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Saltmarsh Angiosperm Assessment Tool for Ireland (SMAATIE)

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Comhshaol, Pobal agus Rialtas Áitiúil
Environment, Community and Local Government

www.epa.ie

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EPA Research Programme 2014–2020

Saltmarsh Angiosperm Assessment Tool for Ireland (SMAATIE)

(2013-W-DS-10)

Practitioner's Manual

End of Project Report available for download at http://erc.epa.ie/safer/reports

Prepared for the Environmental Protection Agency

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Contents

List of Figures and Tables

Figure

Tables

Executive Summary

The Saltmarsh Angiosperm Assessment Tool for Ireland (SMAATIE) project developed and applied a tool for the assessment of the ecological status of the saltmarsh component of the angiosperm Biological Quality Element in coastal and transitional waters for the Water Framework Directive. The overall aim of this document is to inform practitioners of how to gather suitable saltmarsh data and how to apply the tool to these data.

Chapter 1 comprises a brief introduction to the Practitioner's Manual, with reference to the End of Project Report for EPA Research Project 2013-W-DS-10. It outlines the various steps required for the application of SMAATIE (water body selection, data collation, fieldwork, tool application, results and testing) in the form of a flow diagram.

Chapter 2 provides information on the first step, namely water body selection. It highlights the need for desk-based research prior to the selection of the water bodies, and also draws attention to fact that the minimum area of saltmarsh required for functional ecosystem services, such as water filtration, is, as yet, unknown.

Chapter 3 describes the desk-based research (i.e. data collation) required for the application of the tool, as well as the various limitations of the data. Guidance on sourcing and processing Light Detection and Ranging (LiDaR) data and interpreting historical maps is provided, along with guidance on the use of aerial imagery and existing habitat maps to produce preliminary habitat maps to bring into the field. A brief description of available Environmental Protection Agency impact or risk data is also given.

Chapter 4 provides field methodology on how to record the necessary data required for the application of SMAATIE (e.g. habitat maps, plot data and lists of pressures). Where applicable, it expands on the methodology used in the assessment of Annex I saltmarsh habitats as required by the Habitats Directive, given that it would be pragmatic and cost-effective if the data for both assessments could be gathered during the same field survey.

Chapter 5 describes the application of SMAATIE to the data, and presents the five metrics with the necessary equations and weightings. It outlines potential modifications to future versions of the tool. It also introduces the reader to one of the outputs of the SMAATIE project, namely the Ecological Quality Ratio (EQR) calculator.

Chapter 6 relates the numerical result produced by SMAATIE, that is, the overall EQR value, to the ecological status of the water body being assessed.

Chapter 7 discusses testing of the tool in relation to data on human pressures.

Appendix 1 provides information on the EQR calculator to aid the practitioner in use of this resource, and Appendix 2 provides a worked example of how to apply SMAATIE if the calculator is not available.

1. Introduction

This document serves as a Practitioner's Manual for the application of the Saltmarsh Angiosperm Assessment Tool for Ireland (SMAATIE). The overall aim of this document is to inform practitioners of how to gather suitable saltmarsh[1] data and how to apply SMAATIE to these data for the ecological status assessment of the saltmarsh component of the angiosperm Biological Quality Element (BQE) in transitional and coastal (TraC) waters for the Water Framework Directive (WFD; 2000/60/EC).

This document covers all aspects involved in applying SMAATIE, with the workflow necessary for implementation of the tool laid out in Figure 1.1. The remainder of this document discusses each of these topics (water body selection, data collation, fieldwork, tool application, results and testing), and highlights the limitations to the methodology and potential future modifications to the tool, where applicable.

It is recommended that this Practitioner's Manual be used in conjunction with the End of Project Report for this project (Devaney and Perrin, 2015). The End of Project Report contains detailed information on the WFD, saltmarsh habitats and vegetation communities, as well as on pressure analysis and descriptions of the assessment tools used by other European Union (EU) Member States (MSs). The End of Project Report describes in detail the development of SMAATIE and the results of its application to a sample of 40 water bodies. It also discusses the aforementioned limitations of SMAATIE and makes recommendations for both applying it and improving it in the future.

1 Brackish and tidal freshwater swamps also fall within the remit of the tool. Hereafter, the inclusion of these habitats should be implicit when the term "saltmarsh" is used, unless otherwise stated.

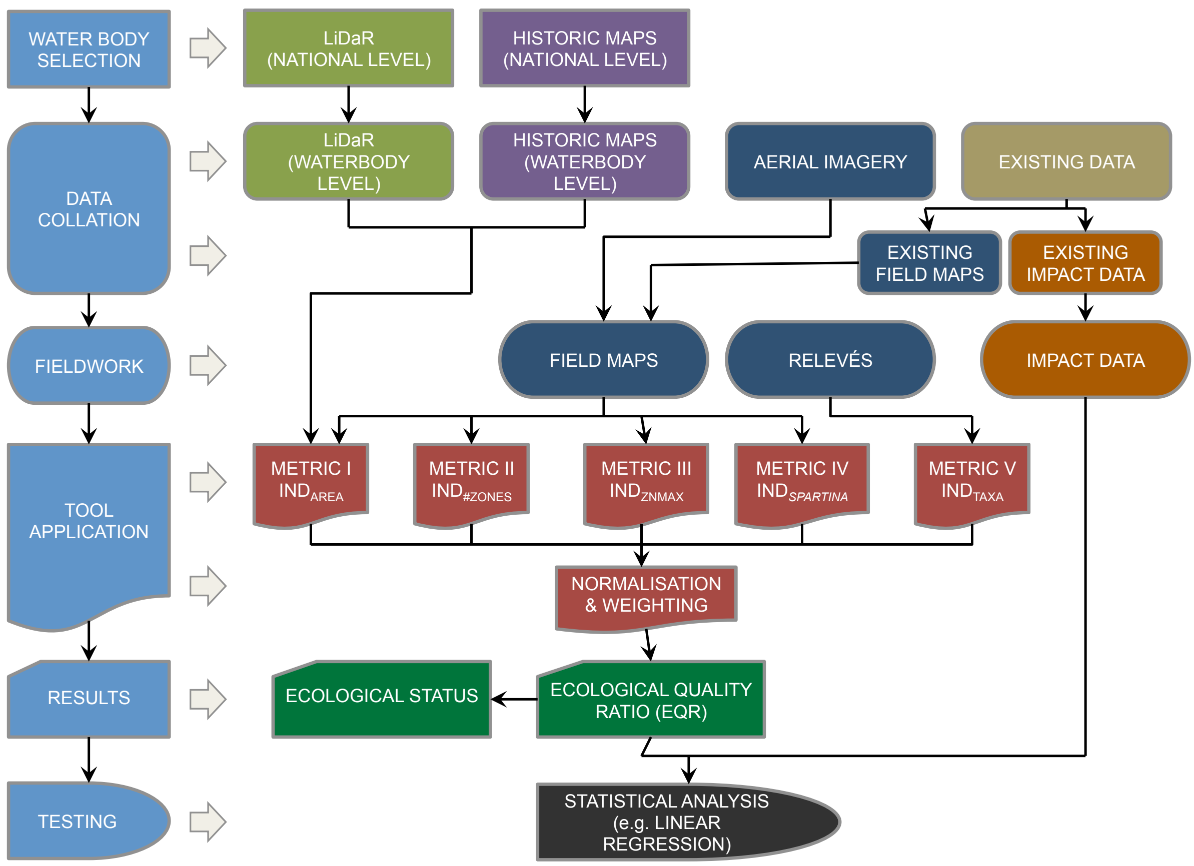

Figure 1.1. Flow diagram identifying the main steps involved in the application of SMAATIE to Irish TraC waters.

2. Water Body Selection

Not all water bodies need to be assessed in terms of the saltmarsh component of the angiosperm BQE. The presence of small areas of saltmarsh may have no significant bearing on the overall ecological status of a particular water body. Therefore, when selecting TraC water bodies for assessment, a minimum area of saltmarsh criterion and a minimum proportion of saltmarsh area relative to water body area criterion should be considered.

When applying these minimum criteria, both the current area of saltmarsh and the "potential saltmarsh area" (PSA) should be taken into account. PSA includes areas suitable for saltmarsh development based on an interpretation of historical maps and verified using Light Detection and Ranging (LiDaR) data where available. If PSA is not considered when applying these criteria, the selection of water bodies for assessment will be biased against water bodies currently containing highly degraded examples of saltmarsh, or, indeed, water bodies in which all previously existing saltmarsh has been lost. This would give a false impression of the ecological quality of some of our water bodies. Details on how PSA is calculated are given in section 3.2.

It is recommended that water bodies be selected for assessment of saltmarsh if they meet one of the following two criteria:

1. Current saltmarsh area + PSA ≥ 10% of current saltmarsh area + PSA + remaining area of water body.
2. Current saltmarsh area + PSA ≥ 400 ha.

Limitations

As part of the SMAATIE project, PSA has only been calculated for 40 TraC water bodies (Devaney and Perrin, 2015). It will be necessary to calculate this for all other remaining TraC waters before water body selection can be finalised. See also the limitations relevant to LiDaR and historical maps in section 3.

3. Data Collation

In order to apply SMAATIE to TraC water bodies, there are a number of necessary data requirements for the metrics:

1. LiDaR data (desk-based);
2. 6-inch historical maps (desk-based);
3. the coastal and transitional water body shapefiles from the Environmental Protection Agency (EPA) (desk-based);
4. current habitat maps of saltmarsh and tidal freshwater swamps associated with the water bodies being assessed (field-based);
5. plot data representative of all the vegetation classes and communities present within the water bodies being assessed (field-based);
6. data on the type of saltmarsh (i.e. estuary, bay, sandflat, lagoon or fringe) within each water body being assessed (field-based);
7. current lists of impacts affecting saltmarshes and tidal freshwater swamps (desk- and field-based).

The desk-based elements listed above will be dealt with in more detail here, with the fieldwork elements addressed in section 4.

3.1 Light Detection and Ranging

3.1.1 Light Detection and Ranging data sources

During the initial development of SMAATIE, LiDaR data were obtained from two sources, the Integrated Mapping for the Sustainable Development of Ireland's Marine Resource (INFOMAR) project (www.infomar.ie) and the Office of Public Works (OPW). The INFOMAR project is conducted jointly by the Geological Survey of Ireland and the Marine Institute. Data were available from the project website for a number of bays along the west coast of Ireland. The OPW have a collation of coastal LiDaR datasets that were recorded primarily for the purposes of coastal flood defence planning. Data were available for the entirety of the east and south-east coasts and selected coastal settlements in the south-west of Ireland.

Limitations

At the time of writing, a number of TraC waters had neither whole nor partial LiDaR data coverage.

3.1.2 Modelling methodology

LiDaR data can be used to model the highest astronomical tide (HAT) line, which provides a good estimation for the upper limits of the development of potential saltmarsh vegetation. The methods described here are the same methods used during the development of SMAATIE (Devaney and Perrin, 2015).

At the time of writing the End of Project Report (Devaney and Perrin, 2015), available INFOMAR data had 5-m spacing between points and used lowest astronomical tide (LAT) as the vertical datum. Assuming that this datum remains the same, the Vertical Offshore Reference Frame (VORF) 2.0 application (University College London/United Kingdom Hydrographic Office: www.ucl.ac.uk/vorf) can be used to convert from LAT to HAT. Each point in the LiDaR data within the coverage of the VORF model is independently converted. The available OPW data typically had 2- to 3-m spacing between points and used Malin Head (MH) as the vertical datum. Assuming that this also remains the same, to convert from MH to HAT, MH data need to be first converted to the European Terrestrial Reference Frame (ETRF) datum. For each water body, this conversion is based on the difference between these two reference systems as calculated by the Grid Inquest 7.0.0 application [Ordnance Survey (OS)] at a single, subjectively chosen point associated with that water body. The VORF model can then be used to convert each point independently from ETRF to HAT.

The GRASS plugin in QGIS 2.0.1 (www.qgis.org/en/site/), which provides access to the tools of GRASS (Geographic Resources Analysis Support System) Geographical Information System (GIS), can be used to convert the resulting HAT point shapefiles to rasters with 5 m × 5 m cells and to produce HAT contours from these rasters.

Limitations

Production of HAT lines is limited by the availability of LiDaR data. Calculations of HAT lines are also limited by the scope of the VORF model, which does not extend far enough inland for some water bodies.

3.2 Historical Maps

Historical maps are used to aid in the calculation of the total area that would be expected to be covered by saltmarsh if anthropogenic activities and alterations that impact on flooding dynamics were removed. This total area comprises current saltmarsh extent and PSA. Interpretation of historical maps is used for the calculation of PSA, whereas current extent is calculated from field surveys. Third-edition[1] OS 6-inch maps were used in Devaney and Perrin (2015). The following areas on these maps are included within PSA:

1. areas marked with "Covered by spring tides";
2. areas marked with "Saltmarsh" or "Saltings";
3. areas marked with "Liable to floods" when closely adjacent to TraC water bodies;
4. areas marked with marsh or swamp symbology when closely adjacent to TraC water bodies;
5. areas marked with "Intake";
6. areas where representations of features relating to reclamation works, including embankments, artificial arterial drainage channels and sluices, and large uniform fields, are obvious.

Areas marked as creeks with a width of 5 m or greater are not included within PSA, nor are any areas that clearly look to be on higher ground than the surrounding saltmarsh. The OS Discovery Series maps can be referred to in order to help determine these higher areas, as can the Street View function on GoogleMaps™ where available. Dense settlements or urbanised areas are not included within PSA even if their locations would be expected to flood if coastal defences were removed, as it would be extremely difficult for saltmarsh to develop on an artificial (concrete) surface. Where LiDaR data are available, PSA can be reviewed and modified where necessary by modelling the HAT line (see section 3.1.2).

Limitations

The OS 6-inch maps are spatially accurate in general terms but are not explicit in defining areas of saltmarsh. It is possible that, without LiDaR data to check the accuracy of PSA, PSA may be overestimated for some water bodies.

3.3 Aerial Imagery and Existing Data

3.3.1 *Water body shapefiles*

The TraC water body shapefiles can be downloaded from the EPA Geoportal website (http://gis.epa.ie/). Owing to limitations with these shapefiles (see below), it is recommended that during both the desk-based PSA work (section 3.2) and the field survey (section 4.2), any saltmarsh or tidal freshwater swamps associated with a water body should be mapped, as opposed to only those found within the water body boundary.

Limitations

Irish TraC water bodies as currently delineated by EPA shapefiles are bounded on the landward side by the mean high water (MHW) mark rather than the recommended HAT line. As a result, the majority of saltmarsh actually currently occurs outside the officially delineated areas for these water bodies. Also, in relation to the delineation of water bodies, the upper limit of transitional waters is intended to be the upper limit of tidal influence, therefore bringing tidal freshwater swamp into the remit of the tool. There is some inconsistency in the application of this delineation, however.

1 The set of digital OS maps referred to here as the third edition is in fact an amalgam of sheets from the second and third editions and sheets from later revisions. No complete set of maps exists for any edition except the first. Sheets within this amalgam could date from as early as 1848 to as late as 1957, depending upon the county. There are no metadata with the digital maps, which are clipped of the margins in which the year of production would have been marked (Robert Ovington, National Parks and Wildlife Service, personal communication, May 2009). It would be necessary to access the original paper maps to obtain the date for each digital sheet.

3.3.2 Aerial imagery and existing field maps

A preliminary habitat map for each water body can be created before fieldwork commences, with the interpretation of aerial photographic images and by also using any existing habitat maps, such as those produced during the Saltmarsh Monitoring Project (SMP) (McCorry and Ryle, 2009). By creating a preliminary habitat map at this stage, the field team can estimate how long each water body will take to survey, identify access points and the route through the habitats, and also plan the number of relevés that will be required. The smp_national_sm_resource_revised_GIS_2011 shapefile [available from the National Parks and Wildlife Service (NPWS)] should form the basis of the first preliminary habitat maps.

3.3.3 Existing impact data

Although data on impacts affecting saltmarsh and tidal freshwater swamps will be recorded as part of the field survey, existing data, which may relate to impacts not obvious from a field survey, can be collated at this stage.

The EPA records risks for each water body under four risk categories: point sources (relating to pollution); morphological risk; marine direct impact assessments; and abstraction (for transitional water bodies only). Risks are currently classified in terms of their influence on the likelihood that a water body will not achieve good ecological or chemical status by 2015, as “1a: At risk”; “1b: Probably at risk”; “2a: Probably not at risk”; or “2b: Not at risk”. Data on the trophic status of water bodies can also be obtained from the EPA. Trophic status is assessed as eutrophic, potentially eutrophic, intermediate or unpolluted depending on specific criteria under three categories, namely nutrient enrichment, accelerated plant growth and disturbance to the level of dissolved oxygen that is normally present.

In addition to EPA datasets, land reclamation, infilling, embankments and other large-scale land modifications which would impact on saltmarshes and tidal freshwater swamps may be more obvious from examining historical maps and aerial imagery. Any factors identified by this method can be verified once in the field.

Limitations

Pressure categories recorded by the EPA do not cover some topics pertinent to saltmarshes such as grazing pressure, soil eutrophication, erosion and land reclamation. Risk assessment data need to be updated. The majority of the risks were determined as part of an earlier risk assessment in 2005, with some additional monitoring carried out by the EPA in 2007 and some revisions made in 2008. Not all TraC waters have had their trophic status assessed.

4. Fieldwork

4.1 Fieldwork Planning

In practical terms, the assessment of saltmarshes for the WFD is likely to have a high degree of overlap with the assessment of Annex I saltmarsh habitats for the Habitats Directive (HD). It would be pragmatic and cost-effective if the data for both assessments could be gathered within the same field exercise. Data requirements for SMAATIE include habitat maps, relevé data and a list of current impacts, all of which are requirements for the individual components of the HD conservation status assessment, that is, habitat extent, structure and functions and future prospects (McCorry and Ryle, 2009; NPWS, 2013).

4.1.1 Scale and timing of work

SMAATIE is to be applied at a water body scale, where, often, there are several distinct saltmarsh systems present (sites), particularly within larger water bodies. Data collected from these saltmarsh sites for the HD assessments should be scaled up to a water body level for the WFD assessment.

The reporting cycles for the HD and WFD are every 6 years, with a difference of 3 years between them (e.g. the last reporting round for the HD was 2007–12, whereas 2015 is the end of the first management cycle for the WFD). Data collected for HD assessments should be used in the subsequent WFD assessment. The best time for carrying out habitat surveys in general is during the growing season for most plants (April to September) (Smith *et al.*, 2011), with the optimal survey period for saltmarsh surveying being June to September (UKTAG, 2013). The study of tide tables is essential prior to fieldwork to identify periods of low tide when lower saltmarsh zones can be mapped and assessed safely (McCorry and Ryle, 2009).

Timing of fieldwork should allow for a training day prior to commencement of the field season. This is for quality-control purposes and ensures that all members of the survey team are consistent in their recording of field data and familiar with and competent in the use of the equipment.

4.1.2 Equipment

Each surveyor should be equipped with a ruggedised handheld mapper with an integrated global positioning system receiver. The handheld mappers should be installed with GIS mapping software with the relevant GIS layers imported. These include aerial photographs, OS Discovery Series maps, site and water body boundaries, and the preliminary habitat map for each site. The mappers should be used to record waypoints for delineating or redefining habitat boundaries and for the recording of additional waypoints for relevés or monitoring stops, negative impacts and other points of interest. Spreadsheet software, such as Microsoft Excel™ Mobile, should also be installed on the mappers to enable all assessment data and site notes to be entered in the field for maximum efficiency. Standardised recording forms should be prepared in advance of the field survey.

In addition, fieldworkers should be supplied with a site pack. Each pack should include a cover sheet that details general site information, such as site area, saltmarsh type(s), habitats recorded at the site by previous surveys (such as the SMP) and the OS Discovery Series map number. A hard-copy map of the survey area should also be supplied displaying the site boundary over aerial photographs at a scale appropriate for mapping. Hard copies of the recording sheets on waterproof paper should also be supplied in the event of technical failure.

4.2 Field Maps

GIS mapping should be consistent with the guidelines of Smith *et al.* (2011). Each polygon in the preliminary habitat map should be ground-truthed and boundaries amended as necessary. A minimum mappable polygon size of 400 m^2 and minimum mappable polyline length of 20 m should be employed, with smaller features, relevés or monitoring stop positions and the occurrence of notable fauna and flora recorded as point features. Habitats should ideally be mapped to community level, as indicated in Table 4.1, or, at a minimum, to zone level. Devaney and Perrin (2015) should be referred to

Table 4.1. Proposed vegetation zones for WFD assessment of saltmarsh indicating typical occurrence in different types of water bodies

			Water body type		
Zones	*Communities*		*Open coast*	*Estuaries*	*Lagoons*
Spartina beds	1a	*Spartina* community	●	●	
Pioneer	1b	*Salicornia* community	●	●	
Lower marsh	2a	*Puccinellia maritima–Salicornia* community	●	●	
	2b	*Puccinellia maritima–Atriplex portulacoides* community	●	●	
	2c	*Puccinellia maritima*-dominated community	●	●	
	2d	*Puccinellia maritima–Aster tripolium* community	●	●	
	2e	*Puccinellia maritima–Plantago maritima* community	●	●	
Middle marsh	3a	*Festuca rubra*-dominated community	●	●	●
	3b	*Festuca rubra–Armeria maritima* community	●	●	●
	3c	*Festuca rubra–Juncus gerardii* community	●	●	●
	3d	*Festuca rubra–Agrostis stolonifera* community	●	●	●
Upper marsh	4a	*Juncus maritimus*-dominated community	●	●	●
	4b	*Juncus maritimus–Festuca rubra* community	●	●	●
Upper transitional	5a	*Agrostis stolonifera–Glaux maritima* community			●
	5b	*Agrostis stolonifera*-dominated community			●
	5c	*Agrostis stolonifera–Eleocharis uniglumis* community			●
	5d	*Agrostis stolonifera–Juncus gerardii* community			●
	5e	*Agrostis stolonifera–Potentilla anserina* community			●
Phragmites/*Typha* swamps	6a	*Phragmites australis* community		●	●
	6d(ii)	*Typha latifolia* community		●	●
Bolboschoenus/ *Schoenoplectus* swamps	6b	*Bolboschoenus maritimus* community	●	●	●
	6c	*Schoenoplectus tabernaemontani* community	●	●	●
Elytrigia atherica[a]/ *E. repens* swards	6d(i)	*Elytrigia repens* community	●	●	●

[a]Not statistically defined by the present classification.

for descriptions of each community. Correspondence of zones or communities with HD Annex I habitats should be noted on a polygon-by-polygon basis.

In cases in which areas of saltmarsh contain an intimate mosaic of saltmarsh communities or zones that cannot be practically separated, each community or zone present in each polygon should be recorded with the approximate percentage area of the polygon they cover. As the total area of each polygon will be known from digitisation, data on the approximate extent of each community or zone can be readily calculated using this method. Attempting to map smaller polygons representing single communities or zones in these areas would greatly increase the amount of time spent mapping and the number of polygons mapped, and would not ultimately eliminate the need for recording mosaics at smaller scales.

4.3 Relevés

It is necessary to record relevés to assess the structure and functions of the various Annex I saltmarsh habitats for the HD. The methods should follow those laid out by McCorry and Ryle (2009). In terms of the WFD, species data are required for the disturbance-sensitive taxa metric (see section 5.2). Within each HD monitoring stop (10 m × 10 m), a 2 m × 2 m quadrat should be surveyed and the percentage cover of each species present recorded. Additional 2 m × 2 m quadrats should be recorded in non-Annex saltmarsh habitat (tidal freshwater swamps, *Elytrigia* swards and other transitional habitats). Sufficient total numbers of relevés should be recorded to adequately describe the overall variation in communities for the entire saltmarsh system within each water body. Nomenclature should follow Stace (2010) for vascular plants, whereas field guides, such as Hubbard (1992), Rose (2006) and Parnell and Curtis

(2012), can be used for the identification of saltmarsh species.

4.4 Impact data

Impact data are recorded differently depending on whether the saltmarsh habitats being assessed are for the WFD or the HD. In terms of the WFD, any pressures or risks that may impact on the saltmarsh zones and/or the water body should be listed using the EPA's system of recording risks. The current list will have to be expanded, however, to include risks such as grazing, soil eutrophication and land reclamation. Ideally, an estimate of area impacted upon and the intensity of the pressure should be given.

The future prospects component of the HD assessment is based on the occurrence and intensity of various pressures and threats recorded as impacting on the Annex I saltmarsh habitats. In a change made since the SMP was carried out, all impacts and activities should follow the standard list of Ssymank (2010), and additional information, including the intensity, effect, percentage of the Annex I habitat affected and source of the impact, should also be included.

Limitations

Impact data are recorded using different systems for the WFD and the HD, which makes integration of the field methodologies difficult for these data. As SMAATIE is a WFD-driven tool, the EPA's system of recording risks should be used, with expansion of the current list of risks.

5. Tool Application

5.1 Ecological Quality Ratio (EQR) Calculator

One of the outputs of this EPA Research Project is an EQR calculator in Microsoft Excel™ format, which is designed to automatically calculate the overall EQR value and ecological status of a water body based on field- and desk-based data. It requires the following data:

- water body details (EU code, MS code, water body name and type);
- saltmarsh type (estuary, bay, sandflat, fringe or lagoon);
- current saltmarsh area;
- potential saltmarsh area;
- number of saltmarsh zones present;
- area of each saltmarsh zone present;
- number of characteristic taxa for each community/class.

Screen shots of the EQR calculator can be found in Appendix 1, showing practitioners how to enter the data and what the outputs will look like. The rest of this section details the individual metrics used to create the overall EQR value and provides the equations embedded in the EQR calculator, so that practitioners can still calculate the overall EQR value and ecological status of a water body if the calculator is not available.

5.2 Tool Metrics

Three key elements are used to classify the ecological status of the angiosperm BQE for TraC waters, namely angiosperm abundance, taxonomic composition and disturbance-sensitive taxa. In the context of assessing saltmarsh within the angiosperm BQE, these three key elements can be taken to translate roughly as saltmarsh extent (angiosperm abundance), saltmarsh zonation (taxonomic composition) and presence of halophytes (disturbance-sensitive taxa), which is an approach similar to that used in the UK (UKTAG, 2013).

SMAATIE is composed of the following five metrics, designed to measure and assess these key elements:

1. saltmarsh extent as a proportion of the reference area ($Area_{ref}$) (angiosperm abundance);
2. proportion of saltmarsh zones present (taxonomic composition);
3. proportion of saltmarsh area covered by the dominant saltmarsh zone (taxonomic composition);
4. proportion of saltmarsh composed of *Spartina* (taxonomic composition);
5. proportion of observed taxa, up to 15 taxa (disturbance-sensitive taxa).

These metrics were designed to use available data, in particular those collected by the SMP (McCorry and Ryle, 2009). Where these metrics could be modified in light of the recommended fieldwork methodology above (section 4), this is highlighted.

5.2.1 *Metric I: saltmarsh extent as a proportion of the reference area ($Area_{ref}$)*

The reference value for this metric is set at the total area that would be expected to be covered by saltmarsh if anthropogenic activities and alterations that impact on flooding dynamics (e.g. embankments) were removed ($Area_{ref}$). $Area_{ref}$ (Equation 5.1) comprises current extent ($Area_{current}$) and "potential saltmarsh area" ($Area_{PSA}$), where $Area_{current}$ can be calculated from field maps and $Area_{PSA}$ from the historical maps and LiDaR data:

$$Area_{ref} = (Area_{current} \times 1.0) + (Area_{PSA} \times 0.75) \qquad (5.1)$$

A weighting of 0.75 is applied to $Area_{PSA}$ to allow for the presence of smaller creeks and non-saltmarsh habitats, such as sandflats and mudflats, and also to allow for a certain degree of error or uncertainty in the map-derived data. This is the same downweighting adopted by the UK for its reference condition for historical saltmarsh, citing uncertainty in its datasets (UKTAG, 2013).

The index value for the angiosperm abundance metric (Ind_{Area}) is calculated by expressing current extent as a proportion of $Area_{ref}$ (Equation 5.2):

$$Ind_{Area} = \frac{Area_{current}}{Area_{ref}} \times 100 \qquad (5.2)$$

Modifications to the tool

It is envisaged that in future rounds of reporting a new metric for area could be implemented, namely recent change in area. As the SMP was essentially a baseline survey of saltmarshes, this metric could not be developed for the current version of SMAATIE. With subsequent monitoring of saltmarsh (required by both the HD and the WFD), recent changes in area (from one reporting period to the next) will be measured and this potential metric will then have the necessary data to be included in the tool.

5.2.2 Metric II: proportion of saltmarsh zones present

The reference condition for this metric is the presence of the expected number of saltmarsh zones that should occur naturally within the water body for a fully functioning saltmarsh. These zones should essentially represent the full successional sequence of a saltmarsh in "dynamic equilibrium" (Wanner *et al.*, 2007), and the presence of these zones within a saltmarsh reflects the "successfulness of its ecological functioning" (UKTAG, 2013). Note that, for this metric, it is the number of zones present that is important, rather than a requirement to have specific zones. The presence of *Spartina* within the water bodies is assessed by a separate metric, and, therefore, the *Spartina* zone is not considered here.

Modification to the tool

In Devaney and Perrin (2015), the number of zones present within TraC water bodies was calculated from the SMP datasets. The SMP essentially mapped using three HD Annex I categories (1310, 1330, 1410) and an 'Other saltmarsh' category. Habitat 1330 Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) was divided into two zones by Devaney and Perrin (2015), representing the *Puccinellion maritimae* and the *Armerion maritimae*, using plot data classified as communities 2(a–e) and 3(a–d), respectively (see Table 4.1). Therefore, data on five zones were available, and this metric is currently defined on the basis on these five zones.

It will be noted that the new classification scheme presented in Table 4.1 contains eight zones (excluding the *Spartina* zone). For the purposes of calculating this metric, *Elytrigia* swards, *Phragmites/Typha* swamps and *Bolboschoenus/Schoenoplectus* swamps should be combined to form an 'Other saltmarsh' zone. Similarly, the upper transitional zone should be considered part of the upper marsh zone.

It is recommended that reference values for this metric be revised in the future (following field tests) to reflect the eight relevant zones. This was beyond the scope of the current SMAATIE project.

The expected number of zones (reference value) differs depending on the type of saltmarsh present. The estuary type of saltmarsh would be expected to have five zones, as this type tends to have a high diversity of surfaces at different elevations owing to the presence of creeks, channels and eroding surfaces; this results in a range of different vegetation types (Curtis, 2003). The five expected zones are the pioneer zone, lower marsh, middle marsh, upper marsh and other saltmarsh habitats.

The bay and sandflat types of saltmarsh would be expected to have at least four zones. *Phragmites* swamps can be absent from these coastal types if there is no freshwater runoff or no creek system (UKTAG, 2013). If all swamp types and *Elytrigia* swards are absent from these types, then the required number of zones would necessitate the presence of the pioneer, lower marsh, middle marsh and upper marsh zones.

Zonation for the lagoonal type is dependent on the nature of the shore and the tidal range within the lagoon (Healy, 2003). Reeds, sedges and rushes are usually present, but overall saltmarsh vegetation is species-poor (Healy, 2003); the reference value for this type of saltmarsh is, therefore, set at two of the aforementioned zones.

The fringe saltmarsh type does not follow the classic dynamic model, and it is by definition composed of narrow areas of saltmarsh. The extent of this saltmarsh type is determined by its seaward gradient (Curtis and Sheehy Skeffington, 1998). The reference value for this type is also set at two of the aforementioned zones.

Many water bodies will contain more than one type of saltmarsh. Where this occurs, the reference value is set to the type that would be expected to contain the largest number of zones. In hierarchical terms, this would be: estuary (five zones) > bay and sandflats (four zones) > lagoon and fringe (two zones). It is strongly recommended that classification of individual saltmarsh sites in accordance with the scheme of Curtis and Sheehy Skeffington (1998) (bay, estuary, fringe, lagoon and sandflat) be reviewed.

It should be stressed that the reference conditions set here are guidelines only. Surveyors in the field should ultimately decide what the reference value should be on a water body by water body basis. The pioneer zone, for example, may be missing altogether if a saltmarsh is naturally undergoing erosion, and the reference value should reflect this natural state. For example, the expected number of zones for an eroding sandflat saltmarsh would be lowered from four zones to three. Similarly, some fringe saltmarsh sites may naturally have only one zone owing to the seaward gradient; therefore, the reference condition for these saltmarshes should be reduced from two zones to one. It should be noted that water bodies supporting only fringe saltmarsh comprising one zone may not contain sufficient habitat to warrant assessment under the WFD.

To be considered present within a water body for the purposes of this metric, the pioneer zone should comprise a minimum of 1% of the total saltmarsh area, excluding any area of *Spartina* swards, whereas all other zones should comprise a minimum of 5%.

The index value for this metric ($Ind_{\#Zones}$) is expressed as the number of zones present within the water body as a proportion of the reference value (expected number of zones) (Equation 5.3):

$$Ind_{\#Zones} = \frac{\text{Number of zones present}}{\text{Expected number of zones}} \times 100 \qquad (5.3)$$

5.2.3 Metric III: proportion of saltmarsh area covered by the dominant saltmarsh zone

The reference condition for this metric is that no one zone within the saltmarsh should dominate. Working from the maximum number of zones (currently five), with no one zone dominant over the others, the reference value for this metric is set to 20%. Dominance of any one zone suggests that the natural cycles of erosion and deposition, which are intrinsically linked to saltmarsh succession, are being impacted upon.

Although the reference value is set at 20%, the lower threshold of "High" status is set to 50% for the largest zone. This is to allow for some natural variation between the zones, for example, as an acknowledgement that the saltmarsh may have been undergoing an erosion or deposition event at the time of survey. As discussed above, both the lagoon and fringe type of saltmarsh can exhibit poor zonation naturally. It would be unfair to assess the ecological status of water bodies containing only these saltmarsh types as less than "Good" in relation to the dominant saltmarsh zone. For this reason, it is recommended that this metric not be applied when assessing these two saltmarsh types.

Modification of the tool

For Devaney and Perrin (2015), this calculation was not as straightforward. As mentioned above, the lower and middle marsh zones were mapped together as HD Annex I habitat 1330 Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) polygons. An approximation of the area of each of these zones was calculated based on the proportion of plots within this Annex I habitat classified as communities 2(a–e) and 3(a–d), respectively. The remaining three zones were mapped separately by the SMP.

Currently, zones should be combined for the purposes of this metric, as stated above for Metric II. If Metric II is changed to reflect the recording of eight different zones, they should be treated separately here also. Technically, the reference value for this metric would then have to be changed to 12.5% from 20%.

The index value for this metric (Ind_{ZnMax}) is expressed as the area of the largest zone as a proportion of the total saltmarsh area, excluding areas of *Spartina* swards (Equation 5.4):

$$Ind_{ZnMax} = \frac{\text{Area of largest zone}}{\text{Area}_{\text{current (excl. } Spartina)}} \times 100 \qquad (5.4)$$

5.2.4 Metric IV: proportion of saltmarsh composed of Spartina

The reference condition for this metric is the absence of *Spartina* swards. *Spartina* is a non-native genus in Ireland, which was first planted in Cork Harbour in 1925 (McCorry *et al.*, 2003). Although non-native, the presence of *Spartina* can, however, have some positive effects on saltmarsh. These include the promotion of saltmarsh development through rapid sediment accretion and the protection of seaward zones from erosion. The lower threshold for "High" class status is therefore set at 5% to acknowledge the potential for net positive effects of *Spartina* swards at lower abundances. The EPA's stance on invasive species is that, although, ideally, no invasive species should be present at the reference condition, the water body can still attain high status in the presence of a small amounts of such species, providing that no impact on the BQEs can be observed (Robert Wilkes, EPA, personal communication, 9 May 2014).

The index value for this metric ($\text{Ind}_{Spartina}$) is expressed as the area of *Spartina* swards as a proportion of the total saltmarsh area (Equation 5.5):

$$\text{Ind}_{Spartina} = \frac{\text{Area of } Spartina \text{ swards}}{\text{Area}_{\text{current}}} \times 100 \qquad (5.5)$$

Modification of the tool

Use of the *Spartina* metric can also be developed with future monitoring by looking at increases or decreases in $\text{EQR}_{Spartina}$ over time. In particular, a spread of *Spartina* into any water body where it was not recorded previously, even if the proportion of extent is <5%, needs to be instantly flagged so that this can be monitored and control measurements put in place as soon as possible to prevent further spread.

Table 5.1. List of halophytes with their characteristic classes/communities (see Table 4.1 for community names)

Species	Characteristic class/ community	Category
Armeria maritima	2, 3, 4	C
Aster tripolium	2, 3, 4	C
Atriplex portulacoides	1, 2	C
Atriplex prostrata	3, 5, 6	C
Blysmus rufus	3	R
Bolboschoenus maritimus	6a, 6b, 6c	C
Carex extensa	3, 4, 5	C
Centaurium pulchellum	5	R
Cochlearia spp.	2, 3, 4	C
Eleocharis uniglumis	5, 6	C
Elytrigia atherica	6d	R
Elytrigia repens	6d	C
Glaux maritima	3, 4, 5	C
Juncus acutus	4	R
Juncus gerardii	3, 4, 5	C
Juncus maritimus	4	C
Limonium binervosum agg.	2	C
Limonium humile	1, 2	C
Oenanthe lachenalli	4, 5	C
Phragmites australis	6a, 6b, 6c	C
Plantago coronopus	3, 5	C
Plantago maritima	2, 3, 4	C
Puccinellia maritima	2	C
Salicornia spp.	1	C
Samolus valerandi	4, 5, 6	C
Sarcocornia perennis	1, 2	R
Schoenoplectus tabernaemontani	6a, 6b, 6c	C
Seriphidium maritimum	2, 3, 4	R
Spergularia spp.	2	C
Suaeda maritima	1, 2	C
Trifolium fragiferum	5	R
Triglochin maritima	2, 3, 4	C

Under category, "C" indicates a common halophyte requiring 15% frequency to score and "R" indicates a rare halophyte requiring presence only to score.

5.2.5 Metric V: proportion of observed taxa up to 15 taxa

The reference condition for this metric is the presence within saltmarsh habitat of at least 15 of the halophytes listed in Table 5.1. Relatively common halophytes are counted only if they have a frequency of at least 15% in terms of the number of plots in which they are present within their characteristic vegetation classes (or communities). Locally distinctive plants, however, are counted solely on their presence within the water body. The reference value of 15 taxa is approximately half the number of Irish halophyte taxa, but is otherwise arbitrarily selected.

The index value for this metric (Ind_{Taxa}) is expressed as the number of halophytes present as a proportion of the minimum requirement of 15 taxa (Equation 5.6). If Ind_{Taxa} is > 100, it is truncated to 100:

$$Ind_{Taxa} = \frac{\text{No of common taxa + No of rare taxa}}{15} \times 100 \quad (5.6)$$

Modification of the tool

A potential metric would be a measure of the presence or abundance of specific indicator species for disturbance. Abundant *Agrostis stolonifera* may be a good indicator of eutrophication and, similarly, an absence of *Atriplex portulacoides* could indicate overgrazing. There is currently, however, insufficient research in this area to develop this metric for the tool.

Species checklists specific to each water body should be considered in an additional metric for the disturbance-sensitive taxa element. This metric would compare current species lists with those from previous rounds of monitoring.

5.3 Normalisation and Weighting

5.3.1 Normalisation of index values

To allow for the combination of all indices, each index value needs to be normalised to the EQR scale (0.0–1.0, with five equidistant class divisions). The same approach used by UKTAG (2013) is applied here, as shown in Equation 5.7, where Ind indicates index values, EQR indicates normalised values, Upper is the relevant upper class boundary, Lower is the relevant lower class boundary, and *x* is one of the five metrics (area, number of zones, ZnMax, *Spartina* or taxa):

$$EQR_x = EQR_{Upper} - \left(\left(Ind_x - Ind_{Upper} \right) \times \left(\frac{0.2}{Ind_{Lower} - Ind_{Upper}} \right) \right) \quad (5.7)$$

Modification of the tool

The values for the Lower index class boundary, Upper index class boundary and Index class range for the next version of SMAATIE and the EQR calculator will need to be adjusted once Metrics II and III are modified.

All of the values to be used in Equation 5.7 are taken from Table 5.2, with the exception of Ind_x, which is calculated for each metric using Equations 5.2–5.6 above. If an index or EQR corresponds exactly with a class boundary, the upper class division is taken. A worked example is given in Appendix 2.

5.3.2 Overall Ecological Quality Ratio and weightings

The overall EQR value for each water body containing saltmarsh ($EQR_{Overall}$) can be calculated using Equation 5.8 once individual EQRs for the above metrics have been normalised (see bottom of page).

Some metrics are deemed to be more important than others and have higher weightings. The metric for angiosperm abundance (EQR_{Area}) is deemed to be of primary importance; even if the metrics for taxonomic composition and disturbance-sensitive taxa score highly, a low EQR_{Area} score will prevent a water body from scoring highly overall.

Three different metrics are used to assess taxonomic composition compared with one metric for each of the other two key elements. Two of the metrics for taxonomic composition, EQR_{ZnMax} and $EQR_{Spartina}$, are downweighted for this reason. Another reason for downweighting $EQR_{Spartina}$ is because of the level of uncertainty in where the threshold between net positive and negative effects of *Spartina* swards actually lies in terms of relative *Spartina* abundance.

The final element, disturbance-sensitive taxa, is assessed using EQR_{Taxa}. There is some overlap between this metric and those of taxonomic composition, as

$$EQR_{Overall} = \frac{\left(3 \times EQR_{Area}\right) + \left(1 \times EQR_{\#Zones}\right) + \left(0.5 \times EQR_{ZnMax}\right) + \left(0.5 \times EQR_{Spartina}\right) + \left(1 \times EQR_{Taxa}\right)}{6} \quad (5.8)$$

Table 5.2. Values for the normalisation of index values to EQR values for the five metrics

	Class division	Lower index class boundary	Upper index class boundary	Index class range	Lower EQR class boundary	Upper EQR class boundary	EQR class range
Ind_{Area}	High	80	100	20	0.8	1.0	0.2
	Good	60	80	20	0.6	0.8	0.2
	Moderate	40	60	20	0.4	0.6	0.2
	Poor	20	40	20	0.2	0.4	0.2
	Bad	0	20	20	0	0.2	0.2
$Ind_{\#Zones}$	High	80	100	20	0.8	1.0	0.2
	Good	60	80	20	0.6	0.8	0.2
	Moderate	40	60	20	0.4	0.6	0.2
	Poor	20	40	20	0.2	0.4	0.2
	Bad	0	20	20	0	0.2	0.2
Ind_{ZnMax}	High	50	20	30	0.8	1.0	0.2
	Good	60	50	10	0.6	0.8	0.2
	Moderate	70	60	10	0.4	0.6	0.2
	Poor	80	70	10	0.2	0.4	0.2
	Bad	100	80	20	0	0.2	0.2
$Ind_{Spartina}$	High	5	0	5	0.8	1.0	0.2
	Good	15	5	10	0.6	0.8	0.2
	Moderate	30	15	15	0.4	0.6	0.2
	Poor	50	30	20	0.2	0.4	0.2
	Bad	100	50	50	0	0.2	0.2
Ind_{Taxa}	High	80	100	20	0.8	1.0	0.2
	Good	60	80	20	0.6	0.8	0.2
	Moderate	40	60	20	0.4	0.6	0.2
	Poor	20	40	20	0.2	0.4	0.2
	Bad	0	20	20	0	0.2	0.2

species composition is linked to the number of zones present. For this reason, disturbance-sensitive taxa has the lowest overall weighting of the three key elements.

Modification of the tool

If any of the additional metrics outlined above are adopted in future versions of the tool and EQR calculator (e.g. recent change in saltmarsh extent, disturbance indicator species), the weightings within Equation 5.8 will have to be re-examined and modified.

6. Results

The outcome of using SMAATIE is the production of an overall EQR value for the water body being assessed. The overall EQR value can be easily related to the ecological status of the water body (Table 6.1). If the overall EQR value corresponds exactly with a class boundary (i.e. 0.20, 0.40, 0.60, 0.80), the upper class division is taken. For example, an overall EQR value of 0.60 gives an ecological status of “Good”.

Table 6.1. The relationship between the overall EQR value of a water body and its ecological status

EQR values	Ecological status
0.80–1.00	High
0.60–0.80	Good
0.40–0.60	Moderate
0.20–0.40	Poor
0.00–0.20	Bad

7. Testing

Devaney and Perrin (2015) analysed the overall EQR values in relation to impact and status data. The testing of the tool is an important part of the intercalibration process because, if the results of the metrics developed for SMAATIE show no relationship with the impacts recorded within the water bodies, the boundary-setting process for these metrics cannot proceed (EC, 2011). Statistical analyses included analysis of variance for categorical data and Pearson's product moment correlation for numerical data.

Modification of the tool

If there is any modification to SMAATIE, this testing step must be carried out again in order to ensure compliance with the intercalibration process, and to ensure that the next version of SMAATIE is working as it should.

This step should ideally be repeated even if SMAATIE is not modified, as it is hoped that the future recording of impact data for TraC water bodies will include the recording of new risk categories that are more applicable to saltmarshes.

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Abbreviations

BQE	Biological Quality Element
EPA	Environmental Protection Agency
EQR	Ecological Quality Ratio
ETRF	European Terrestrial Reference Frame
EU	European Union
GIS	Geographical Information System
GRASS	Geographic Resources Analysis Support System
HAT	Highest astronomical tide
HD	Habitats Directive
INFOMAR	Integrated Mapping for the Sustainable Development of Ireland's Marine Resource
LiDaR	Light Detection and Ranging
LAT	Lowest astronomical tide
MH	Malin Head
MHW	Mean high water
MS	Member State
NPWS	National Parks and Wildlife Service
OPW	Office of Public Works
OS	Ordnance Survey
PSA	Potential saltmarsh area
SMAATIE	Saltmarsh Angiosperm Assessment Tool for Ireland
SMP	Saltmarsh Monitoring Project
TraC	Transitional and coastal
VORF	Vertical Offshore Reference Frame
WFD	Water Framework Directive

Appendix 1 Screen Shots of the SMAATIE EQR Calculator Version 1.0

The SMAATIE EQR calculator is a Microsoft Excel™ file comprising six worksheets.

The first worksheet, “README”, provides information for the practitioner and lists the data requirements for the calculator.

The second worksheet, “Input data”, is the sheet in which the practitioner enters the data required for the calculation of the overall EQR value and ecological status. Columns highlighted in green must be filled in for each water body being assessed. The Expected # Zones column updates automatically depending on the type of saltmarsh selected from the dropdown menu (“SM type” column); however, this number can be over-ridden if the practitioner thinks that a different number of expected zones should be used based on expert opinion.

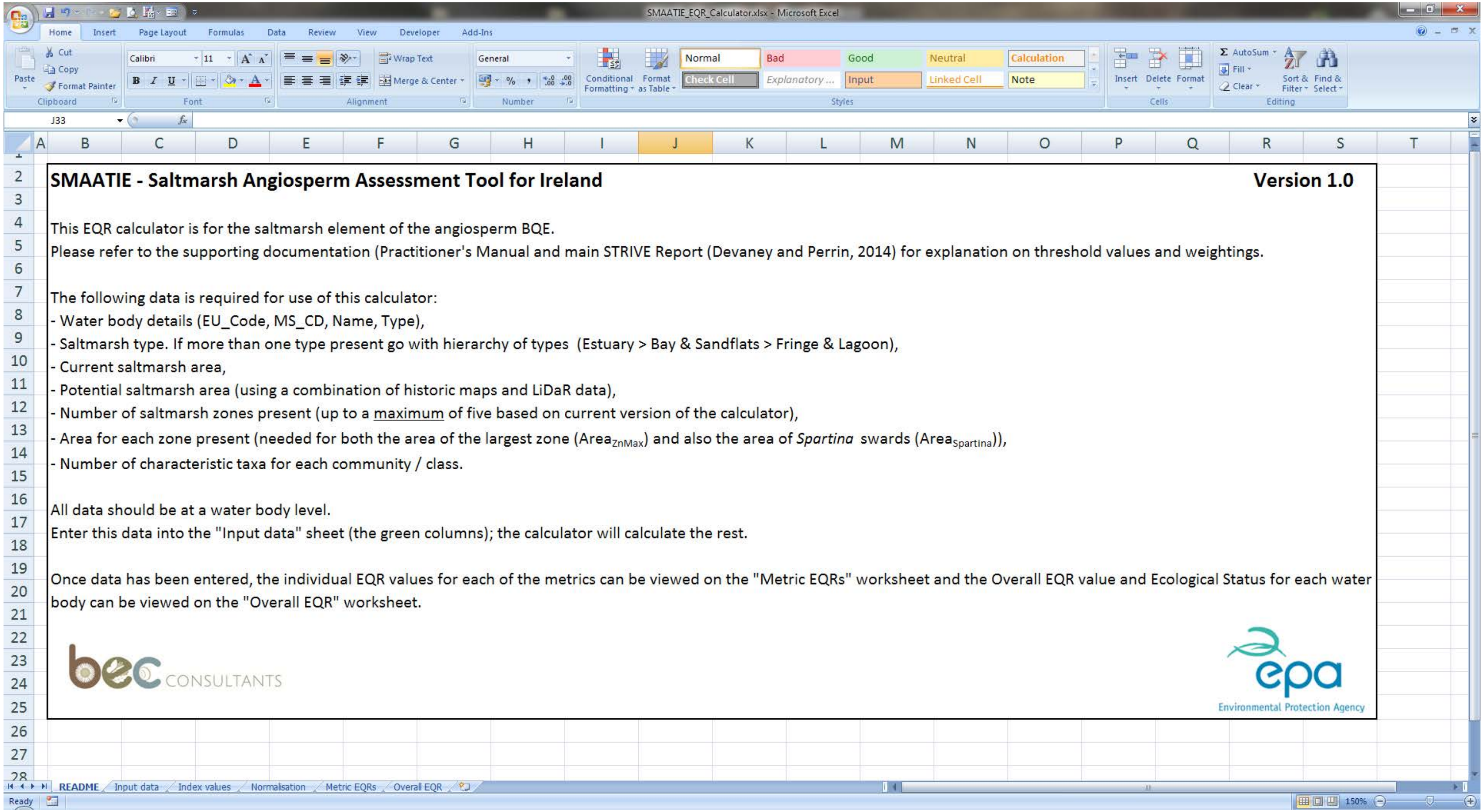
The third and fourth worksheets, “Index values” and “Normalisation”, are the internal calculations of the calculator. These worksheets cannot be edited by the practitioner.

The fifth and sixth worksheets, “Metric EQRs” and “Overall EQR”, are the outputs of the calculator. “Metric EQRs” provides the practitioner with the individual EQR values for each of the five metrics, and “Overall EQR” provides the practitioner with the overall EQR value and the ecological status for each water body being assessed.

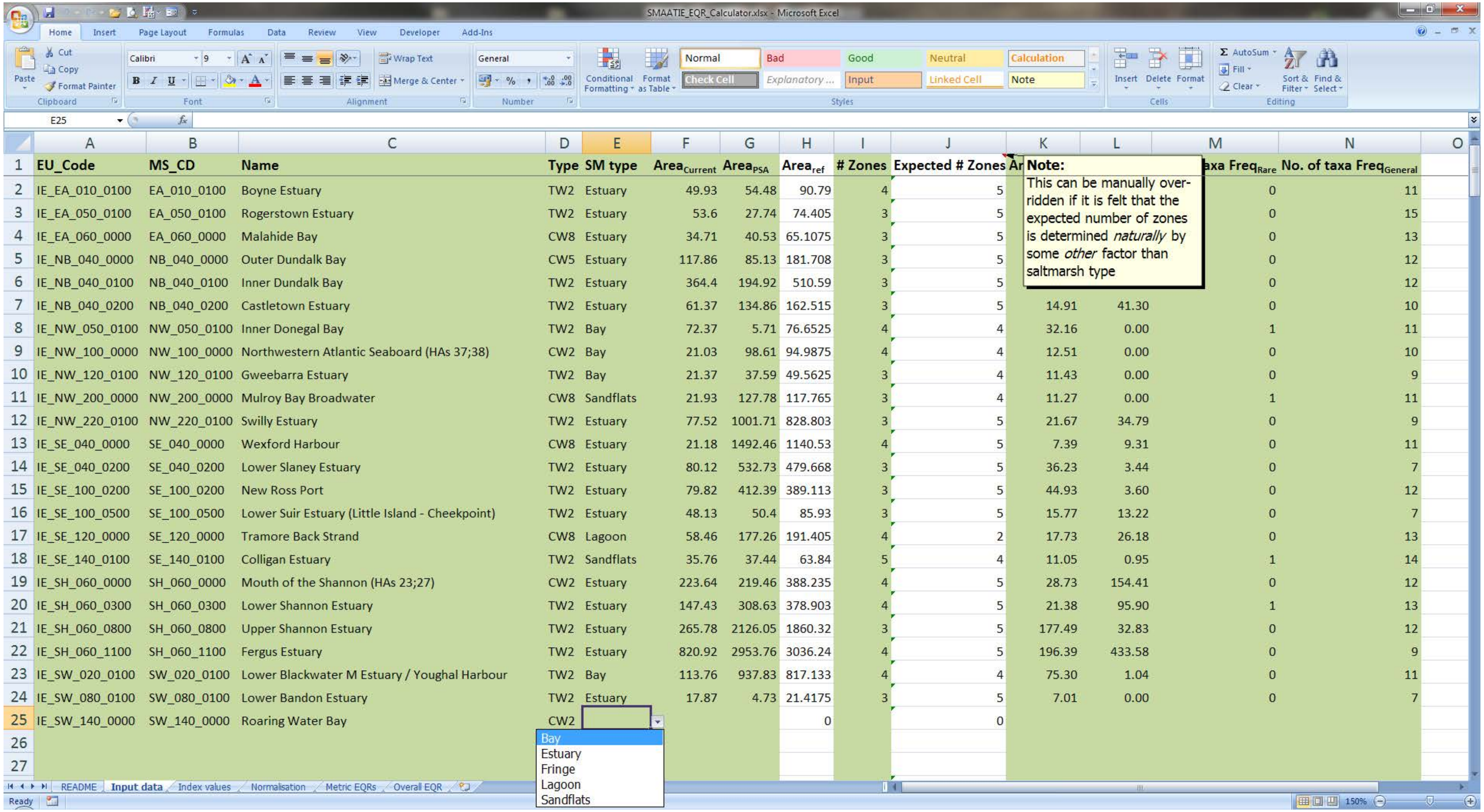
This appendix contains the following screen shots of the SMAATIE EQR Calculator, partially filled in using the data collated for the 40 sample water bodies used by Devaney and Perrin (2015):

- the “README” worksheet;
- the “Input data” worksheet;
- the “Metric EQRs” worksheet;
- the “Overall EQR” worksheet.

“README” Worksheet

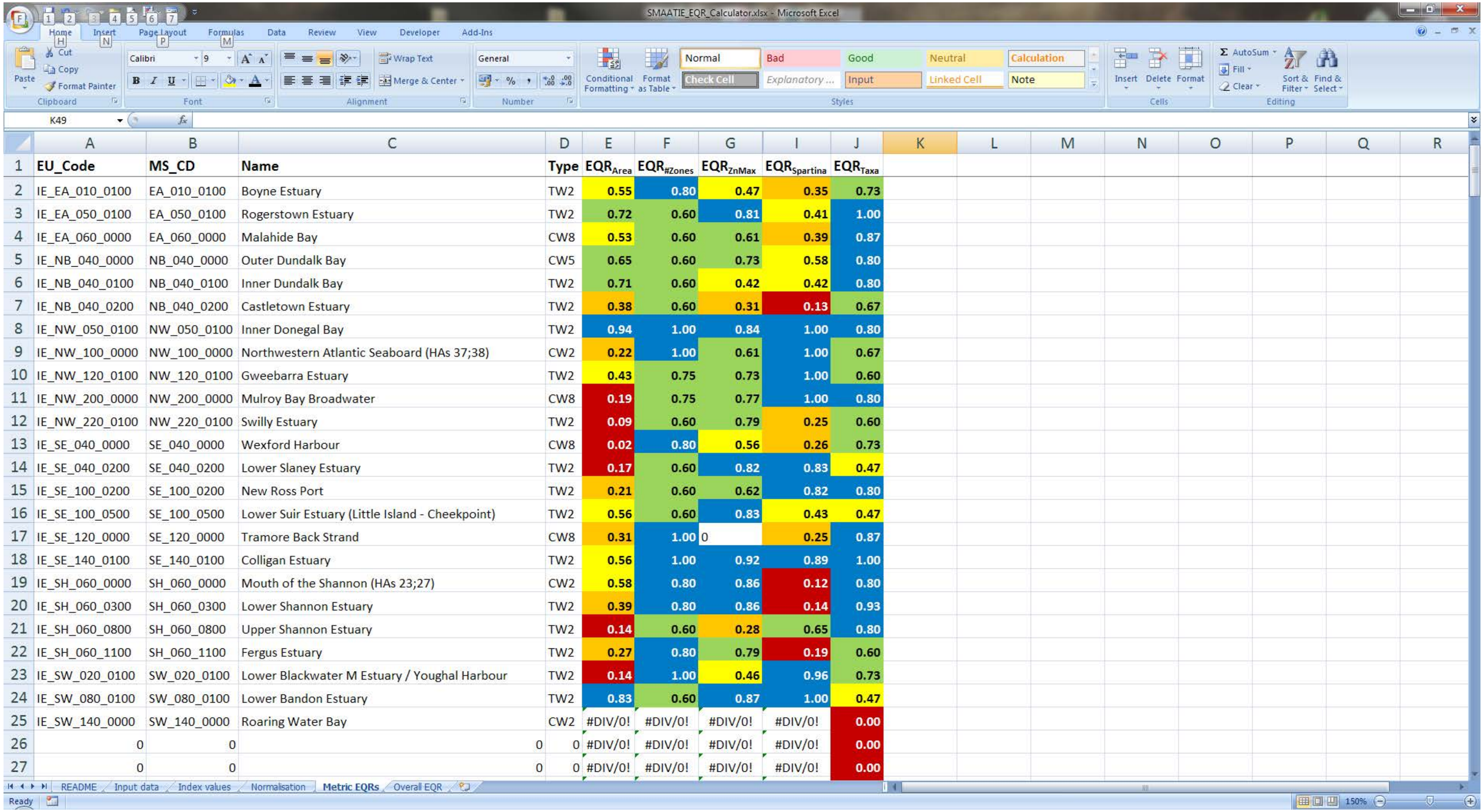


“Input data” Worksheet



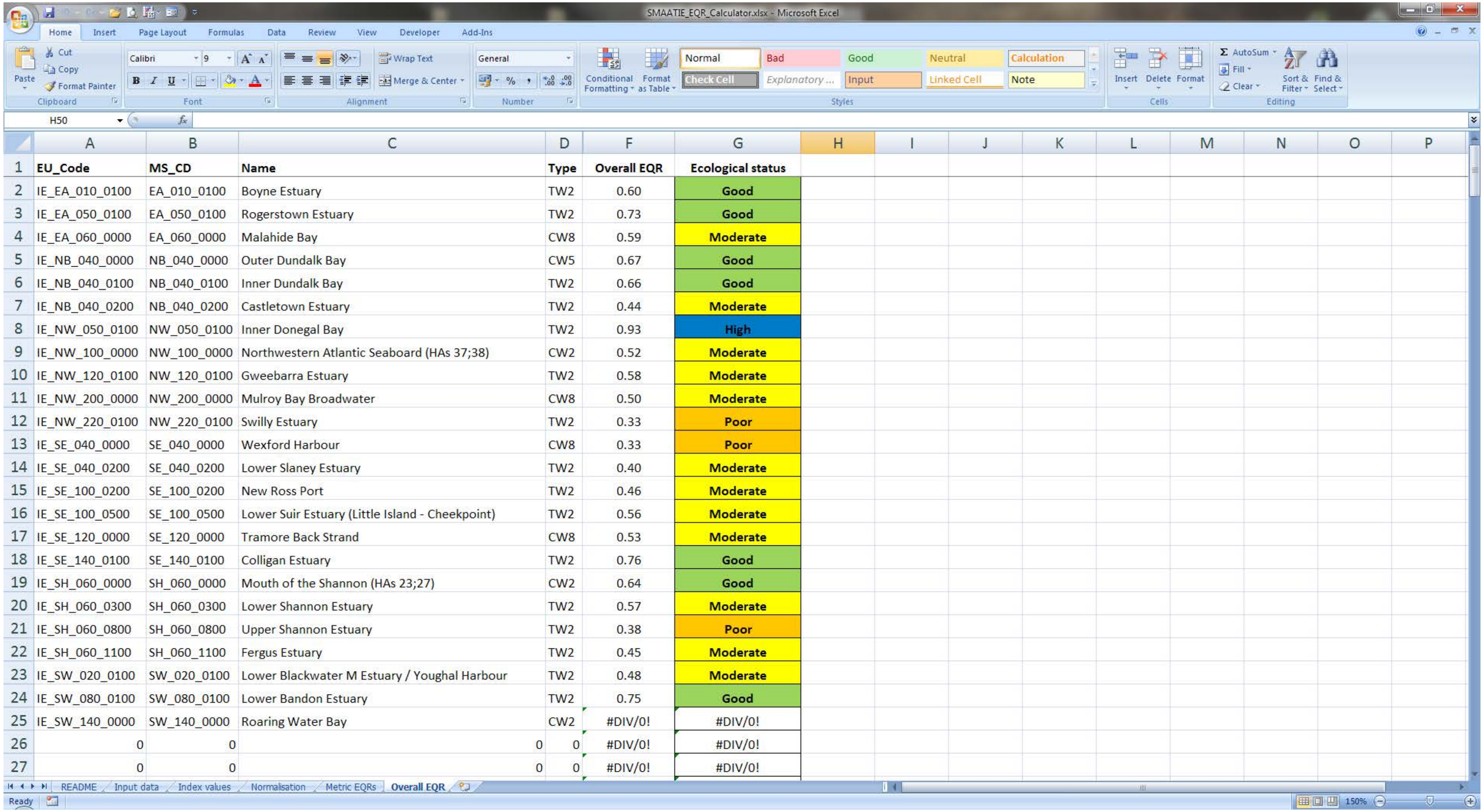
	EU_Code	MS_CD	Name	Type	SM type	$Area_{Current}$	$Area_{PSA}$	$Area_{ref}$	# Zones	Expected # Zones	Ar		axa $Freq_{Rare}$	No. of taxa $Freq_{General}$
2	IE_EA_010_0100	EA_010_0100	Boyne Estuary	TW2	Estuary	49.93	54.48	90.79	4	5			0	11
3	IE_EA_050_0100	EA_050_0100	Rogerstown Estuary	TW2	Estuary	53.6	27.74	74.405	3	5			0	15
4	IE_EA_060_0000	EA_060_0000	Malahide Bay	CW8	Estuary	34.71	40.53	65.1075	3	5			0	13
5	IE_NB_040_0000	NB_040_0000	Outer Dundalk Bay	CW5	Estuary	117.86	85.13	181.708	3	5			0	12
6	IE_NB_040_0100	NB_040_0100	Inner Dundalk Bay	TW2	Estuary	364.4	194.92	510.59	3	5			0	12
7	IE_NB_040_0200	NB_040_0200	Castletown Estuary	TW2	Estuary	61.37	134.86	162.515	3	5	14.91	41.30	0	10
8	IE_NW_050_0100	NW_050_0100	Inner Donegal Bay	TW2	Bay	72.37	5.71	76.6525	4	4	32.16	0.00	1	11
9	IE_NW_100_0000	NW_100_0000	Northwestern Atlantic Seaboard (HAs 37;38)	CW2	Bay	21.03	98.61	94.9875	4	4	12.51	0.00	0	10
10	IE_NW_120_0100	NW_120_0100	Gweebarra Estuary	TW2	Bay	21.37	37.59	49.5625	3	4	11.43	0.00	0	9
11	IE_NW_200_0000	NW_200_0000	Mulroy Bay Broadwater	CW8	Sandflats	21.93	127.78	117.765	3	4	11.27	0.00	1	11
12	IE_NW_220_0100	NW_220_0100	Swilly Estuary	TW2	Estuary	77.52	1001.71	828.803	3	5	21.67	34.79	0	9
13	IE_SE_040_0000	SE_040_0000	Wexford Harbour	CW8	Estuary	21.18	1492.46	1140.53	4	5	7.39	9.31	0	11
14	IE_SE_040_0200	SE_040_0200	Lower Slaney Estuary	TW2	Estuary	80.12	532.73	479.668	3	5	36.23	3.44	0	7
15	IE_SE_100_0200	SE_100_0200	New Ross Port	TW2	Estuary	79.82	412.39	389.113	3	5	44.93	3.60	0	12
16	IE_SE_100_0500	SE_100_0500	Lower Suir Estuary (Little Island - Cheekpoint)	TW2	Estuary	48.13	50.4	85.93	3	5	15.77	13.22	0	7
17	IE_SE_120_0000	SE_120_0000	Tramore Back Strand	CW8	Lagoon	58.46	177.26	191.405	4	2	17.73	26.18	0	13
18	IE_SE_140_0100	SE_140_0100	Colligan Estuary	TW2	Sandflats	35.76	37.44	63.84	5	4	11.05	0.95	1	14
19	IE_SH_060_0000	SH_060_0000	Mouth of the Shannon (HAs 23;27)	CW2	Estuary	223.64	219.46	388.235	4	5	28.73	154.41	0	12
20	IE_SH_060_0300	SH_060_0300	Lower Shannon Estuary	TW2	Estuary	147.43	308.63	378.903	4	5	21.38	95.90	1	13
21	IE_SH_060_0800	SH_060_0800	Upper Shannon Estuary	TW2	Estuary	265.78	2126.05	1860.32	3	5	177.49	32.83	0	12
22	IE_SH_060_1100	SH_060_1100	Fergus Estuary	TW2	Estuary	820.92	2953.76	3036.24	4	5	196.39	433.58	0	9
23	IE_SW_020_0100	SW_020_0100	Lower Blackwater M Estuary / Youghal Harbour	TW2	Bay	113.76	937.83	817.133	4	4	75.30	1.04	0	11
24	IE_SW_080_0100	SW_080_0100	Lower Bandon Estuary	TW2	Estuary	17.87	4.73	21.4175	3	5	7.01	0.00	0	7
25	IE_SW_140_0000	SW_140_0000	Roaring Water Bay	CW2				0		0				

“Metric EQRs” Worksheet



	A	B	C	D	E	F	G	I	J
1	EU_Code	MS_CD	Name	Type	EQR_{Area}	$EQR_{\#Zones}$	EQR_{ZnMax}	$EQR_{Spartina}$	EQR_{Taxa}
2	IE_EA_010_0100	EA_010_0100	Boyne Estuary	TW2	0.55	0.80	0.47	0.35	0.73
3	IE_EA_050_0100	EA_050_0100	Rogerstown Estuary	TW2	0.72	0.60	0.81	0.41	1.00
4	IE_EA_060_0000	EA_060_0000	Malahide Bay	CW8	0.53	0.60	0.61	0.39	0.87
5	IE_NB_040_0000	NB_040_0000	Outer Dundalk Bay	CW5	0.65	0.60	0.73	0.58	0.80
6	IE_NB_040_0100	NB_040_0100	Inner Dundalk Bay	TW2	0.71	0.60	0.42	0.42	0.80
7	IE_NB_040_0200	NB_040_0200	Castletown Estuary	TW2	0.38	0.60	0.31	0.13	0.67
8	IE_NW_050_0100	NW_050_0100	Inner Donegal Bay	TW2	0.94	1.00	0.84	1.00	0.80
9	IE_NW_100_0000	NW_100_0000	Northwestern Atlantic Seaboard (HAs 37;38)	CW2	0.22	1.00	0.61	1.00	0.67
10	IE_NW_120_0100	NW_120_0100	Gweebarra Estuary	TW2	0.43	0.75	0.73	1.00	0.60
11	IE_NW_200_0000	NW_200_0000	Mulroy Bay Broadwater	CW8	0.19	0.75	0.77	1.00	0.80
12	IE_NW_220_0100	NW_220_0100	Swilly Estuary	TW2	0.09	0.60	0.79	0.25	0.60
13	IE_SE_040_0000	SE_040_0000	Wexford Harbour	CW8	0.02	0.80	0.56	0.26	0.73
14	IE_SE_040_0200	SE_040_0200	Lower Slaney Estuary	TW2	0.17	0.60	0.82	0.83	0.47
15	IE_SE_100_0200	SE_100_0200	New Ross Port	TW2	0.21	0.60	0.62	0.82	0.80
16	IE_SE_100_0500	SE_100_0500	Lower Suir Estuary (Little Island - Cheekpoint)	TW2	0.56	0.60	0.83	0.43	0.47
17	IE_SE_120_0000	SE_120_0000	Tramore Back Strand	CW8	0.31	1.00	0	0.25	0.87
18	IE_SE_140_0100	SE_140_0100	Colligan Estuary	TW2	0.56	1.00	0.92	0.89	1.00
19	IE_SH_060_0000	SH_060_0000	Mouth of the Shannon (HAs 23;27)	CW2	0.58	0.80	0.86	0.12	0.80
20	IE_SH_060_0300	SH_060_0300	Lower Shannon Estuary	TW2	0.39	0.80	0.86	0.14	0.93
21	IE_SH_060_0800	SH_060_0800	Upper Shannon Estuary	TW2	0.14	0.60	0.28	0.65	0.80
22	IE_SH_060_1100	SH_060_1100	Fergus Estuary	TW2	0.27	0.80	0.79	0.19	0.60
23	IE_SW_020_0100	SW_020_0100	Lower Blackwater M Estuary / Youghal Harbour	TW2	0.14	1.00	0.46	0.96	0.73
24	IE_SW_080_0100	SW_080_0100	Lower Bandon Estuary	TW2	0.83	0.60	0.87	1.00	0.47
25	IE_SW_140_0000	SW_140_0000	Roaring Water Bay	CW2	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	0.00
26	0	0	0	0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	0.00
27	0	0	0	0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	0.00

“Overall EQR” Worksheet



	A	B	C	D	F	G
1	EU_Code	MS_CD	Name	Type	Overall EQR	Ecological status
2	IE_EA_010_0100	EA_010_0100	Boyne Estuary	TW2	0.60	Good
3	IE_EA_050_0100	EA_050_0100	Rogerstown Estuary	TW2	0.73	Good
4	IE_EA_060_0000	EA_060_0000	Malahide Bay	CW8	0.59	Moderate
5	IE_NB_040_0000	NB_040_0000	Outer Dundalk Bay	CW5	0.67	Good
6	IE_NB_040_0100	NB_040_0100	Inner Dundalk Bay	TW2	0.66	Good
7	IE_NB_040_0200	NB_040_0200	Castletown Estuary	TW2	0.44	Moderate
8	IE_NW_050_0100	NW_050_0100	Inner Donegal Bay	TW2	0.93	High
9	IE_NW_100_0000	NW_100_0000	Northwestern Atlantic Seaboard (HAs 37;38)	CW2	0.52	Moderate
10	IE_NW_120_0100	NW_120_0100	Gweebarra Estuary	TW2	0.58	Moderate
11	IE_NW_200_0000	NW_200_0000	Mulroy Bay Broadwater	CW8	0.50	Moderate
12	IE_NW_220_0100	NW_220_0100	Swilly Estuary	TW2	0.33	Poor
13	IE_SE_040_0000	SE_040_0000	Wexford Harbour	CW8	0.33	Poor
14	IE_SE_040_0200	SE_040_0200	Lower Slaney Estuary	TW2	0.40	Moderate
15	IE_SE_100_0200	SE_100_0200	New Ross Port	TW2	0.46	Moderate
16	IE_SE_100_0500	SE_100_0500	Lower Suir Estuary (Little Island - Cheekpoint)	TW2	0.56	Moderate
17	IE_SE_120_0000	SE_120_0000	Tramore Back Strand	CW8	0.53	Moderate
18	IE_SE_140_0100	SE_140_0100	Colligan Estuary	TW2	0.76	Good
19	IE_SH_060_0000	SH_060_0000	Mouth of the Shannon (HAs 23;27)	CW2	0.64	Good
20	IE_SH_060_0300	SH_060_0300	Lower Shannon Estuary	TW2	0.57	Moderate
21	IE_SH_060_0800	SH_060_0800	Upper Shannon Estuary	TW2	0.38	Poor
22	IE_SH_060_1100	SH_060_1100	Fergus Estuary	TW2	0.45	Moderate
23	IE_SW_020_0100	SW_020_0100	Lower Blackwater M Estuary / Youghal Harbour	TW2	0.48	Moderate
24	IE_SW_080_0100	SW_080_0100	Lower Bandon Estuary	TW2	0.75	Good
25	IE_SW_140_0000	SW_140_0000	Roaring Water Bay	CW2	#DIV/0!	#DIV/0!
26	0	0	0	0	#DIV/0!	#DIV/0!
27	0	0	0	0	#DIV/0!	#DIV/0!

Appendix 2 Worked Example of Application of SMAATIE

This worked example is provided to aid practitioners in the application of SMAATIE to assess the ecological status of a TraC water body. This method can be used in the absence of the SMAATIE EQR Calculator (Microsoft Excel™ file).

This worked example is based on data from the Kilmakilloge Harbour water body (MS code: SW_190_0200). Data were collated for this water body and 39 other sample water bodies in Devaney and Perrin (2015).

Measured parameters:

$Area_{current}$	11.76 ha	
$Area_{PSA}$	4.04 ha	
$Area_{ref}$	14.79 ha	(calculated using Equation 5.1)
Ind_{Area}	**79.5%**	(calculated using Equation 5.2)
No of zones present	3	
Saltmarsh type	Fringe	
Expected no of zones	2	
$Ind_{\#zones}$	**100%**	(calculated using Equation 5.3)
Area of largest zone	9.02 ha	
Ind_{ZnMax}	**76.7%**	(calculated using Equation 5.4)
Area of *Spartina*	0.00 ha	
$Ind_{Spartina}$	**0%**	(calculated using Equation 5.5)
No of common taxa	11	
No of rare taxa	0	
Ind_{Taxa}	**73.3%**	(calculated using Equation 5.6)

Using the values from Table 5.2, Equation 5.7 is populated as follows for each of the five metrics:

$$EQR_{Area} = 0.8 - \left(\left(\mathbf{79.5} - 80 \right) \times \left(\frac{0.2}{-20} \right) \right) = 0.80 \left(\text{High} \right) \quad \text{(A2.1)}$$

$$EQR_{\#Zones} = 1.0 - \left(\left(\mathbf{100} - 100 \right) \times \left(\frac{0.2}{-20} \right) \right) = 1.00 \left(\text{High} \right) \quad \text{(A2.2)}$$

$$EQR_{ZnMax} = \text{Not applicable} \quad \text{(A2.3)}$$

$$EQR_{Spartina} = 1.0 - \left(\left(\mathbf{0.0} - 0 \right) \times \left(\frac{0.2}{5} \right) \right) = 1.00 \left(\text{High} \right) \quad \text{(A2.4)}$$

$$EQR_{Taxa} = 0.8 - \left(\left(\mathbf{73.3} - 80 \right) \times \left(\frac{0.2}{-20} \right) \right) = 0.73 \left(\text{Good} \right) \quad \text{(A2.5)}$$

Using these EQR values, the overall EQR value (and overall status) can be calculated by populating Equation 5.8 (see bottom of page).

$$EQR_{Overall} = \frac{\left(3 \times 0.80\right) + \left(1 \times 1.00\right) + \left(0.5 \times \text{Not applicable}\right) + \left(0.5 \times 100\right) + \left(1 \times 0.73\right)}{6 - 0.5\left(\text{ZnMax: not applicable}\right)} = 0.84 \left(\text{High}\right) \quad \text{(A2.6)}$$

AN GHNÍOMHAIREACHT UM CHAOMHNÚ COMHSHAOIL

Tá an Ghníomhaireacht um Chaomhnú Comhshaoil (GCC) freagrach as an gcomhshaol a chaomhnú agus a fheabhsú mar shócmhainn luachmhar do mhuintir na hÉireann. Táimid tiomanta do dhaoine agus don chomhshaol a chosaint ó éifeachtaí díobhálacha na radaíochta agus an truaillithe.

Is féidir obair na Gníomhaireachta a roinnt ina trí phríomhréimse:

Rialú: *Déanaimid córais éifeachtacha rialaithe agus comhlíonta comhshaoil a chur i bhfeidhm chun torthaí maithe comhshaoil a sholáthar agus chun díriú orthu siúd nach gcloíonn leis na córais sin.*

Eolas: *Soláthraímid sonraí, faisnéis agus measúnú comhshaoil atá ar ardchaighdeán, spriocdhírithe agus tráthúil chun bonn eolais a chur faoin gcinnteoireacht ar gach leibhéal.*

Tacaíocht: *Bímid ag saothrú i gcomhar le grúpaí eile chun tacú le comhshaol atá glan, táirgiúil agus cosanta go maith, agus le hiompar a chuirfidh le comhshaol inbhuanaithe.*

Ár bhFreagrachtaí

Ceadúnú

- Déanaimid na gníomhaíochtaí seo a leanas a rialú ionas nach ndéanann siad dochar do shláinte an phobail ná don chomhshaol:
- saoráidí dramhaíola (m.sh. láithreáin líonta talún, loisceoirí, stáisiúin aistrithe dramhaíola);
- gníomhaíochtaí tionsclaíocha ar scála mór (m.sh. déantúsaíocht cógaisíochta, déantúsaíocht stroighne, stáisiúin chumhachta);
- an diantalmhaíocht (m.sh. muca, éanlaith);
- úsáid shrianta agus scaoileadh rialaithe Orgánach Géinmhodhnaithe (OGM);
- foinsí radaíochta ianúcháin (m.sh. trealamh x-gha agus radaiteiripe, foinsí tionsclaíocha);
- áiseanna móra stórála peitril;
- scardadh dramhuisce;
- gníomhaíochtaí dumpála ar farraige.

Forfheidhmiú Náisiúnta i leith Cúrsaí Comhshaoil

- Clár náisiúnta iniúchtaí agus cigireachtaí a dhéanamh gach bliain ar shaoráidí a bhfuil ceadúnas ón nGníomhaireacht acu.
- Maoirseacht a dhéanamh ar fhreagrachtaí cosanta comhshaoil na n-údarás áitiúil.
- Caighdeán an uisce óil, arna sholáthar ag soláthraithe uisce phoiblí, a mhaoirsiú.
- Obair le húdaráis áitiúla agus le gníomhaireachtaí eile chun dul i ngleic le coireanna comhshaoil trí chomhordú a dhéanamh ar líonra forfheidhmiúcháin náisiúnta, trí dhíriú ar chiontóirí, agus trí mhaoirsiú a dhéanamh ar leasúchán.
- Cur i bhfeidhm rialachán ar nós na Rialachán um Dhramhthrealamh Leictreach agus Leictreonach (DTLL), um Shrian ar Shubstaintí Guaiseacha agus na Rialachán um rialú ar shubstaintí a ídíonn an ciseal ózóin.
- An dlí a chur orthu siúd a bhriseann dlí an chomhshaoil agus a dhéanann dochar don chomhshaol.

Bainistíocht Uisce

- Monatóireacht agus tuairisciú a dhéanamh ar cháilíocht aibhneacha, lochanna, uiscí idirchriosacha agus cósta na hÉireann, agus screamhuiscí; leibhéil uisce agus sruthanna aibhneacha a thomhas.
- Comhordú náisiúnta agus maoirsiú a dhéanamh ar an gCreat-Treoir Uisce.
- Monatóireacht agus tuairisciú a dhéanamh ar Cháilíocht an Uisce Snámha.

Monatóireacht, Anailís agus Tuairisciú ar an gComhshaol

- Monatóireacht a dhéanamh ar cháilíocht an aeir agus Treoir an AE maidir le hAer Glan don Eoraip (CAFÉ) a chur chun feidhme.
- Tuairisciú neamhspleách le cabhrú le cinnteoireacht an rialtais náisiúnta agus na n-údarás áitiúil (m.sh. tuairisciú tréimhsiúil ar staid Chomhshaol na hÉireann agus Tuarascálacha ar Tháscairí).

Rialú Astaíochtaí na nGás Ceaptha Teasa in Éirinn

- Fardail agus réamh-mheastacháin na hÉireann maidir le gáis cheaptha teasa a ullmhú.
- An Treoir maidir le Trádáil Astaíochtaí a chur chun feidhme i gcomhair breis agus 100 de na táirgeoirí dé-ocsaíde carbóin is mó in Éirinn

Taighde agus Forbairt Comhshaoil

- Taighde comhshaoil a chistiú chun brúnna a shainaithint, bonn eolais a chur faoi bheartais, agus réitigh a sholáthar i réimsí na haeráide, an uisce agus na hinbhuanaitheachta.

Measúnacht Straitéiseach Timpeallachta

- Measúnacht a dhéanamh ar thionchar pleananna agus clár beartaithe ar an gcomhshaol in Éirinn (m.sh. mórphleananna forbartha).

Cosaint Raideolaíoch

- Monatóireacht a dhéanamh ar leibhéil radaíochta, measúnacht a dhéanamh ar nochtadh mhuintir na hÉireann don radaíocht ianúcháin.
- Cabhrú le pleananna náisiúnta a fhorbairt le haghaidh éigeandálaí ag eascairt as taismí núicléacha.
- Monatóireacht a dhéanamh ar fhorbairtí thar lear a bhaineann le saoráidí núicléacha agus leis an tsábháilteacht raideolaíochta.
- Sainseirbhísí cosanta ar an radaíocht a sholáthar, nó maoirsiú a dhéanamh ar sholáthar na seirbhísí sin.

Treoir, Faisnéis Inrochtana agus Oideachas

- Comhairle agus treoir a chur ar fáil d'earnáil na tionsclaíochta agus don phobal maidir le hábhair a bhaineann le caomhnú an chomhshaoil agus leis an gcosaint raideolaíoch.
- Faisnéis thráthúil ar an gcomhshaol ar a bhfuil fáil éasca a chur ar fáil chun rannpháirtíocht an phobail a spreagadh sa chinnteoireacht i ndáil leis an gcomhshaol (m.sh. Timpeall an Tí, léarscáileanna radóin).
- Comhairle a chur ar fáil don Rialtas maidir le hábhair a bhaineann leis an tsábháilteacht raideolaíoch agus le cúrsaí práinnfhreagartha.
- Plean Náisiúnta Bainistíochta Dramhaíola Guaisí a fhorbairt chun dramhaíl ghuaiseach a chosc agus a bhainistiú.

Múscailt Feasachta agus Athrú Iompraíochta

- Feasacht chomhshaoil níos fearr a ghiniúint agus dul i bhfeidhm ar athrú iompraíochta dearfach trí thacú le gnóthais, le pobail agus le teaghlaigh a bheith níos éifeachtúla ar acmhainní.
- Tástáil le haghaidh radóin a chur chun cinn i dtithe agus in ionaid oibre, agus gníomhartha leasúcháin a spreagadh nuair is gá.

Bainistíocht agus struchtúr na Gníomhaireachta um Chaomhnú Comhshaoil

Tá an ghníomhaíocht á bainistiú ag Bord lánaimseartha, ar a bhfuil Ard-Stiúrthóir agus cúigear Stiúrthóirí. Déantar an obair ar fud cúig cinn d'Oifigí:

- An Oifig Aeráide, Ceadúnaithe agus Úsáide Acmhainní
- An Oifig Forfheidhmithe i leith cúrsaí Comhshaoil
- An Oifig um Measúnú Comhshaoil
- An Oifig um Cosaint Raideolaíoch
- An Oifig Cumarsáide agus Seirbhísí Corparáideacha

Tá Coiste Comhairleach ag an nGníomhaireacht le cabhrú léi. Tá dáréag comhaltaí air agus tagann siad le chéile go rialta le plé a dhéanamh ar ábhair imní agus le comhairle a chur ar an mBord.

EPA Research Report 163

Saltmarsh Angiosperm Assessment Tool for Ireland (SMAATIE)

epaResearch
Climate - Water - Sustainability
Identifying pressures • Informing policy • Developing solutions

Author: Fiona M. Devaney and Philip M. Perrin

Identifying Pressures

Ireland is obliged under the Water Framework Directive (WFD) to report to the European Union on the ecological status of water bodies and to achieve good status in all our water bodies. As part of this commitment, the quality of transitional and coastal waters must be assessed and classified. One of the Biological Quality Elements (BQE) to be assessed is “angiosperms” a category which includes saltmarshes. However, no methodology to measure this BQE has previously existed for Ireland.

This report collated existing data on Irish saltmarshes and the environmental pressures being exerted on them.

Informing Policy

Of 193 water bodies in Ireland containing saltmarsh, 40 were assessed using the developed tool. Initial results indicate that, using WFD categories, four (10.0%) had a BQE status of High, fifteen (37.5%) were Good, eighteen (45.0%) were Moderate and three (7.5%) were Poor.

By describing criteria and targets which define good ecological status, this project assists policy makers to set national and local management objectives.

Knowledge gaps were identified in the functioning and ecosystem services of saltmarshes and the relationships between environmental pressures and ecological indicators.

Developing Solutions

Following a review of tools used by other Member States, a tool for monitoring and assessing saltmarsh in terms of the angiosperm BQE for transitional and coastal waters was developed to satisfy WFD requirements. A classification system for saltmarsh vegetation communities was also developed, using existing ecological data, to assist in application of this tool.

Comhshaol, Pobal agus Rialtas Áitiúil
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