooks downloaded through IFISH2. *NB. This data includes **ALL** vessels fishing for king scallops (except vessels from Ireland for which we do not receive EU logbook data) and not only those vessels that are currently licenced to fish for king scallops within the Isle of Man's territorial sea.*
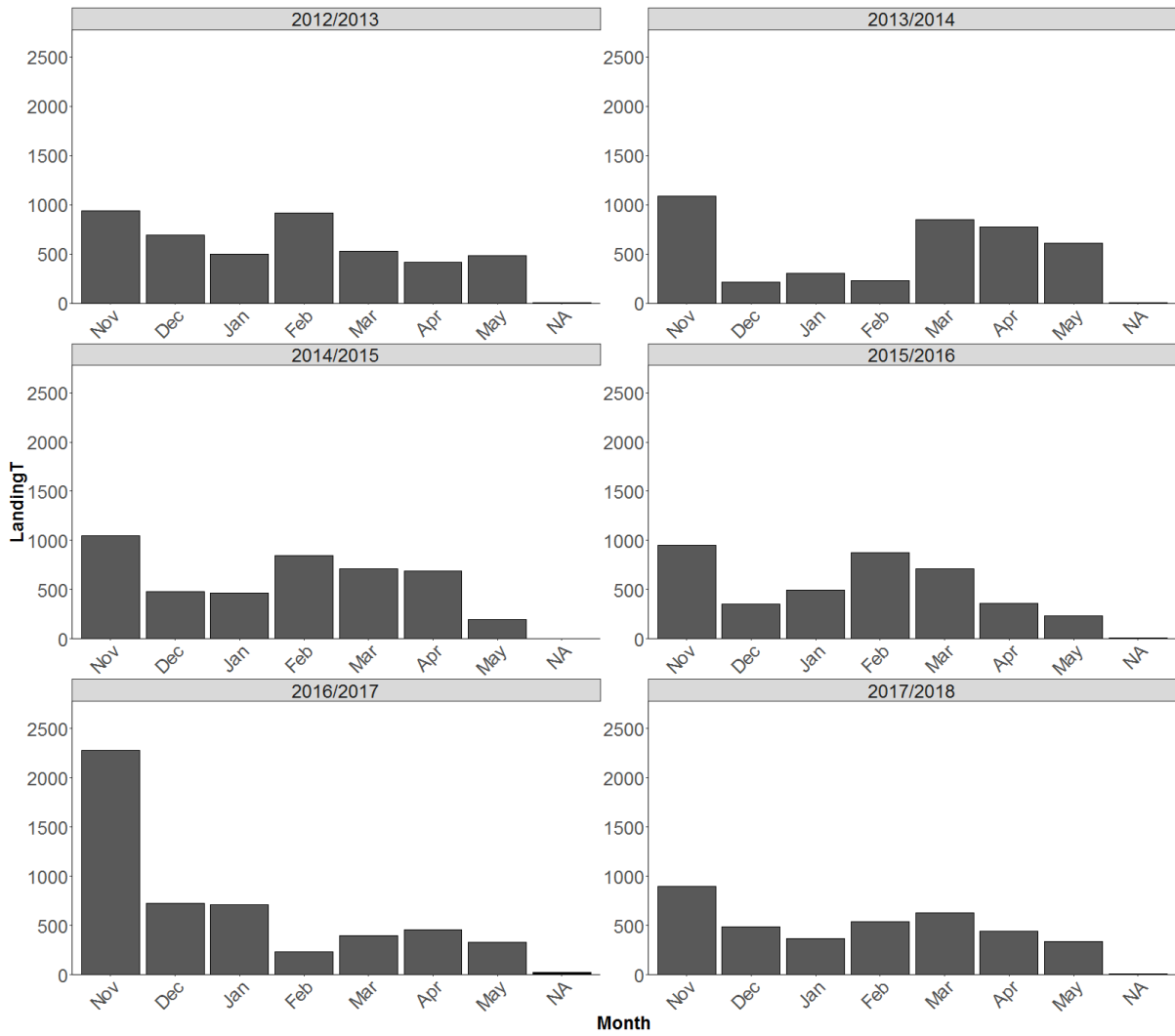
Figure 4: Landings of king scallops from 36E5, 37E5 and 38E5. Data are presented for each fishing season from 2012/2013 to 2017/2018 (1st Nov Year^n to 31st May Year^{n+1}). Data source: EU Logbooks downloaded through IFISH2. *NB. This data includes **ALL** vessels fishing for king scallops (except vessels from Ireland for which we do not receive EU logbook data) and not only those vessels that are currently licenced to fish for king scallops within the Isle of Man's territorial sea.*

2. TAC Calculation for 2018/2019 SCE fishing season (Abundance Index)

2.1 ICES data-limited approach for Category 3 stocks

The king scallop stock within the Isle of Man's territorial sea is currently categorised as data-limited as there is no full peer-reviewed quantitative stock assessment in place. Within the framework outlined by the ICES it is considered a category 3 stock (i.e. a stock for which survey-based assessments indicate trends (ICES 2012)).

The proposal that a king scallop TAC would be based on the precautionary approach outlined by ICES for Category 3 (Data-limited) stocks was accepted by the SMB. For category 3 stocks, without a quantitative assessment, an abundance index from research surveys, can be used as an indicator of stock size to estimate the level of TAC advised for the following year.

The annual advice is based on a two-over-three rule with a comparison of the average of the last two year's survey indices relative to the average of the three preceding years. Survey indices can contain a level of noise within the data, as such a +/- 20% cap on inter annual changes in the TAC is advised (ICES, 2012). The methods are designed to be precautionary and where there is uncertainty due to a deficiency of information (i.e. stock status relative to reference points or exploitation is unknown) a 'Precautionary Buffer' of a 20% reduction in catch is advised, unless expert knowledge or evidence indicates that the stock is not reproductively impaired or that stock size is increasing (ICES, 2012). When a biomass index becomes available this should be used in preference to an abundance index.

As per the Survey Based Methods (Category 3) Decision Tree, Method 3.2 will be used. The protocol for this method is (ICES, 2012):

1. Use the survey trend to adjust the catch
2. Limit the survey's noise with the uncertainty cap (+/- 20 %)
3. Apply the precautionary buffer to the catch advice

2.2 Survey abundance index

Spring surveys of the Isle of Man's scallop populations have been undertaken annually since 1992. The 2018 scallop survey was undertaken using the RV Prince Madog from 4th – 17th April. Although the extent and number of survey stations has been increased since 2013 (Bloor & Kaiser, 2017) (recently introduced stations are represented by either just a number e.g. 46 or a number prefixed with an F e.g. F12; Figure 5) only the standard eleven historical scallop survey stations (BRI, BRO, CHI, EDG, LAX, PEL, POA, PSM, RAM, SED and TAR), were included in the current survey abundance index assessment as these reflect the extent of the main, persistent king scallop beds within the Isle of Man's territorial sea. All stations were surveyed using the protocol described by Murray *et al*. (2009).
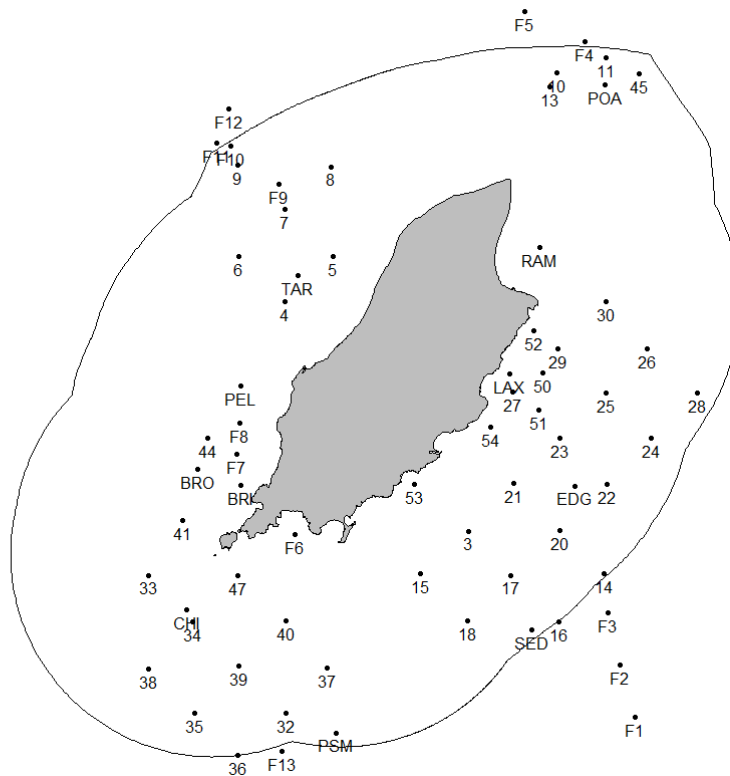
Figure 5: All survey stations sampled onboard the R.V. Prince Madog as part of the scallop stock assessment survey. The stations labelled with 3 letter codes (e.g. CHI) are the 11 historical stations that have been surveyed since 1992. The stations labelled with numbers (e.g. 11) are the newer stations added since Bangor University took over the survey in 2013 and the stations prefixed with F (e.g. F1) are stations suggested by industry in 2015.

The geometric mean of king scallop density was calculated across survey stations using data from **only** queen scallop dredges to derive the abundance indices. *Data from only queen scallop dredge types was used as the number of king scallops was generally higher in the queen scallop dredges across all length categories.*

The use of the geometric mean was precautionary and necessary to obtain meaningful stock assessment results. A failure to use the geometric mean which down-weights isolated high-density patches of scallops would increase the risk of over-estimating population size (Hutchings, 1996) and would provide a misleading over-optimistic estimate of scallop abundance. Weightings were applied to Chickens and Targets to take into account the high levels of cyclical recruitment that occurs at these sites.

The length based abundance index presented within this section shows a general increasing trend in the mean abundance of recruits (scallops < 110 mm) from 1992 and 2015. However, the two most recent years show lows levels in the mean abundance of recruits (Figure 6). The mean abundance of post-recruits (scallops ≥ 110 mm) reached the highest levels on record in 2013. However, the mean abundance of post-recruits has decreased annually since 2016 (Figure 7).
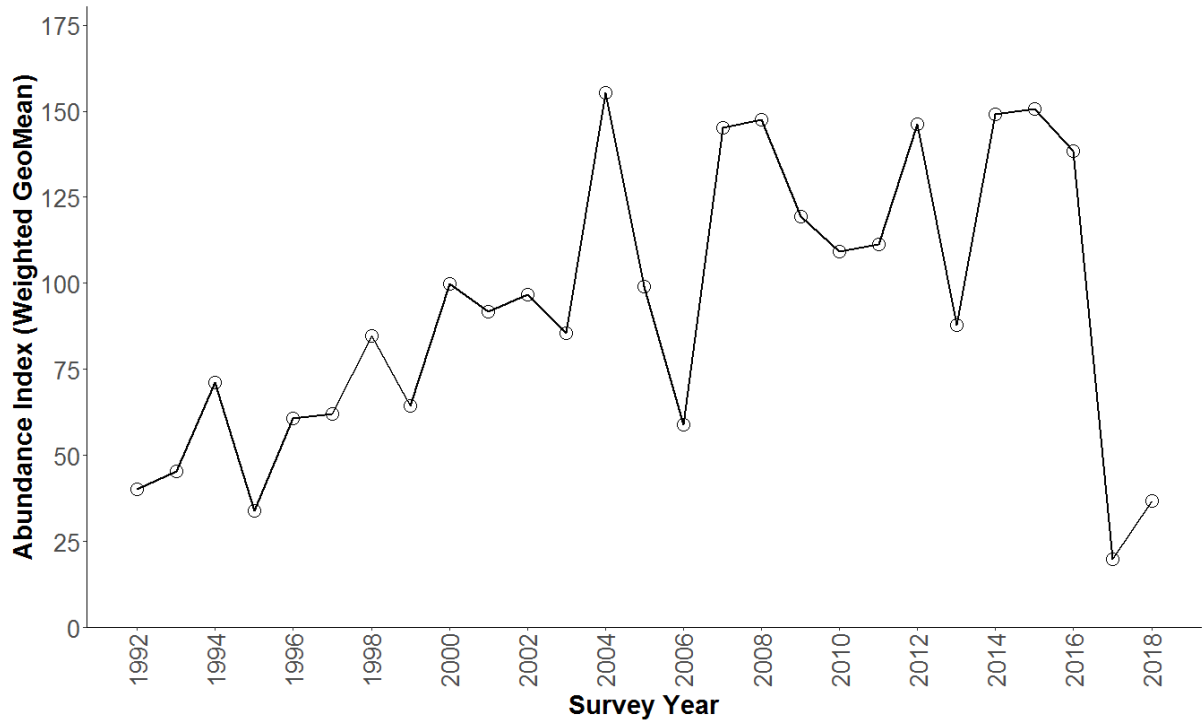
Figure 6: Length based abundance index (based on weighted geometric mean) for recruits (scallops under 110 mm) from queen scallop dredges only. This is calculated using data from only the 11 historical survey stations.
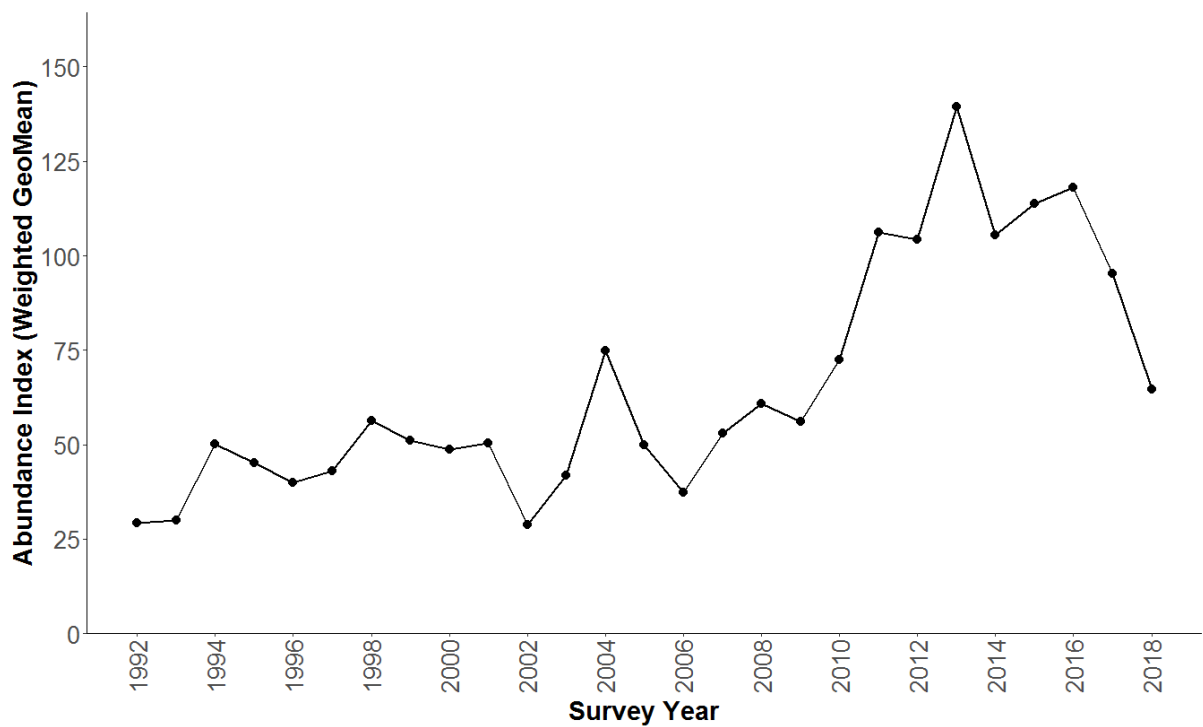

Figure 7: Length based abundance index (based on weighted geometric mean) for post-recruits (scallops over 110 mm) from queen scallop dredges only. This is calculated using data from only the 11 historical survey stations.
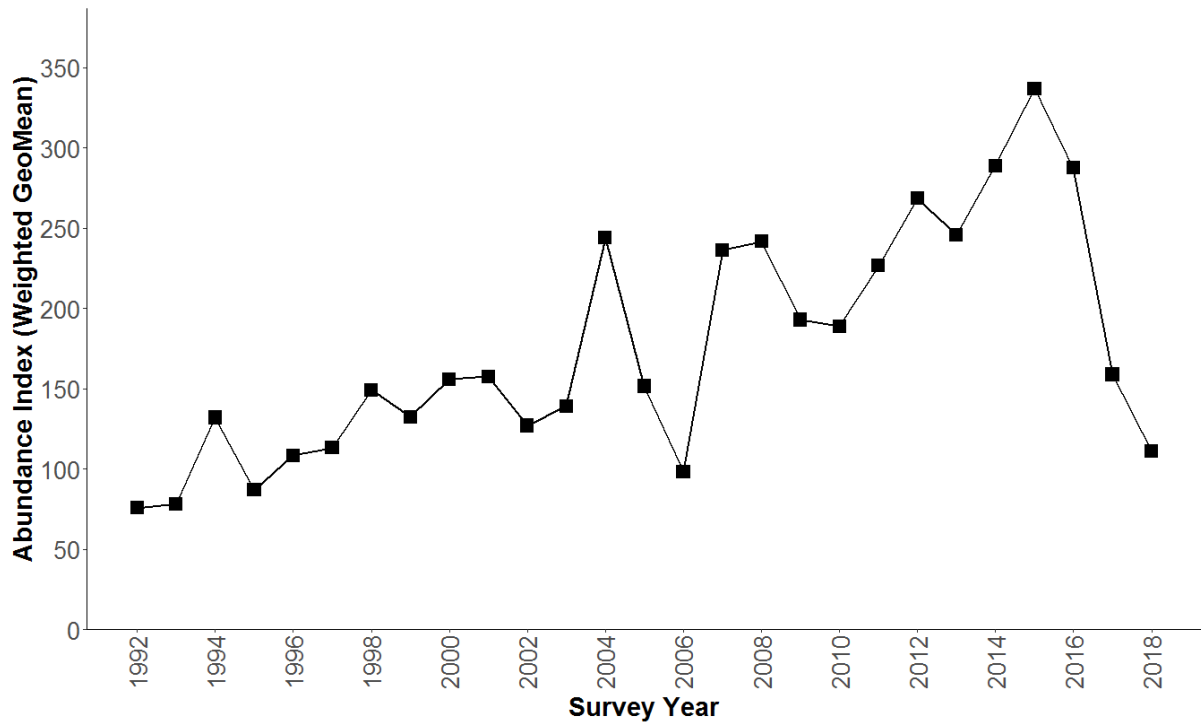
Figure 8: Length based abundance index (based on weighted geometric mean) for all scallops from queen scallop dredges only. This is calculated using data from only the 11 historical survey stations.

The recent low levels observed in the recruitment index together with increasing fishing pressure on post-recruits is likely to explain, at least in part, the recent decline in the post-recruit index, as the rate of removals of adult king scallops from the stock, as a result of high fishing effort, exceeds stock replacement by recruits. Given the current knowledge of spat distribution and settlement which indicates a strong link between the Irish Sea king scallop stocks the significant increase in fishing effort not just within the locality of 36E5, 37E5 and 38E5 but also the wider Irish Sea (Area VIIa) could additionally be impacting recruitment within the Isle of Man's territorial sea.
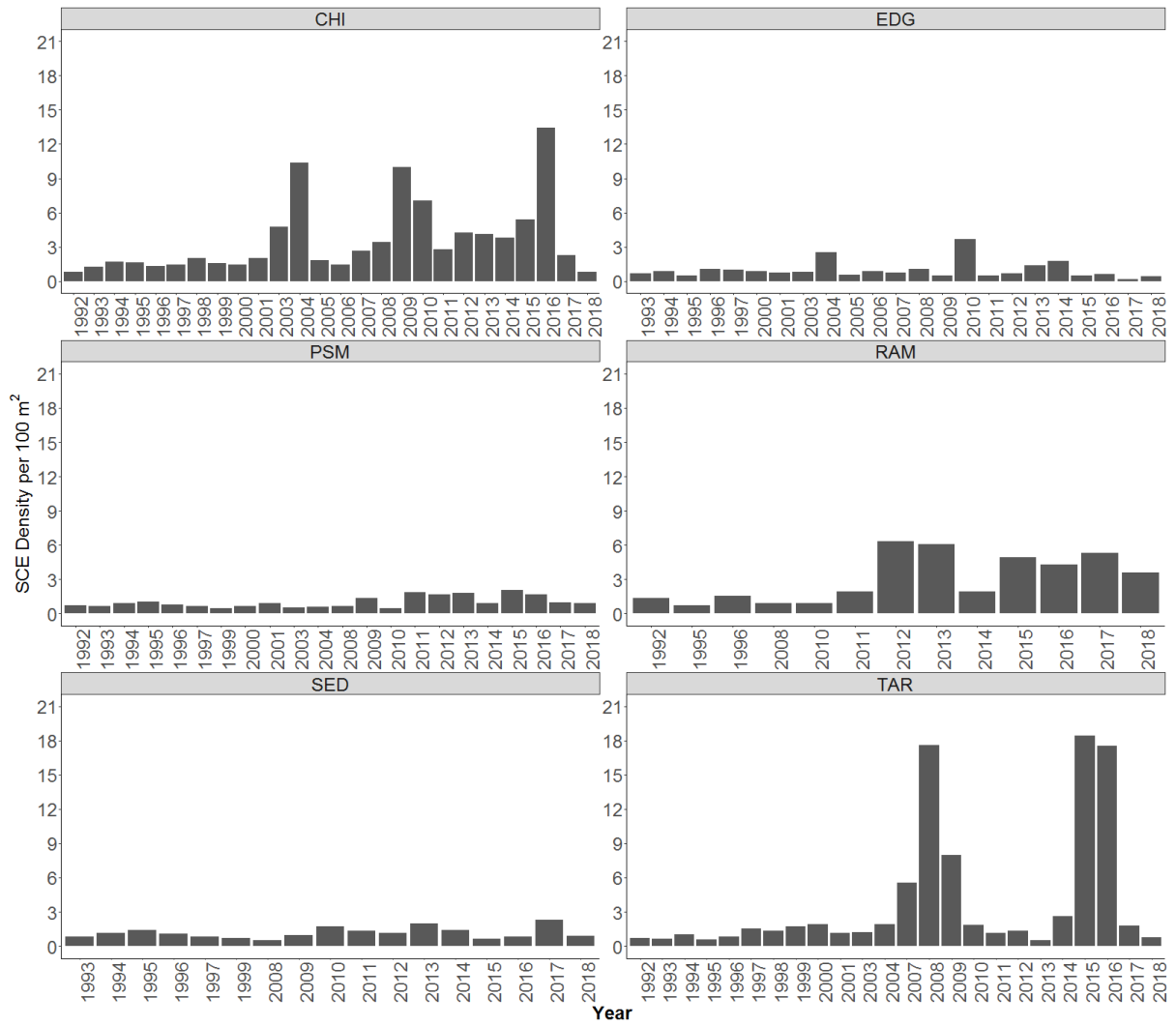
Figure 9: Survey densities (king scallops per 100 m²) displayed by survey station for six historical stations for surveys from 1992 to 2018: TAR – Targets, EDG – East Douglas, CHI – Chickens, PSM – Port St Mary, RAM – Ramsey and SED – South East Douglas. ***Please note: x axes only displays years when the stations were surveyed.***
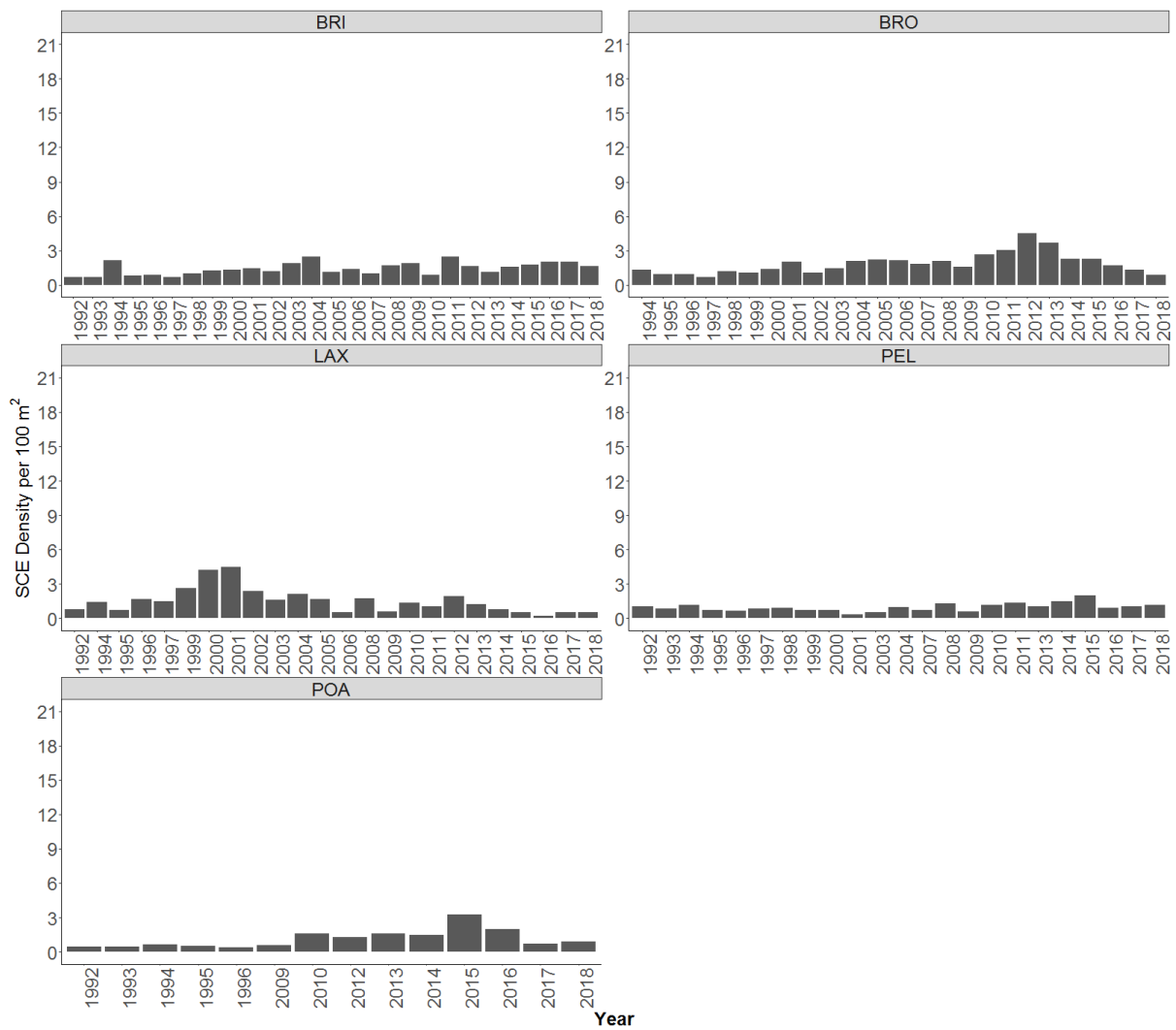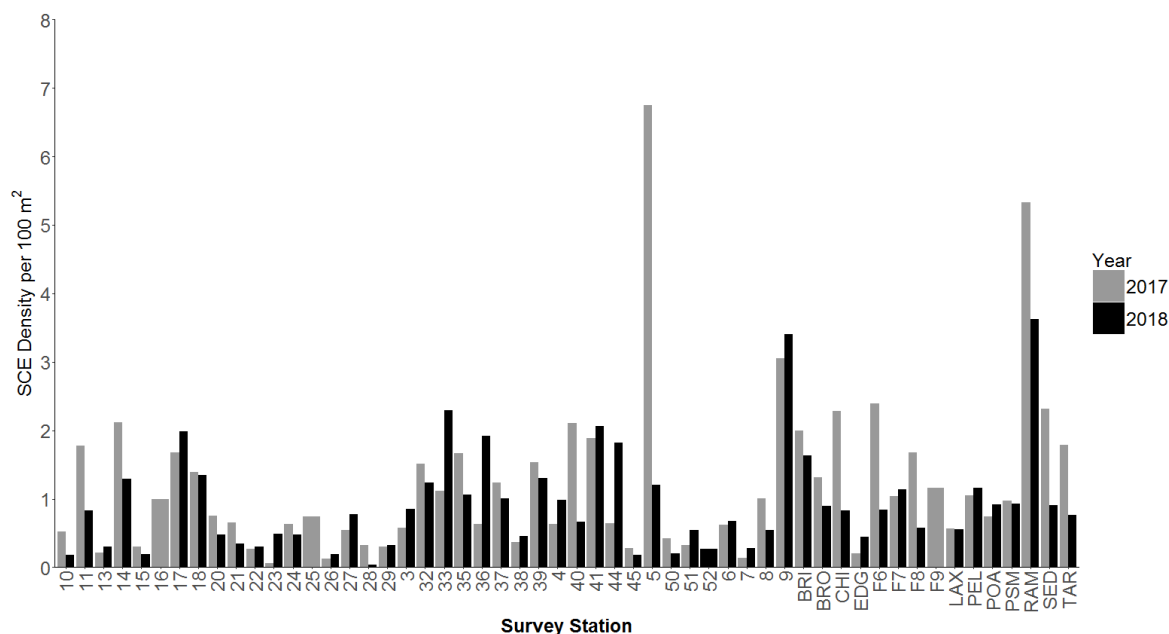
Figure 10: Survey densities (king scallops per 100 m²) displayed by survey station for six historical stations for surveys from 1992 to 2018: BRO – Bradda Offshore, LAX – Laxey, POA – Point of Ayre, BRI – Bradda Inshore, PEL – Peel. ***Please note: x axes only displays years when the stations were surveyed.***

The average density of king scallops (of all sizes caught) per 100 m² among fishing grounds around the Isle of Man for 2017 and 2018 surveys are displayed in Figure 11 for all survey stations. In 2017 the fishing grounds to the west and north-east of the Island (ST5 and RAM) had the highest densities of king scallops per 100 m² (~7 and 5 king scallops per 100 m² respectively).

For 2018 there was a large decrease in scallop density on the west coast of the Island (reduced from ~7 to 1 king scallops per 100 m²). The highest densities for were recorded at RAM (North-East coast) and ST9 (offshore West coast) with densities of ~ 3.5 scallops per 100 m² at both sites. However, these densities are significantly lower than the highest densities recorded in 2016 at Chickens and Targets (13 and 18 scallops per 100 m² respectively) of 2017 at Station 5 (7 scallops per 100 m²) (Figure 13).

Figure 11: Survey densities (king scallops per 100 m^2) displayed by survey station for spring 2017 & 2018 surveys.

The advice for the 2018/2019 king scallop fishing season is based on a length based abundance index (Table 1) which is calculated from annual survey data. This is a temporary measure while the preliminary quantitative Stock Assessment method is finalised and a full external peer reviewed biomass index becomes available.

Table 1: Abundance Index values for 2014 to 2018 from the annual spring scallop survey.

Survey Year	Abundance Index Value
2014	289
2015	337
2016	287
2017	159
2018	111

- Index A (2017 – 2018) = 135 Index B (2014 – 2016) = 304; Index Ratio = 0.44

2.3 Previous catch advice

The TAC for 2017/2018 king scallop fishing season was set at 3203 t.

2.4 TAC calculation and catch advice

Using the data and methods outlined in the previous sections, the provisional catch advice for 2018/2019 was calculated as 2562 t (without the precautionary buffer applied) (Table 2). Given the recruit index shows low levels for 2017 and 2018 (recruitment impaired; Figure 6) and fishing mortality remains relatively high (high F; Figure 2) combined with a decrease in the post-recruit index (Figure 7) a precautionary buffer (an additional 20% reduction in catch to safeguard against significant biomass declines) could also be applied.

11

Table 2: Calculations and catch advice for the Isle of Man king scallop fishery using the ICES methodology outlined for a Category 3 stock (Method 3.2). Index A is the average of the last two year's survey abundance indices (2017 – 2018); Index B is the average of the three preceding year's survey abundance indices (2014 – 2016); Index Ratio is a ratio of Index A divided by Index B. Survey indices can contain a level of noise within the data, as such a +/- 20% cap (Uncertainty Cap) on inter annual changes to the TAC from the Index Ratio is advised (ICES, 2012). These methods are designed to be precautionary and so where there is uncertainty sue to a deficiency of information (i.e. stock status relative to references points or exploitation is unknown) a 'Precautionary Buffer' of a 20% reduction in catch is advised unless expert knowledge or evidence indicates that the stock is not reproductively impaired or that stock size is increasing (ICES, 2012).

	I	II
Index A (2017 - 2018)	135	135
Index B (2014 - 2016)	304	304
Index Ratio (A/B)	0.44	0.44
Uncertainty cap	0.80	0.80
TAC from 2017/2018 season	3203	3203
Discard rate	-	-
Precautionary buffer	NA	0.8
Catch advice for 2018/2019**	2562	2050

** For Scenario I: TAC for 2017/2018 x Uncertainty Cap; For Scenario II: (TAC for 2017/2018 x Uncertainty Cap) x Precautionary Buffer

3. Stock Assessment

A statistical catch at age based approach to estimate stock status for king scallops in ICES Rectangles 36E5, 37E5 and 38E5 based on the stock assessment software a4a, developed as part of the FLP project (http://flr-project.org), was undertaken in collaboration with the developers at the Joint Research Centre for the European Commission based in Ispra, Italy in September 2017.

3.1 Stock assessment (Statistical Catch at Age)

Assessment for All (a4a) is an innovative data-limited approach to stock assessment developed by the Joint Research Centre for the European Commission (Jardim et al., 2017). The a4a initiative is based on a risk type analysis that explicitly accounts for major sources of uncertainty and uses a statistical catch at age assessment model implemented in R (R Core Team, 2016) and FLR.

The *a4a* stock assessment model requires setting up three submodels for the fishing mortality (the *fmodel*), the index catchability (the *qmodel*, one for each index) and recruitment (the *rmodel*). For the *fmodel*, age and year were considered to interact and were thus modelled using a tensor product of cubic splines with the '*te'* method while the *qmodel* incorporated a smoother on age only. The degrees of freedom on the smoothers and tensor splines was adjusted for the number ages and years of data within the survey and catch.

For this assessment the survey data was split into two separate indices (Index 1: king scallops from queen scallop dredges; Index 2: king scallops from king scallop dredges). Index 1 was used to create an age based survey abundance index and Index 2 (adjusted for the growth period between the survey and the fishery and filtered to scallops above 110 mm) was used to assign the commercial landings to age categories. Preliminary results from the a4a assessment model showed a good fit to the data through all the model diagnostics and residuals, which allow the fit quality and assumptions of the model to be inspected. Standardised log-residuals were checked for biased results or large variances. The standardisation should produce residuals with variance 1, which means that most residual values should be between – 2 and 2, which they were for this model, indicating that there were no deviances from the log normal assumption (Jardim et al., 2017). In addition information on the number of parameters, observations, generalised cross-validation (GCV) score and Akaike information criterion (AIC) and Bayesian information criterion (BIC) were quantified (Table 3).

Table 3: Model diagnostics used to assess the fit of the model

	Model values
No. Parameters	72
No. Observations	250
GCV	0.58
AIC	431
BIC	685

The model estimates of stock biomass and fishing mortality are shown in Figure 12 and indicate a decline in Stock Biomass for king scallops within the stock assessment unit since 2013, following a period of increasing stock biomass between 2007 and 2012.
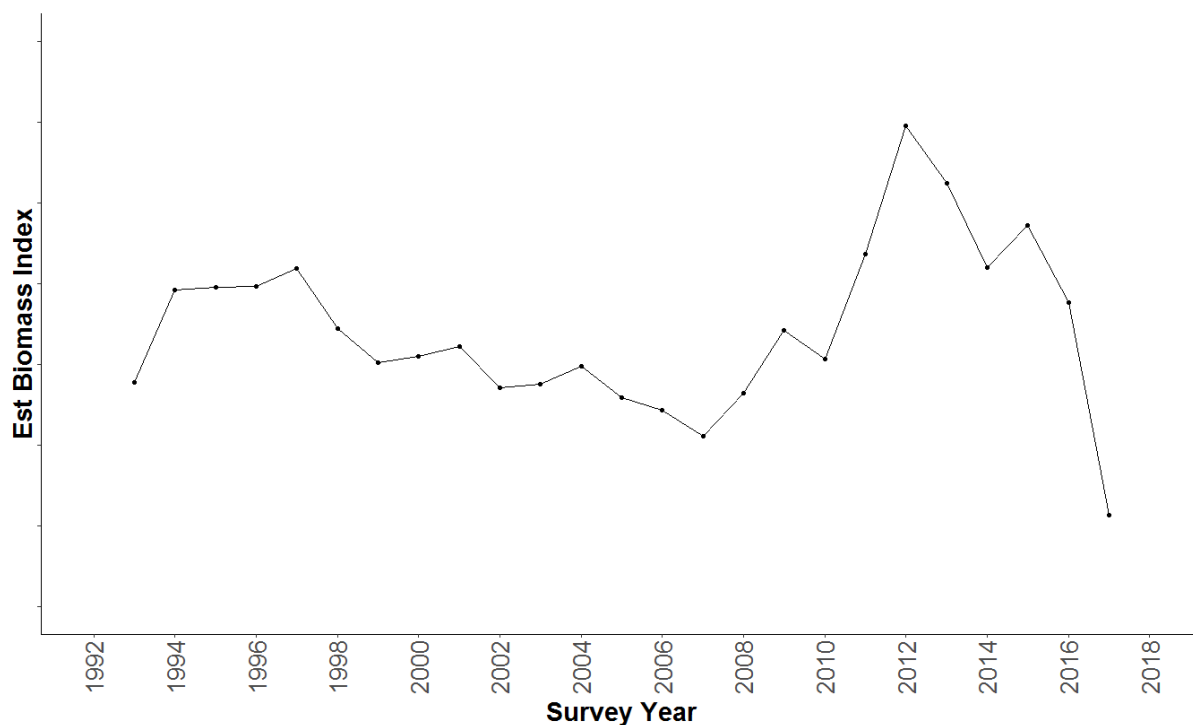
Figure 12: Stock biomass for king scallops in ICES Rectangles 36E5, 37E5 and 38E5. The assessment year runs from 1st November Year to 31st October Year 1, as such the data for 2017 is biomass as of 31st October 2018.

Table X: King scallops in the Isle of Man's territorial sea. The basis for catch options. Index A is the average of the last two year's Biomass index (2017 – 2018); Index B is the average of the three preceding year's survey Biomass index (2014 – 2016); Index Ratio is a ratio of Index A divided by Index B. Biomass indices can contain a level of noise within the data, as such a +/- 20% cap (Uncertainty Cap) on inter annual changes to the TAC from the Index Ratio is advised (ICES, 2012). These methods are designed to be precautionary and so where there is uncertainty sue to a deficiency of information (i.e. stock status relative to references points or exploitation is unknown) a 'Precautionary Buffer' of a 20% reduction in catch is advised unless expert knowledge or evidence indicates that the stock is not reproductively impaired or that stock size is increasing (ICES, 2012).

	I	II
Index A (2017 - 2018)	6903	6903
Index B (2014 - 2016)	10759	10759
Index Ratio (A/B)	0.64	0.64
Uncertainty cap	0.80	0.80
TAC from 2017/2018 season	3203	3203
Discard rate	-	-
Precautionary buffer	NA	0.8
Catch advice for 2018/2019**	2562	2050

** For Scenario I: TAC for 2017/2018 x Uncertainty Cap
** For Scenario II: (TAC for 2017/2018 x Uncertainty Cap) x Precautionary Buffer

4. Conclusions

- A TAC for the 2018/2019 Isle of Man's king scallop fishery was defined on the basis of ICES protocol for Category 3 stocks (Method 3.2).
- For the 2018/2019 king scallop fishing season the TAC calculation continues to be based on a survey abundance index pending the peer review of the quantitative stock assessment methods.
- Method 3.2 outlined by ICES compares the values from the two most recent years of the abundance index with the values from the three preceding years. The TAC is then adjusted by the percentage difference of these two values (44% reduction calculated from survey abundance index) taking into account the 20% uncertainty cap. As there is evidence of recruitment impairment and high fishing mortality (F) an additional 20% precautionary buffer could also be applied.
- The provisional catch advice for 2018/2019 king scallop fishery within the territorial sea is 2562 t.
- Should the TAC be adopted without the application of an additional precautionary buffer it is recommended that a review of the fishery is undertaken following the first month of the season with the option to revisit the application of the Precautionary Buffer.
- The Irish Sea king scallop fishery should be managed at the appropriate spatial scale. Unpublished genetic and oceanographic research indicates that the northern Irish Sea may be the most appropriate management unit for the fishery surrounding the Isle of Man. It is therefore vital that work continues towards achieving a collaborative management approach for king scallop stocks within the different regions of the Irish Sea.

6. References

Bloor, I.S.M. and Kaiser, M.J. (2017). Isle of Man king scallop (*Pecten maximus*) stock advice: A data-limited approach for setting a total allowable catch for the 2017/2018 fishing season and progress towards a quantitative stock assessment for the 2018/2019 fishing season. Bangor University Report No. 73. pp. 1 -20.

Duncan, P.F., Brand, A.R., Strand, Ø and Foucher, E (2016). The European Scallop Fisheries for Pecten maximus, *Aequipecten opercularis, Chlamys islandica* and *Mimachlamys varia*. In Scallops: Biology, Ecology, Aquaculture, and Fisheries. Developments in Aquaculture and Fisheries Science 3rd Edition, Volume 40, Edited by Shumway, S.E. and Parsons, G.J.

Hutchings, J.A. (1996). Spatial and temporal variation in the density of northern cod and a review of hypotheses for the stock's collapse. Canadian Journal of Fisheries and Aquatic Sciences, 53, 943-962.

Murray, L.G., Hinz, H. & Kaiser, M.J. (2009) Marine fisheries research report to DAFF 2007/2008. Fisheries & Conservation report No. 7, Bangor University. pp. 67. URL: http://pages.bangor.ac.uk/~oss801/welcome_files/webreports/7.pdf

ICES (2018a). Official Nominal Catches 2006 – 2015. Accessed on 14/08/2018 via http://www.ices.dk/marine-data/dataset-collections/Pages/Fish-catch-and-stock-assessment.aspx

ICES (2018b). Historical Nominal Catches 1950 – 2010. (Accessed on 14/08/2018) via http://www.ices.dk/marine-data/dataset-collections/Pages/Fish-catch-and-stock-assessment.aspx

ICES (2012). ICES Implementation of Advice for Data-limited Stocks in 2012 in its 2012 Advice. ICES CM 2012/ACOM 68/ 42pp.

IFISH2 (2017). EU Logbook Data. (Accessed on 16/08/2018).

Jardim, E., Millar, C., Scott, F., Osio, C. and Mosqueira, I. (2017). Assessment for All initiative (a4a). The a4a Stock Assessment Modelling Framework. R Vignette downloaded on 13th September 2017.