NAFC Marine Centre
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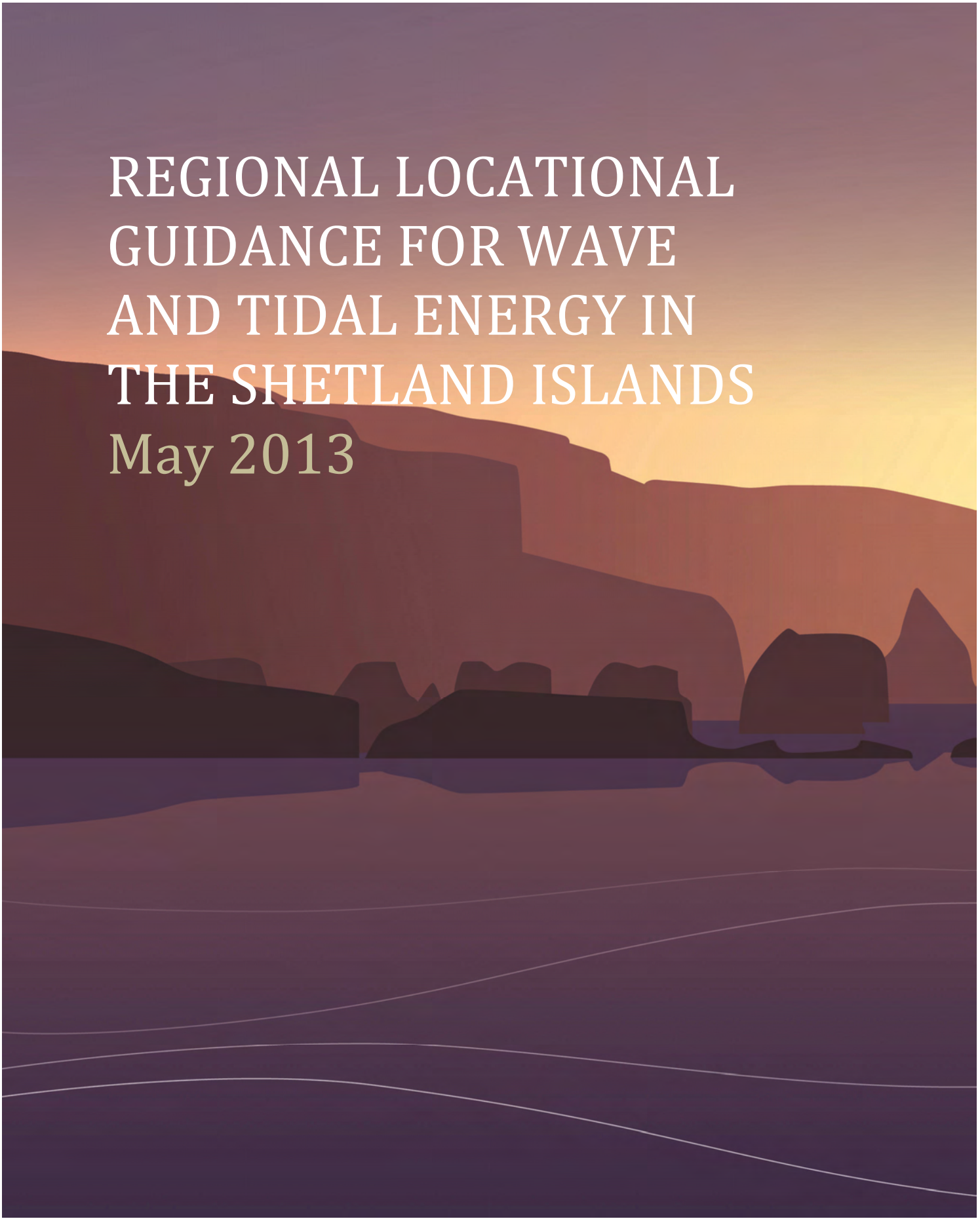
The Scottish Government

marinescotland

# REGIONAL LOCATIONAL GUIDANCE FOR WAVE AND TIDAL ENERGY IN THE SHETLAND ISLANDS

May 2013



This report has been prepared as part of the 'Marine Spatial Plan Marine for the Shetland Islands' (SMSP) which is administered by the NAFC Marine Centre and is guided by a local advisory group. Funding for the SMSP and this assessment is provided by Marine Scotland and the NAFC Marine Centre.



This report should be referenced as:
Tweddle, J.F., Kelly, C., Shucksmith, R. (2013). Regional Locational Guidance for wave and tidal energy in the Shetland Islands- May 2013. NAFC Marine Centre report. pp19.

This document is available from our website at http://www.nafc.ac.uk/SMSP.aspx
http://www.nafc.ac.uk/Shetland-Marine-Energy-Development.aspx

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# 1. Context

Over the last decade, the marine renewables industry has been subject to significant research and development investment, driven by increasing concerns over climate change and energy security. The Scottish Government has set a target of 30% of total energy demand being met by renewable sources by 2020, to be achieved by renewables satisfying 100% of electricity demand (31% by 2011), and 11% of heat demand (Scottish Government, 2011). It is anticipated that marine renewable energy sources (tidal and wave power) will play an important role in reaching these objectives. Whilst the development of a marine renewables industry is generally looked upon favourably, consideration must be given to potential environmental and social impacts, as well as conflicts with other users.

The Shetland Islands have been identified as having potential for both tidal and wave powered developments (Scottish Government, 2007; Natural Power, 2011). Figure 1 illustrates the tidal resource around Shetland, and Figure 2 illustrates the wave resource. The development of a large scale renewable industry in Shetland is currently limited by the absence of an interconnector to the UK national grid. However, it is anticipated that an interconnector will be in place by 2018, and there is increasing interest in the development of the renewables industry in Shetland. Within Shetland, developers must gain both a Works Licence, issued by the Shetland Islands Council, and a Marine Licence, issued by Marine Scotland. One exploratory Works Licence has been granted by the Shetland Islands Council for a wave energy device, and a Works Licence and Marine Licence have been granted for a small scale, community owned tidal energy device.

It is anticipated that the number of licence applications for renewable devices around Shetland will increase in the future. To help guide the placement of renewable energy developments and associated cable landings, ArcGIS® has been used to map and integrate spatial data on resource opportunities and development constraints. This assessment incorporates environmental, social and economic considerations into the site selection process for marine renewable energy.

This guidance forms part of the 'The Marine Spatial Plan for the Shetland Islands' which has guided the siting of marine developments in Shetland since 2008 (NAFC Marine Centre, 2013). The Shetland Marine Spatial Plan (SMSP) contains spatial data on the marine and coastal environment and its uses, in addition to establishing an overarching policy framework. The spatial extent of the plan includes all territorial waters seaward of mean high water springs, out to 12 nautical miles, but also includes onshore habitats / ecological processes that are clearly affected by marine developments, such as cable landing sites.

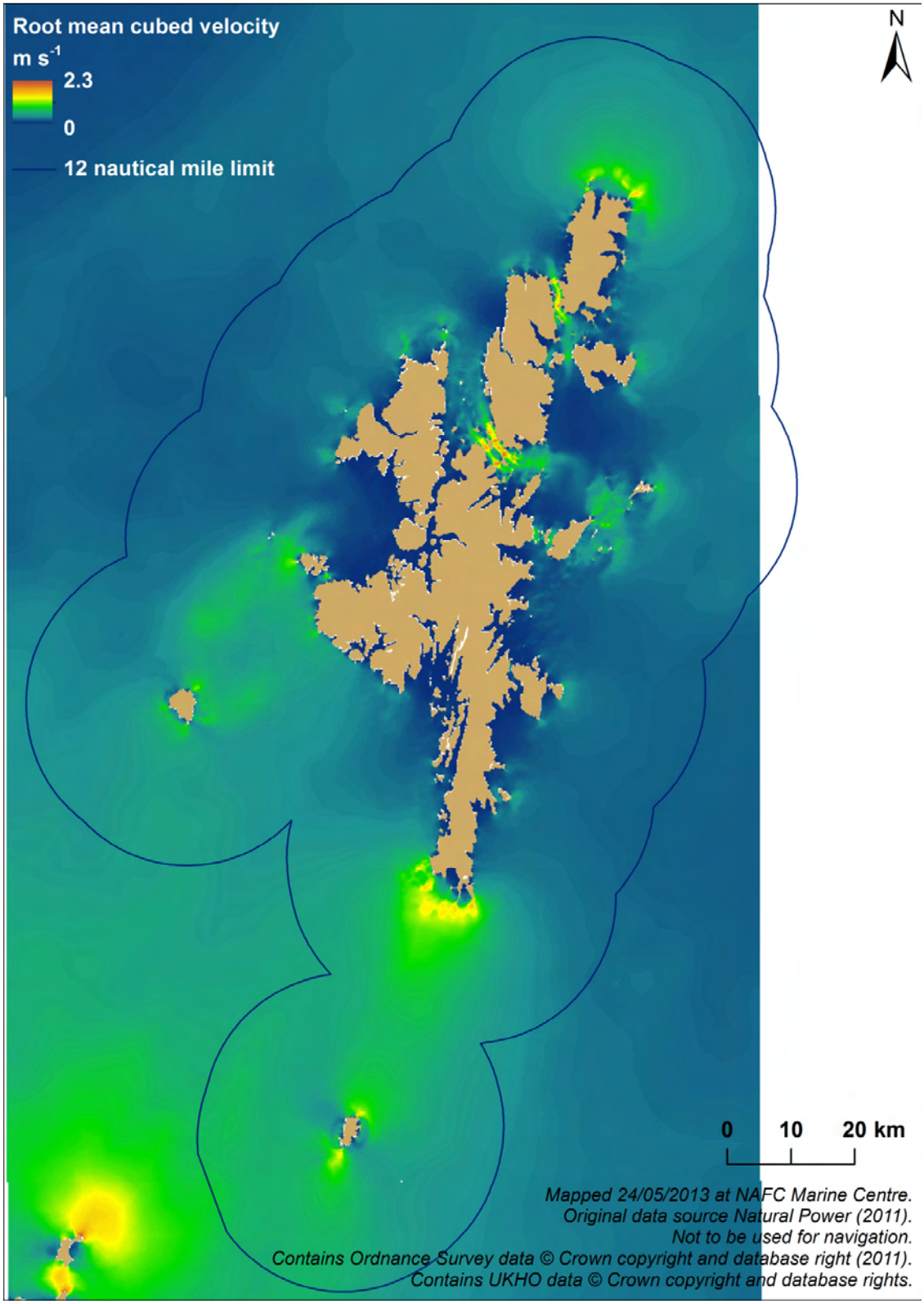


**Figure 1. Tidal resource around the Shetland Islands.**
Average tidal speeds (m $s^{-1}$) over the water column, calculated as a root mean cubed velocity. Original data source Natural Power (2011).

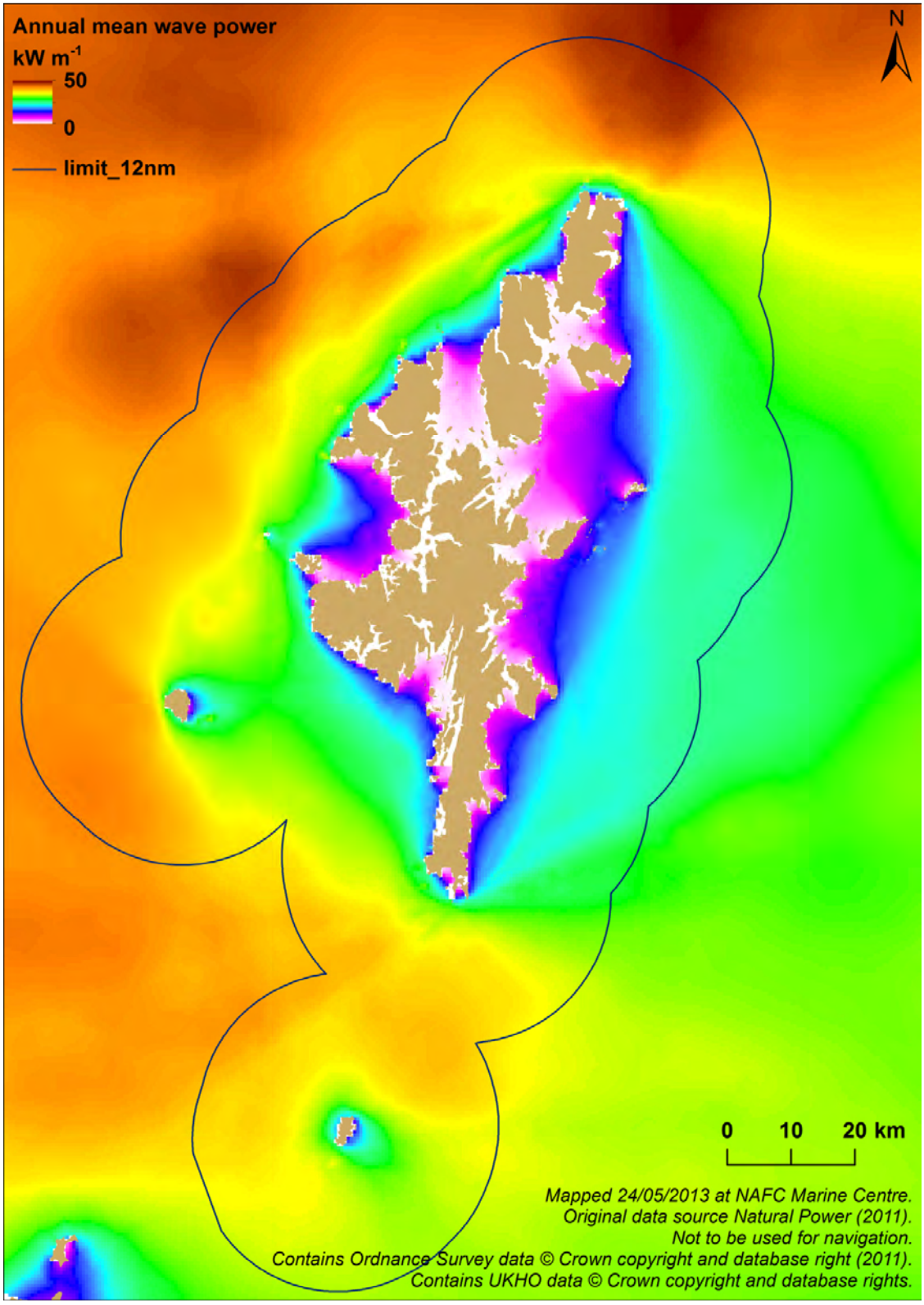


**Figure 2. Wave resource around the Shetland Islands.**
Average wave power (kW $m^{-1}$), calculated as an annual mean wave power. Original data source Natural Power (2011).

## 2. Approach

The SMSP has previously identified and mapped marine features and maritime activities in Shetland's waters. The spatial extents of these features and activities have been subject to local consultation, producing both local datasets and locally amended national datasets. A spatial model has been created showing potential areas of least resistance (lowest constraint) in the planning regime towards renewable energy developments, reflecting a process of consultation on constraints with local advisors, planners, regulators, communities and developers. The model is designed as a decision support tool to assist in making more informed decisions about where developments are likely to be successful and where they are not. The maps presented do not illustrate clear boundaries between favourable and unfavourable areas for marine development, but represent the likelihood of finding suitable locations in an area.

## 3. Model Structure

Constraints mapping within the model was based on information held within the SMSP. Local stakeholders (Appendix 1) were initially asked to provide a preliminary assessment of the level of constraint their activity or area of responsibility may cause to marine renewable developments in Shetland waters. An initial model output (Tweddle et al., 2012) was consulted upon with the local stakeholders, and the feedback from this process has guided the development of the 2013 edition. A summary of the factors considered as potential constraints and their final evaluation, provided by local stakeholders, is included in Tables 1 & 2. These factors were used to evaluate:

### a. Constraints at sea

These are constraints relevant to device placement at sea. A range of economic, cultural, and environmental activities and features were provided by stakeholders as being constraints to device placement (Table 1).

### b. Constraints at the coast

These are constraints relevant to cable landings. Coastal land within 200 metres of the shore was identified, in consultation with industry and local stakeholders, as the potential area where the cables, connecting the devices at sea to the electrical grid on land, would make landfall. Cultural and environmental constraints were considered as limiting factors to cable landings (Table 2). Islands without electrical grid, including Fair Isle and Foula, were excluded from the analysis.

A spatially varying level of constraint was generated from each mapped feature or activity, onto a fixed grid of 10 m by 10 m. Constraint levels of between 0 and 4 were assigned, as according to Tables 1 & 2. Generally, the constraint levels due to each feature/activity were rescaled between 0 and 1, with 0 representing no constraint and 1 maximum constraint. However, where legal or local precedent defined areas of very high constraint, these were assigned a value of 4. Similarly, Special Areas of Conservation (SACs), Special Protected Areas (SPAs) and Historic Marine Protected Areas (HMPAs) were defined with a constraint

level of 2, ensuring they were always of high constraint, as it was felt that this best reflected the legal protection afforded to them.
The constraint levels were designated in one of two ways:

- Exclusion buffers - where exclusion distances (very high constraint level) have been defined in the past, through, for example, legislative or precedence of past planning decisions. For example, pipelines have an exclusion buffer of 230m either side based on local precedent. The use of exclusion buffers ensured these features were always of very high constraint.

- Defined constraint level - where a feature has been given a set constraint value. For example, Nature Conservation designated areas have a set constraint level within their border, and no constraint outside their border. Defined constraint levels are also used to map activities where no use intensity data is available, such as for recreation.

- Varying constraint level - where an activity generates a continuous range of constraints, from high to low. Fuzzy logic was used to rescale the activity range from 0 (no activity occurring) to 1 (maximum activity occurring). This scoring method was used for activities which are spatially continuous but vary in intensity, such as varying levels of fishing activity. This type of constraint is also used to reflect distance from an important feature, for example the further the distance from a seabird colony, the lower the constraint.

The constraint level maps for individual features and activities were then overlain and summed to create maps of total constraint, for both the coast (constraints applicable to cable landing sites) and at sea (constraints applicable to device placement). The constraint maps were added with equal weighting, without attributing priority to any factor.

## 4. Model Output

The model output was mapped, showing total constraint both at sea (Figure 3) and at the coast (Figure 4). Total constraint levels were classified as low (total constraint level $< 0.75$), medium ($0.75 \leq$ total constraint level $< 2$), high ($2 \leq$ total constraint level $<4$) and very high (total constraint level $\geq 4$). Visual assessment of the model output confirmed the results were acceptable. The resilience of the model output was tested in an early iteration of the model by doubling the constraint level of each of four factors (for both sea and coastal constraints), and comparing the results to the non-doubled model output (Tweddle et al., 2012). The statistical distributions of total constraint levels within the model results were not significantly different between model runs.

**Table 1. Constraints at sea.**
**Data used to model constraints at sea. Data listed alphabetically.**

| Constraint | Data Source | Data available from | Constraint Type | Constraint Level | Constraint Consultee |
|---|---|---|---|---|---|
| **Aquaculture (Fin Fish) Site** | Shetland Islands Council | SMSP | Exclusion- 250 m<br>Defined- 250 - 500 m<br>Varying- 500 - 1000 m | 4<br>1<br>1 – 0 | Shetland Island Council<br>Representatives of Aquaculture Industry |
| **Aquaculture (Shellfish & Algae) Site** | Shetland Islands Council | SMSP | Exclusion - 250 m<br>Varying- 250 - 1000 m | 4<br>1 – 0 | Shetland Island Council Representatives of Aquaculture Industry |
| **Cables** | KIS-CA; Shetland Islands Council | SMSP | Exclusion - 250 m | 4 | Subsea Cables UK(2012) Guidelines |
| **Cetaceans** | Shetland Amenity Trust | SMSP | Defined- 300 m<br>Varying- 1000 m | 1<br>1 – 0 | Scottish Natural Heritage;<br>Shetland Biological Records Centre* |
| **Demersal Fishing** | Marine Scotland | SMSP | Varying- intensity based | 1 – 0 | Shetland Fishermen's Association |
| **Dredge and Disposal Grounds** | Lerwick Port Authority; Natural Capital; UKHO | SMSP; UKHO | Exclusion - extent | 4 | Lerwick Port Authority; Shetland Islands Council |
| **Important Species and Habitats (PMFs)** | Various | SMSP | Defined- extent | 1, cumulative | Scottish Natural Heritage |
| **Local Policy Development Restrictions** | Shetland Islands Council; Lerwick Port Authority; Broonies Taing Pier Trust | SMSP | Defined- extent | 1 | NA |
| **National Scenic Areas & Local Landscape Areas** | Scottish Government; Shetland Islands Council | SMSP; SIC | Defined- extent | 1 | NA |
| **Nature Conservation Designated Areas** | Scottish Natural Heritage; RSPB; Shetland Islands Council | SMSP; RSPB | Defined- SAC, cSAC & SPA<br>Defined- SSSI, RAMSAR, LNCS, NNR & RSPB | 2, cumulative<br>1 | NA |

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| | | | | | |
|---|---|---|---|---|---|
| **Otters** | Shetland Amenity Trust | SMSP | Defined- 400 m<br>Varying- 400 - 500 m, to 10 m depth contour | 1<br>1 – 0 | Shetland Biological Records Centre* |
| **Pipelines** | Shetland Islands Council | SMSP | Exclusion - 230 m | 4 | Shetland Islands Council |
| **Recreational Use** | NAFC SMSP | SMSP | Defined- extent | 0.5, cumulative (maximum 1) | NA |
| **Seabirds** | Shetland Amenity Trust | SMSP | Defined- 100 m<br>Varying- 100 - 1000 m | 1 – 0 | Shetland Biological Records Centre*; SOTEAG |
| **Seals- Protected Haul-outs** | Scottish Government | SMSP | Defined- extent<br>Varying- 0 - 500 m | 1<br>1 – 0 | Scottish Natural Heritage |
| **- Nursing & Pupping Areas** | Scottish Natural Heritage; Sea Mammal Research Unit | SMSP | Defined- extent<br>Varying- 0 - 500 m | 0.5<br>0.5 – 0 | |
| **- Density at sea** | Scottish Government | | Varying- Intensity based | 1 -0 | |
| **Shellfish Fishing** | Interviews with local fishermen; Shetland Shellfish Management Organisation | SMSP | Varying- economic contribution based | 1 – 0 | Shetland Shellfish Management Organisation |
| **Shipping Routes** | Maritime and Coastguard Agency; Shetland Islands Council | SMSP | Exclusion - 250 m | 4 | Maritime and Coastguard Agency |
| **Waste-Water Discharge & Water Abstraction** | Scottish Environment Protection Agency | SMSP | Varying- 100 m | 1 – 0 | SEPA Environmental Quality Standards |
| **Wrecks & Historic Marine Protected Areas** | Shetland Amenity Trust; RCAHMS; Historic Scotland | SMSP; RCAHMS; | Defined- HMPA<br>Varying- 1000 m | 2<br>1 – 0 | Legislation<br>Shetland Regional Archaeologist* |

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**Table 2. Constraints at the coast**
**Data used to model constraints at the coast. Data listed alphabetically.**

| Constraint | Data Source | Data available from | Constraint Type | Constraint Level | Constraint Consultee |
|---|---|---|---|---|---|
| **Archaeology** | Shetland Amenity Trust | SMSP | Varying- 500 m | 1 – 0 | Shetland Regional Archaeologist* |
| **National Scenic Areas & Local Landscape Areas** | Scottish Government; Shetland Islands Council | SMSP; SIC | Defined- extent | 1 | NA |
| **Nature Conservation Designated Areas** | Scottish Natural Heritage; RSPB | SMSP; RSPB | Defined- SAC & SPA<br>Defined- SSSI, RAMSAR, NNR, LNCS & RSPB | 2<br>1 | NA |
| **Otters** | Shetland Amenity Trust | SMSP | Defined- 400 m<br>Varying- 400 - 500 m | 1<br>1 – 0 | Shetland Biological Records Centre* |
| **Recreational Use** | Various; NAFC Marine Centre | SMSP | Defined- extent | 0.5, cumulative (maximum 1) | NA |
| **Seabird colonies** | JNCC | SMSP; JNCC | Defined- 100 m<br>Varying- 100 - 1000 m | 1<br>1 – 0 | Shetland Biological Records Centre*; SOTEAG |
| **Seals- Protected Haul-outs** | Scottish Government | SMSP | Defined- extent<br>Varying- 0 - 500 m | 1<br>1 – 0 | Scottish Natural Heritage |
| **- Nursing & Pupping Areas** | Scottish Natural Heritage; Sea Mammal Research Unit | SMSP | Defined- extent<br>Varying- 0 - 500 m | 0.5<br>0.5 – 0 | |
| **Wildness** | Scottish Natural Heritage | SMSP | Varying | 1 – 0 | NA |

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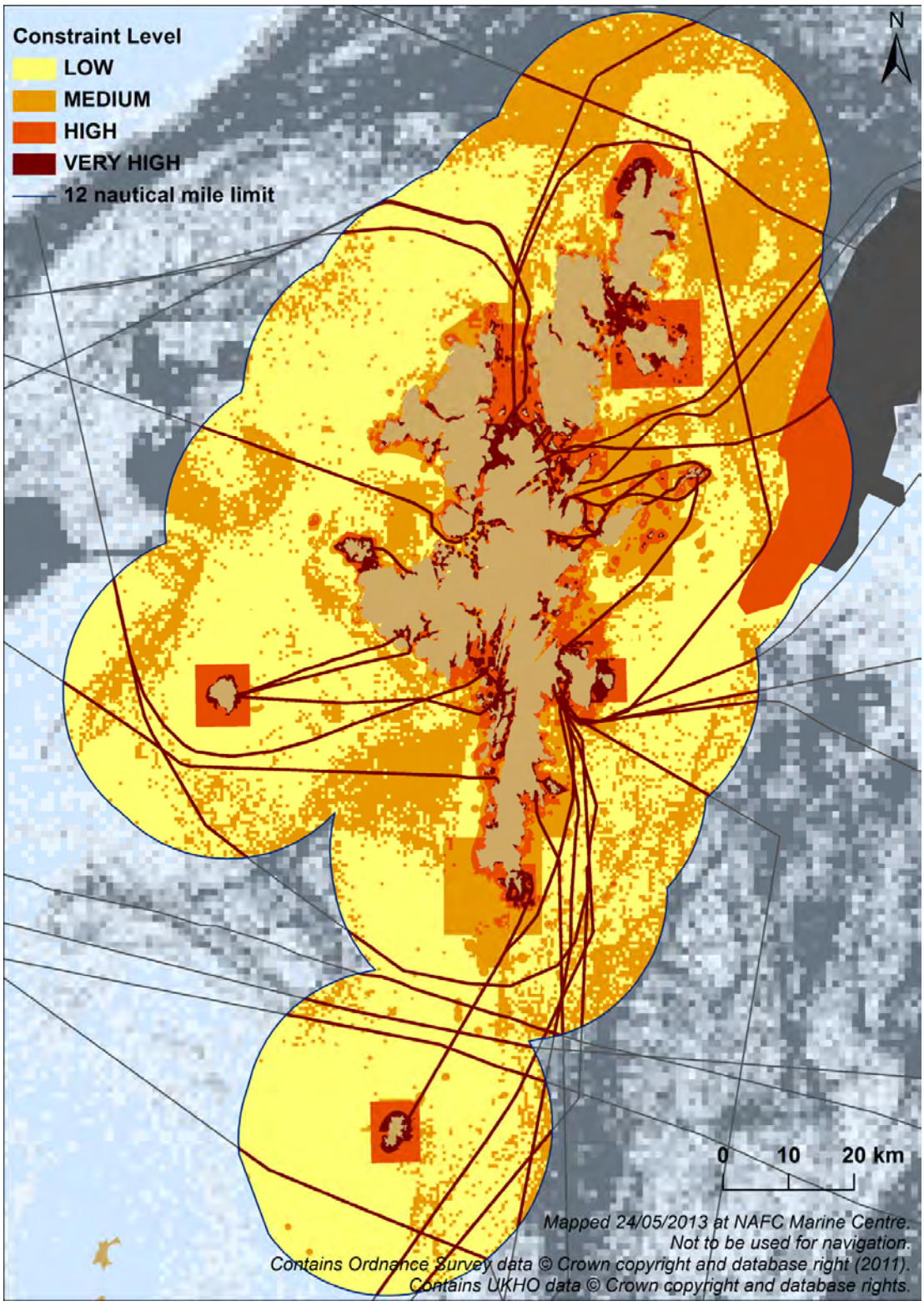


**Figure 3. Total constraints at sea.**

Marine constraints within the Shetland 12 nautical mile limit were mapped and summed in order to model total constraint levels. Developments will encounter increasing likelihood of conflicts at increasing levels of constraint.

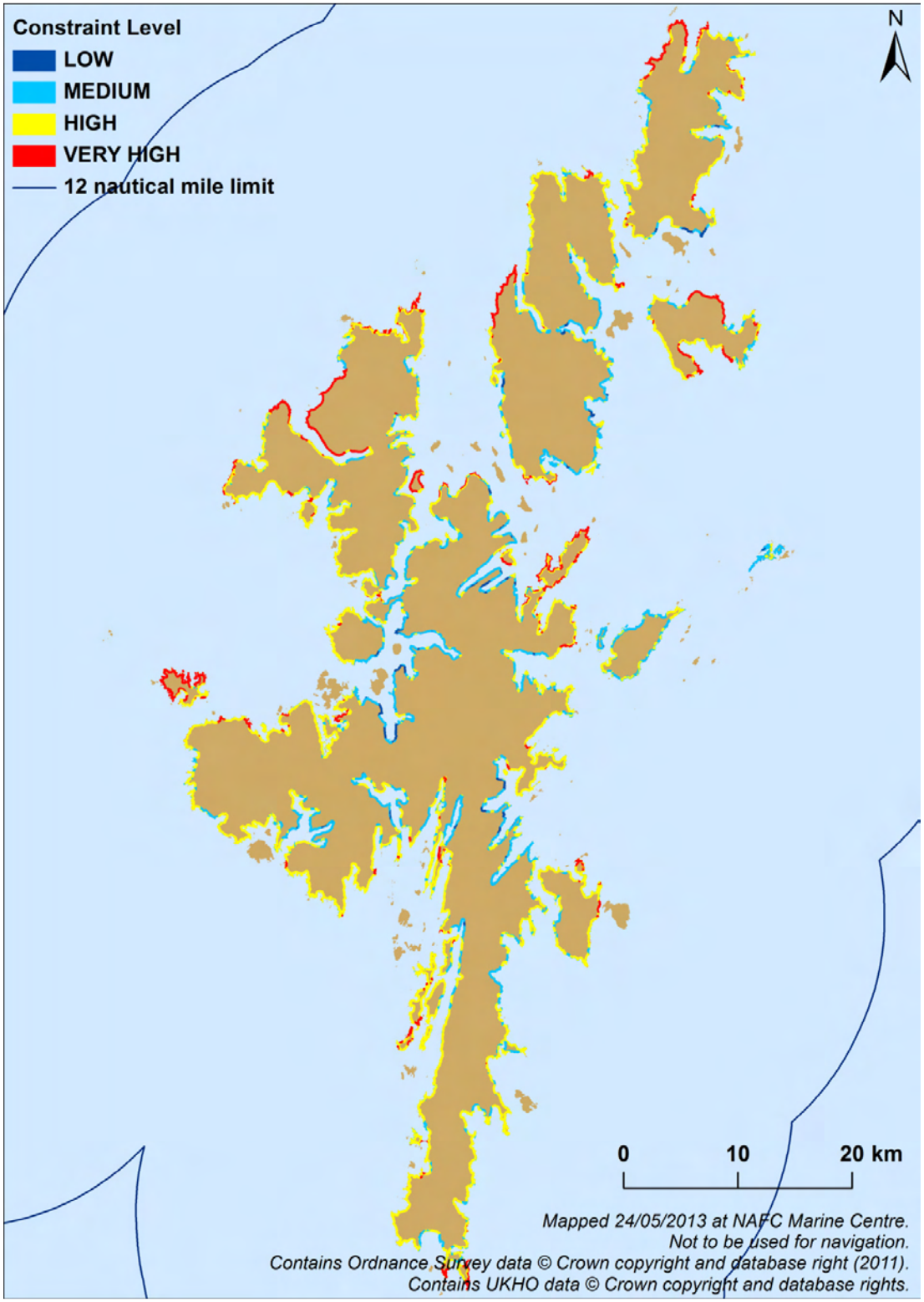


**Figure 4. Total constraints at the coast.**

Constraints within 200 m of the coast were mapped and summed in order to model total constraint levels. Developments will encounter increasing likelihood of conflicts at increasing levels of constraint.

## 5. Conclusions

The maps do not conclusively depict sites for marine renewable developments, but instead represent the likelihood of an area of being suitable. The outputs from the model have been integrated into the fourth edition of the Shetland Marine Spatial Plan through marine renewables policy MSP NRG3 (NAFC Marine Centre, 2013). The policy is intended to guide developments towards areas of low constraint, and encourage the development of mitigation measures in areas of medium to very high constraint. The findings of this assessment are part of an ongoing process, and will change as new information is captured. These regional locational guidelines (RLG) will be reviewed every 6 months, and revised as new or updated data becomes available.

## 6. Caveats

All maps should be interpreted taking into consideration:

1. Stakeholders assessing constraints did so without reference to specific wave or tidal projects. Assessments of environmental and socio-economic impacts are likely to vary with specific wave and tidal development schemes.

2. The model will be updated as new data becomes available. The most up to date output maps should be used (available from www.nafc.ac.uk).

3. The method of data collection and recording can influence the distribution of data on a map. For example, absence of data within an area of map may not represent no constraint, but may reflect data gaps generated by non-systematic surveys (as is the case with mobile species and archaeology datasets) and observer bias, particularly towards inshore sightings (as is the case with cetaceans). It is advisable that consideration be given to whether an area with a low constraint value is truly an area with a low degree of constraint, or if the low constraint value is a consequence of small survey effort.

4. The presence of a high degree of constraint does not explicitly prohibit the development of marine renewables. Instead, it highlights that the area at sea or along the coast already is subject to several activities, or contains important marine features. Marine renewable developers are encouraged to consult with stakeholders to identify whether mitigation measures may permit developments in these areas.

5. There may be activities or marine features currently not considered within the layers of these models, which will need to be addressed in any marine renewables development proposal.

## References

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## Appendix 1. Local Stakeholders and Consultees

Industry
Aquamarine Power (Megan Richardson)
Grieg Seafood Hjaltland UK Ltd. (Rachel Hope, John McEvoy)
Hammerfest Strøm (Inger Lise Mathisen)
Lerwick Port Authority (Captain Alexander Simpson)
Nova Innovation (Gary Connor, Simon Forrest)
Pelamis Wave Power (Laura Carse, Rosalind Hart)
Seafood Shetland (Ruth Henderson)
Shetland Fishermen's Association (Simon Collins and Leslie Tait)
Shetland Shellfish Management Organisation (Jennifer Mouat)
SSE (Nathan Coote)
Vattenfall (Harvey Appelbe)
Voith Hydro Wavegen Ltd (David Langston)

Local and Central Government
Joint Nature Conservation Committee (Tim Dunn, Kerstin Kober)
Marine Scotland (Robert Watret)
Marine Scotland Licensing Operations Team (Gillian Graham)
Scottish Environment Protection Agency (Janet Davies)
Scottish Natural Heritage (Karen Hall)
Shetland Islands Council (Martin Holmes, Ryan Leask, John Rosie, John Williamson)

Heritage
Royal Society for the Protection of Birds (RSPB) (Pete Ellis)
Royal Yachting Association Scotland (Michael Gray, Graham Russell)
Sea Mammal Research Unit (Lindsay Wilson)
Shetland Amenity Trust (Paul Harvey, Val Turner)
Shetland Oil Terminal Environmental Advisory Group (Martin Heubeck)

Others
The Crown Estate (Alex Adrian)