

Technical Note

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Water & Maritime

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Subject: Scottish Salmon Wave Climate Assessment - Annex 12: North Gravir

1 Introduction

Royal HaskoningDHV have been commissioned to undertake Wave Climate Assessments (WCA) at a number of areas where Scottish Salmon Company (SSC) sites are operating. This Annex presents the wave climate derived for the **North Gravir** site with location illustrated in **Figure 1**. The site is located in approximately 76.4m water depth. Detailed description of the extreme wave and wind conditions assessment and development and calibration of the wave transformation model is provided in the main Scottish Salmon - Wave Climate Assessment Report (doc ref. PC2241-RHD-ZZ-XX-RP-Z-0002).



Figure 1: Location of the North Gravir Site

2 Approach

To determine the wave climate at each site, firstly extreme value analysis of the purchased hindcast data at four locations (ERA5¹ points) was undertaken to derive extreme offshore wave conditions and extreme wind speeds for a range of return period events and number of relevant directional sectors. These were then used in a calibrated regional model, covering the whole of the western coast of mainland Scotland and Outer Hebrides.

Results from the regional model were used as input conditions to smaller, more refined local wave transformation models focused on specific areas of interest. The local models were also simulated with extreme wind conditions (without offshore waves) to derive locally wind generated waves at the site location. That was only considered for sites where locally wind generated waves could be of concern.

The **North Gravir** site is located within local model Domain 1, as illustrated in **Figure 2**. The site is sheltered from westerly directions but exposed to wave approaching from the easterly directions. Therefore, all easterly and north-easterly directional sectors were considered in the wave transformation modelling. That includes resultant waves from northerly and north-easterly directions and locally wind generated waves from easterly directions. Further details on the model set-up are provided in the main Scottish Salmon - Wave Climate Assessment Report.



Figure 2: Location of the North Gravir Site within local model domain

¹ Open data source available from the European Centre for Medium-Range Weather Forecasts (ECMWF)

3 Sensitivity Tests

Following derivation of the extreme wave and wind conditions (discussed in the Scottish Salmon - Wave Climate Assessment Report), a series of sensitivity tests were carried out to determine the worst wave direction for each site. These tests were undertaken for the design event, i.e. 1 in 50-year return period only. The derived worst direction was then adopted in wave modelling for all required return period events.

Results of the sensitivity test for the **North Gravir** site are presented in **Table 1**, with the determined worst wave direction outlined in red. The results show that for the **North Gravir** site, the worst direction is 30°N, i.e. from the north-east. As such, this direction was adopted for extreme wave and wind conditions in the wave transformation model runs for the full set of return period events.

Table 1: Results of the sensitivity tests to derive the worst wave direction for the North Gravir site

| Site ID | Boundary Conditions | | | | | Results | | |
|---------|---------------------------|------------|------------------|---------------------|-----------------------|---------------------|-----------------------|----------------------------|
| | Offshore Direction (degN) | ERA5 Point | Wind speed (m/s) | Wave Height, Hs (m) | Wave Period, Tp (sec) | Wave Height, Hs (m) | Wave Period, Tp (sec) | Mean Wave Direction (degN) |
| 27 | 330 | Point 3 | 29.26 | 14.98 | 14.96 | 3.25 | 14.82 | 29 |
| | 0 | Point 3 | 25.32 | 13.12 | 14.06 | 5.00 | 13.89 | 44 |
| | 30 | Point 3 | 23.65 | 11.02 | 13.62 | 6.01 | 13.48 | 49 |
| | 60 | Point 3 | 23.50 | 8.42 | 12.09 | 5.58 | 11.70 | 52 |
| | 90 | Point 3 | 21.85 | WIND ONLY | | 3.08 | 6.73 | 81 |
| | 120 | Point 3 | 23.99 | | | 3.32 | 6.75 | 117 |
| | 150 | Point 3 | 24.88 | | | 3.31 | 7.25 | 144 |

For the above sensitivity tests, diffraction was not enabled in the wave model to reduce computational time required for the simulations. However, for the final model runs the diffraction was included.

4 Wave Model Results

Table 2 presents the derived extreme wave conditions at the **North Gravir** site for the 1 in 1-year, 1 in 10-year, 1 in 50-year, 1 in 100-year and 1 in 500-year return period events, respectively.

Table 2: Results of the wave modelling at the North Gravir site for all return period events (30°N direction)

| Return Period (year) | Boundary Conditions | | | Results | | |
|----------------------|---------------------|---------------------|-----------------------|---------------------|-----------------------|----------------------------|
| | Wind speed (m/s) | Wave Height, Hs (m) | Wave Period, Tp (sec) | Wave Height, Hs (m) | Wave Period, Tp (sec) | Mean Wave Direction (degN) |
| 1 | 17.35 | 6.14 | 10.58 | 3.74 | 10.48 | 47 |
| 10 | 21.20 | 9.02 | 12.51 | 5.11 | 12.45 | 48 |
| 50 | 23.65 | 11.02 | 13.62 | 6.00 | 13.47 | 49 |
| 100 | 24.67 | 11.88 | 13.98 | 6.39 | 13.82 | 49 |
| 500 | 26.99 | 13.82 | 15.21 | 7.21 | 15.05 | 50 |

Contour plots of the wave model results at the site location (marked with a pink point) are presented in **Figure 3** to **Figure 7**, for the five return period events, respectively.

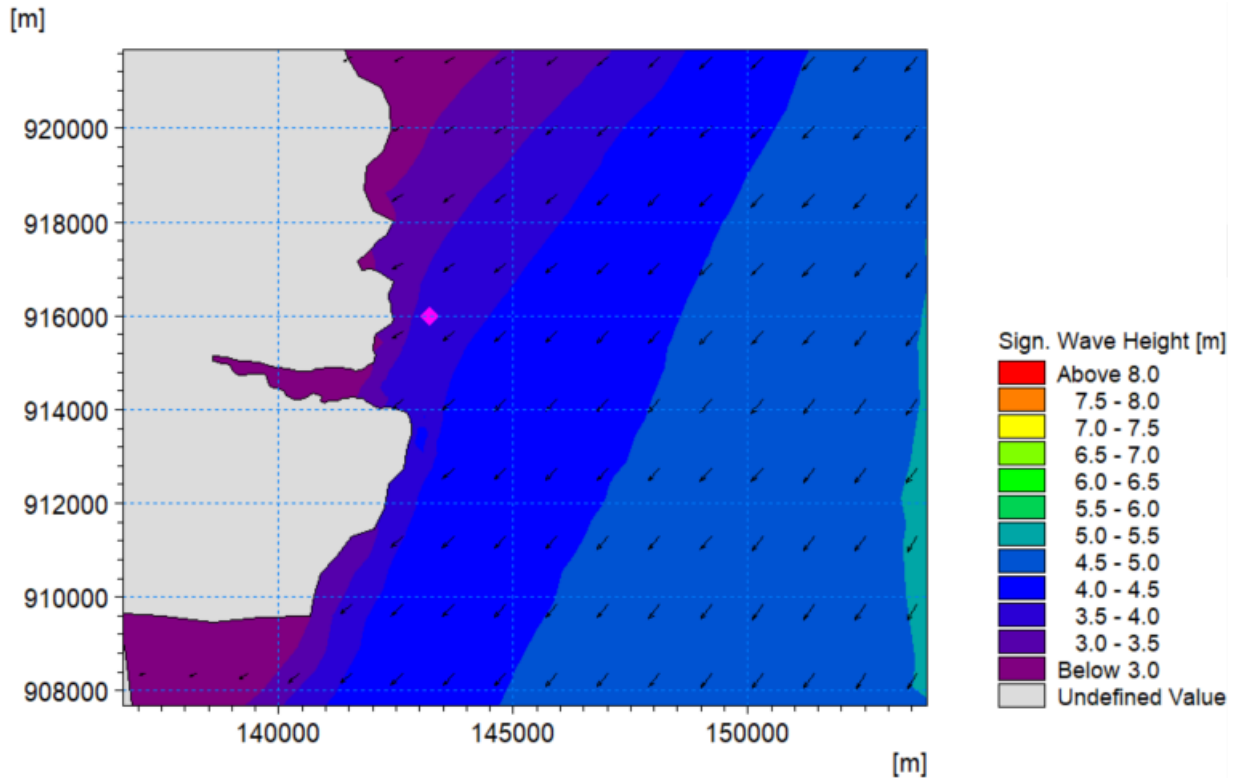


Figure 3: Wave conditions at the North Gravir Site (pink point) – 1 in 1-year return period event

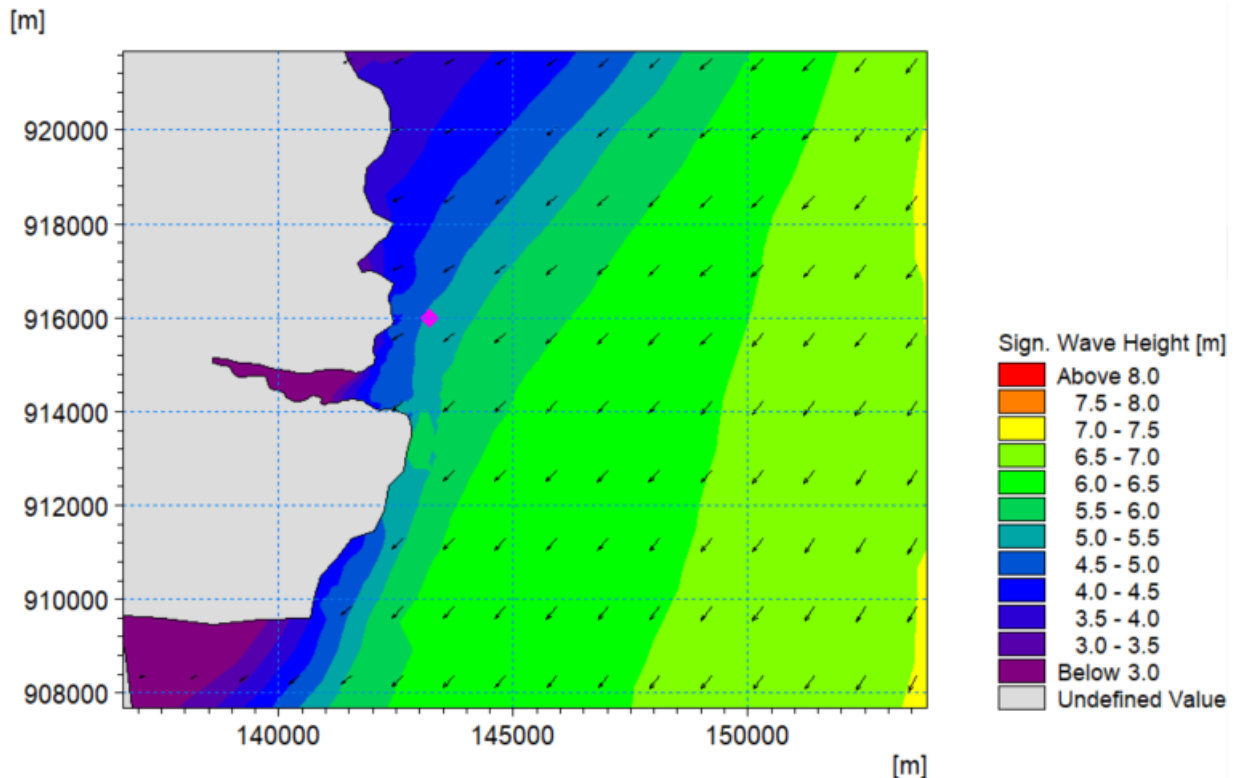


Figure 4: Wave conditions at the North Gravir Site (pink point) – 1 in 10-year return period event

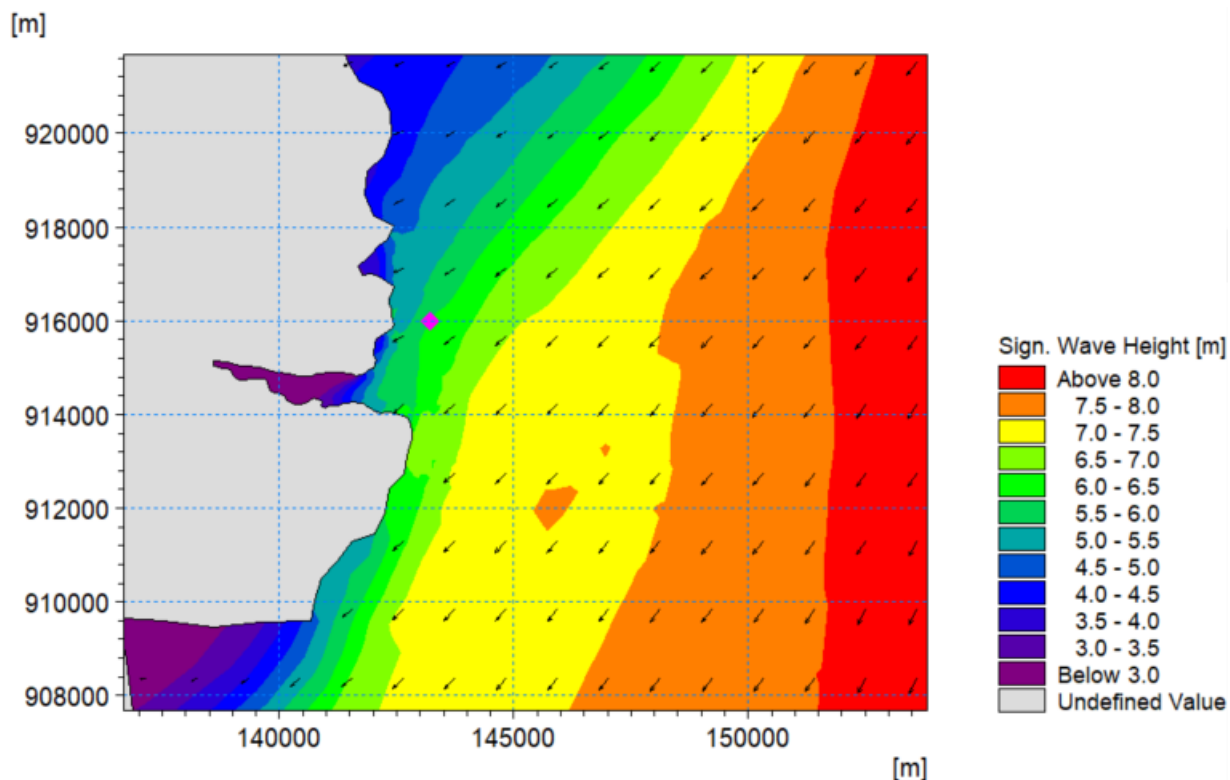


Figure 5: Wave conditions at the North Gravir Site (pink point) – 1 in 50-year return period event

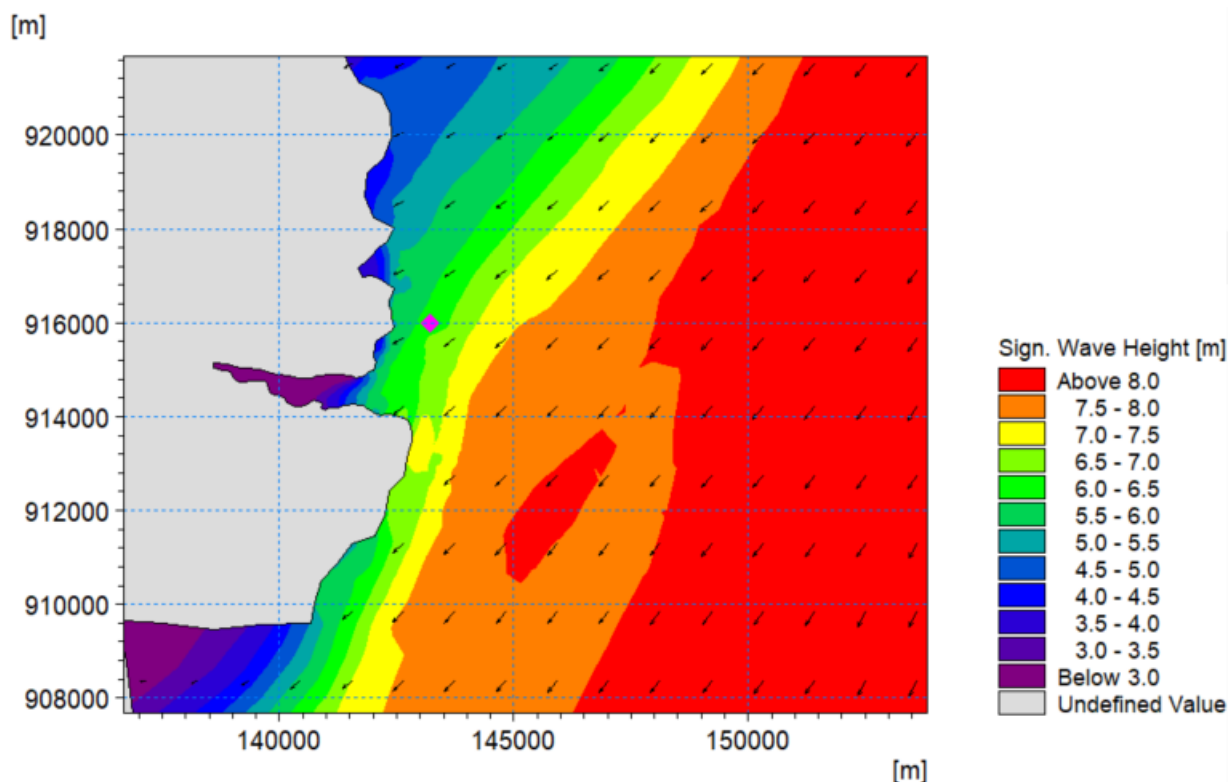


Figure 6: Wave conditions at the North Gravir Site (pink point) – 1 in 100-year return period event

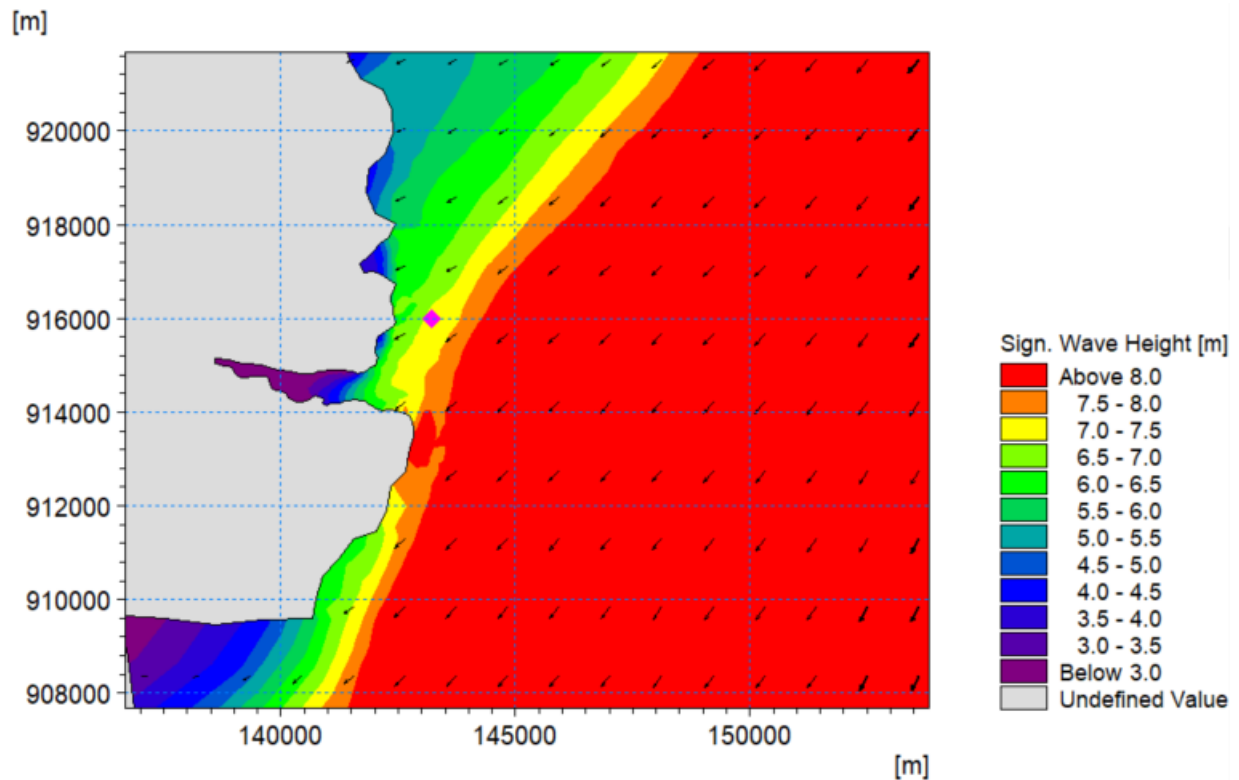


Figure 7: Wave conditions at the North Gravr Site (pink point) – 1 in 500-year return period event