Regional Marine Spatial Planning- the data collection and mapping process

Rachel Shucksmith[a*], Lorraine Gray[a1], Christina Kelly[a2], Jacqueline F. Tweddle[a3]

[a] NAFC Marine Centre, Port Arthur, Scalloway, Shetland Islands, ZE1 0UN, UK

* Corresponding author. NAFC Marine Centre, Port Arthur, Scalloway, ZE1 0UN.
Phone: +441595 772000 Fax: +441595 772001 Email: rachel.shucksmith@uhi.ac.uk

Abstract

Marine spatial planning (MSP) is increasingly being recognised as an important tool in the sustainable management of marine ecosystems. In preparation for the development of MSP across Scotland, the Scottish Government, via Marine Scotland, first piloted regional marine planning in 2006, through the Scottish Sustainable Marine Environment Initiative (SSMEI). The overarching aim of SSMEI was to develop and test the effectiveness of differing management approaches to deliver sustainable development in Scotland's coastal and marine environment. The Shetland Islands' Marine Spatial Plan (SMSP) was first developed under the SSMEI programme, and in 2014 the Shetland Islands Council is intending to adopt the fourth edition of the SMSP on a statutory basis as Supplementary Guidance to its Local Development Plan. Using Geographic Information Systems (GIS) the SMSP has incorporated spatial data on existing marine and coastal environmental, socio-economic and cultural features and activities into the decision making process, and is an example of place based management. This has required collecting and collating 127 data sets from a range of data sources, and has utilised local stakeholders to verify the evidence. This process has required significant resources by a dedicated marine spatial planning team, as well as by local stakeholders. The data within the SMSP has also been used to develop spatially-specific policies to guide the future development of Shetland's coastal and marine environment. It has been used by a range of users including developers and decision makers in planning and assessing areas for development, allowing potential conflicts to be avoided or mitigated early in the development process.

Keywords: marine spatial planning, data, Scotland, Shetland, mapping, regional planning, integrated coastal zone management

Highlights:

- An example of incorporating spatial data on socio-economic, environmental and cultural uses into the decision making process
- Local scrutiny and stakeholder engagement has increased the range of data sets incorporated into the SMSP and has also increased confidence in the mapping outputs
- Illustrates the benefits of data collection to guide policy development without fixing spatial boundaries or creating zonation;

---

[1] Present address: Marine Atlas Consultants, 31 David Street, Inverbervie, Nr Montrose, DD10 0RR

[2] Present address: School of Planning, Architecture and Civil Engineering, Queen's University Belfast, David Keir Building, Stranmillis Road, Belfast BT9 5AG.

[3] Present address: School of Biological Sciences, Zoology Building, University of Aberdeen, Tillydrone Avenue, Aberdeen, AB24 2TZ and Marine Scotland, Marine Laboratory, PO Box 101, 375 Victoria Rd, Aberdeen, AB11 9DB

- Highlights how spatial data can be used by decision makers and developers in the development process

1. Introduction

Marine spatial planning (MSP) is increasingly being recognised as an important tool in the sustainable management of marine ecosystems [1]. Whilst several definitions exist for MSP, UNESCO defines it as 'a public process of analysing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic, and social objectives that usually has been specified through a political process' [2].

In the UK, a legal framework for the development of marine spatial plans has been initiated under the Marine and Coastal Access Act, 2009, Marine (Scotland) Act, 2010 and Marine Act (Northern Ireland) 2013. In Scotland, under the Marine (Scotland) Act, there is provision for the development of both a national marine plan and regional marine plans. The Scottish Government consultation on Scotland's draft National Marine Plan was launched in 2013. The boundaries of the regional marine plan areas were also subject to consultation in 2013, and it is expected that the development of regional marine plans will begin in 2014. Within the UK the development of these plans will be influenced by a range of existing directives and policies, e.g. the EU Integrated Maritime Policy [3], Blue Growth [4], Water Framework Directive [5], Marine Strategy Framework Directive [6], and Habitats Directive [7]. In addition, the European Union (EU) has recently proposed a directive to establish a framework for Maritime Spatial Planning and Integrated Coastal Zone Management [8].

In preparation for the development of MSP across Scotland, the Scottish Government, via Marine Scotland, first piloted regional marine planning in 2006, through the Scottish Sustainable Marine Environment Initiative (SSMEI). Four pilot areas were selected: the Berwickshire coast, the Firth of Clyde, the Sound of Mull and the Shetland Islands. The overarching aim of SSMEI was to develop and test the effectiveness of differing management approaches to deliver sustainable development in Scotland's coastal and marine environment [9].

MSP exercises worldwide have highlighted that a critical component to efficacy within MSP is comprehensive ecological and social data to support the process [10]. Of the four SSMEI projects, the Shetland MSP pilot focused most strongly upon the collection of baseline spatial data, and was the only pilot to include the publication of a 'Marine Atlas'. Here we examine the process of data collection in the Shetland Islands' regional marine plan; the range of available data sources, the application of the spatial data, and the resources required to undertake the mapping process.

2. Methods

The Shetland Islands' Marine Spatial Plan (SMSP) was initiated as a pilot in 2006, and was led by a dedicated project team based at the NAFC Marine Centre. The development of the SMSP was guided by both a Local and a National Steering Group, comprising representatives from government agencies, local government, industry representatives, local community and non-government organisations (NGOs).

The SMSP has been developed through a cyclical process, Figure 1. Mapping important environmental, socio-economic and cultural features and activities was undertaken in parallel to policy development, with both processes helping to highlight the ecosystem services delivered by the SMSP area. The seven key steps in the mapping process were:

- Step 1: Define the SMSP area including seaward and landward extents; define the scope and responsibilities of the SMSP
- Step 2: Identify important marine and coastal biophysical features as well as ecosystem services relevant to the SMSP area and within a planning context
- Step 3: Examine available data sources and identify data gaps. Prioritise new data collection, and convert data from multiples sources to a Geographical Information System (GIS) format to produces maps of features and activities
- Step 4: Consultation with key stakeholders, including the establishment of local subgroups to scrutinise the national evidence base and create a local evidence base
- Step 5: Formal public consultation
- Step 6: Local Steering Group facilitate the implementation of the SMSP
- Step 7: Review and evaluation

During the SSMEI pilot three editions of the SMSP were published, with feedback from each consultation helping to refine the SMSP's development. The first edition of the SMSP was launched in 2007 and in 2008 the Local and National Steering Groups agreed that the second edition of the SMSP should be adopted on a voluntary basis. Consequently the SMSP was referenced in marine planning applications and licensing documents, such as Environmental Statements, consultation responses, appropriate assessments and marine consent notices.

In 2010 the SSMEI pilot ended, however the continued development of the SMSP was supported by Marine Scotland and the NAFC Marine Centre. This continued development of the SMSP was guided by a Local Advisory Group whose memberships included all members of the Local Steering Group and additional industry and NGO representation. In 2012 a full review of the SMSP was undertaken which included a number of assessment methodologies, including interviews with stakeholders and analysis of the use of the SMSP (see [11]). In 2013 the fourth edition of the SMSP was developed, guided by the Reviews findings. This fourth edition is due to form Supplementary Guidance to the Shetland Islands Council's Local Development Plan when it is formally adopted in summer 2014.

2.1 Capturing local data

Local data and knowledge was captured in a Marine Atlas using a variety of methods: interviews, scrutinising official national datasets, assessing local data sets and establishing subgroups of the Steering Group (latterly the Advisory Group). The subgroups were used to get a collective opinion on the distribution of important features and decide on the most appropriate way of presenting the data, including testing of a zoning approach.

During the SMSP's initial development two data subgroups, 'Biodiversity' and 'Spatial Analysis' identified what marine and coastal activities would fall within the SMSP's management responsibility (step 1) and what existing uses and features could be impacted by these activities e.g. user-user conflicts and user-environment conflicts (step 2); and what data sources were available for each

feature or activity (step 3). These two subgroups assessed the data to determine its quality, what data gaps existed and guided new data collection. They also determined:

- What spatial and temporal data should be included for each feature or activity
- How to present data, e.g. raw data versus aggregated data
- What caveats should be applied
- How data and mapping should be made available, e.g. paper format, in GIS format

2.1.1 Biodiversity subgroup

In 2006 the biodiversity subgroup established that mapping of biophysical features should not only focus on sites with international and national nature or geological conservation designations, but also the distribution of ecologically 'significant' biological and geological features out with designated areas. These features included those protected under national or international designations or law, including OSPAR [12], EU Habitats Directive [13], and EU Birds Directive [14], Birds of Conservation Concern [15], UK BAP [16], and species identified in the Wildlife and Countryside Act [17].

A comprehensive seabed survey of the entire archipelago was unfeasible, so a predictive biotope map was commissioned in 2006 to reduce the knowledge gaps on broader ecosystem types. The predictive map was ground-truthed at selected sites and analysed to biotope level in 2009.

In 2013 ecological significance was re-defined in-line with newly released national guidance. Marine biological significant components were defined as those listed by the Scottish Government as 'Priority Marine Features' or PMFs [18], as well as protected bird species and coastal habitats.

2.1.2 Spatial Analysis subgroup

In 2007 the Spatial Analysis subgroup trialled a zoning approach to marine management. The rationale was to utilise a methodology established in South Australian [19], with the mapped outputs to be used to inform policy. The approach was underpinned by the desire to create a 'smooth' transition through the planning system. Two mapping exercises were trialled, one to evaluate potential conflicts between activities to identify zones suitable for development and one to add cumulative pressures as a feature to influence the decision making process.

A method to assess zones suitable for development was developed by the Spatial Analysis Working Group, and despite approving the use of the model, the overarching local Steering Group did not approve publication. The methodology was initially considered too complex and academic by the Steering Group, and it was decided that a hard zoning approach was too inflexible. There was also a level of mistrust in the original model, and there was concern that it risked being misleading.

In 2010 a project officer was appointed to examine the potential for specific development advice for the emerging marine renewable industry; this methodology did not create hard zones but looked at mapping areas of high and low constraint (see 20). This approach was accepted to form part of the SMSP through policy in the fourth edition of the SMSP.

Cumulative pressure mapping also began in 2007, however due to incomplete data sets the model could not be developed to a useable level of granulation. In 2012 the Spatial Analysis subgroup was

re-formed to examine the potential to map cumulative pressures utilising the updated and more comprehensive data held within the Marine Atlas. This methodology has been used to highlight areas of high and low relative pressure, with the aim of assisting developers and planners in assessing the additional pressures of new developments [21].

2.1.3 Incorporating local data sets

A number of local data sets were identified as suitable for inclusion within the SMSP. In Shetland records of marine and coastal historic and archaeological features are recorded by the Regional Archaeologist, incorporating both professional surveys and public findings. These local data sets were used to both verify national data sources and to expand data sets.

A number of local data sets also exist for a range of marine species, including marine mammals, birds and plants. These data sets comprise professional surveys, including data collected by the Sullom Voe Oil Terminal Environmental Advisory Group (SOTEAG), surveys for new developments and monitoring surveys undertaken by local natural heritage staff, as well as data recorded through public observation. Records of important species reported by the public are locally collated by the Shetland Biological Records Centre (SBRC), where reporting's are screened for accuracy before inclusion in the SBRC species database.

Due to the licensing powers afforded to the Shetland Islands Council through the Zetland County Council Act (1974), all marine developments out to the 12 nm limit most gain a Works Licence, with the exception of aquaculture. Aquaculture sites are also licensed by the Shetland Islands Council but require planning permission under the Town and Country Planning Act. The location of pipeline, cables, piers, marinas and aquaculture sites were provided by the Council, and this was used to augment pre-1974 national data sets and to correct errors found within the data.

Significant shipping routes were mapped by interview with the Shetland Coastguard based upon the experience of using Automatic Identification System (AIS) tracking, and in 2013 using updated AIS data at the NAFC Marine Centre.

2.1.4 Local knowledge

Shetland has had local control of marine planning through the Zetland County Council Act (1974) since the Sullom Voe Oil Terminal was built in 1974, and as such, had the local knowledge of which groups were disaffected by the current consenting regimes. Fishermen and marine recreational users were identified as groups who would benefit by having evidence recorded of marine use, helping to guide development towards areas of low conflict and also to support any potential objections to new developments. Important fishing grounds were mapped through interviews with fishermen in 2006. Shellfish grounds were also identified by habitat type through the predictive habitat map. This data was scrutinised by local fishermen in 2007 and additional grounds were incorporated. In 2012 demersal fishery mapping was updated through newly available Vessel Monitoring System (VMS) data. The accuracy of the VMS data was checked through interviews with the demersal fleet, significant errors removed, and the information re-mapped.

Marine recreation and tourism was mapped through interview, and limited to activities which were considered spatially inflexible, e.g. sea angling from land, dive sites, rowing routes, and wildlife watching. Marine recreation which was considered spatially adaptable was not included, e.g. kayaking. In 2013 it was decided to increase the types of marine recreation mapped, due to the perceived potential for the large scale developments, e.g. offshore wind, which could impact the setting of marine and coastal recreational activities and hence reduce its value to participants. For this reason coastal nature reserves and coastal tourism facilities where the view was considered an important element of the experience were also mapped.

2.2 Consultation process

2.2.1 Internal Assessment

All mapping outputs were assessed by the Steering Group / Advisory group, and where appropriate by the data provider, as a level of quality control (step 4).

In 2014 the data was also subject to a data confidence assessment. A modified version of the criteria developed by the Marine Management Organisation [22] was used to assess data sets, Table 1. The assessment was translated into a percentage score, with scores of 0-60% classed as 'low', 60-70% 'medium' and over 70% as 'high' confidence.

2.2.2 Public Consultation

After the Steering/ Advisory Groups approval, each of the editions of the 'Marine Atlas' and 'Policy Framework' were subject to a 12 week consultation period (step 5). Mapping and data was made available in a variety of formats online to increase access, including using Google Earth, in addition to paper copies of maps. All 18 Community Councils were visited and some important data gaps were filled in this way.

2.3 Implementation

Following consultation of the first to third editions of the SMSP the Local Steering Group was responsible for the SMSPs approval and its subsequent implementation (step 6). From 2008 the SMSP was used voluntarily by developers, consultees and regulators when assessing marine development applications. After implementation, the SMSP's use was monitored by the NAFC Marine Centre marine spatial planning team. Before the fourth edition can be formally adopted by the Shetland Islands Council it must be given approval by the Council following public consultation.

2.4 Review and evaluation of the Plan

The SMSP's use and consultation responses were reviewed to guide the development of subsequent editions (step 6). The review methodology is described elsewhere (see [11]).

2.5 Strategic Environmental Assessment (SEA) and Habitats Regulation Assessment (HRA)

A Strategic Environmental Assessment (SEA) is now a legal requirement for all public plans and programmes under the EU SEA Directive [23] with the directive coming into force in 2001 and a requirement for it to be transposed into law by Member States by 2004. However, in Scotland the Directive did not come into force until February 2006 when it was transposed into Scottish law through the Environmental Assessment (Scotland) Act. As the SSMEI project inception was prior to the establishment of the Act an SEA was not a legal requirement and the SEA process was not

initiated. However, a retrospective application was made in 2009, when a SEA was conducted in parallel to the development of the third edition. In terms of data collation, the omission of SEA at the SMSP initial development not set-back the project because the Marine Atlas produced at the time was the equivalent to the Environmental Report (baseline). A further SEA was undertaken in conjunction to the development of the fourth edition.

In 2010 it became a requirement to undertake a Habitats Regulation Appraisal (HRA) in conjunction a plan or projects development where it is likely that the plan or project will have a significant effect on a European Protected (Natura 2000) site. To support the development of the fourth edition a HRA was therefore undertaken, with the spatial data within the SMSP aiding the identification and assessment process. This helped to ensure policies within the SMSP did not result in adverse effects on a protected site.

2.6 Data Stewardship

At the time of data collation and creation, metadata records that fulfilled ISO standards were scant. After publication of the Shetland Marine Atlas, new metadata records were created and catalogued with the Marine Environmental Data Information Network (MEDIN). MEDIN have produced a data standard for marine metadata and a set of tools to create metadata records that comply with the MEDIN Metadata Standard. The MEDIN Metadata Discovery Standard complies with other international conventions such as EU INSPIRE Directive [24] which came into force in 2007 and ISO 19115 metadata standard [25].

3. Results

The SMSP area was defined as all territorial waters seaward of the mean high water of the spring tide (MHWS), out to 12 nautical miles. Data on coastal habitats / ecological processes or features that are clearly affected by marine use, e.g. salt marshes and archaeological features within 150 m of the coastline, were also mapped and included in the Marine Atlas and Policy Framework. In 2013, the landward extent of the data included with the Marine Atlas was extended to 500m inshore, to include a range of land based environmental features and designations, socio-economic uses and relevant cultural features. This extension reflected changing guidance relating to the setting of archaeological features, and a perceived increase in potential marine developments which could impact terrestrial features and activities, e.g. pipelines, large scale marine renewable devices and associated infrastructure. It was also extended to ensure greater integration between terrestrial and marine management, thus promoting Integrated Coastal Zone Management (ICZM).

The process of data prioritisation, collation and creation initial took 12 months to complete (2006-2007), with an additional 6 months trialling different zoning approaches. During this period 52 important environmental components or features, 11 socio-economic activities, and 4 cultural features or activities were identified as being present in Shetland. In 2013 this had increased to 66 important environmental components or features, 15 socio-economic activities and 9 cultural features or activities. Of these socio-economic and cultural features and activities 60% could be considered to be reliant upon the ecosystem, and thus considered to be an ecosystem services. A total of 18 administrative features and boundaries were identified and considered relevant for inclusion, of these four related to natural heritage designations, e.g. Special Areas of Conservation (SACs), Special Protected Areas (SPAs). In 2013 the number maps relating to administrative areas

was reduced to 16, of which a greater number (9) related to natural heritage designations, primarily due to an increase in the types of designations, e.g. the creation of Marine Protected Areas (MPAs) and local conservation designations. In 2013 two resource maps and two guidance maps relating to marine renewable energy potential (wave and tidal) were included for the first time.

Information on the spatial extent of these features and activities was initially gathered from 105 data sets, from 55 separate sources. Data sources included: Environmental Statements, central and local government agencies, NGOs, published reports and books, and local knowledge. Whilst some data was available in GIS format (predominantly local and central government data), many data sets had to be digitised and converted to a GIS format. By 2013 the maps included in the Fourth Edition had incorporated 127 data sets, from 60 separate sources, complied in a process that took four months. Of the features mapped within the SMSP 80% had more than one data set or data source associated with it, Table 2.

Combined data sets were initially presented across 37 maps; in 2013 this was extended to 43 maps, examples of which are given in Figure 2-4. Data caveats were added to 17 maps, 8 relating to biophysical features, 2 relating to cultural features, 3 relating to economic uses, 2 relating to resources and 2 relating to constraint mapping.

Following a data confidence assessment, a score of 'high' was assigned to the dataset. Environmental datasets received the lowest scores (generally between 40 - 75%), due to incomplete survey effort, issues with ‘spatial confidence’ (location and extent), and timelessness. Across the data sets, scrutiny by local experts helped to improve the ‘quality standard’ score, and combining multiple data sets helped to increase the ‘completeness score’.

4. Discussion

Data collection and verification was initially the most time consuming process in the development of the Shetland Marine Spatial Plan (SMSP). However, once a platform was established, data stewardship was more efficient. The centralisation of Shetland’s marine data has been central to the management approach adopted by the SMSP.

It is important to recognise that there are a range of sources of information, including sea users [26]. Within the SMSP mapping marine and coastal features required the collation of multiple data sets from multiple sources, several of which had not previously been publically available. This process required significant resources to collate, map and assess data quality. Where numerous data sets exist relating to the same feature some may contradict each other and new data collection and consultation may be required to identify the true current state of the environment.

Data verification highlighted a number of errors in national data sets, due both to errors in the mapping process and due to the age of some of the data sets. For example, historical records of horse mussel and maerl beds were utilised by the Shetland Shellfish Management Organisation (SSMO) to initiate a series of closed areas to scallop dredging, helping to gain Marine Stewardship Council (MSC) accreditation. The locations of these features were verified and mapped using ROV and multi-beam echo-sounder. The indicated location of some of these features from historical

records was found to be of low accuracy in terms of feature extent and location, however they were found to be useful point from which to start detailed surveying (see [27]).

Mapping also highlighted where data gaps existed, in particular in relation to community use and fisheries. Mapping effort tends to focus on uses and features that are considered of national or societal importance, or economic activities which require a licence to operate in a specific place. This can mean that data relating to activities which do not require a licence to operate in a spatially specific place, such as fisheries or boat cruises, can be limited. In addition, data relating to local community usages, such as marine recreation, is not routinely collected by government agencies, and in Shetland this data was primarily collected through participatory mapping.

Whilst it might be desirable to map all known features and uses of the marine environment, the collation of existing data is very time consuming. Determining which features should be mapped first or prioritised is an initial decision which will need to be made by a marine spatial planning team. Features which are considered to be 'significant' should generally be mapped first. Criteria for environmental significance have been defined by the Convention for Biodiversity [28] and significant cultural features have also been defined by the ICES Expert Working Group on cultural ecosystem service [29].Where knowledge of the spatial extent of significant features and uses is limited, planners will need to decide how to allocate resources for new data gathering. This should focus on areas of potential conflict [30].

New data on significant marine features and activities became available during the development of the SMSP, as surveys revealed new features, new industries emerged and sources made new data available. The landward consideration of the SMSP area was also extended during the SMSPs development, increasing the number of activities and features for inclusion within the SMSP.

Whilst many of the datasets within the SMSP were collected by government agencies and publically available, some of the data sets were owned by NGOs, companies, organisations and individuals. These data sets could be only included with the data owner or knowledge holders' agreement. When mapping and distributing data, consideration had to be given to a number of factors including; data ownership, data usage, presented granulation, inclusion of suitable caveats, the potential effects of incomplete surveying, frequency of re-surveying, and seasonality. In this study, data uncertainty was highlighted with caveats included with each map to ensure that both decision makers and developers were fully aware of any data limitations. The policy document also highlighted that the provision of data did not remove the need for development specific surveying, nor for consultation with key stakeholders.

The way the data was presented and made available to third parties had to be acceptable to the data owner, and the data had to be presented in a format that is easy to understand both by users and by those with a management remit [31].Mapping has the potential to both create reality as well as to represent it [32] and consideration should therefore be given to conscious and unconscious decisions made in a maps creation [33]. Including stakeholders in the process of mapping helped to increase buy-in into the process and foster trust between the SMSP team and stakeholders.

The data and mapping outputs were made available to use in a number of formats, including paper copies and downloadable GIS data for use in a range of software packages, including software which is freely available. Within the GIS files, additional data was provided, including information on temporal uses to allow the user to utilise the data in a variety of ways. A flexible approach to using the data has always been the desire of the SMSP Steering/ Advisory Group.

All spatial data is linked to policies within the SMSP, and each of the maps includes information to highlight which policy or policies the information is relevant to. Whilst the spatial data held within the SMSP could be used to initiate zoning of the sea space to guide future use of the marine and coastal environment, it was not favoured by the Local Steering/ Advisory Group for a number of reasons [11]. Some stakeholders expressed the belief that some previous efforts elsewhere in Scotland at zoning development areas were based on somewhat arbitrary or directly challengeable assumptions [11]. In spite of this, it was acknowledged that without any clear spatial guidance on the types of activities that may be able to coexist in which areas, the SMSP may not be able to provide clear direction on the future use of the marine and coastal environment.

Specific spatial guidance was developed using the spatial data within the SMSP to develop a sensitivity led approach to assessing the suitability of areas around the Shetland Islands for renewable energy development [20]. This approach allows the guidance model and output maps to be updated as new data become available, removing the need to redefine hard 'zones'. This was designed to encourage the co-location of marine space and to provide an adaptable management strategy, an approach which has always underpinned MSP in Shetland.

A review of the SMSP revealed that developers and decision makers were using the data and polices within the SMSP to help in the planning and assessing of development proposals [11]. This indicates that the mapping of important features is providing an evidence base which is being used to shape the future use of Shetland's marine environment.

The number of data sets (127) utilised in the SMSP is consistent with other regional plans such as Canada which utilised 100 biophysical data sets [34]. In the UK, it has been estimated that to provide spatial data for MSP it will cost approximately £10,000 per region [35]. The collection and collation of spatial data within this SMSP has been at a considerably greater cost, with the initial process taking 18 months (equivalent to £40,000 in staff time) and the data update taking four months (equivalent to £10,000). Whilst typical policy cycles for review are every 2-7 years [26] uses of the marine environment have the potential to alter over this time frame. As spatial data becomes out-of-date there is the potential for it to misinform decision making, therefore consideration should be given to the frequency in which the data are reviewed, and whether this should occur more frequently than that of the overall marine spatial plan. Spatial data within the SMSP is currently being reviewed and updated on a six-month cycle. This highlights the need to resource the maintenance of data sets and mapping.

Whilst mapping in MSP covers a range of uses of the marine environment, so far it has focused upon the tangible benefits derived by the local community. The marine environment can also provide a number of intangible benefits including spiritual and creative inspiration, and these have not

currently been identified within the SMSP. Processes for mapping these benefits and values is less well advanced and would require additional application of resources.

Significant effort has been made nationally and internationally to make data sets more accessible. Within Scotland publications such as Scotland's Marine Atlas [36] and the Scottish Government's National Marine Planning Interactive website [37] should make the data collation exercise easier and more efficient. What is missing from national datasets is the benefit of scrutiny by local experts, as well as the addition of data collected locally and the data collected through the development consenting process. This 'localisation' of data in the SMSP is a true asset to the local planning agenda and data stewardship.

Conclusions

The SMSP has incorporated spatial data relating to environmental, socio-economic and cultural features and activities into the decision making process, and is an example of place-based management. It has also incorporated data on local and nationally important features, utilising a wide range of data sets and sources, which has required significant investment of resource.

The data within the SMSP has been subject to local scrutiny, and this stakeholder engagement has increased the range of data sets incorporated into the SMSP and has also increased confidence in the mapping outputs. Whilst this data has not been used to develop a zoning approach it has been used by a range of users including developers and decision makers to shape the future use of the marine environment.

Acknowledgments

We would like to thank Marine Scotland for their continued financial support for this project. We also wish to acknowledge the time and efforts of the SMSP Advisory Group, and the stakeholders involved in this work.

We would also like to acknowledge past Shetland Marine Spatial Plan team members who contributed to the data collection: Ilaria Marengo and David Dunoon.

References

[1] Schaefer N, Barale V. Maritime spatial planning: opportunities & challenges in the framework of the EU integrated maritime policy. Journal for Coastal Conservation 2011; 15: 237–245.

[2] Ehler C, Douvere F. Marine spatial planning: a step-by-step approach towards ecosystem-based management. Intergovernmental Oceanographic Commission and Man and the Biosphere Programme. IOC Manual and Guides No.53, ICAM Dossier No. 6. Paris: UNSECO. 2009 (English).

[3] European Commission. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and Committee of the Regions. An Integrated Maritime Policy for the European Union. COM (2007) 575 Final.

[4] European Commission. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions.

Blue Growth Opportunities for Marine and Maritime Sustainable Growth. COM (2012) 494 Final.
[5] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (Water Framework Directive).
[6] Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive).
[7] Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora.
[8] Commission of the European Communities. Communication from the Commission. Roadmap for Maritime Spatial Planning: Achieving Common Principles in the EU. COM (2008) 791
[9] Marine Scotland. Scottish Sustainable Marine Environment Initiative. Project Evaluation. March 2010.
[10] Foley MM, Halpern BS, Micheli F, Armsby MH, Caldwell MR, Crain CM, Prahler E, Rohr N, Sivas D, Beck MW, Carr MH, Crowder LB, Duffy JE, Hacker SD, McLeod KL, Palumbi SR, Peterson CH, Regan HM, Ruckelshaus MH, Sandifer PA, Steneck RS. Guiding ecological principles for marine spatial planning. Marine Policy 2010; 34: 955–966.
[11] Kelly C, Gray L, Shucksmith R, Tweddle JF. Review and evaluation of marine spatial planning in the Shetland Islands. Marine Policy 2014: 46: 152-160.
[12] The Convention for the Protection of the marine Environment of the North-East Atlantic (the 'OSPAR Convention') Oslo and Paris Commissions Paris on 22 September 1992.
[13] Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora.
[14] Council Directive 2009/147/EC of 30 November on the conservation of wild birds.
[15] Newton, S., Donaghy, A., Allen, D. & D. Gibbons. Birds of Conservation Concern in Ireland. Irish Birds. 1999: 6(3): 333-344.
[16] HMSO. UK Biodiversity Action Plan (UK BAP). 1997. pp192.
[17] Wildlife and Countryside Act 1981.
[18] Scottish Government, Planning Scotland's Seas. Consultation on Priority Marine Features. [http://www.scotland.gov.uk/Resource/0042/00428389.pdf] accessed on 3rd February 2014.
[19] Department for Environment and Heritage (2006). Marine Planning Framework for South Australia. Available online: [http://www.environment.sa.gov.au/files/c42d2f66-2230-43b6-8945-9e3001187388/mp_framework.pdf] accessed on 3rd February 2014.
[20] Tweddle JF, Gray L, Gray L, Shucksmith R. Developing Regional Locational Guidance for wave and tidal energy in the Shetland Islands. Marine Policy submitted 2014.
[21] Kelly C, Gray L, Shucksmith R, Tweddle JF. Investigating options on how to address cumulative impacts in marine spatial planning. *Submitted Oceans and Coastal Management*.
[22] Marine Management Organisation, 2013. Process for evidence quality assurance. Available online from: [http://www.marinemanagement.org.uk/evidence/documents/qa-evidenceprocess.pdf] accessed on 3rd February 2014.
[23] Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment.

[24] Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE)

[25] ISO 19115 Geographic Information - Metadata. International Organization for Standardization (ISO), Geneva, 2003.

[26] Gilliland PM, Laffoley Dd'A. *Key elements and steps in the process of developing ecosystem-based marine spatial planning.* Marine Policy 2008; 32(5): 787-796.

[27] Shelmerdine RL, Stone D, Leslie B, Robinson M. Implications of defining fisheries closed areas based on predicted habitats in Shetland: A proactive and precautionary approach. Marine Policy 2014; 43: 184–199.

[28] Convention on Biologically Diversity. Rio de Janeiro. 1992.

[29] ICES. 2013. Report of the joint HZG/LOICZ/ICES workshop: Mapping cultural dimensions of marine ecosystem services (WKCES), 17-21 June 2013, Helmholtz Zentrum Geesthacht, Germany. ICES CM 2013/SSGHIE:07.

[30] Ehler C, Douvere F. Marine spatial planning: a step-by-step approach towards ecosystem-based management. Intergovernmental Oceanographic Commission and Man and the Biosphere Programme. IOC Manual and Guides No.53, ICAM Dossier No. 6. Paris: UNSECO. 2009 (English).

[31] Portman ME. Zoning design for cross-border marine protected areas: the red sea marine peace park case study. Ocean and Coastal Management 2007; 50:499–522.

[32] Smith G, Brennan R. Losing our way with mapping: Thinking critically about marine spatial planning in Scotland. Ocean & Coastal Management 2012; 69: 210-216.

[33] Kitchin R, Dodge M (2007) Rethinking maps. *Progress in Human Geography* 31(3): 331-344.

[34] Ban N, Bodtker K, Nicolson D, Robb C, Royle K, Short C. Setting the stage for marine spatial planning: Ecological and social data collation and analyses in Canada's Pacific waters. Marine Policy 2013; 39: 11-20.

[35] DEFRA. A sea change—a Marine Bill White Paper, partial regulatory impact assessment. DEFRA (Department for Environment, Food and Rural Affairs). London, 2007.

[36] Baxter JM, Boyd IL, Cox M, Donald AE, Malcolm SJ, Miles H, Miller B, Moffat CF (Eds.). Scotland's Marine Atlas: Information for the National Marine Plan. Marine Scotland, Edinburgh, 2011. Available from: http://www.scotland.gov.uk/Publications/2011/03/16182005/0 (accessed 18.02.14).

[37] National Marine Plan Interactive http://www.scotland.gov.uk/Topics/marine/seamanagement/nmpihome/nmpi (accessed online 18/02/2014).