

# Using satellite imagery to understand the benefits that marine nature reserves provide to society: ecosystem services and the workshop programme

## Summary

This document provides an introduction to ecosystem services and benefits provided by saltmarshes, written by Senior Ecological Economist Dr Daryl Burdon of the Institute of Estuarine and Coastal Studies, University of Hull. The programme and time schedule for a workshop used for the mapping of saltmarshes features and services using satellite imagery is also provided. This project was funded through the NERC VNP scheme led by The Wash and North Norfolk Marine Partnership in collaboration with the Institute of Estuarine and Coastal Studies, University of Hull, Marine Conservation Society and Lincolnshire Wildlife Trust.

## An Introduction to ecosystem services and benefits provided by saltmarshes

### 1. What Do We Mean by Natural Capital, Ecosystem Services and Societal Benefits?



We can consider the marine environment in terms of stocks, flows and well-being. Natural capital can be defined as the “the world’s stocks of natural assets, which include geology, soil, air, water and all living things” (WFNC, 2018). Such natural assets can deliver a range of ecosystem services which can be defined as the links (‘flows’) between the marine ecosystem (i.e. the natural assets) and the benefits which are obtained by society and improve societal well-being (Atkins et al. 2011). For example, in a healthy marine ecosystem, sandbanks provide suitable habitat for sandeel populations to thrive (‘stock’), seabirds (e.g. puffins) then feed on sandeel (‘flows’), resulting in a healthy seabird colony which provides a valuable resource for recreation in the form of nature watching.

The marine environment provides a range of ecosystem services and societal benefits including food to eat, climate regulation, waste breakdown, flood defence and opportunities for leisure, recreation, education and research. The range of services are commonly categorised as provisioning, regulating, supporting and cultural services (MA, 2005). In a marine context, a UK ecosystem service framework has been developed which

identifies and defines the key marine components and processes (the 'stock'), the intermediate and final ecosystem services (i.e. the 'flows') and the goods/benefits provided for society (i.e. linking to 'well-being') (Turner et al., 2015). This framework differentiates between indirect (intermediate) and direct (final) ecosystem services and recognises the importance of the input of built, human and/or social capital required for society to obtain benefits.

## **2. Why Are Ecosystem Service Approaches Important?**

Ecosystem services are a fundamental part of applying an ecosystem approach to management, as required e.g. by the Convention for Biological Diversity (CBD, 2000). Such an approach provides a means of integrating the natural environment with society (Burdon, 2016), and simplifies the system complexity, thus making it understandable to policymakers and stakeholders (Beaumont et al., 2007).

Ecosystem services have the potential to lead to benefits for society and therefore it is appropriate to consider their value (Atkins et al., 2013). The total social value of ecosystem services however must consider ecological and socio-cultural values alongside economic values (Burdon et al., 2018). With respect to the latter, for some ecosystem services market prices may reflect their value (e.g. food provision), however other markets may not exist or may be inadequate (e.g. health benefits) and therefore a range of non-market methods can be applied (Atkins et al., 2013). Ecosystem service indicators can be identified and applied to identify behaviour, state and trajectory in marine systems, and thus be used for monitoring and management purposes (Atkins et al., 2015; Hattam et al., 2015).

## **3. What Do We Know About Saltmarsh Benefits?**

Saltmarshes deliver a range of ecosystem services which provide a number of benefits for society (Atkins et al., 2015). For example: saltmarshes are an important coastal flood defence, in terms of dissipating wave energy (regulating service); saltmarshes provide habitat for birds and invertebrates (supporting service); saltmarshes store both nutrients and carbon (regulating service); saltmarshes provide the opportunity for recreation and amenity associated with nature watching and wildfowling (cultural service); and provide food and nursery grounds for fish, including commercial fish species such as sea bass (provisioning service). It is of note that in terms of natural capital, farmed animals (e.g. saltmarsh lamb) are not included as they are seen as produced rather than natural assets, instead the habitat/vegetation which supports them is regarded as an ecosystem service and so is included in natural capital assessment (ONS, 2018). Further information on

coastal zone ecosystem services from science to values and decision making is available in Turner and Schaafsma (2015).

## The Valuing Nature Placement workshop programme and time schedule

### Workshop Objectives

1. Identify saltmarsh ecological sub-features on Sentinel 2 satellite maps for three parish regions (Wainfleet, Friskney, Wrangle) on The Wash, Lincolnshire, using knowledge and expertise from local relevant stakeholder groups\*
2. Identify and map the services and benefits provided by saltmarshes and evaluate whether there is a correlation between ecological sub-features and services and benefits provided
3. Determine the major disturbance problems to saltmarshes
4. Explore the value of the exercise and determine the pros and cons and potential developments for the approach **A summary of the workshop time schedule and activities**

Time	Activity
0930-1000	Registration and tea/coffee
<b>1000 - 1010</b>	<b>Introduction– purpose, outcomes, broader values and next steps (Sam Lew)</b>
<b>1010 – 1200</b>	<b>Exercise 1 – Mapping saltmarsh sub-features using Sentinel 2 maps</b>
1010 – 1020	Introduction to satellite mapping (Rodney Forster)
1020 – 1030	Introduction to exercise 1 (Sam Lew)
1030 - 1200	Undertake exercise 1
<i>1200 - 1300</i>	<i>Lunch</i>
<b>1300 – 1500</b>	<b>Exercise 2 – Identify and map saltmarsh services and benefits</b>
1300 – 1310	Introduction to services and benefits (Daryl Burdon)
1310 – 1320	Introduction to exercise 2 (Sam Lew)
1320 – 1450	Undertake exercise 2
<i>1450 - 1500</i>	<i>Tea/coffee break</i>
<b>1500 – 1600</b>	<b>Discussion</b>
1500 – 1540	Disturbance factors to both saltmarsh ecology, benefits and services
1540 – 1600	Discuss pros and cons from the day and complete feedback forms

## Workshop programme and time schedule

Time	Activity
0945-1000	Registration (name badges and table allocation) and tea/coffee
<b>1000 - 1010</b>	<p><b>Introduction to the workshop – purpose, outcomes, broader values and next steps</b> <b>(Sam Lew)</b></p> <p><b>Purpose</b> –The purpose of this workshop is to gather information on the natural features and societal benefits of The Wash saltmarshes to provide regulators and coastal managers with the information required to make appropriate decisions on management that reflect both natural and societal needs.</p> <p>This project is a collaboration between WNNMP, IECS, MCS and LWT funded by NERC VNP (4mth)</p> <p><b>Outcomes</b> –</p> <ol style="list-style-type: none"> <li>1. Identify saltmarsh ecological sub-features on Sentinel 2 satellite map of three parishes on The Wash, Lincolnshire, using knowledge and expertise of local stakeholders – e.g. of sat. classification issues and where we are with EA work</li> <li>2. Identity and map the services and benefits provided by saltmarshes</li> <li>3. Determine the major disturbance issues and the impact on ecological sub-features, services and benefits provided by saltmarshes</li> <li>4. Explore the value of the exercise and determine the pros and cons and potential developments for the approach</li> </ol> <p><b>Broader benefits of the project</b> - we will use the results of this workshop to write a survey and send to The Wash and North Norfolk Marine Partnership to determine the broader values of saltmarsh protected status and derived societal benefits that go beyond what has been identified in the workshop. I.e. do identified benefits offer added value to members of the Partnership</p> <p><b>Next steps</b> –</p> <ol style="list-style-type: none"> <li>1. the pilot study will be refined and extended to other regions of The Wash and North Norfolk coast</li> <li>2. it will be determined whether satellite classification techniques can replicate stakeholder sub-feature mapping</li> <li>3. potential national roll out through training for coastal practitioners and production of the research toolkit</li> </ol>

<b>1010 - 1200</b>	<b>Exercise 1 – Mapping saltmarsh ecological sub-features using Sentinel 2 satellite maps</b>
1010 -1020	Exercise 1 – Introduction to satellite mapping (Rodney Forster) <ol style="list-style-type: none"> <li>1. How satellites work</li> <li>2. Sentinel 2</li> <li>3. Classification and the need for ground truthing</li> </ol>
1020 – 1030	Introduction to the exercise (Sam Lew) – as below
1030 – 1200	Undertake exercise 1 <ol style="list-style-type: none"> <li>1. Each table has a balanced set of saltmarsh stakeholders and everyone has been assigned to a table.</li> <li>2. A1 laminated satellite maps are provided for each section for saltmarsh with major landmarks and access points given                     <ol style="list-style-type: none"> <li>a. Please see larger reference maps for position of parish marsh region relative to The Wash</li> </ol> </li> <li>3. As a group please determine the ecological sub-features that you can see on the map                     <ol style="list-style-type: none"> <li>a. First go through maps from east to west and make an exhaustive list features that you can see</li> <li>b. Sam Lew to give an example of the map on the overhead projector and point out features</li> <li>c. Circle features with a pen and number matching features and note what they are e.g. pioneer marsh, creek, pool</li> <li>d. Groups to switch tables for verification (10 minutes per map), debate as necessary. Maps and facilitators to stay on same table</li> <li>e. Please note any pros and cons of satellite maps for sub-feature analysis – important for final survey</li> <li>f. If time permits, look at spring saltmarsh maps</li> </ol> </li> </ol> <p>Equipment – maps, pens for maps, pen and paper for sub-feature list</p>
1200 – (1245) 1300	<i>Lunch and an opportunity to discuss broader benefits of the project and networking I will be calling everyone back at 1245 to ensure you can grab a cuppa etc</i>
<b>1300 - 1450</b>	<b>Exercise 2 – Identify and map saltmarsh services, benefits and capital</b>
1300 – 1310	Introduction to services and benefits (Daryl Burdon)

<p>1310 – 1320</p> <p>1320 – 1450</p>	<ol style="list-style-type: none"> <li>1. What do we mean by ecosystem services, benefits and capital in the broader context?</li> <li>2. Why are ecosystem service approaches important?</li> <li>3. What do we know about saltmarsh benefits? Provide a few examples within the provisioning, cultural, regulation, ecological categories to ensure the room has a good idea of what they are being asked for in the exercise</li> </ol> <p>Introduction to the exercise (Sam Lew) – as below</p> <p>Undertake exercise 2</p> <ol style="list-style-type: none"> <li>1. Individually spend 10 minutes writing down the benefits that the saltmarshes provide. They don't have to be directly linked to you             <ol style="list-style-type: none"> <li>a. Then around the table ask each member to give one benefit until the list is exhausted</li> <li>b. Write on the flip charts and present to the room. After each tables facilitator presents, ask the other groups if they think they have missed anything? If yes, note on the board in red</li> </ol> </li> <li>2. Using the prioritised list of services and benefits (based on Saunders et al., 2015) work your way through the list and map each on the sub-features identified in Exercise 1.</li> <li>3. Then using your sub-feature maps discuss whether your benefits are associated with individual or multiple sub-features or are general saltmarsh benefits             <ol style="list-style-type: none"> <li>a. Mark on maps using sticky dots and standardise using numbers</li> <li>b. State on map what sub-features they correlate with</li> </ol> </li> <li>4. Groups to switch tables for verification (10 minutes per map), debate as necessary. Maps and facilitators to stay on same table</li> </ol> <p>Equipment - maps, pens for maps, pen and paper for benefits list, pen remover for mistakes on maps, flip charts with stand</p>
<p>1450 - 1500</p>	<p><i>Tea/coffee break</i></p>
<p><b>1500 - 1600</b></p>	<p><b>Discussion</b></p>
<p>1500 – 1540</p>	<p>Disturbance factors to both saltmarsh ecology, benefits and services</p> <ol style="list-style-type: none"> <li>1. Through interrogation of the Common Ground data catalogue collated via the Community Voice Method, saltmarsh discussions centred around concerns regarding disturbance through visitors</li> </ol>

<p>1540 - 1600</p>	<p>2. An open discussion session to focus on saltmarsh disturbance with the discussion being faithful to the principle of balancing the ecological view with the social benefits view</p> <ul style="list-style-type: none"> <li>• i.e. activity (benefit/service) → ecological disturbance → impact on benefit/service/capital</li> </ul> <p>Discussion questions</p> <ol style="list-style-type: none"> <li>1. What are the priority disturbance issues to consider for saltmarsh management?</li> <li>2. Are they the same for each Parish saltmarsh and the sub-features within each Parish?</li> <li>3. Do you have any suggestions for how these pressures should be managed?</li> <li>4. Could the method that you have proposed today be of value to addressing disturbance issues</li> </ol> <p>Discuss pros and cons from the day and complete feedback forms</p> <p>Final wrap-up (SL) – survey will be sent out, please fill it in as it is an essential part of the process</p> <p>Equipment – Daryl and Rodney take notes on the discussion. Sam to lead discussion</p>
	<p><b>Equipment list</b></p> <ol style="list-style-type: none"> <li>1. Name tags and table layout</li> <li>2. Maps: spring and autumn</li> <li>3. Pad of paper</li> <li>4. Pens</li> <li>5. Markers for maps</li> <li>6. Flip charts</li> </ol>

## Bibliography

- Atkins, J.P., Burdon, D., Elliott, M. & Gregory, A.J., 2011. Management of the marine environment: integrating ecosystem services and societal benefits with the DPSIR framework in a systems approach. *Marine Pollution Bulletin*, 62, pp. 215-226.
- Atkins, J.P., Banks, E., Burdon, D., Greenhill, L., Hastings, E., & Potts, T., 2013. *An analysis of methodologies for defining ecosystem services in the marine environment*. JNCC Report 491 (Contract number: C12-0170-0612).
- Atkins, J.P., Burdon, D. & Elliott, M., 2015. Chapter 5. Identification of a practicable set of indicators for coastal and marine ecosystem services. In: Turner, R.K. & Schaafsma, M. (Eds.) *Coastal zones ecosystem services: from science to values and decision making*. Studies in Ecological Economics, Volume 9, Springer, Switzerland.
- Beaumont, N.J., Austen, M.C., Atkins, J.P., Burdon, D., Degraer, S., Dentinho, T.P., Deros, S., Holm, P., Horton, T., Van Ierland, E., Marboe, A.H., Starkey, D.J., Townsend, M. & Zarzycki, T., 2007. Identification, definition and quantification of goods and services provided by marine biodiversity: Implications for the ecosystem approach. *Marine Pollution Bulletin*, 54, pp. 253-265.
- Burdon, D., 2016. An interdisciplinary approach to marine management: Bridging the divide between natural and social sciences research. PhD by published work, University of Hull, UK.
- Burdon, D., Boyes, S.J., Elliott, M., Smyth, K., Atkins, J.P., Barnes, R.A. & Wurzel, R.K., 2018. Integrating natural and social marine science to manage sustainably vectors of change: Dogger Bank transnational case study. *Estuarine, Coastal and Shelf Science*, 201, pp. 234-247.
- CBD, 2000. Convention on Biological Diversity. <http://69.90.183.227/doc/legal/cbd-un-en.pdf>.
- Hattam, C., Atkins, J.P., Beaumont, N., Börger, T., Böhnke-Henrichs, A., Burdon, D., De Groot, R., Hoefnagel, E., Nunes, P., Piwowarczyk, J., Sergio, S. & Austen, M.C., 2015. Marine ecosystem services: linking indicators to their classification. *Ecological Indicators*, 49, pp. 61-75.
- MA, 2005. Millennium Ecosystem Assessment – Ecosystems and human wellbeing biodiversity synthesis. Island Press, Washington, DC.
- ONS, 2018. Office for National Statistics. Website accessed 19 February 2018. <https://www.ons.gov.uk/>
- WFNC, 2018. The World Forum on Natural Capital. Website accessed 19 February 2018. <https://naturalcapitalforum.com/about/>
- Turner, R.K. & Schaafsma, M. (Eds.), 2015. *Coastal zones ecosystem services: from science to values and decision making*. Studies in Ecological Economics, Volume 9, Springer, Switzerland.
- Turner, R.K., Mee, L., Elliott, M., Schaafsma, M., Burdon, D., Atkins, J.P., Saunders, J., Potts, T., Jickells, T., Beaumont, N. & Bee, E., 2015. Chapter 2. Conceptual framework. In: Turner, R.K. & Schaafsma, M. (Eds.) *Coastal zones ecosystem services: from science to values and decision making*. Studies in Ecological Economics, Volume 9, Springer, Switzerland.