Seaweed: stinking problem or natural asset?

Often, the quantity of seaweed floating in the surf zone is enough to suppress waves.

The amphipod *Allorchestes compressa* on a piece of seaweed, which it eats.

The stench of rotting seaweed, piled up to 2 m high on many of Western Australia's long wide beaches, annoys seaside residents, holiday-makers, and amateur fishermen. In response, some municipal councils provide temporary relief by taking the stuff away by the truckload. As often as not, the next tide makes good the deficit.

The prolific quantities of seaweed washed up on the State's beaches after storms and heavy swells lead us to ask the question: is it playing a significant role in the coastal ecosystem?

Commercial and sport fishermen are particularly interested in the question. Inshore fish nurseries (sheltered waters within a hundred metres of the beach) constitute an important addition to the small number of Western Australian estuaries where juvenile fish hatch and grow.

Dr Alistar Robertson and Ms Judi Hansen, of the CSIRO Division of Fisheries Research at Marmion, W.A., have conducted a detailed research program over the past 2 years to answer the question scientifically.

They have found that the accumulations of seaweed and seagrass in the surf zone have two important functions. The material forms the basis of a food chain supporting commercial fish species, and it supplies nutrients that can be utilized by near-shore plant and animal communities.

Large numbers of juvenile fish species are associated with the drifting seaweed in the surf zone — many more than in the adjacent weed-free areas. The seaweed harbours numerous invertebrates, which are food for the fish, and probably provides some protection from predators.

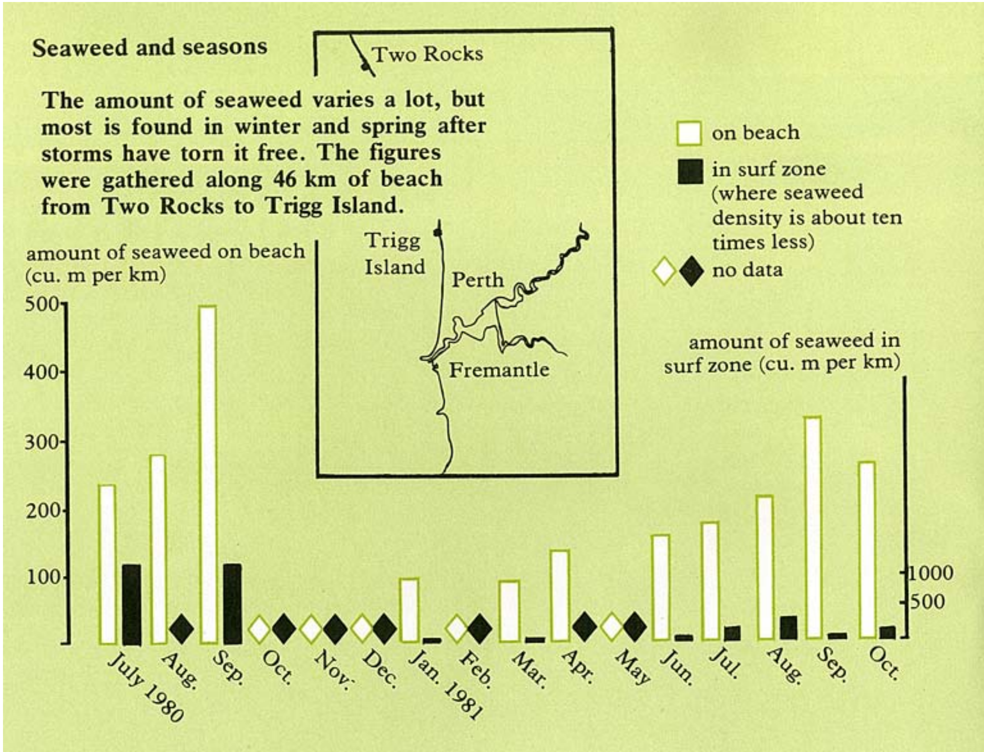
Decaying seaweed releases nitrogen and phosphorus — nutrients necessary for the growth of the extensive seagrass and seaweed beds along the Western Australian coast. The oceanic waters off the coast are generally poor in nutrients and there are few other nutrient sources to the system. Nutrient recycling from the decaying plant matter sustains a high production of seaweed and seagrass. The surf zone and beach are important sites for this recycling.

The seaweed State

Along the 1500 km of coast between Geraldton and Esperance grows an expanse of seaweeds and seagrasses (macrophytes) far larger and denser than elsewhere in Australia. A limestone reef runs along this section of coast some 4–8 km offshore, enclosing a vast shallow pool (up to 8 m deep). Together with an inflow of nutrients from groundwater entering the pool, this provides ideal conditions of light and temperature for many species of seaweed and encourages the growth of extensive seagrass 'meadows'.

Strong waves tear loose some of this impressive accumulation of plant life. The plants either aggregate into dense patches in the surf zone (they sometime almost totally suppress waves there) or pile up on the beach in 'wrack banks'.

To put figures on the volume of detached macrophytes, each month the researchers walked along portions of a 46-km stretch of beach from Two Rocks to Trigg Island (near Perth). They measured the amount of plant material they came across in the water and on the beach. Aerial photographs from the Australian Survey Office supplemented their surveys on foot.



Seaweed and seasons

The amount of seaweed varies a lot, but most is found in winter and spring after storms have torn it free. The figures were gathered along 46 km of beach from Two Rocks to Trigg Island.

Decaying seaweed releases nitrogen and phosphorus.

The densest aggregation of beached seaweed they came across was 5457 cubic metres along a particular 1-km stretch of beach. Over the whole 46 km of coast, a maximum mean density of 504 cu.m per km was recorded in the spring of 1980. In the surf zone, the maximum mean figure was reckoned as 1188 cu.m per km in the winter of that year (the volume occupied by seaweed in the sea is about ten times less than when it is beached).

Not surprisingly, the amounts of beached vegetation varied seasonally, with the winter–spring maximum followed by a minimum in summer. The bar chart shows the readings month by month.

The survey showed that seaweed dumped on the beach may remain only until the next tide, or it may lie rotting there for months. Watching the movement of tagged plants revealed that, once washed back into the surf, seaweed may remain there for days or weeks before being taken out to sea; or it may be dumped back on shore.

These findings, together with the results of observations and experiments to determine the seaweed's rate of breakdown by microbes and waves, allowed the research pair to calculate the detached plants' average lifetime. This varied from a few weeks for kelp, through several months for red algae, and probably years for seagrass.

Their data on the volume of weed beached annually, and the lifetime figures, gave them a way of estimating the turnover of biomass. They arrived at a value of 290 kg of carbon per metre of coastline for the amount of plant material recycled annually through the beach and surf zones.

Mr Hugh Kirkman of the Marmion laboratory had earlier measured the amount of kelp and seagrasses offshore, and their growth rate. This gave a figure of about 1500 kg of carbon per metre of coastline for the total amount of organic material turned over annually.

In other words, every year about 20% of the annual growth of sea vegetation is torn loose and finds its way onto the beach or next to it, whereupon it breaks down and renews the cycle.

How seaweed decays

Detached seaweed decays in two distinctly different ways, depending on where the decomposition occurs. The researchers found that beached seaweed behaves like a marine compost heap, whereas seaweed in the surf zone gets ground up into little pieces when waves dump it against sand and rocks.

Composting can take place under aerobic or anaerobic conditions, and temperatures within the seaweed heaps usually climb to 30–40°C after several days. The marine scientists recorded one actively rotting pile stewing at 54°C. After a week and a half, temperature in the heaps returns to near that of their surroundings, and decomposition proceeds at a more leisurely pace.

Especially where the heaps are poorly drained and waterlogged, anaerobic bacteria thrive. Methane and hydrogen sulfide ('rotten-egg gas') were detected in samples taken from these heaps. Many beachgoers' noses have also detected the presence of this latter gas.

Although the seaweed drifting in the surf zone is gradually being worn away, many plants remain alive for a long time. The scientists found that much of the seaweed in newly formed accumulations was still actively photosynthesizing.

One freshly harvested kelp plant was tagged and released 3 km offshore: when recovered after drifting for 8 weeks it was still producing oxygen at as great a rate as attached, actively growing, plants.

However, similar kelp plants released into the surf zone died after about 4 weeks because of the harsh beating they experienced there. The pounding surf reduced weighed and tagged specimens to half of their former selves in about 16 days, and after 4 weeks in the surf they retained only 10% of their original weight.

Bacteria decompose dead, and largely fragmented, plant remains more slowly in water than on the beach. If oxygen-consumption measurements made on plants floating in backwaters are any guide, the rate is probably two to four times less.

Food chains

Seaweed is the starting point of a food chain. It provides the energy and nutrients necessary for every life form that follows upon it.

The research team found high concentrations of dissolved nutrients in water near decomposing seaweed, whereas the

Masses of seaweed piled up on Western Australia's beaches.

waters offshore and close to seaweed-free beaches were relatively deficient in nutrients. For example, they found phosphate levels of 0·2–0·3 micromole per litre off open beaches and between 1 and 7 μM per L near wrack accumulations.

Observations by Dr Robertson, Ms Hansen, and Mr Rod Lenanton of the Western Australian State Fisheries and Wildlife Department revealed that seaweed-laden (and nutrient-rich) waters support large numbers of invertebrates and fish. Six times as many fish (mainly juveniles) and twice as many species inhabit surf beaches with accumulations of macrophytes as live over bare sandy beaches.

In mobilizing nutrients from seaweed, bacteria are very important, as we have seen. Dr Robertson and Ms Hansen also found that a small animal — an amphipod — is just as important in linking the plant biomass to higher consumers.

The amphipod *Allorchestes compressa,* a small crustacean usually less than 0·5 cm long, is the major inhabitant of drifting seaweeds, which it eats. It completes its whole life cycle in the surf zone, and often more than 150 individuals can be found on each gram (dry weight) of seaweed.

Beached seaweed behaves like a marine compost heap.

Fish, in turn, eat the amphipod. The scientists' analysis of the stomach contents of several species of commercially valuable fish showed that *A. compressa* accounted for half to three-quarters of the diet of yellow-eyed mullet, ruff, and cobbler. Since the amphipod lives only on free-floating seaweed, this plant material is very important in sustaining the growth of juvenile fish.

The scientists' research has shown that decaying seaweed on our beaches is not just an offensive blot on the scene. We can look at it in the light of scientific evidence, not the prejudice of our noses!

Andrew Bell

More about the topic

Decomposing seaweed: a nuisance or a vital link in coastal food chains. A.I. Robertson and J.A. Hansen. *CSIRO Division of Fisheries Research Divisional Report* 1979–81.

Nearshore accumulations of detached macrophytes as nursery areas for fish. R.C.J. Lenanton, A.I. Robertson, and J.A. Hansen. *Marine Ecology Progress Series,* 1982, **9**, 51–7.