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Interim Report of the Working Group to Demonstrate a Celtic Seas wide approach to the application of fisheries related science to the implementation of the Marine Strategy Framework Directive (WGMSFDemo)

28–30 April 2015

Dublin, Ireland

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International Council for the Exploration of the Sea
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Executive Summary

The Working Group to Demonstrate a Celtic Seas[1] wide approach to the application of fisheries related science to the implementation of the MSFD (WGMSFDemo) co-chaired by Jean-Paul Lecomte (France), Eugene Nixon (Ireland) and Carl O'Brien (UK) met for its second meeting on 28–30 April 2015 in Dublin, Ireland, to develop and initiate a 3-year work programme. The ToR of the Working Group (WG) are set out in the Introduction section of this report.

The WG considered how data collected under the Common Fisheries Policy (CFP) could be used to carry out a Celtic Seas wide assessment for Descriptor 1, 3, and 6 using selected OSPAR Indicators (both common and candidate). This will support the OSPAR 2017 Intermediate Assessment. Data on demersal fish community and the incidentally-caught benthic flora and fauna were identified as have significant potential for the assessment. It is anticipated that an assessment could be carried out on up to 20 indicators.

Progress was also made on the analysis of data from fisheries surveys and from commercial fishing vessels to explore the possibility of establishing an ecosystem-based stratification for the Celtic Seas. This approach could provide valuable information to improve the efficiency of monitoring and of habitat status assessments but additional analysis is needed and will be carried out over the duration of the WG's 3 year work programme.

The WG identified the need to produce quality assured data from the DATRAS database that is suitable of the calculation of the MSFD indicators. The WG will progress this through the development of a decision tree protocol and in close consultation with OSPAR and other ICES groups.

WGMSFDemo will collate and quality assure the relevant data during 2015 and should be in a position to run a Celtic Seas wide assessments using selected indicators in 2016, feeding into the OSPAR 2017 Intermediate Assessment.

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[1] Celtic Seas refer to OSPAR Region III and includes the Irish Sea, the Celtic Sea and the area west of Ireland and west of Great Britain to the 200 m depth contour. See http://www.ospar.org/content/content.asp?menu=00480213000000_000000_000000

1 Introduction

The Working Group to Demonstrate a Celtic Seas wide approach to the application of fisheries related science to the implementation of the MSFD (WGMSFDemo) co-chaired by Jean-Paul Lecomte (France), Eugene Nixon (Ireland) and Carl O'Brien (UK) met for its first[2] meeting on 28-30 April 2015 in Dublin, Ireland to develop and initiate a 3-year work programme. The ToR for WGMSFDemo are:

a) To run a Celtic Seas wide MSFD Assessment with a focus on maximizing the use of fisheries related science, infrastructure, data and knowledge acquired under the Common Fisheries Policy (CFP), in particular but not exclusively D1, 3, 4, 6, 10, and 11.

b) Based on the experience gained in implementing the first MSFD cycle and a systematic analysis of the Directive (and associated Decisions) and MSFD reports generated by the three Member States to:

    i. Select the elements ICES can progress within the time frame;

    ii. Collate, examine and where appropriate utilize the outputs the relevant research projects on the implementation of the MSFD;

    iii. Examine and provide recommendations on the coherence of the Good Environmental Status (GES), Targets (including ranges for targets), Indicators and monitoring programmes established by the 3 Celtic Seas Member States with a focus on accommodating the different approaches into a coordinated Celtic Seas wide implementation process.

    iv. Prepare a concise report with recommendations.

The work of this group coincides with, and supports, the OSPAR Intermediate Assessment in 2017. WGMSFDemo will ensure that, on an ongoing basis, progress will be communicated and feedback considered from the appropriate administrations within each of the 3 Member States (France, Ireland, and the United Kingdom), the European Commission (EC), OSPAR, ICES Member Countries and other relevant organisations.

The WGMSFDemo will report by 29 May 2015 (via SSGIEA) for the attention of SCICOM, ACOM, CSG MSFD and other relevant groups.

[2] An informal preparatory meeting was held in Dublin on 22 January 2015.

2 Conduct of the meeting

It was decided that participants would work in one of three subgroups to progress the group's work during this meeting – a subgroup focusing on indicators and targets (presented in Section 3), a subgroup on monitoring (presented in Section 4) and a subgroup addressing issues of data quality and assurance of the ICES DATRAS database (presented in Section 5).

It was reaffirmed that the overall plan is to collate and quality assure the data during 2015 and be in a position to run the assessments using selected indicators on the Celtic Seas data during 2016. This will feed into the OSPAR Intermediate Assessment 2017.

3 Indicators and targets (subgroup 1)

3.1 Fish Indicators

The fish indicators considered are shown in Table 3.1.1

Table 3.1.1: Descriptions for fish indicators under consideration for MSFD monitoring for descriptor 1: Biological diversity is maintained. Types of indicators O = Operational, St = State, P = Pressure, Su = Surveillance. Colour coding indicates indicators that WGMSFDemo proposes to use (green) in its demonstration assessment of the state of the Celtic Seas subregion, and indicators that it does not intend to use (red). Superscript numbers link to notes following the table.

OSPAR ID	Indicator description	MSFD ID	Status	Type	Lead
FC-1	Population abundance/biomass of a suite of selected species(1)	1.2.1	Common	O/St	UK
FC-2	OSPAR EcoQO for proportion of large fish (LFI)(2)	1.7.1	Common	O/St	UK
FC-3	Mean maximum length of demersal fish and elasmobranchs(3)	1.7.1	Common	O/St	NL
FC-4	Bycatch rates of Chondrichthyes(4)	1.2.1	Candidate	P	
FC-5	Conservation status of elasmobranch and demersal bony-fish species (IUCN)(5)		Candidate		
FC-6	Proportion of mature fish in the populations of all species sampled adequately in international and national fish surveys(6)	1.3.1	Candidate	O/St	
FC-7	Distributional range of a suite of selected species(7)	1.1.1	Candidate	Su/St	IE/UK
FC-8	Distributional pattern within range of a suite of selected species(7)	1.1.2	Candidate	Su/St	UK
FW-3	Size composition in fish communities (LFI)(8)	4.2.1	Common	O/St	UK
FW-4	Changes in average trophic level of marine predators (cf MTI)(9)	4.3.1	Common	Su/St	Fr
FW-7	Biomass and abundance of functional groups(10)	4.3.1.	Candidate	Su/St	UK/SP
	Species evenness in defined size classes and/or trophic guilds of fish(11)	1.7.1		O/St	

(1) A suite of 'sensitive' species – sensitivity to additional anthropogenic mortality determined on the basis of life-history traits (Greenstreet and Rindorf, submitted). Targets and assessment process is described in Greenstreet *et al.*, 2012a.

(2) The procedure for deriving the LFI and carrying out assessments at the subregional scale has been developed in the North Sea (Greenstreet *et al.*, 2011) and this process has been applied in subdivisions of the Celtic Seas and Bay of Biscay subregions (Shephard *et al.*, 2011; Modica *et al.*, 2014).

(3) This is a community level indicator as it reflects change in the life-history trait composition of fish within the community. Clear pressure-state relationships have been established in the scientific literature (Jennings *et al.*, 1998; Jennings *et al.*, 1999; Greenstreet and Rogers, 2000; Greenstreet and Rogers, 2006; Greenstreet *et al.*, 2012b), and there is some indication as to what suitable targets might be (Greenstreet

and Rogers, 2006), so this indicator could be made operational. Testing in a demonstration assessment will help to further develop this indicator.

(4) The metric is not defined. If the metric is a measure of cpue, it could perhaps be used as a 'state' type indicator of abundance, but because of relatively low catches, it is likely to be a noisy measure. It is proposed as 'pressure' indicator, but because the metric is not defined, it is not clear how it will be interpreted? Also, why the focus just on Chondrichthyes as there are lots of teleost species with similar life-history traits in the community as well. With all bycatch pressure type metrics it is not clear how these should be interpreted. Under other D1 Criteria, it is expected that these 'sensitive' type species are required to increase in abundance as progress towards GES is made. If all else remains constant, i.e. no change in fishing practice, as population numbers increase, bycatch rates might also be expected to increase.

(5) This indicator, developed by Dulvy *et al.*, (2006), has subsequently been challenged by ICES (2012). There are two options: (i) exclude this indicator from the assessment process, or (ii) taking account of the reservations expressed by ICES (2012), to redesign a more robust indicator that still addresses its original objectives. At present it is not clear what MSFD indicator type presented in the EC Decision document this metric actually relates to. Unless this can be addressed, this might be sufficient reason to follow option (i); namely, to exclude this indicator from the assessment process.

(6) This indicator has been trialled by Greenstreet *et al.*, (2012a), where the metric was applied to the same suite of 'sensitive' species for which abundance/biomass indicators and targets were discussed. The same trends-based target setting procedures can be applied. This metric was intended to provide an equivalent to the spawning-stock biomass (SSB) state indicator used in classical fisheries management, but for the whole fish assemblage. In the cited example, it was only applied to 'sensitive' non-target species for which there is a sound theoretical basis for setting positive trends-based targets for population recovery. This is therefore potentially a useful operational indicator and testing in a demonstration assessment for the Celtic Seas could provide the evidence to support its promotion to 'common' indicator status. This indicator is also is listed for commercial stocks in D3.3 and works across the two descriptors.

(7) Greenstreet *et al.*, (2012a) applied distribution metrics to suite of 'sensitive' species indicators and concluded that the metrics used were unreliable. A study of various distribution range and pattern metrics also concluded that here were serious issues with many of these (Rindorf and Lewy, 2012). However, because of climate-change induced changes in the latitudinal (Perry *et al.*, 2005) and depth (Dulvy *et al.*, 2008) range of many species, information provided by distribution indicators could be invaluable in the interpretation of abundance/biomass change that might be observed in individual MSFD subregions. Work is therefore underway to develop useable distribution range and pattern metrics, which if delivered will most likely perform a surveillance indicator role.

(8) An emergent property of undisturbed aquatic foodwebs is the approximately even distribution of community biomass over the logarithmic body-size axis (a linear size spectrum, Sheldon *et al.*, 1972, Kerr and Dickie, 2001), where "body size" can be either the current body size of individuals or a measure for their adult size (e.g. L_{max}, Kerr and Dickie, 2001). Large-bodied species tend to be more vulnerable to fishing than smaller ones, which is why the size composition in fish communities is sensitive (Greenstreet *et al.*, 2011, ICES 2011) and specific (Houle *et al.*, 2012) to fishing pressure. The metric currently used for the indicators is the proportion of large fish individuals in groundfish surveys (LFI), but other metrics with their own distinct advantages have been proposed (Shephard *et al.*, 2012, WGECO 2014). Models (ICES 2011, Shephard *et al.*, 2013, Fung *et al.*, 2013, Rossberg, 2012) and data (Fung *et al.*, 2012) show that recovery of fish community size structure from pressures can be slow (lasting several decades), implying that the indicator represents a highly vulnerable ecosystem component. The OSPAR target for FW3 in the current assessment cycle is an increasing trend of the (smoothed) time-series of the metric at the time of the assessment. Absolute targets for use in the next assessment cycle are currently being developed following a proposal by the DEVOTES collaboration (Rossberg *et al.*, 2015).

(9) This indicator derives from the concept of 'fishing down the foodweb' initially proposed by Pauly *et al.*, (1998). This concept suggests that fishing initially concentrates on the larger fish that operate at higher trophic level, and as these populations become depleted, fisheries progress to target smaller fish at lower trophic levels. Consequently the mean trophic level calculated across sampled communities' declines over time. The metric involves assigning a particular trophic level to each species, and then calculating the mean over all species weighted by each species' abundance. Determining appropriate trophic levels for each species is therefore a fundamental prerequisite to using this indicator, and for many species this information may not be available directly. Also many species demonstrate ontogenetic development of

their diet, and it is not clear how this change in trophic level with length with such species will be accounted for.

[10] Contrasting other indicators for foodweb ecological status, this indicator relates to absolute biomasses. Marine foodwebs couple fish community production and biomass to primary production (Chassot *et al.*, 2007; Moreau and De Silva, 1991; Thurow, 1997; Ware and Thomson, 2005). By monitoring the biomass of fish, their benthic and pelagic resources, and primary production (or proxies thereof), imbalances in these couplings can be detected. The indicator addresses vulnerable ecosystem components; fish community biomass, for example, has been shown to recover from overexploitation on a decadal time-scale (McClanahan, 2007). Differentiation between trophic/functional groups in fish biomass time-series can be advantageous because (i) survey catchability differs by functional group and corrections for this are difficult (see, however, Fraser *et al.*, 2007) and (ii) more detailed information is provided, thus improving interpretation and assessment of time-series (Greenstreet *et al.*, 1997; Heath, 2005a; Heath 2005b). Ideally, the indicator is supported by a numerical model that causally interprets changes in the biomasses of functional groups and relations among these. Such a model will be developed by the EcApRHA project. The choice of guilds for the indicator is informed by the structure of the statistically best supported model among several alternatives. Too high resolution of guilds is unlikely to be successful, because high resolution leads to structural instability of models (Rossberg, 2013). Novel approaches to benthic monitoring and data analysis, such as those developed by the TIME project, could fill existing data gaps for the biomass of benthic functional groups, in particular the component available as food to fish (Sections 4.3 and 4.4).

[11] Criteria 1.7 requiring Ecosystem level indicators addressing change in ecosystem structure, has been addressed by relatively few Member States (MSs). Those that have addressed this Criterion have proposed indicators of change in community structure (e.g. the LFI, FC-2). In a Descriptor that purports to address the maintenance of biological diversity, it raises questions that no actual biodiversity metrics have been proposed. In previous initiatives seeking to use ecological indicators to support indicator-based management frameworks as the basis for implementing ecosystem-based fisheries management, application of criteria to assess the performance of candidate metrics (Rice and Rochet, 2005; Piet *et al.*, 2008) have identified shortcomings in species diversity metrics that have preclude their selection (Greenstreet, 2008). A key failing has been inconsistencies between the different studies that have used such metrics, but this issue has subsequently been addressed (Greenstreet and Piet, 2008). Another failing has been the lack of a well-defined theoretical relationship linking changes in species diversity to variation in anthropogenic pressure on the system. Instead of using indicator performance criteria to preclude the use of species diversity metrics, these criteria can be used to identify particular failings. If these can be adequately addressed, this could then render such metrics suitable for use in indicator-based management frameworks and allow their inclusion in the suite indicators used to support MSFD implementation. In previous studies, diversity metrics have been applied to the whole demersal fish assemblage, but this includes fish operating at different trophic levels. Thus top down control processes, from natural predation and as a result of fishing, have been confounded with bottom–up processes, in the resulting metric trends. This makes interpretation difficult as results were frequently contradictory to hypothesized expectations. Applying these metrics to separate trophic guilds should reduce this confusion and give rise to more reasonable results.

3.2 Benthic Indicators

The benthic indicators considered are shown in Table 3.2.1

Table 3.2.1: Descriptions for benthic indicators under consideration for MSFD monitoring [1] for Descriptor 1 and Descriptor 6. Superscripts link to notes following the table.

OSPAR ID	Indicator description	MSFD ID	Status	Type	Lead
BH-1	Typical species composition[2]	None	Candidate / Unknown	St	Es
BH-2	Condition of benthic habitat defining communities (Multimetric indices)	1.6.1 6.2.2	Common	St	Fr
BH-3	Physical damage of predominant and special habitats[3]	6.1.2	Common	Pr/St	UK/De

[1]) The present status of all of the benthic indicators was not clear to the WG at the time of the meeting and further consultation with ICG-COBAM is needed.

(2) Intermittent past output documents from ICG-COBAM suggest that BH-1 has not been progressed and its current status needs to be clarified.

(3) The status of BH-3 has change to Common in March 2015 and needs clarification.

The data collected by the IBTS, in respect of both the demersal fish community and the incidentally-caught benthic flora and fauna, could provide useful information for addressing elements of all three benthic indicators.

Work undertaken in the TIME project and separately in Ireland has indicated that a statistical definition of "ecologically relevant seabed habitat types" may be derived from the fish and benthic bycatch data when combined with depth, substratum and other information. This could allow the nomination of spatial strata for the development of benthic habitat status assessments and would also inform a more efficient sampling strategy.

The addition of beam trawl and grab sampling to the existing IBTS *Grand Ouverture Verticale* (GOV) trawls has been recommended by the TIME project (a UK Defra funded project entitled "Developing fisheries surveys to incorporate other ecosystem monitoring requirements: saving money and improving advice") as this will increase the benthic invertebrate catch success, thus improving the integrity of the spatial strata.

The use of the ecologically relevant spatial strata in combination with pressure mapping data, notably fishing intensity derived from VMS, may provide a statistically-supportable means of addressing Indicator BH-3.

Note, however, that the habitat types defined through this process may not align directly with the current Commissioned-defined "Predominant Habitat Types" (PHT) that are specified within the indicator text and are the current basis for a consistent approach to MSFD reporting against GES. At best, the ecologically relevant habitat types emerging from IBTS analyses will form "sub-habitats" of some of the sedimentary PHTs, but alignment may be sufficiently poor to justify a reconsideration of the PHTs. If this issue does arise, this will be highlighted to the appropriate administrations and organizations as per WGMSFDemo ToRs.

3.3 Commercial Fish and Shellfish Indicators

The commercial fish and shellfish indicators considered are shown in Table 3.3.1

Table 3.3.1: Descriptions for commercial shellfish and fish indicators under consideration for MSFD monitoring for descriptor 3[(1)]. 3.3.2 is regarded as unsuitable for D3 ICES 2014 ICES advice 2014). Superscript numbers link to notes following the table.

Indicator description	MSFD ID
Fishing mortality (F)[(2)]	3.1.1
Catch/biomass ratio[(3)]	3.1.2
Spawning-stock biomass (SSB)[(4)]	3.2.1
Biomass indices[(5)]	3.2.2
Proportion of fish larger than the mean size of first sexual maturation[(6)]	3.3.1
Mean maximum length across all species found in research vessel surveys[(6)]	3.3.2
95% percentile of the fish length distribution observed in research vessel surveys[(6)]	3.3.3
Size at first sexual maturation, which may reflect the extent of undesirable genetic effects of exploitation[(6)]	3.3.4

[(1)] Descriptor 3 requires that "populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock." This applies to the stocks covered by Regulation (EC) No 199/2008 (within the geographical area of Directive 2008/56/EC). Its application depends on the data available (taking the data collection provisions of Regulation (EC) No 199/2008 into account), which will determine the most appropriate indicators to be used.

[(2)] The primary indicator for the level of pressure of the fishing activity (Descriptor 3.1) is fishing mortality (F). To achieve or maintain GES, F values are required to be equal to or lower than F_{MSY}, the level capable of producing Maximum Sustainable Yield (MSY). As set out in 'Implementing sustainability in EU fisheries through maximum sustainable yield' (European Commission, 2006), this means that in mixed fisheries and where ecosystem interactions are important, long-term management plans may result in exploiting some stocks more lightly than at F_{MSY} levels in order not to prejudice the exploitation at F_{MSY} of other species (European Commision, 2006). It is worth noting, however, that under the revised CFP multi-annual management plans under development include ranges of F which are advised by ICES to be considered consistent with F_{MSY}. Therefore there is a need to consider how Fs within these ranges (e.g. at the upper end) are interpreted with regards F_{MSY} and the achievement of GES.

[(3)] The secondary indicator for monitoring the level of pressure from fishing activity is the ratio between catch and biomass index. The value for the indicator that reflects F_{MSY} needs to be determined by scientific judgement following analysis of the observed historical trends of the indicator combined with other information on the historical performance of the fishery. Where stock production-based assessments are available, the catch/biomass ratio yielding MSY can be taken as indicative reference. Alternatively to the catch/biomass ratio, secondary indicators may be developed on the basis of any other appropriate proxy for fishing mortality, adequately justified.

[(4)] The primary indicator for the reproductive capacity of the stock is the Spawning-stock biomass (SSB). This can be estimated from analytical assessments based on the analysis of catch-at-age or at length and ancillary information. Where an analytical assessment allows the estimation of SSB, the reference value reflecting full reproductive capacity is SSB_{MSY}, i.e. the spawning-stock biomass that would achieve MSY under a fishing mortality equal to F_{MSY}. Any observed SSB value equal to or greater than SSB_{MSY} is considered to meet this criterion. Further research is needed to address the fact that a SSB corresponding to MSY may not be achieved for all stocks simultaneously due to possible interactions between them. It is also important to note that when fishing at F_{MSY} you would achieve a biomass at or above SSB_{MSY} only 50% of the time due to natural fluctuations in stock productivity, which should be considered when evaluating GES achievement.

(5) Secondary indicators can be used if analytical assessments yielding values for SSB are not available. The biomass indices can be used if it can be obtained for the fraction of the population that is sexually mature. In such cases, such indices need to be used when scientific judgement is able to determine, through detailed analysis of the historical trends of the indicator combined with other information on the historical performance of the fishery, that there is a high probability that the stock will be able to replenish itself under the prevailing exploitation conditions.

(6) Primary indicators for population age and size distribution are determined by characterizing healthy stocks as having a large proportion of old, large individuals. Three primary indicators based on the relative abundance of large fish include; proportion of fish larger than the mean size of first sexual maturation; mean maximum length across all species found in research vessel surveys; and 95% percentile of the fish length distribution observed in research vessel surveys. The secondary indicator suggested here is the size at first sexual maturation, which may reflect the extent of undesirable genetic effects of exploitation. For both sets of indicators (proportion of old fish and size at first sexual maturation), expert judgement is required for determining whether there is a high probability that the intrinsic genetic diversity of the stock will not be undermined. The expert judgement needs to be made following an analysis of the time-series available for the indicator, together with any other information on the biology of the species.

3.4 Subdivisions

Where deemed appropriate, the MSFD allows for analytical assessments to be performed at a smaller spatial scale than the subregional scale: at the scale of the 'subdivison'. However there has to be a sound biological basis underpinning these subdivisions. In the North Sea for example, distinct communities occupying the northwestern and southeastern halves of the area, have been demonstrated in both demersal fish (Fraser *et al.,* 2008) and benthic invertebrates (Callaway *et al.*, 2002). In assessing community level indicators, analysis might be more suitably done on different subdivisions of the subregion that reflects spatial heterogeneity in the community concerned. Conversely, analysis of species-level indicators may be more appropriately undertaken at the subregional or even regional scale as these indicators will address changes in the abundance, distribution or population condition of whole populations occupying subregions or regions. The alignment of the spatial scale of community and species indicators to the spatial scale of GES determination requires careful attention for a meaningful assessment.

4 Monitoring (subgroup 2)

Within the context of the UK TIME project a process based ecosystem stratification plan for the Celtic Sea has been developed. This work has also been supported by the "Towards joint monitoring for the North Sea and the Celtic Sea – JMP NS/CS"- project Co-financed by the European Union/DG Environment. Grant Agreement No. 07.0335/2013/659567/SUB/C2. Additional funding was provided by national authorities in France and Ireland.

4.1 Theory and principles of integrated ecosystem monitoring

These projects have developed an approach to ecosystem monitoring focusing on process rather than status as the basic characteristic of ecosystems. Evaluation of the theoretical construct and the practicalities of implementation carried out in the projects demonstrate that the process method will not only serve to deliver more efficient monitoring to estimate the anthropogenic impacts, but it will also provide the necessary ecosystem understanding to evaluate options to minimize these effect while maximizing the sustainable resource usage of the Celtic Sea, or other marine, ecosystems. It relies much less on standardizing monitoring (variance minimizing) and instead accepts the existing variance as a means of interpreting variance as a result of variation in ecosystem processes (variance compensating).

4.2 Spatial and temporal scales at which the important ecosystem processes occur in the Celtic

WGMSFDemo reviewed the evidence available for the Celtic Sea and determined that it is possible to practically apply this approach in the ecoregion at the international level. Many different ecosystem components demonstrate consistent spatial gradients of variability which means we can imply the spatial temporal scale on which processes are important in ecosystem function. Accounting for this common variance structure increases precision compared to conventional monitoring while providing the operational efficiency to conduct monitoring for a multitude of processes at the same time on the same vessel. The WG ascertains that a monitoring program designed around processes can deliver the legislative requirements of status based indicators within the MSFD while maintaining consistency with past monitoring particularly those time-series used as part of management in the Common Fisheries Policy (CFP).

4.2.1 Spatial consistency of multiple ecosystem components

In a first analysis using fisheries survey information, abundances of the 40 most common fish species (of 139 spp, 73% of total catch numbers) caught in annual beam trawl surveys were log-transformed. Clusters were identified using Bray–Curtis dissimilarity with samples joined based on Ward's distance (cluster means method). Presence-absence data of the 90 (of 95 spp.) most prevalent epibenthic species was used to define communities.

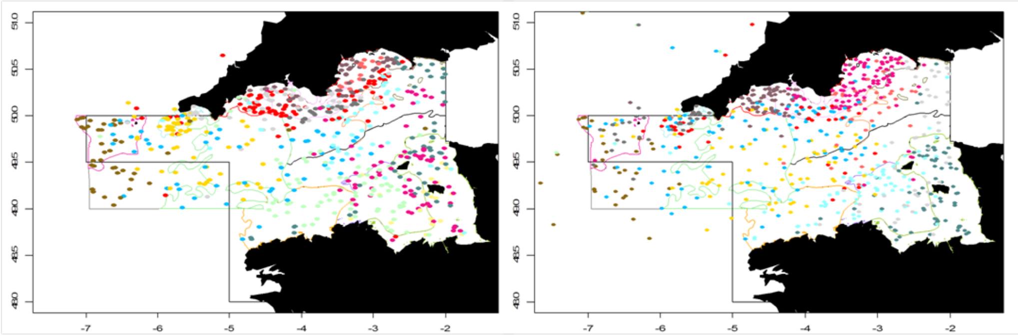

Figure 4.2.1.1: Analysis of community structure of fish (left) and epibenthic organisms (right) from a beam trawl survey undertaken between 2006 and 2014.

Even without defining the processes that link fish and epibenthic communities we can suggest that the same processes influence both fish and epibenthic communities because the spatial correlation between these ecosystem components is very high. Arguably the predation of fish on epibenthos is likely to contribute to the observed patterns, but we cannot say if this is a cause–effect relationship or a habitat dependence without further investigation. The clustering of fish species and the clustering of epibenthic organisms produce similar patterns and the the processes that define where these species cluster are both pressure related and habitat related.

4.2.2 Spatial consistency across seasons

In a second analysis, using catch data from fisheries, catch composition was measured by French, Irish, and UK observers on commercially operating fishing vessels that were using otter and beam trawls in the Celtic Sea between 1995 and 2013. Trawl data were aggregated into spatial cells of varying size to ensure that clustering was based on data of similar sampling sizes. In each spatial cell for each quarter, cumulative catch compositions were calculated for each cell and 4th root-transformed. Cells were clustered into communities using Bray–Curtis dissimilarity with samples joined based on Ward's distance (cluster means method).

Comparison of the quarterly plots suggests that, although there is variation in catch composition between areas, there is significant spatial consistency in community type through the seasons. Our *a priori* expectation is that significant change would be observed because demersal communities in coastal areas rely heavily on primary productivity as an energy source, and that this productivity peaks in spring. However, these observations suggest that the timing of monitoring demersal fish stocks could be made more flexible. We still do not fully understand the reason for the commonality in spatio-temporal pattern, so we need to keep a watching brief (i.e. sample enough to detect changes in the relationship) to account for future change. We only need to sample processes if they vary in space or time. So we do not need to sample all the time, or in all locations.

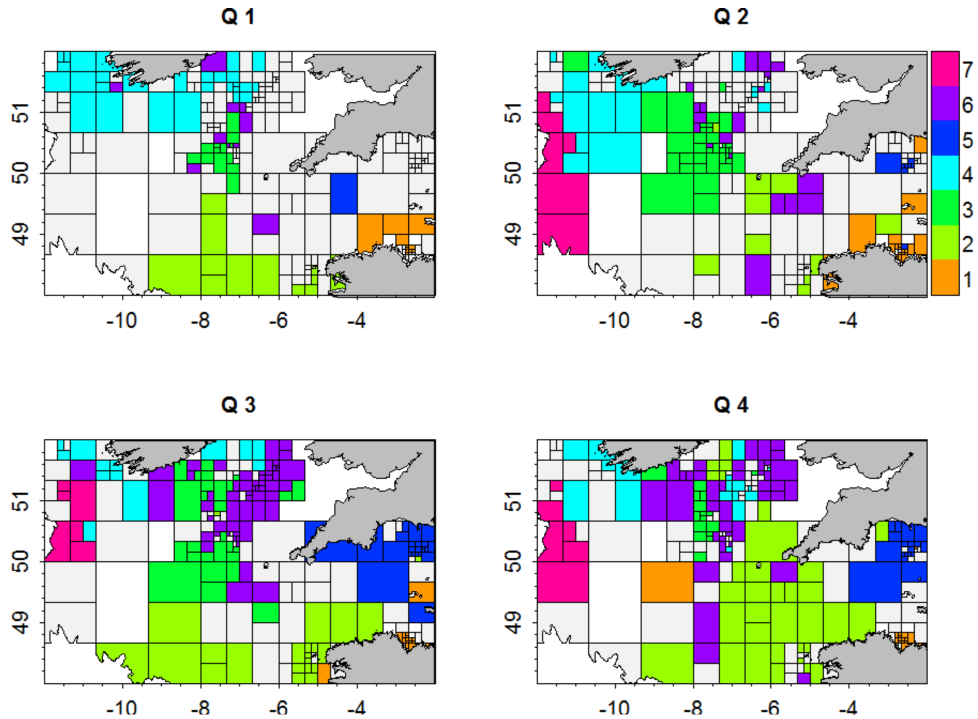

Figure 4.2.2.1: Temporal analyses conducted on French, Irish, and UK otter and beam trawler discard observer data [1995–2013]. The spatial aggregation of samples was allowed to vary to permit clustering based on similar numbers of samples (small areas = high sampling intensity, large areas = low sampling intensity). Grey and white cells show areas where available data were insufficient.

4.3 Ecosystem based stratification for the Celtic Sea

Taken together the evidence supports the establishment of ecosystem process based stratification for the Celtic Sea. The first study above suggests that many different components of the ecosystem are likely to have similar spatial structuring patterns. The second suggests that it is reasonable to assume that this spatial structure is reasonably consistent across the year.

Based on this we have developed a stratification map for demonstration purposes for the Celtic Sea that reflects meaningful ecosystem entities. In turn then, this stratification could be used to allocate survey stations by stratum and to collect sampling/monitoring data on this basis. In developing this stratification we made use of a wide range of supporting data. This included *inter alia*:

- Multidimensional analysis of fish community structure from the existing surveys;
- Multidimensional analysis of epibenthic community structure from the existing surveys – this was mainly from beam trawl surveys rather than the GOV surveys:
    - Benthic infaunal information where available;
    - Combined distribution maps for fisheries based on VMS and landings information;
    - On board observer data from commercial vessels;
    - Locations of key hydrological features e.g. fronts and currents, from oceanographic models etc. ;
    - Bathymetry – most particular in the context of defining strata along the shelf edge;

- Some substratum information was used e.g. muddy "*Nephrops*" areas, and areas of hard rock. Otherwise we did not utilize substratum information mainly due to the lack of detailed multibeam mapping and ground-truth information.

The approach incorporated data from the UK, Ireland, and France. The resultant stratification map, to be seen as a first attempt for demonstration purposes, is presented in Figure 4.3.1. Assignment of these strata is preliminary and will guide further refinement and consolidation, based on further consideration of ecological and physico-chemical characteristics, resulting in an anticipated reduction of the number of overall strata.

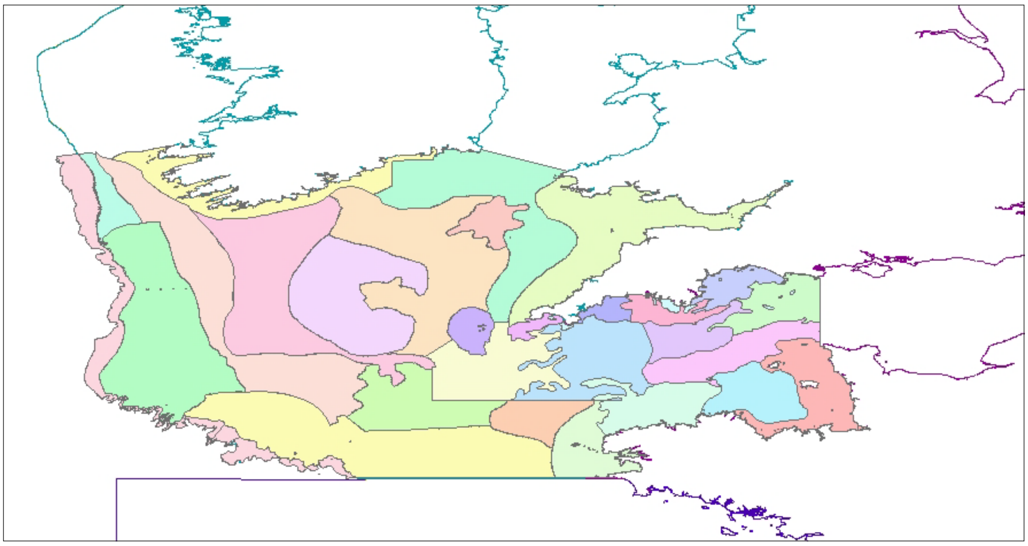

Figure 4.3.1 Preliminary map of epibenthic community strata based on mulivariate analyses of fish species abundance data obtained from fisheries surveys, combined with a range of physico-chemical data. Further refinement will be necessary.

This approach and the resultant strata could represent more coherent ecologically relevant habitat types than the universal seabed habitat assessment "units" defined by the Commission (European Commission, 2011) for status assessments relating to Descriptors 1 and 6 of the MSFD. Combining the use of biological community data, together with substrata and other physical information to define ecologically precise units, has the potential to provide a significant improvement in the ability to assess habitat status and the effects of anthropogenic pressures.

Next steps: Principal agreement on using a common stratification scheme for Celtic Sea surveys was reached in the TIME project. The derived principles need to be used to extend the stratification to the rest of the Celtic Seas region. It needs to be evaluated whether this new stratification can be adopted and implemented on fisheries surveys. It is also important that any additional sampling methods (gear deployments) are justified for delivering data and information to significantly contribute to the monitoring and assessment requirements of the MSFD at a regional level. Fisheries surveys, sampling demersal habitats, are generally not well suited to dealing with higher tropic levels of the pelagic ecosystem (fish upwards). More consideration than was possible in the TIME project is necessary to develop the integrated approach to include these components. Lastly, careful consideration is also required to establish how the stratification and associated ecologically relevant habitat types relate to the current MSFD Predominant Habitat Types as reported by Celtic Seas Member States.

4.4 Consider what information could be collected to support the development of new indicators

The same process based considerations that form the theoretical basis of the stratification scheme, also form the basis of the monitoring considerations as to the ecosystem components to collect. The proposed monitoring programme focuses on samples to collect, rather than specific indicators to service. There are two reasons for this:

Monitoring programmes are practically focused and have to assess the practicality and efficiency of deploying gear types with the appropriate distribution of effort, rather than the analytical considerations and statistical characteristics of a potential new indicator. This does not mean it ignores the ultimate objectives or the need to retain consistency in time-series for common agreed indicators for the Celtic Seas which are both important consideration.

Most current indicators are based on existing data. New indicators will therefore presumably be predominantly focused on additional data, the utility of which can only be assessed at the point at which such data becomes available. To fill the gaps in data availability the existing understanding of the ecosystem process, in their overall importance, their natural variability and their importance in describing pressure state relationships to link these back to samples that could describe these processes has been used. A proposed list of samples to collect as part of the internationally coordinated integrated monitoring programme developed in the TIME project is provided in Table 4.4.1. The WG invites critique with reasoning or evidence from experts on the Celtic Seas ecosystem to amend/complete this sample list for consideration by WGMSFDemo. Clearly the important pelagic component is underrepresented in these samples because the project was focused on demersal DCF funded.

Table 4.4.1: Proposed samples to be collected as the internationally coordinated integrated ecosystem monitoring programme based on table of samples possible to collect on fisheries surveys WGISUR 2013.

Priority assessed by WGECO(adjusted)	Gear to be used in CSECOS	Task	MSFD descriptor related to										
			1	2	3	4	5	6	7	8	9	10	11
		Fish and shellfish (survey specific)											
1	GOV / beam (site specific)	Organism collection (e.g. for contaminants, fatty acids analysis etc.)	x	x	x	x				x	x		
		Physical and chemical oceanography (e.g. CTD, chlorophyll, oxygen, nutrients, turbidity, etc.)											
2	ferry box	Continuous underway oceanographic measurements [from the ship]							x				
1	ESM2 + calibr.	Station oceanographic measurements							x				
2	ESM2 + calibr.	Station nutrient samples					x						
		Biological oceanography											
3	vertical ringnet	Station phytoplankton samples	x	x	x	x	x			x			
3	vertical ringnet	Station zooplankton samples [dipped]	x	x	x	x				x			
		Invertebrates											
3	Hammond grab	Infauna	x	x		x		x					
3	beam / 2m beam	Epifauna [towed]	x	x		x		x					
		Habitat description											
3	SPI	Camera [specifically SPI+C21]	x	x				x					
3	MB	Multi beam echosounder	x					x					
2	Hammond grab	Ground truthing	x					x					
		Pollution											
3	beam	Sinking litter										x	
2	grab	Pollution in the sediment								x	x	x	
		Environmental conditions											
1	observation	Weather conditions (manually recorded)							x				

Specific question posed within the Working Group were:

a) Consider what benthic information could be mined from beam trawls for Carnivorous Savaging Benthos (CSB) and Suspension and Depositing Benthos (SDB) and how it could inform biodiversity, seafloor and foodwebs.

An interesting conceptual model of foodweb dynamics (Heath *et al.*, 2014) suggests that significant progress in understanding and predicting foodwebs could be achieved by a simple box model, with boxes corresponding to judiciously define trophic guilds and abiotic compartments (nutrients). Necessary for such an approach is the availability of time-series of absolute biomass within the different guilds. Beam trawls sample the epibenthos effectively in relative terms, but catchability and size based selectivity present significant complications in deriving absolute estimates of guild biomass. Data exists, mainly at the level of the national laboratories that could be used to estimate catchabilities. However, it is unlikely that long time-series of such derived guild biomasses can be derived from fisheries survey data, because of evolution of the methodology of data collection (Presence absence, numbers or biomass, different levels of species aggregation, certainty in species identification).

The WG will consider the available information, possibly in other ecoregions, to determine what is possible for developing absolute abundance estimates of Suspension and Depositing Benthos (SDB) and Carnivorous Savaging Benthos (SBD).

b) Consider the issues around catchability of *Grand Ouverture Verticale* (GOV) 2 m, and 4 m beam trawls

Seafloor integrity indicators are currently poorly defined. Currently the only time-series monitoring information on epibenthic organisms exists as bycatch from fisheries oriented monitoring gears. The information content of the data (relevance to ecosystem processes) and how they relate to each other (relative selectivity) is currently poorly understood. Some exploratory investigations have been conducted that suggest in the absence of other information on the epibenthic component there may be useful information in these data and the utility should be further explored, see also point a. above.

The WG will collate current analyses and conduct additional ones to examine if the epibenthic catches from the standard fishing gears present different information or merely the same information from a different perspective because of different selectivities. If catch selectivity can be determined these data may provide valuable information for establishing, monitoring and assessing specific seafloor integrity indicators.

4.5 Standardized protocol across the ecoregion for benthic monitoring.

Benthic fauna are important components in marine shelf ecosystems for nutrient cycling, detrital decomposition and as a food source for higher trophic levels. These characteristics mean they have the potential to be useful indicators of anthropogenic and environmental impacts. Through the Marine Strategy Framework Directive (MSFD) member states are required to report on Biodiversity, including benthic species and habitats, and Sea-floor Integrity, covering both physical structure and benthic communities. Fisheries monitoring programmes within Europe are currently focused on national data collection; this may prove problematic when data are combined to produce indicators and targets at regional scales. To improve the situation countries have been independently reviewing protocol on fisheries surveys. In Ireland for example, a review of benthic procedures was recently undertaken. This included a quality control exercise to assess the taxonomic identification, analyses of the coherency of the community structures found in the Celtic Sea and a pilot comparative gear efficiency study. The quality control exercise highlighted several species groups which consistently cause identification issues. Clear protocols must be put in place to address these key issues in data quality, prior to analyses being undertaken at a regional level. In 2015 the Irish Groundfish Survey (IGFS) began a pilot study comparing GOV benthic catches to beam trawl catches at the same temporal and spatial location in order to determine comparative benthic sampling efficiency. Further sampling and gear modifications are required to undertake a fully operational offshore benthic monitoring add on, but provided an important step towards building holistic multi-purpose ecosystems surveys that may allow a large data return through small modifications to existing surveys; importantly without disrupting the surveys primary objectives and primary statutory obligations within the CFP. Careful consideration needs to be given to how these national benthic datasets should be quality checked and combined for MSFD monitoring purposes.

4.6 Provision of feedback for DATRAS cleaning product

Feedback was provided to the DATRAS MSFD product subgroup from a data provider perspective on QA issues in order to identify the decision points that could be included in a MSFD DATRAS QA Decision Tree. The monitoring subgroup has provided feedback to the DATRAS subgroup and those issues are addressed there (Section 5.2).

5 ICES DATRAS database (subgroup 3)

5.1 DATRAS data Quality Assurance

There was discussion of the quality assurance procedure to be applied in the DATRAS data cleaning stage. This is required in order to produce a QA'd data product suitable for calculation of MSFD indicators. It was agreed this process should dovetail with the statistical analysis being undertaken by ICES on North Sea IBTS data to identify any similar problems which may be evident in Celtic Seas survey data. For example, from a cursory analysis it was identified that the DATRAS database includes tows labelled as 'valid' which were either at night-time or outside the defined door spread and/or headline tolerance levels set out in the IBTS manuals (ICES, 2012), see Figure 5.1.1. These are clear data quality flags which should be highlighted in the data product. Of primary concern were patterns which may bias indicator calculation and subsequent spatial and temporal trends, such as increased door spread in particular years (e.g. see Figure 5.1.1.) or vessel, depth, time of year, survey effects etc. which should be taken into account in calculating indicators.

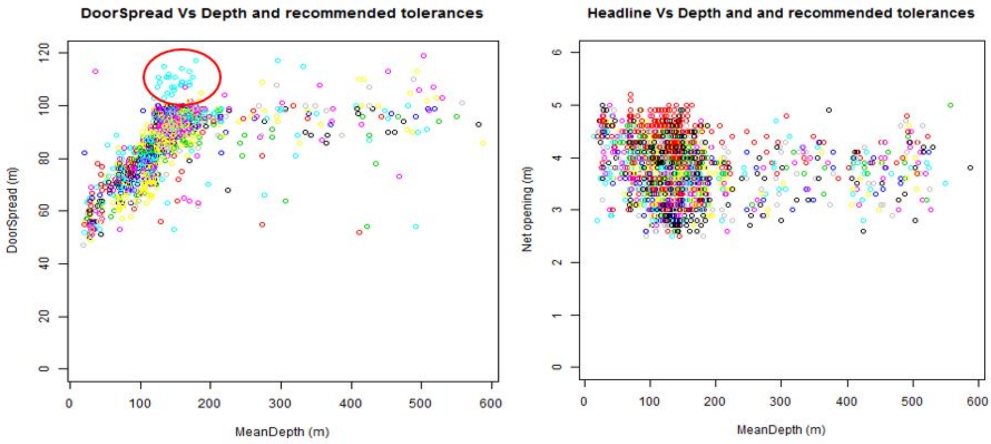

Figure 5.1.1: EVHOE HH DATRAS exchange data 1997–2014 valid hauls showing the Doorspread as a function of Depth (left) and Headline as a function of Depth (right). Data downloaded from DATRAS on 30 April 2015. Colours indicate different years. Red circled area in left panel shows potential problem with a year-effect door spread increase.

5.2 Decision Processes for MSFD DATRAS Data QA Version 1

WebEx with Axel Rossberg, Dave Stokes, Verena Trenkel (after discussion in plenum).

The following decisions for data preparation for standard dataset for MSFD, were compiled following a discussion of criteria for cleaning based on work done for the North Sea. All three haul-level files in the DATRAS archive where considered: HL (numbers at length by haul and species); HH (haul metadata); CA (numbers-at-age by haul and species). As an example of the process the figures below describe the decisions made for calculations for filling in swept-area for missing cases.

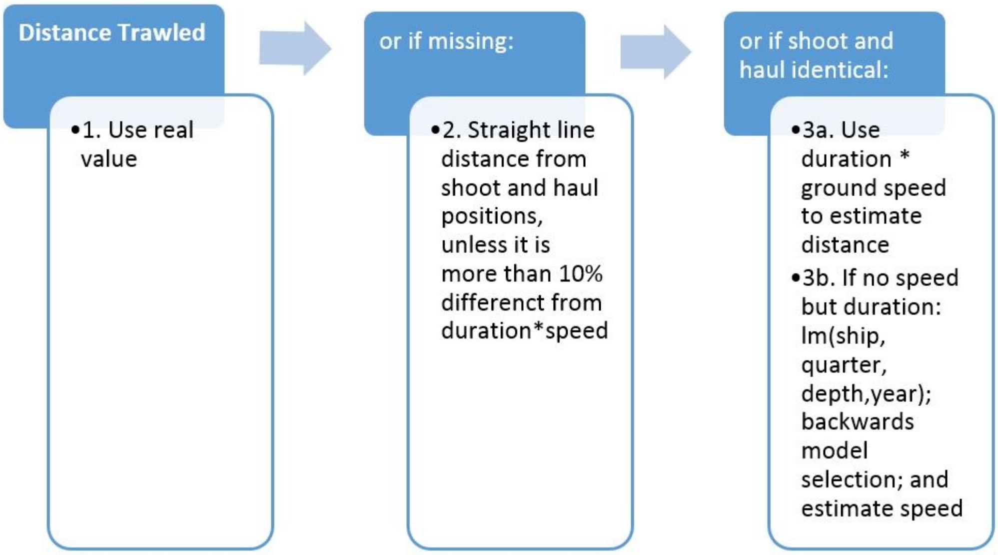

Figure 5.2.1: Decision process for filling in distance trawled parameter when missing, from (Scott Large script)

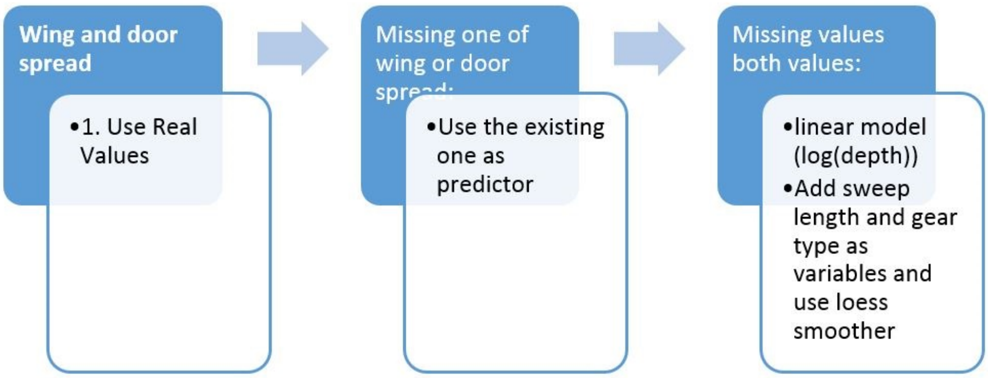

Figure 5.2.2: Decision process for filling in wing and door spread parameter when missing, from (Scott Large script)

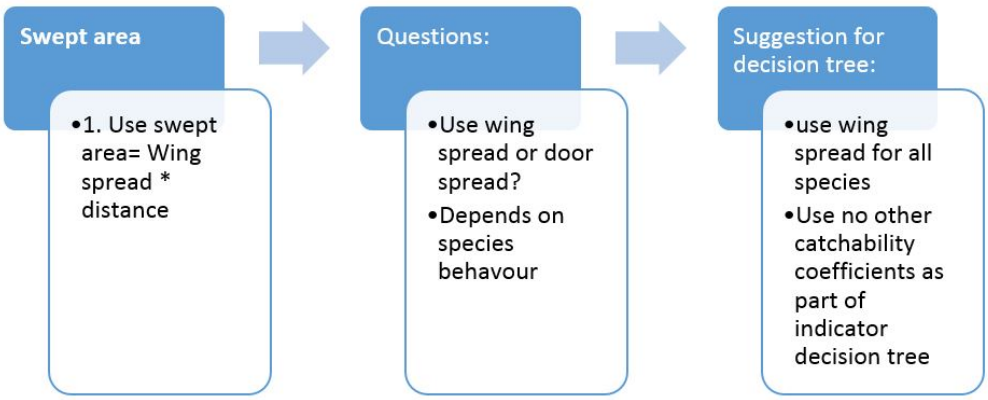

Figure 5.2.3: Decision process for calculating swept-area parameter using wingspread, from (Scott Large script)

5.2.1 Version Control for Decision Processes for Data Cleaning Version 1

This section lists the decisions outlined in the figures above, and highlights other issues for consideration within the data cleaning process. This will provide a skeleton structure to be built upon in the intercessional work programme.

5.2.1.1 CA data file clean up

1) Distance trawled
   a) Use real value
   b) Or if missing: straight line distance from shoot and haul positions, unless it is more than 10% difference with duration*speed
   c) Or if shoot and haul identical:
      i) use duration*ground speed to estimate distance
      ii) if no speed but duration: lm (ship, quarter, depth, year); backwards model selection and estimate speed
2) Wing and door spread
   a) Missing either wing or door spread: use the existing one as predictor
   b) Missing both values: use depth (suitably transformed as required) as the predictor variable. Other variables, such as sweep length and gear type, could also be useful in a multivariate relationship. A loess smoother might also be useful
      i) Suggestion: a global statistical analysis needs to be carried out
         (1) Filtering of extreme values based on clear selection criteria: create distribution of wing spread values for whole dataset, identify outliers and remove them and replace by estimate;
         (2) Option for no wing spread values at all: different options, including half footrope length (values are available in survey manuals), or a mean value calculated over defined data subsets, with an explanation provided for the subset selection (e.g. mean of all known wing spread values for a given vessel/gear/survey combination used to infill missing wing-spread values where no door-spread, or depth data are available, so there is no other reliable estimation option is open).
3) Swept-area
   a) swept-area = Wing spread*distance
   b) In general, wing spread densities will be reported for all species in the DATRAS data product as, for the majority of species, the herding effect of the doors and sweeps does not result in a catchability coefficients for the GOV of >1 (Fraser *et al.*, 2007). However, the DATRAS data product does need to include estimates of mean distance between the doors for each trawl sample so that the catchability coefficients reported by Fraser *et al.*, (2007) for the two species where the herding effect was significant, whiting and haddock, can be corrected appropriately.

5.2.1.2 HL data file clean up

1) Weight-length relationship parameters:
   a) ***Suggestion for decision tree***: use a common parameter list for Celtic Sea and other areas that includes all species to be available; parameter values that differ between years need to be dealt with at the indicator calculation stage;
   b) ***Decision tree question*****:** Use recorded weights or calculated weights? Suggestion, use only calculated weights (these are needed for large fish indicator);
   c) ***Suggestion for additional checking step:*** Use weight-length relationship with check coherence between recorded weights and numbers, if more than 30% use to detect raising factor issues, length unit errors (cm vs. mm).
2) Unreliable species identification: on occasion size can be useful in determining species identification. For example an unidentified weever of >16 cm is highly unlikely to be a lesser weaver (*Echiichthys vipera*) (FishBase) and so could confidently be recorded as a greater weaver (*Trachinus draco*). Similarly any unidentified dragonets >16 cm are highly unlikely to be spotted dragonet (*Callionymus maculatus*) or reticulated dragonets (*Callionymus reticulatus*) (FishBase), and so could confidently be recorded as common dragonets (*Callionymus lyra*) (e.g. Greenstreet *et al.*, 1999)
3) Issue of changing species code: use look up table to correct historic species codes
   a) ***Decision tree question*****:** compare list of unreliably identified species (list exists for Evhoe) with list of vulnerable species for the Celtic Sea; if not vulnerable species merge species on genus level (sum abundance and biomass) or add flag for unreliable identification;
   b) ***Decision tree question:*** what to do with occasionally unidentified species, only genus level? use species proportion in surrounding hauls in same year to split into species.
4) Check of haul validity flag: for all valid hauls look at gear parameter range, speed range, time of day according to protocol, change validity to "dubious" plus add a column to state what is dubious but include in dataset
   a) ***Decision tree question:*** only include valid hauls and dubious identified just above.
5) Minimum length to be retained: No fish records should be excluded from the DATRAS data product on the basis of fish length; all valid records should be retained. However, sampling efficiency of smaller sized fish is likely to be poor, so all records of fish ≤8 cm should be tagged with a suitable 'health warning'.
   a) **Decision tree question:** remove individuals below a certain size? Set to 0 cm for Celtic Sea GOV data.
6) Indicator calculation decision tree
   i) All species will be retained in the DATRAS data product regardless of how well or otherwise they are likely to be sampled by the trawl gear used in any given survey. Different indicators in different regions use different subsets of species; species selection therefore needs to be at the discretion of the data user and dependent on the particular indicators being derived. However, a list of species, for example sardine, anchovy, mackerel, blue whiting, horse mackerel, boarfish, and herring,

and potentially all non-fish species, could be tagged with appropriate 'health warnings'.

6 Intersessional work

The following tasks will be undertaken intersessionally and considered at the next WG meeting.

1) The indicators and targets subgroup, led by Simon Greenstreet has identified the need for a theoretical integration (aggregation) of indicators to assess GES. This group is well placed to address a coherent integration process for each individual indicator result so as to permit an assessment against a target value and/or GES. There are a lot of methods for integrated indicator results; one out all out, weighted averages etc. The WG considers valuable information and understanding of the process could be gleaned from an exercise is to do a theoretical integration of D3 Fish Indicators. This will facilitate further discussion at the next WGMSFDemo meeting on approaches to use to integrate the demo indicator results and assess them against targets and/or GES. The idea is to provide the indicator target information, some preselected integration methods and "dummy" indicator results. Each member will be asked to weight the indicators in the way they feel is most appropriate to the assessment and provide their rational at choosing that method. The results will then be summarized for the next meeting.
2) The monitoring subgroup, led by Sven Kupschus, has identified intersessional tasks to be undertaken (Section 4.5 and 4.6), they are summarized below:
    - The principles agreed upon in the TIME project need to be used to extend the stratification described above to the rest of the Celtic Seas region.
    - Describe how fisheries surveys need to be adapted to use the stratification scheme defined as efficiently as possible.
    - Undertake trails on further sampling and gear modifications required to undertake a fully operational offshore benthic monitoring add on to existing fisheries surveys to provide additional information for MSFD assessments.
    - Further consideration is necessary to develop the integrated approach to include components not examined in the TIME project as outlined in Section 4.5.
    - Consider the available information, possibly in other ecoregions to determine what is possible for developing absolute abundance estimates of SDB and CSB.
    - Collate current analyses and conduct additional ones to examine if the epibenthic catches from the standard fishing gears present different information of merely the same information from a different perspective because of different selectivities.
3) The data quality subgroup led by Axel Rossberg will upload the DATRAS cleaning protocol onto the OSPAR Basecamp, for comments and considerations from the providers and end-users. This protocol will be modified to address any issues which arise and the most recent version will be stored on Basecamp. The final protocol will be agreed by the WG and used to QA the DATRAS data prior to undertaking the demonstrations assessments.
4) The meeting did not discuss Descriptor 3, Commercial Fish and Shellfish. However Ireland has subsequently offered to lead on the Celtic Seas assessment under D3.1 and D3.2. and to consider what additional work is required under D3.3.

7 Date of Next Meeting

The next meeting of WGMSFDemo will take place during the week starting on 2 November 2015. France have provisionally offered to host the meeting in Paris (to be confirmed).

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