

### 34. Kelp forest

*Irish name: Ceilp*



Figure A10.34.1. Kelp forest. Image licence David Baird CC BY-SA 2.0

#### **Background**

Kelp forest is underwater “forest” dominated by brown algal species of the order Laminariales and is a feature along much of the Irish coastline. In Irish waters there are five species of kelp which can form forests: *Laminaria digitata*, *L. hyperborea*, *Saccharina latissima* (formerly *L. saccharina*), *Saccorhiza polyschides* and *Alaria esculenta*. *Laminaria hyperborea* grows on bedrock, from the shallow subtidal to as deep as 40 m in areas of high-water clarity. It can grow up to 4 m in length, attaching to substrata via a holdfast from which a thick stipe (stem) extends to a broad, large flat golden- to dark-brown blade which is divided into multiple fingers (Tyler-Walters, 2007). *Laminaria hyperborea* can live up to 18 years, with the oldest individual recorded in Ireland estimated to be 15 years. Average age in Ireland is 4 years, mainly due to removal by winter storms (Schoenrock et al., 2022). *Laminaria digitata* is morphologically similar to *L. hyperborea* but easily identified by its stipe, which is oval in cross section, compared with the circular cross section of *L. hyperborea*. Another difference is in the texture of the stipe, which in *L. digitata* is smooth and typically lacks any

epiphytes. In contrast, *L. hyperborea* has a stipe that is tough in texture, which encourages epiphytic growth (Tyler-Walters, 2007). *Saccharina latissima* is brown, with a short stipe that leads to a long undivided frond with a distinctive frilly undulating margin and no midrib (White & Marshall, 2007). *Alaria esculenta* has a short stipe and a long, slightly wavy blade, which can be distinguished from that of *S. latissima*, by the presence of a midrib (Tyler-Walters, 2008). *Saccorhiza polyschides* is an opportunistic fast growing annual species which is easily identified by a holdfast which is large, bulbous with a wart covered appearance, and a flat stipe with distinctive frilly edges (White, 2008).

In Irish waters, *Laminaria hyperborea* can form dense forests along semi-exposed rocky coastlines while, in more sheltered areas, *L. digitata* forms smaller forests (Schoenrock et al., 2020a). Kelp forests are highly diverse and productive ecosystems that provide a multitude of ecosystem services (Schoenrock, 2020). They provide habitat for various marine vertebrate and invertebrate species, including commercially important ones e.g., Atlantic cod and European lobster (Schoenrock, 2021) and form substrata for diverse assemblages, including other marine algae (Norderhaug et al., 2002). Both the stipe and the holdfast host associated species, with the holdfast being more important for epifauna and the stipe hosting more epiphytic species (Schoenrock et al., 2021). A single *L. hyperborea* holdfast from Galway was recorded with 949 epiphytes comprising 14 species; a single stipe had 1660 epiphytes comprising eight species. This is likely an underestimation as mobile micro- and mesofauna probably evaded collection due to the mesh size of the collection bags (Schoenrock et al., 2021). The species assemblages found in kelp forests vary by season (Schoenrock et al., 2021), latitude (Araújo et al., 2016), and among locations depending on local environmental parameters (Norderhaug et al., 2014), meaning it is important to carry out thorough local studies to get a true ecological baseline to understand the processes which affect kelp forests. Kelp forests are at the base of multiple food chains, including as a carbon source for phytoplankton (Fredriksen, 2003), and supporting deeper habitats offshore via kelp detritus deposition (Ramirez-Llodra et al., 2021). They reduce coastal erosion by dampening wave energy (Lovas & Tørum, 2001).

### **Rationale for spatial protection in the Celtic Sea**

Kelp forest was nominated for inclusion on the feature list due to its ecological importance. Kelp forest habitat is complex and benefits many species, increasing ecosystem diversity and biomass compared with regions without kelp forest. The habitat is listed as under threat and/or in decline in OSPAR region III (Celtic Seas). Additionally, *Laminaria hyperborea* displays a high degree of genetic diversity along the southern coast of Ireland, potentially due to presence of a glacial refugium off the Celtic Sea shelf during the last glacial maximum (Assis et al., 2016; Schoenrock et al., 2020b). Genetic diversity can facilitate adaptation, and therefore resilience, to climate change induced shifts in

environmental conditions. For these reasons, kelp forest is suitable for spatial protection in the Celtic Sea.

### **Sensitivity assessment**

The sensitivity assessment was based on the 12 kelp level 5 biotopes, as described under The Marine Habitat Classification for Britain and Ireland (JNCC, 2022), within the Celtic Sea (Table 1). The results of individual sensitivity assessments for all 14 biotopes were identical or very similar. Where sensitivities differed between biotopes, the highest sensitivity value was taken for the overall sensitivity assessment. The pressures ‘physical change (to another sediment type)’, ‘habitat structure change-removal of substratum (extraction)’, and ‘penetration or disturbance of substratum subsurface’ are not relevant for hard substratum habitats and were not assessed (Tyler-Walters et al., 2018).

**Kelp forest is highly sensitive to pressures associated with the construction and operation of offshore renewable infrastructure.** All marine habitats and benthic species are considered to have a high sensitivity to physical loss to land or freshwater. All kelp species need a rocky substratum to attach to, and if this was to be replaced with sedimentary substrata, they would be unable to persist in the region, meaning they are highly sensitive to the pressure of physical change (to another seabed type). Kelp forest is highly sensitive to the introduction or spread of invasive non-indigenous species. Competition from potentially invasive macroalgae such as *Undaria pinnatifida*, *Sargassum muticum* and *Codium fragile* could threaten kelp forests and possibly alter the community of associated species. The introduction of invasive species is also a pressure associated with shipping and the fishing sector. Kelp forest has a medium sensitivity to heavy smothering and siltation pressures. The gametophytic and zoospore stages are more vulnerable to this pressure than adult forms, as siltation can inhibit settlement (Bartsch et al., 2008) and cause abnormal development of zoospores (Burrows, 1971).

**Kelp forest is highly sensitive to pressures associated with the fishing sector.** The aforementioned ORE pressures of physical change (to another seabed type), physical change (to another seabed type), and introduction or spread of invasive non-indigenous species, are also pressures associated with the fishing sector. Kelp forest has a medium sensitivity to both targeted and non-targeted removal of species. Harvesting of wild kelp is a relatively small industry in Irish waters, a combined total of 72.6 wet tonnes of *L. digitata*, *A. esculenta*, and *S. latissimi* in 2020 (CTCCBRG, 2022), and involves the removal of the canopy, which can recover within 2 – 6 years. However recurrent disturbance during recovery can extend recovery time beyond six years (Kain, 1975). Accidental

removal of the canopy by fishing methods (non-targeted removal) will cause similar effects to direct harvesting).

Table A10.34.1. The 12 kelp biotopes, as described under The Marine Habitat Classification for Britain and Ireland (JNCC, 2022) whose sensitivity analyses were used to assess the sensitivity kelp forest in the Celtic Sea. The reference for the sensitivity analysis of each is given.

#	Biotope Name	Reference
1	<i>Alaria esculenta</i> on exposed sublittoral fringe bedrock	Stamp et al., 2023c
2	<i>Laminaria digitata</i> on moderately exposed sublittoral fringe rock	Hill et al., 2023
3	<i>Laminaria digitata</i> , ascidians and bryozoans on tide-swept sublittoral fringe rock	Stamp et al., 2022d
4	<i>Laminaria hyperborea</i> forest with a faunal cushion (sponges and polychinids) and foliose red seaweeds on very exposed upper infralittoral rock	Stamp et al., 2023b
5	<i>Laminaria hyperborea</i> on tide-swept, infralittoral mixed substrata	Stamp et al., 2023a
6	<i>Laminaria hyperborea</i> on tide-swept, infralittoral rock	Stamp et al., 2023e
7	<i>Laminaria hyperborea</i> park and foliose red seaweeds on moderately exposed lower infralittoral rock	Stamp et al., 2023d
8	<i>Laminaria hyperborea</i> with dense foliose red seaweeds on exposed infralittoral rock	Tyler-Walters et al., 2023
9	Mixed <i>Laminaria hyperborea</i> and <i>Laminaria saccharina</i> on sheltered infralittoral rock	Stamp et al., 2022c
10	<i>Saccharina latissima</i> and/or <i>Saccorhiza polyschides</i> on exposed infralittoral rock	Stamp et al., 2022a
11	<i>Saccharina latissima</i> on very sheltered infralittoral rock	Jasper et al., 2022

12	<i>Saccorhiza polyschides</i> and other opportunistic kelps on disturbed sublittoral fringe rock	Stamp et al., 2022b
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**Kelp forest is highly sensitive to a pressure associated with shipping i.e., the introduction or spread of invasive non-indigenous species.** Most pressures associated with the shipping sector were not assessed for Kelp forest due to a lack of evidence. These include chemical pressures (Transition elements & organo-metal contamination, Hydrocarbon & PAH contamination, Synthetic compound contamination, introduction of other substances), and physical pressures (underwater noise). All these pressures are also associated with ORE and fishing. Further research is needed on the sensitivity of this biotope to these pressures and the shipping sector.

#### **Data sources available**

Data sources for kelp forest in the Celtic Sea AOI that were available to the MPA Advisory Group, and the quality / suitability of those data for conservation prioritization analyses (See Table 3.2.1 Main Report), are shown in Figure A10.34.2. For information on how data were prepared for use in prioritization analyses, and for a visualisation of layers used, see Appendix 5e, section 5e.4.

#### **Further research needs**

Multiple pressures could not be assessed for Kelp forest, particularly chemical pressures, due to lack of evidence. Further research is needed to assess the sensitivity of kelp species to all pressures, but particularly chemical pressures. The species assemblages found in kelp forests vary among locations depending on local environmental parameters. It is therefore important to carry out thorough local studies within the Celtic Sea to get a true ecological baseline to understand the processes and sensitivities which affect kelp forests. Genetic data could help identify populations with high genetic variability or distinctness, and provide information on connectivity among populations. An integrated approach where genetic data are used in combination with sensitivity and conservation prioritization analyses could provide more comprehensive spatial protection.

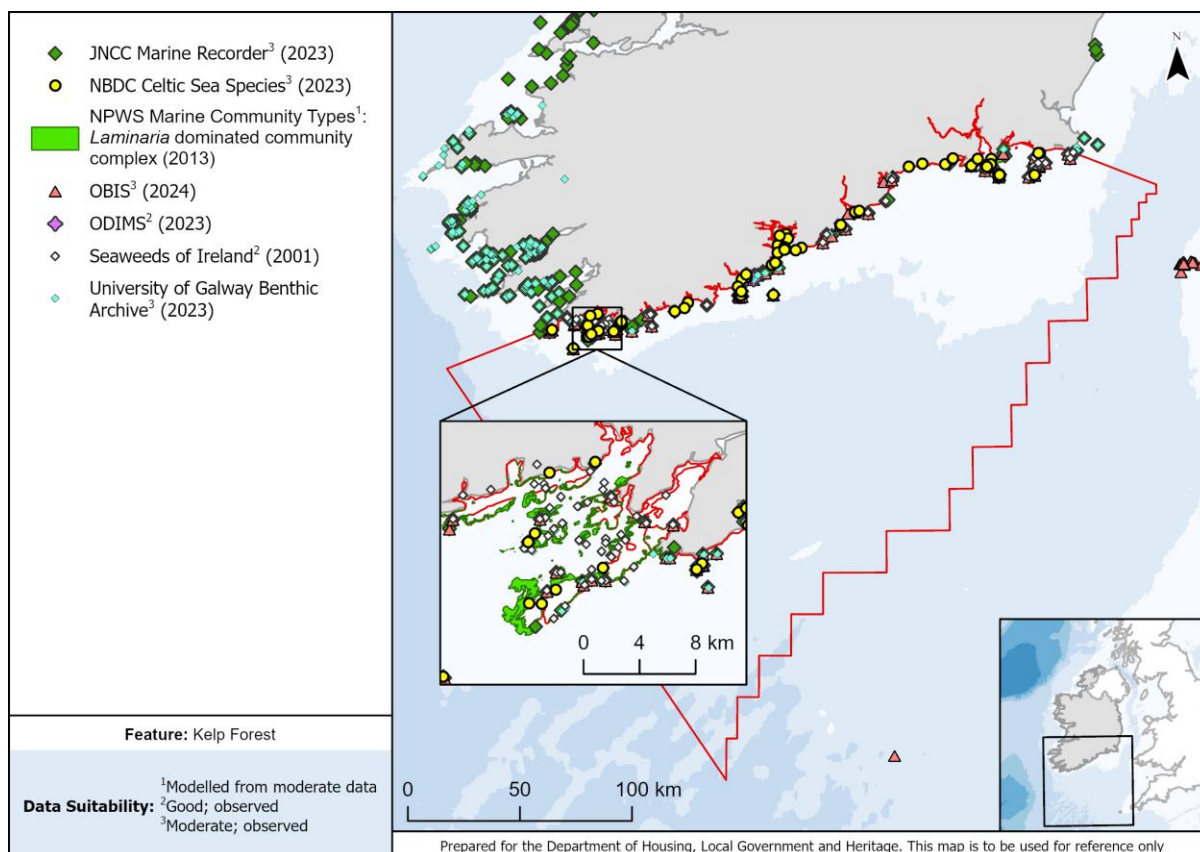


Figure A10.34.2. Data available on the distribution of Kelp forest in the Celtic Sea.

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