Beasts of the kelp forest

In a departure from our well-kent terrestrial forests, Duncan Smallman *leads us through the wonders of our kelp forests.*

Scotland has a hidden forest that is only visible around certain phases of the moon. It is rich in colour, hues of gold, rich browns, different shades of red, iridescent blues and vibrant greens and the name lends itself to a creature that features in Scottish mythology. Kelpies are mythical creatures that look like horses but on closer inspection are hideous creatures covered in seaweed, in particular kelp.

More recently, in 2018, our kelp forests made the news after a scoping report was published for a proposal to mechanically harvest (or dredge) some of the kelp, which sparked a huge public outcry leading to the banning of large-scale mechanical harvesting of seaweed (and subsequently led to the formation of a seaweed review group by the Scottish Government). The campaign to stop mechanical harvesting helped raise the status and highlight the importance of kelp forests in the marine ecosystem, their role in climate change mitigation and the health of our oceans and their role in the socio-economic sustainability of our coasts.

Above, clockwise from top: Upper edge of the kelp forest seen at spring low tide; Blue ray limpets; *Odonthalia dentata*. Photos: Duncan Smallman.

Know your seaweeds

Before delving into our kelp forests, it is necessary to introduce what kelp and seaweeds are. What gets called 'seaweed' are broadly three very distinct groups of photosynthesising organisms, characterised by their colour: greens (*Chlorophyta*), reds (*Rhodophyta*) and browns (*Phaeophyta*). Taxonomically, only the green seaweeds are considered part of the plant kingdom. The red seaweeds are unique enough that they may (or may not) be considered broadly part of the plant kingdom, for it is likely they do share a common ancestor with what are commonly known as plants. However, during no part of their life cycle do any of the red seaweeds have flagella unlike green seaweeds and brown seaweeds, which is a key difference.

Brown seaweeds are completely different again. Yes they photosynthesise and kind of look like other seaweed species, but they belong in the biological kingdom *Chromista*, making them as related to the red and green species of seaweed, as we (humans) are related to red and green species of seaweed. These differences are seen in the various

life cycles, the cell structures and importantly the pigments we see and the compounds these seaweeds produce.

The same terminology for the main parts (or thallus) is used across species: the holdfast, where the seaweed is attached to the substrate; the stipe, the stalk-like structure that connects the blade to the holdfast; the blade (or lamina in the kelp species), the leaf-like structure where most of the photosynthesis occurs and often where the reproductive organs develop. What this means is the seashore and our coastal waters hold a high diversity of primary producers, something completely different from what we see on land and just as diverse and exciting.

Tidal habitats

The upper fringes of our kelp forests are visible from the shore at the lowest tides, around full or new moons, forming a slippery golden-brown band along the low-tide mark, just visible poking out of the water offshore. In this way they are a bit like the tree line seen when descending a mountain, and the seashore (the intertidal area between high and low water) can be viewed by this analogy.

Once below the high-water mark we are in a marine environment, albeit a harsh and extreme one. There are some terrestrial organisms that can survive (and even require) submersion in the sea but these are only found around the high shore area (likewise there are some seaweed species that cannot survive long submersion). Fewer and generally smaller species are found in the upper shore area, similar to the higher altitudes of mountains.

Then as we head down the shore, the number of species increases and the size increases, as seen with the seaweeds. The intertidal rocky shore is dominated by the brown seaweed wracks, such as bladderwrack and eggwrack, and the change in biomass and species composition is often used to identify the shore zone. The number of red species increases as well and can often be found hidden underneath the wracks or even using the wracks as a substrate to grow on. By the low-tide mark, most rocks will be covered with a seaweed of some kind, be it a wrack, kelps, some of the fine bushy reds or even the lilacs and pinks of the encrusting coralline red seaweed (yes, the pink rocks that are visible are red seaweed).

Above, clockwise from top left: Royal fern weed (*Osmundea osmunda*) with *Lomentaria articulata* and coral weed *Corallina officinali*; Mixed species on a bed of corraline; Isopod sitting on coral weed amongst the kelp *Laminaria digitata* and other seaweed species. Photos: Duncan Smallman.

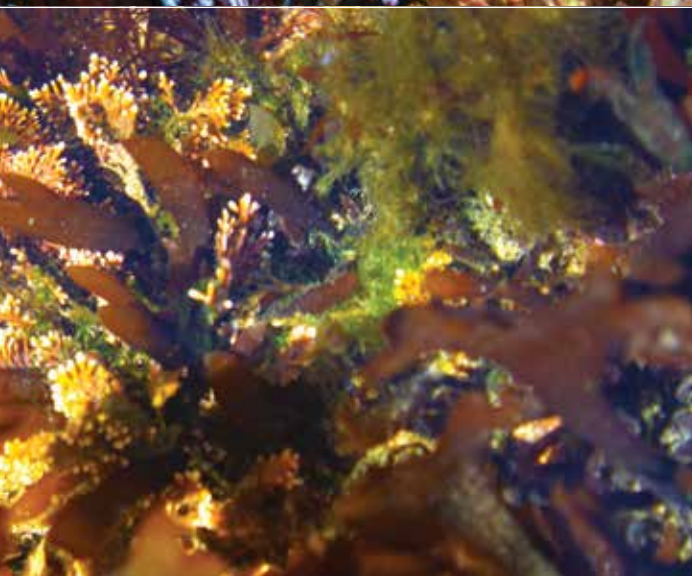
Descending into the forest, we say goodbye to the wracks and enter the realm of the big kelps, the tree/not-trees of the marine world. Our kelp forests are what is known as a Priority Marine Feature, putting it in the same category as the likes of seagrass meadows and mearl (a calcified red seaweed) beds in terms of protection status and importance to our marine (and overall) ecosystems.

The kelp forests

The species that really gives these forests their name is cuvie or forest kelp, *Laminaria hyperbore*a, and was the species of interest for the mechanical harvesters. Cuvie is a source of an important and widely used compound called alginate, which has uses from pharmaceuticals and medicine to textiles and paints to a thickener and stabiliser in food. The commercial application of alginate alone makes cuvie an attractive species to harvest.

Of course there is more to cuvie and our kelp forests than just biochemical extraction. Because our kelp forests are home to a huge diversity of species—not mobile species swimming or moving through the forest, but species actually living in the complex holdfast structures, along with other phaeophytes, rhodophytes and animals living on the stipes and blades. Nature Scot have the number of species living in the holdfast alone as 30 to 70 species with many thousands of animals often found in a single holdfast. Within UK kelp forests themselves the diversity has been recorded as close to 300 different taxonomic units, although this number is likely to be higher. A recently published study looking at the complete food-web of kelp forests off the coast of California found 942 species associated with kelp forests. It is reasonable to consider that a similar diversity may be found in the UK kelp forests.

This diversity includes lots of commercially important species, such as juvenile cod and haddock,



pollock, whiting, sea bream, bass, lobster, crabs, squat lobsters and scallops. But this diversity also includes lots of flora and fauna that are just beautiful. A kelp forest is not just cuvie, it is a whole assorted canopy and undergrowth of different red seaweeds, some very plant-like, such as the delicate bladed sea beech (*Delesseria sanguinea*) or the wonderfully blood red toothed *Odonthalia dentata*. The crustose coralline red species range from lilacs, to pinks to deep purples and the fern weeds (*Osmundea* species) that look like small deep red versions of their terrestrial namesakes. These and other seaweeds provide an important habitat for small crustaceans such as amphipods and isopods that are often food for the commercial species mentioned. Then there are the brightly coloured and adorned sea slugs, the alien looking feather stars, numerous species of jewel-like anemones, that fill up the spaces or live on the different seaweeds and the tall, towering cuvie stands.

High biodiversity (and lots of living things) is also a good way of locking away carbon and keeping that carbon cycle here, rather than flowing just into the atmosphere or dissolving into the sea. Though it is thought that kelp forests are not quite as efficient at locking away carbon as say mangroves or seagrass meadows, the carbon cycling within a kelp forest and between them and the deeper parts of the seas and oceans is not well understood and currently needs more research. Like mangroves, salt-marshes and seagrass meadows, kelp forests can also help contribute to protection against coastal erosion by attenuating wave action.

Unknown losses

Recent reviews regarding kelp forest ecology around the UK highlight significant gaps in our knowledge about these golden glades compared to research carried out in west coast United States and Australia. One key gap is knowing how much kelp forest we have potentially lost. This does not mean that we have not lost some of our kelp forests—the threats are multiple. One estimate has global kelp forests declining by a third.

Historical activity, such as channel dredging, removal of material for construction and poor water quality through poor land-use (namely, increased sediment load in the water, decreasing light penetration and increased freshwater runoff, which lowers salinity) can all have negative impacts on the distribution of our kelp. Current threats include climate change as well as poor land-use, water quality and dredging activity (potentially including mechanical harvesting). Climate change and the increasing sea temperature is certainly a visible effect already being seen off the southwest coast of England. Some species are being replaced as colder water kelps are replaced with warmer water species. This includes cuvie retreating and being replaced with golden kelp (*L. ochroleuca*). We have also seen the southern distribution of winged kelp (*Alaria esculenta*) start to retreat.

Replacement of species changes the biodiversity, potentially irreversibly. Changing water temperature and water conditions generally also allows for other threats, such as grazing urchins to potentially over-graze and create what are known as 'urchin barrens'. These events are well recorded for the kelp forests of the western United States, but are not currently a threat around Scotland, though we do have urchin species that graze on kelp and other seaweeds and so it may only take a bit of a tip in the urchins favour and we will start seeing more kelp forest lost.

Kelp futures

As mentioned above, *L. hyperborea* and the forest beds they form are a priority marine feature and therefore protected under Scotland's National Marine Plan and other legislation. This means that they have to be considered when structures are being deposited or moored along our coasts, which helps protect what we currently have. Are there ways we could try increasing the area of our kelp forests? Trials are taking place in the United States, Canada and Tasmania where their own native kelp forest-forming species are being planted. In the UK, native oyster bed rewilding and the planting of seagrass to re-establish lost seagrass meadows has started, in efforts to rewild the marine habitat. This should be possible for forest kelp and already along the Sussex coast a kelp rewilding project is planned. The creation of *L. hyperborea* forests is something I would very much like to see and I am currently working to put together such a project.

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