

Using satellite imagery to understand the benefits that marine nature reserves provide to society: a study of The Wash and North Norfolk coast saltmarshes



Saltmarsh sea lavender on The Wash – Photograph taken by Robert Enderby of Lincolnshire Wildlife Trust

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Host organisation: Institute of Estuarine and Coastal Studies, University of Hull

Acknowledgements

This placement was funded by the Natural Environment Research Council as part of the Valuing Nature Programme. This research programme aims to better understand and represent the complexities of the natural environment in valuation analyses and decision making, by considering the economic, societal and cultural value of ecosystem services. A Programme Coordination Team is running activities to help build an interdisciplinary research community capable of working across the natural, biological and social sciences, and the arts and humanities, and to build strong links with research users through the Valuing Nature Network.

Special thanks go to researchers at the Institute of Estuarine and Coastal Studies (IECS), University of Hull, Dr Daryl Burdon, Dr Rodney Forster and Shona Thomson for their invaluable help and expert training throughout the placement. Sue Ranger of the Marine Conservation Society for software training and data access from the Common Ground Project and Lincolnshire Wildlife Trust for providing the venue and catering for the placement workshop.

Summary

This project aimed to develop tools, skills and resources to enhance the balanced protection of marine nature and culture, with research techniques piloted at The Wash and North Norfolk coast. Satellite tools were used to map regions of saltmarsh and its sub-features. A practitioner's toolkit has been produced giving an entry level tutorial for the satellite-based classification methods used in this project. A workshop was held with local community saltmarsh specialists to identify saltmarsh sub-features and the benefits provide to society, using satellite imagery. Further work is to develop techniques to objectively compare stakeholder with satellite-based classification schemes. Workshop outputs can be accessed from this report including an interactive PDF for saltmarsh sub-features and societal benefits. Satellite tools provide an easy to use and open-access resource for mapping marine features and are an attractive engagement tool for relationship development across a range of marine management groups and local community members.

Introduction

The Wash and North Norfolk coast is celebrated for its remarkable natural heritage and has protected status under the EU Habitats and Species Directives and UK Habitats Regulations. These marine reserves are part of a European wide family called the Natura 2000 series, protecting rare, endangered and endemic species and their habitats. The UK Habitats Regulations states that certain regulators have a statutory duty to ensure the protected features within these reserves stay in or are restored to ‘favourable condition’.

Although the features within these reserves provide significant services and benefits to our society, there is no explicit legal protection for the livelihoods and culture they support within the UK Habitats Regulations. The Regulators Code (2014), produced by the Department of Business, Innovation and Skills does, however, provide legal representation for local livelihoods and culture and states that “regulators should carry out their activities in a way that supports those they regulate to comply and grow”.

These pieces of complementary legislation should in theory lead to the development of business models that are conducive to the sustainable use of resources within these reserves.

The Wash and North Norfolk Marine Partnership (WNNMP) supports collaborative working between the coastal regulators and the local community to ensure balanced protection for the remarkable nature and rich culture of this unique part of the great British coastline.

The aim of this Valuing Nature Placement is to develop tools, skills and resources that enhances the balanced protection for the nature and culture of The Wash and North Norfolk coast. Specifically, the project forms a multidisciplinary collaboration between the WNNMP, IECS and Marine Conservation Society (MCS) to investigate the use of satellite imagery to map features within marine reserves and use stakeholder workshops to glean information from the regulator, conservation and coastal community on the benefits they provide to society.

The focus of this pilot project was on saltmarsh and its sub-features. The Wash and North Norfolk saltmarshes are the most extensive example of this habitat type in the UK and there is an established and engaged network of saltmarsh users and specialists within the WNNMP. There is also huge national and international interest in saltmarsh due to its natural and societal value.

The objectives of the placement, which included specialist training for the WNNMP Project Manager are as follows:

1. Create saltmarsh sub-feature classification maps for regions of The Wash and North Norfolk coast using Sentinel-2 satellite derived data. Training in satellite oceanography and software use were provided by IECS Director and Satellite Oceanographer Dr Rodney Forster and IECS GIS Specialist Shona Thomson.
2. Undertake stakeholder workshops with the WNNMP network to;
 - a. Verify the satellite derived saltmarsh sub-feature classification schemes
 - b. Identify the services and benefits provided by saltmarsh and sub-features

Training in the use of established Valuing Nature Network matrices (Potts et al., 2014; Saunders et al., 2015) and workshop planning and delivery to identify saltmarsh services and benefits was provided by IECS Senior Ecological Economist Dr Daryl Burdon.

3. Interrogate local marine reserve stakeholder opinion data collated through a state-of-the-art process: [Community Voice Method](#), to provide an initial evidence base that may direct enquiry and the scope of the project. Training in the use of NVivo qualitative data analysis software was provided by MCS Engagement and Education Manager Sue Ranger.
4. Create a toolkit and draft a methods paper to share the tools and skill set developed within this project with the wider Valuing Nature community.

This placement was undertaken by the WNNMP Project Manager Dr Sam Lew over 40 days between 13th November 2017 and 30th March 2018. Four intensive week-long training sessions were given at IECS, University of Hull throughout the placement and the remaining time was invested through 1.5 days per week part-time remote working from the WNNMP Head Quarters in King's Lynn, Norfolk.

This project presented a unique and highly valuable opportunity to combine on-the-ground practitioner and researcher expertise to develop skills and tools that can actively be used in the management of The Wash and North Norfolk marine reserves day-to-day.

Activities carried out during the placement

Objective 1

Saltmarsh sub-feature classification maps have been created using Sentinel 2 satellite-based classification schemes using SNAP and QGIS. An additional piece of open-source publishing software called Scribus was used to create layered pdfs that enhances the viewing of the saltmarsh classification schemes.

Appendix 1 provides the toolkit that was developed during this placement. This toolkit is a tutorial for the use of SNAP, QGIS and Scribus to download, analyse, visualise and publish satellite data and provides examples of saltmarsh classification schemes for regions of The Wash saltmarshes. The toolkit also introduces the use of satellite tools for coastal and marine monitoring.

Objective 2

A one-day stakeholder workshop was undertaken with members of the WNNMP network and IECS researchers that took place at Lincolnshire Wildlife Trust's Gibraltar Point Visitors Centre on Tuesday 20th February 2018. Workshop attendees included representative from Natural England, Environment Agency, Eastern Inshore Fisheries and Conservation Authority, Lincolnshire Wildlife Trust, RSPB, Wildfowling Clubs, National Farmers Union and land owners.

The workshop originally intended to verify the satellite classification schemes and identify the services and benefits provided by the saltmarsh sub-features. Satellite classification schemes, however, require decisions on both the number of features and the combination of the 13 optical Sentinel bands to classify. As a result, there are many different potential classifications for the same region of saltmarsh and it is not feasible for workshop participants to compare them all. A new approach was therefore taken. The full workshop approach, time schedule and introduction to ecosystem services valuation are given in Appendix 2a. The following is a short summary.

1. Identify the saltmarsh sub features on large print outs of the same satellite images used in the classification scheme
2. Identify the services and benefits provided by the saltmarsh and specific sub features identified on the satellite maps

Key learning outcomes and developments from the workshop based on discussion and feedback forms

1. Variable correlation was found between saltmarsh sub-features and the services and benefits provided. Appendix 2b provides the outputs from the stakeholder workshops including photographs of the

workshop, stakeholder derived sub-features and services and benefits maps. A digitised example in layered pdf format is found in Appendix 2c

2. Sentinel 2 satellite imagery provides appropriate visual coverage for major saltmarsh features; however, elevation data is key for saltmarsh sub-feature identification and is not available using Sentinel data
3. Ground truthing for sub-feature ecology is essential. Site rangers who know regions of the saltmarsh well don't know enough about the area to verify plant ecology in the workshop
4. Appendix 2d provides a synthesis of the workshop feedback forms

Objective 3

Interrogation of local marine reserve [stakeholder opinion video footage](#) data collated through the [Community Voice Method](#) was undertaken. From analysis of the recorded footage from the Community Voice Method project it was found that the most common theme of discussion around saltmarsh were concerns about human disturbance. As a result, a final session of the workshop was an open discussion on the disturbance to the marsh.

Key issues raised from the workshop discussion include;

- Increased access to previously inaccessible parts of the coast through the England Coastal Path;
- Disturbance is most significant at and around access points;
- Dog walking is the most popular use of the coast and biggest disturbance problem relative to other recreational activities;
- Cable routes from windfarms have caused significant damage to saltmarshes;
- MoD helicopters are perceived to cause significant bird disturbance; and
- MoD owned lane gives vehicle access to an area of saltmarsh that is otherwise difficult to access.

The placement learning experience

A working philosophy for conservation developed through the experiences in this placement

Conservation seeks to balance the needs of the natural world with the needs of the social structures that we have created for ourselves to live in. We therefore need a balanced use of natural and social science research techniques to understand how to live sustainably. At present, it is evident that natural sciences dominate the field of conservation. Reassuringly, the Valuing Nature community view social science integration into the conservation movement as a priority for effective progress.

The importance of community engagement

The people who make their livelihoods from The Wash and North Norfolk coast and define its culture are key to understanding the benefits and services provided by marine reserves. Management approaches and academic research within Valuing Nature must effectively engage with local communities to understand how to protect nature and the benefits it delivers for society.

Language and communication

The language used throughout academic and management circles in Valuing Nature is complex and often has little relevance to local communities. A priority for Valuing Nature, science and management must be to refine our language into one that is used by all who value nature, i.e. everyone.

Within Valuing Nature, definitions of natural capital, ecosystems services and other terms are rarely used consistently. Multiple definitions for complex terminology creates significant challenges for communicating Valuing Nature principles to not only the public but also academic researchers and management groups.

Satellite classification vs community classification

The satellite classification schemes for marine reserve features used in this project provide a quick, easy to use and open access approach to the analysis of saltmarsh sub-features. However, subjective comparison with stakeholder classification maps is challenging due to the multiple options available to the researcher to classify using Sentinel 2 data. A comparison approach will need to be developed that can objectively compare classification schemes conducted using satellite approaches and local stakeholder knowledge.

Opportunities and challenges

The tools developed throughout this project can be used to understand the services and benefits provided by other protected features in other marine reserves. Benefits of the approach to other practitioners include:

- Data and software are open access and the toolkit is available to provide entry level training;
- Satellite technologies and data outputs are advancing rapidly;
- Satellite techniques provide high spatial and temporal resolution; and
- WNNMP represents an extensive regional network of regulators, management groups, conservation NGOs and local communities to identify benefits and services provided by one of the largest EC designated sites in Europe.

Other opportunities that have arisen through the Valuing Nature Placement

- Collaborative working with researchers at the University of Cardiff on saltmarsh services and benefits
- Successful collaborative research application to the MMO between the University of Hull and the WNNMP to investigate non-licensable activity impacts on Marine Protected Areas (MMO1136)

Progress on outputs

- Tool kit for satellite mapping has been completed– see Appendix 1
- The workshop was successfully completed with the final programme, run sheet and outputs attached– see Appendix 2
- Drafting a scientific research article on expanding the role of participatory mapping and deliberation for the management of MPAs and coastal developments – the workshop outputs from this placement will be one of multiple case studies within the paper
- Investigate the potential to objectively compare the stakeholder maps with the various classification schemes using satellite image analysis
- Further workshops on other areas of The Wash and North Norfolk coast are to be undertaken
- Investigating an opportunity to hold a national workshop to share and teach the toolkit skill set with other coastal practitioners. Course title: An Introduction to the use of SNAP, QGIS, and Scribus for satellite mapping of saltmarsh, sand- and mudflats given by IECS and WNNMP

Appendices

Please follow the link to the [WNNMP publications page](#) where each appendix can be viewed and downloaded. If you would like to be kept informed about updates to project output in each appendix please get in touch with the WNNMP Project Manager via sam.lew@wnnmp.co.uk. Full contact details can be found on the WNNMP [website](#).

Appendix 1: A toolkit for the use of satellite imagery to map marine reserve features. It is likely that follow up versions will be produced

Appendix 2a: Workshop approach, time schedule and introduction to ecosystem services valuation

Appendix 2b: Outputs from the stakeholder workshops including photographs of the workshop and stakeholder derived sub-feature and services and benefits maps

Appendix 2c: An example of a saltmarsh features and services map for Wrangle Parish saltmarsh derived from the stakeholder workshop. A completed suit of saltmarsh sub-features and services maps will be produced upon completion of The Wash and North Norfolk coast saltmarsh stakeholder workshops

Appendix 2d: A summary of the feedback form responses from the saltmarsh stakeholder workshop

Appendix 3a: Slides for the presentation given to the VNP group at the start-up meeting in November 2017

Appendix 3b: Slides for the presentation given to the VNP group at the wrap-up meeting in March 2018