FACTSHEET

Macroalgae

Alan Millar, Principal Research Scientist, Royal Botanic Gardens, Sydney

What are macroalgae?

Macroalgae are members of the huge group of aquatic plants know as algae (singular 'alga'). The algae (the primary producers of the planet) are primitive photosynthetic plants that include the single celled 'phytoplankton' of the oceans and the multi-celled macroalgae, or seaweeds, that can range in size from microscopic to the massive bull kelps (*Durvillaea*) and giant kelps (*Macrocystis*).

Macroalgae should not be confused with seagrasses. The latter are closely related to land plants as they have roots, vascular tissue and produce flowers and pollen.

Macroalgae on the other hand, derive all their nutrients directly from the surrounding water through their tissue, a bit like a sponge soaks up moisture, and their holdfasts are purely for physically anchoring the thallus to the seabed.

While seaweeds do reproduce sexually, their reproductive structures are mostly microscopic and require fine dissection to be revealed.

Most macroalgae fall into four basic groups: the blue-green algae (Cyanophyta/Cyanobacteria) that are often associated with blooms in rivers; the green algae (Chlorophyta) such as sea lettuce; the brown algae (Heterokontophyta) that include the large kelps; and the red algae (Rhodophyta), the most diverse group of all.

The red algae should not be confused with "red tides" which are actually caused by single-celled algae (phytoplankton), some species of which can produce toxins that can kill fish or cause paralytic shellfish poisoning. No marine macroalgae are known to be toxic or harmful to humans. These different 'colours' of algae are the result of the different photosynthetic pigments or chlorophylls that each alga uses and these reflect different wavelengths of light.

Where are macroalgae found?

With few exceptions, macroalgae are strictly benthic plants; that is they are always attached to the seabed or a solid substratum such as natural reef, rocks, shells, mangrove roots, boat hulls, jetty pilings, mooring lines etc. When dislodged, most macroalgae have a limited lifespan as free floating seaweed drift and they may only live for hours to several months.

Only a few macroalgae, such as *Caulerpa* species, can grow in soft sediments and anchor themselves either with long root-like rhizoids or simply by entanglement around seagrass fronds.

Macroalgae grow both intertidally and subtidally. Because they derive their nutrients by diffusion through their tissue, the water movement across fronds has to be continually refreshed and by being anchored to the seabed, they increase their

Figure 1 Hormosira banksii, a common brown alga on rocky intertidal shores in NSW (Millar, 2007)

chances of this. When floating with the currents and tides, the water immediately surrounding them is not replenished as rapidly.

The one notable exception is a species of *Sargassum*. The famous Sargasso Sea (western north Atlantic) is named after this seaweed that floats there in massive rafts and can maintain itself by simple fragmentation.

Since macroalgae are true photosynthetic organisms, they can only grow in the “photic” zone of the coastal regions, where the light penetrates sufficiently for photosynthesis to occur. In clear waters, macroalgae can survive and grow at depths of over 200 metres, but in murky waters this is reduced to only a few metres.

Along the NSW coast the maximum depth for most macroalgae is about 35-45 metres.

Figure 2 Dislodged *Durvillaea potatorum* washed up on a beach (Millar, 2007)

Significance

As a result of their photosynthetic activity, marine algae (macroalgae and phytoplankton) are considered to produce between 50% and 75% of the earth’s oxygen as well as taking up about 25% of the carbon dioxide.

Crustose coralline algae, a very significant group of red seaweeds, make rocks look pink in colour and, when broken apart, are major contributors to the sediments of intertidal and subtidal reefs as they actively lay down Calcium Carbonate (chalk) in their tissues.

Geological cores taken on the Great Barrier Reef have shown that up to 70% of the marine sediments are made up of calcium carbonate deposits from the green algal genus *Halimeda.* In fact, they should probably be called macroalgal reefs rather than coral reefs.

Macroalgae are an important resource as food and/or shelter for a large range of fish, shellfish and other invertebrate species, and they often act as nurseries for juvenile fish. As drift, seaweeds are a vital food source for many beach invertebrates and, when rotting on the sand, they return vital nutrients back into the beach ecosystem.

Globally, macroalgae have been valued at about 11 billion dollars annually. Kelp forests are four times more productive per square metre than any intensively farmed crop on land.

Macroalgae can be harvested from natural stands, such as the fast-growing *Macrocystis* forests along the coast of California where the seaweed grows up to 50 cm a day. Alternatively, they can be farmed in large aquaculture enterprises. In these, the algal spores and/or young plants are seeded onto special ropes that are then attached to long-lines or other structures where they are left to grow for several months before harvesting.

In countries such as the Philippines, the seaweed industry, which is based largely on aquaculture, is one of the largest contributors to the nation’s Gross Domestic Product.

Japan is the largest grower and producer of macroalgae in the world and they grow many different types of seaweed for food (eg, the red algal genus *Porphyra* which is dried to make nori sheets for sushi rolls) or for a range of secondary products such as agar, carrageenen and alginates which are used extensively in making processed foods, pharmaceuticals and cosmetics.

In New South Wales, as in Australia as a whole, very few algae are collected for commercial purposes. The reason for this is that, while NSW is high in diversity of macroalgal species, no one algal species occurs in sufficiently large amounts or grows or recruits rapidly enough to make it commercially viable for harvesting.

Some macroalgae respond rapidly to, and thrive within, waters that receive increased nutrients and often can be used as indicators of water quality. At certain times of the year, especially in spring when

water temperatures and day lengths increase, coupled with some heavy rainfalls supplying nutrients from runoff to the coast and estuarine environments, macroalgae can bloom in massive quantities. In all instances so far studied, the algae involved in these blooms are harmless, non-toxic, native species. They are simply responding to changes in environmental conditions as most plants do.

These major blooms are mostly natural phenomena and occur all over the world. Within NSW waters, they have recently occurred at places such as Port Macquarie, Port Stephens, Jervis Bay, and Merimbula and Pambula on the south coast.

Macroalgae in NSW

There are approximately 800 species of macroalgae presently documented from NSW (Millar 1990; Millar & Kraft 1993, 1994a, 1994b; www.aussiealgae.org). The Australian continent hosts the richest marine macroalgal flora in the world with some 3000 species documented.

The southern coast of Australia has about 1200 of these species. The most common macroalgae are not necessarily the most regularly seen as they only grow subtidally. Those that are most easily seen by beachcombers are the greens and browns, although the red calcified algae (corallines) are often seen in tide pools and as drift after heavy storms.

Some common macroalgae of NSW

Greens

Caulerpa species

Codium species

Ulva species (sea lettuce)

Browns

Hormosira banksii

Phyllospora comosa

Ecklonia radiata

Sargassum species

Dictyota bartaryesiana

Durvillaea potatorum (only south of Tathra)

Reds

Crustose corallines

Cryptonemia sp.

Augophyllum delicatum

Loss of species

Macroalgae are an extremely fragile fish habitat that can be easily destroyed. This loss may contribute to declines in the abundance and diversity of fish and invertebrates in some of these estuaries and nearby coastal zones.

Direct human impacts such as mechanical damage, eutrophication, aquaculture, siltation, coastal constructions, and alteration of food webs; along with indirect human impacts, including the impacts of climate change, can contribute to a widespread loss of macroalgae.

Already, Sydney Harbour is the site of the world's first recorded extinction of a seaweed (Millar 2003) due to dredging, trawling, siltation and seabed/habitat destruction.

Some of the large brown algae along the NSW coastline are experiencing a range retraction south as seawater surface temperatures have increased over the last 60-70 years (Millar 2007).

Macroalgae can be damaged directly by boating-related activities and by dredging and reclamation. Foreshore structures such as pontoons and jetties can indirectly impact by shading macroalgae. Natural disturbances such as storm events, floods, extreme wave-action, predation and disease also may contribute to macroalgal loss.

Subtidal macroalgal species diversity and distribution is dependent on, and affected by:

- The diversity of the seabed topography and geology,
- Regions of upwelling where nutrient-rich cold waters reach the surface at certain localised regions along a coastline,
- Anthropogenic entrance modification to intermittently closed and open estuaries and lagoons (which causes decreased flushing &

Figure 3 *Augophyllum delicatum (Millar, 2007)*

increased residence times),

- Point sources of pollution from industrial discharge, discharge from sewage treatment plants, sewage overflow events and dumping of nutrient rich wastewater,
- Natural climatic events such as storms,
- The introduction of alien or pest species.

How can you help protect macroalgae?

Some simple ways to help protect macroalgae are:

- Avoid anchoring in, or mooring boats over, macroalgal beds.
- Avoid travelling across macroalgal beds in boats at low tide in order to minimise the potential for propeller damage.
- Design waterfront structures such as jetties, boat ramps and seawalls to avoid shading or physical damage to macroalgal beds.
- Ensure dredging and reclamation projects are sensitive to adjacent macroalgae beds.
- Replace decking of jetties with mesh decking to allow sunlight penetration to underlying macroalgal beds.
- Avoid walking through macroalgal areas at low tide.
- Avoid digging for bait in macroalgal beds.
- Promptly report sewer overflows.
- Maintain septic tanks and pumps so that they do not leak.

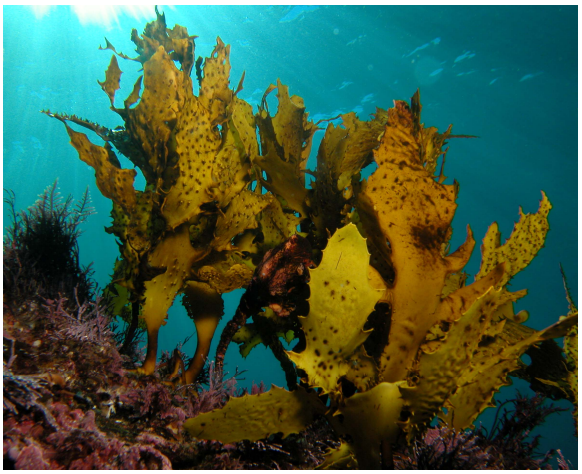

Figure 4 *Ecklonia radiata*, the common subtidal kelp along most of the NSW coast (Thiebaud 2007)

Protection of macroalgae in NSW

Industry & Investment NSW (I&I NSW) has management responsibility for fish and marine vegetation, including macroalgae, under the *Fisheries Management Act 1994*. Any development or activity that may harm macroalgae must be referred to I&I NSW.

Policies and guidelines applicable to the protection of macroalgae can be found on the Department's website at www.industry.nsw.gov.au or can be obtained from I&I NSW offices – see below.

In NSW there are two species of macroalgae currently on the list of threatened species: Bennetts seaweed (*Vanvoorstia bennettiana*) is presumed extinct (see Primefact 186) and marine brown algae (*Nereia lophocladia*) is critically endangered (see Primefact 192).

Harming macroalgae

The Fisheries Management Act sets out provisions to protect marine vegetation (mangroves, seagrasses and macroalgae whether alive or dead) from 'harm'. 'Harm' under the Act means gather, cut, pull up, destroy, poison, dig up, remove, injure, prevent light from reaching or otherwise harm the marine vegetation, or any part of it. A permit is required from I&I NSW to harm marine vegetation, including macroalgae.

The maximum penalty for harming marine vegetation, including macroalgae, without a permit is $220,000 for a Corporation or $110,000 for a person.

Collecting macroalgae

I&I NSW will generally not issue permits for collecting live or dead macroalgae from the water. Exemptions may be considered for the purpose of scientific research or marine life rehabilitation. Collecting will generally not be permitted from Sanctuary Zones within Aquatic Reserves or Marine Parks (see the NSW Department of Environment Climate Change and Water website for the location of these protected areas; www.environment.nsw.gov.au).

I&I NSW will allow persons to remove up to 20kg/day of dead, unattached, drift seaweed (wrack) from beaches or the intertidal zone for personal use (e.g., as compost, fertiliser) without a permit. If a person or organisation wishes to collect quantities of wrack exceeding 20 kg/day, then a permit will be required under Clause 66 of the Fisheries Management (Aquaculture) Regulation 2002. A permit may be issued on a case-by-case basis for a period of a year or more.

Contact details

For further scientific information about macroalgae in NSW, contact the author or:

Dr Bob Creese
Research Leader, Aquatic Ecosystems
Industry & Investment NSW
Locked Bag 1
Nelson Bay NSW 2315
Phone: (02) 4916 3806

Report activities that are harming macroalgae by contacting your nearest Fisheries Office or calling Fishers Watch Hotline on 1800 043 536.

For further information about management issues involving macroalgae, contact I&I NSW's Aquatic Habitat Protection Unit regional offices:

Conservation Manager – North Region
Industry & Investment NSW
1243 Bruxner Highway
Wollongbar NSW 2477
Phone: (02) 6626 1200

Conservation Manager – Central Region
Industry & Investment NSW
Locked Bag 1
Nelson Bay NSW 2315
Phone: (02) 4982 1232

Conservation Manager – Sydney Region
Industry & Investment NSW
PO Box 21
Cronulla NSW 2230
Phone: (02) 9527 8411

Conservation Manager – South Region
Industry & Investment NSW
PO Box 97
Huskisson NSW 2540
Phone: (02) 4441 8969

Further reading

www.aussiealgae.org

www.algaebase.org

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