Looking Through the Surface

With its unspoiled islands and quiet bays, and many interesting creatures thriving in its waters, the Shoalwater Islands Marine Park is an area of great natural beauty. But rapid coastal development to its north and south means that we need to be on our guard against contamination. Satellite imagery is one of a number of tools helping us to understand the movements of water and contaminants within the park.

Nick D'Adamo, Peter Dans, Des Mills and Sandra To

Satellites orbiting 600 kilometres or more above the Earth are packed with remarkable technology. Their instruments can give us important information about features that affect the health of our marine areas—including incidents that appear to be quite small-scale, such as a proliferation of minute organisms. Even from a great distance, they can detect changes in the temperature and composition of sea water. The instruments can measure small variations in sea level and pick up special features, such as a long series of waves approaching the shore in parallel lines.

Satellite readings provide, literally, an overview of oceanic and coastal areas. The Department of Conservation and Land Management (CALM) uses them alongside microscopic studies, field measurements and computer-modelling to analyse the biology and currents of our oceans and coasts. This helps CALM to spot problems and diagnose them.

The accurate, detailed information gained so quickly from satellites makes them a unique tool. Currently, information from satellites is helping us to understand the pressures that our commercial and recreational activities are placing on the ecology, and future recreational value, of the Shoalwater Islands Marine Park.

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Aerial view of the Shoalwater Islands Marine Park.
Photo – Reproduced with permission of DOLA Copyright Licence 607/99. Aerial photograph 5104, 920416 WA 3170(c)

Below: Seagrass beds off Penguin Island provide an important food source for hundreds of animals and help stabilise the sea floor.
Photo – Michael James/CALM

UNIQUE VALUES

The Shoalwater Islands Marine Park, declared in 1990, is a coastal and marine area stretching around and south of Cape Peron to Becher Point. It is best known for its unspoiled islands, which include Penguin Island and Seal Island, and its bays, the largest of which is Warnbro Sound. Its tranquil features provide an ideal setting for recreational and commercial fishing, boating, swimming, diving and other water-based activities. The park, with its high biological diversity and clean water, is one of the State's marine icons.

From an ecological point of view, the entire west coast of our State is unique because of the influence of the Leeuwin Current, which carries warm waters south from the Pacific Ocean, via the Indonesian Archipelago, and from the eastern tropical Indian Ocean. The current brings with it tropical plants and animals, which are added to the temperate species naturally found in the cooler waters of the region.

PLUMES AND OTHER PROBLEMS

As early as the 1960s, aerial photographs taken over Perth's coastal waters showed plumes of stained water moving south from the Swan River into Cockburn Sound, around Garden Island, through the Sepia Depression (which lies to the west of Garden Island, Rockingham and Warnbro Sound) and into Shoalwater Bay. The Sepia Depression is a natural underwater feature. Since 1984, however, treated wastewater has been discharged into this north-south underwater channel, through a four-kilometre-long pipe off Cape Peron. This wastewater is

Right: The yellow zoanthid is one of many colourful invertebrates found in the Marine Park.
Photo – Ann Storrie

Below: In autumn and winter, a band of warm water known as the Leeuwin Current transports the larvae of marine plants and animals to the south of the State.

Below right: The western blue devil lurks under ledges throughout the park.
Photo – Ann Storrie

rich in nutrients and micro-biological organisms.

By the 1990s, satellite photography had become so advanced that the estuarine plumes could be seen moving north in summer and south in winter, from both the Peel-Harvey and Swan estuaries, respectively. In addition, satellite photography could now be used to measure the colour and temperature of these plumes. They were moving water into the heart of the park—water whose colour, showing clearly on the satellite images, indicates significant amounts of micro-algae, a potential threat to the ecological health of the Marine Park and its life forms.

More recently, a combination of field measurements, computer simulations and satellite imagery have been used by the Department of Environmental Protection to clarify the various ways in which water from Cockburn Sound, the Sepia Depression and the Peel-Harvey Estuary can enter the marine park.

In winter, for example, north to north-westerly winds can drive water from Cockburn Sound beneath the Garden Island causeway, into the park via Shoalwater Bay, and into Warnbro Sound. In the same way, water from the Sepia Depression occasionally drifts towards the reefs and coast of the Marine Park.

Both of these nearby sources of water, which can intrude into the Marine Park, may contain substances that could compromise the intrinsic values of the park and its delicately balanced life systems. Treated wastewater discharged to the Sepia Depression contains nutrients and microbiological organisms. Water from Cockburn Sound can be a source of

SENSATIONAL SATELLITES

The NOAA-AVHRR and Landsat 7 satellites are important tools used by CALM and other agencies to understand and monitor the coastal zone off Perth.

They interpret various features of marine waters by sensing the radiation emitted or reflected from the water. Differences in temperature, colour and contaminants alter the nature and intensity of the signals. For example, warm and cold water produce different signals, as do clear water and marine areas rich in colour, particles and microscopic plants.

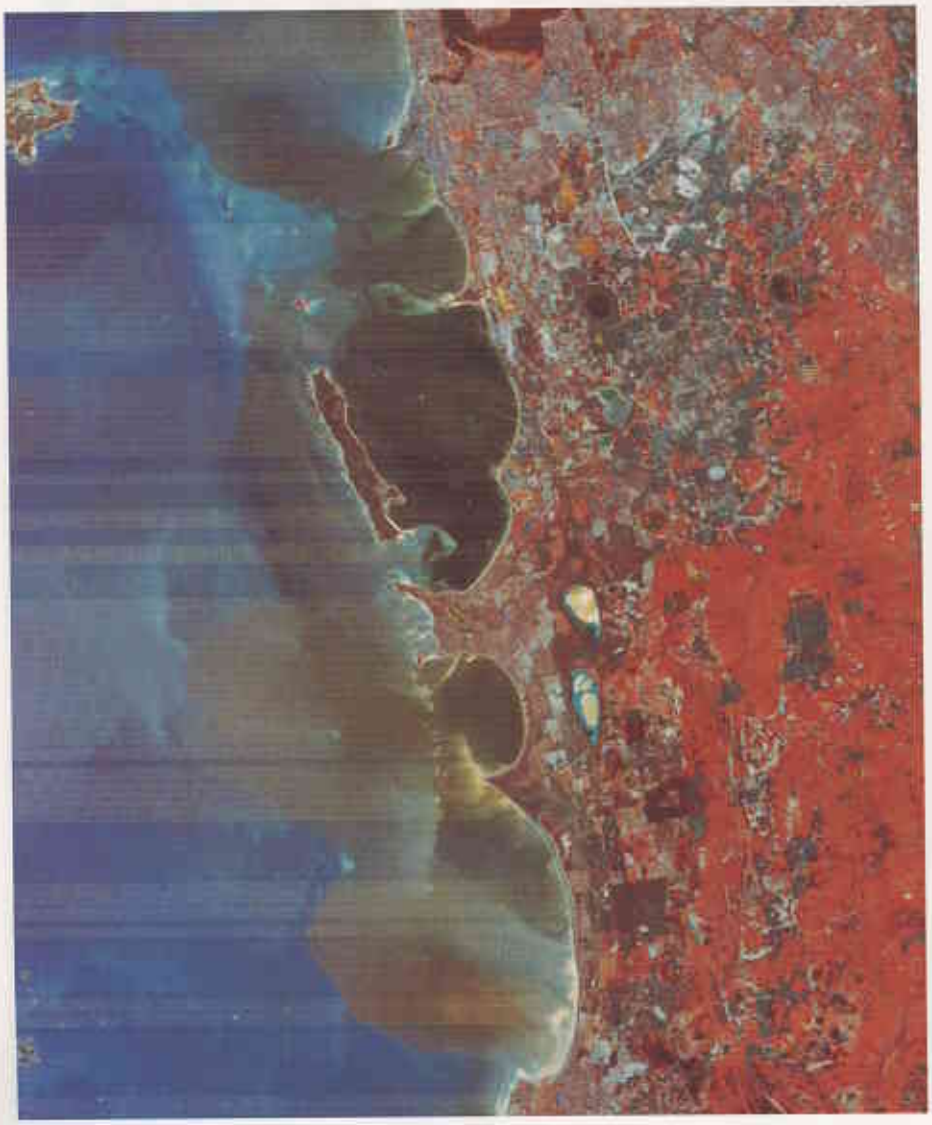
The satellites beam these signals down to receiving stations around the world, including the Australian stations at Alice Springs and Hobart. Information relevant to Western Australia is relayed to the Department of Land Administration in Floreat and to Curtin University of Technology. Here it is converted into useful forms, such as coloured maps, which we can interpret and use to understand the properties of a water body.

The NOAA satellites pass over the same spot on the Earth two or three times a day and sense temperature in one-kilometre squares. The images they produce are useful to fishers and navigators.

The Landsat satellites pass over the same spot around twice every 16 days. They sense temperature, colour and the amount of plant matter (such as phytoplankton) in the water within areas as small as 15 square metres. The detailed information derived is used in coastal studies.

Satellites of these types have been operating for around 30 years.

Further information on satellites can be found at http://www.auslig.gov.au/acres/index.htm



Satellite imagery of water plumes along the coastline between Perth and Mandurah.
Photo – ACRES/produced by DOLA Satellite Remote Sensing Services

toxic substances, such as anti-fouling ingredients, and biologically active organisms, such as marine pests from the hulls and ballast water of large ships.

Nutrient-rich water from the Peel-Harvey Estuary can also enter the Marine Park under sustained south to south-westerly winds, which accompany winter fronts and summer sea breezes.

SOUNDING A WARNING

It is particularly important to protect the Marine Park from such unfavourable intrusions because of the presence of lush seagrass beds over the shallow sand banks in the north and south of the bay. Together with prominent undulations of the ocean floor in the area, these features make the Marine Park an entirely natural, vast aquarium. Its extensive areas of seagrass provide safety and protection for innumerable creatures, and form an important nursery area for many species, including commercially important species such as the western rock lobster, tiger prawn and herring.

The environmental problems of the near neighbours of the Marine Park—Cockburn Sound and the Peel-Harvey Inlet—indicate the need for continued vigilance. We must remain alert to potential problems arising from an imbalance of nutrients and algae in coastal waters.

Whenever there has been an overload of microscopic and larger algae in coastal waters, it has been the result of our interaction with the delicate estuarine and coastal systems. In the case of the Peel-Harvey Inlet, the clearing upstream of large areas of land for agriculture, and the subsequent application of agricultural fertilisers, has caused the contamination of river and estuarine water. Fertilisers flowed to the estuary and triggered its deterioration. In Cockburn Sound, chemical effluent from industrial processes and sewerage had a similar effect. In both cases, a resulting chain of chemical and biological events led to a build-up of contaminants and algae, some of which

destroyed the water's natural integrity—which was essential to the survival of the plants and animals in local ecosystems.

The Shoalwater Islands Marine Park is adjacent to these areas and a major urban centre and it too could be at threat from similar processes. Field studies, when considered in conjunction with the stained waters observed in the satellite photographs, suggest that undesirable substances from outfalls and estuaries may sometimes be driven towards and possibly into the Marine Park.

SHIELDED FROM THE SEA

Western Australia's coast is blessed with Australia's longest continuous temperate limestone reef system, running parallel to and only a few kilometres from the coast near Geraldton to just south of Mandurah, an along-shore distance of about 450 kilometres. The reef system is a key element in the underlying geography of the region. Like many of the coastal bays in the south-west, the waters of the Shoalwater Islands Marine Park are shielded from the full force of the sea by shallow reef chains and sills (banks). As much as 90 per cent of the energy in swell waves is lost through breaking and shoaling over these shallow features as they roll onto the coast. Another effect of these reefs and sills is that water exchange between the open sea and coastal waters is relatively slow, but at the same time, once substances enter the protected near-shore zone they can remain there for extended periods under unfavourable climatic conditions.

Warnbro Sound has a maximum depth of around 17 metres, whereas the chain of shallow reefs separating it from the Sepia Depression is generally less than two metres deep. Coasters Channel is the main gap halfway along this reef chain. The channel is relatively

Above: Wastewater released from treated metropolitan sewerage pipe off Cape Peron.
Illustration based on data from the Water Corporation

Above right: European fan worms, an exotic species (*Sabella spallanzani*), have become established in Cockburn Sound, and could possibly enter the nearby Marine Park.
Photo – Sue Morrison

Right: Each winter, baby loggerhead turtles are carried from northern breeding areas by the warm-water Leeuwin Current. Some end up in the Shoalwater Islands Marine Park.
Photo – Babs & Bert Wells/CALM

Above left: Crested terns breed on Seal Island and feed in the waters of Shoalwater Islands Marine Park.
Photo – Len Stewart/Lochman Transparencies

Above: Macro algae amassed on the shore at Peel Inlet. Such algae can smother marine plants and animals.
Photo – Jiri Lochman

narrow, and has a depth no greater than 10 metres or so.

The reefs prevent the warm, southward-flowing Leeuwin Current from regularly entering the park, even though occasional sorties of water derived from the Leeuwin Current, aided by onshore winds, must occur to sustain the tropical plants and animals found in the area. For example, from late autumn to early spring small loggerhead turtles from the north-west, which presumably arrive as passengers of the Leeuwin Current, are sometimes washed up on shore.

SALINITY

An interesting feature that has been recorded in Warnbro Sound, the most protected part of the park, is that the salinity of its water changes markedly with the seasons.

Through evaporation, during summer and autumn, the salinity of its water increases, making water in the sound denser than ocean water. As a result, the slightly more buoyant ocean water can flow in over the reef and through Coasters Channel, expelling mid-depth water, and remain floating above the deeper resident water in the sound for long periods. As a result, the water at the bottom of the Warnbro Sound basin can be trapped there for an extended time. Given this regular occurrence, anything that brings in water overloaded with micro-organisms, nutrients or undesirable toxicants is to be avoided, because these types of ecosystems are highly sensitive to changes in water purity. For example, seagrasses are particularly sensitive to the smothering effects of algae, which can flourish in problematic proportions if there are excessive nutrients in semi-enclosed, poorly flushed water bodies.

The situation in winter is a contrast. Inter-connecting currents bring low-salinity water from the nearby Swan-Canning and Peel-Harvey estuaries into Warnbro Sound, where it is mixed by storms. The sound becomes less saline, and therefore less dense, than the adjacent ocean. Computer models indicate that ocean water must enter the sound as a dense current, plunging to the bottom and causing deeper resident water to be uplifted to the surface and driven out of the basin more quickly by winds and tides. These exchange processes have been measured in Cockburn Sound, which is similar in its hydrodynamics.

These insights show that, although the park is relatively protected from the ocean's full force, its waters are far from isolated. To manage the park effectively, we need to understand external, as well as internal, factors affecting water quality in the park.

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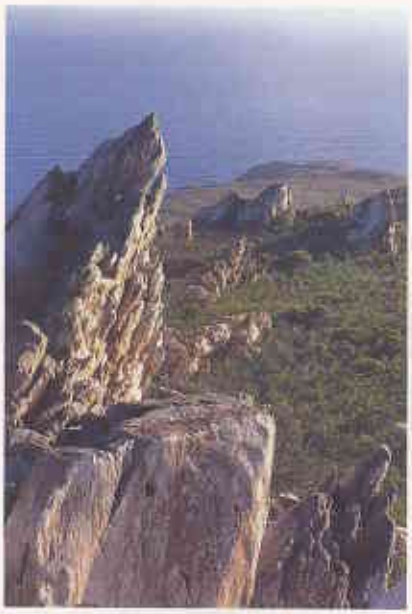

One of the best selling books from CALM has recently been fully revised. See 'The Best of the South-West' on page 10.

A new weapon against the scourge of feral cats was recently tested on Hermite Island. See 'Isle of Cats' on page 18.

In the far north of WA, there is evidence of not one, but two cosmic impacts. See 'Cosmic Impacts in the Kimberley' on page 28.

Satelite imagery is helping us to fight maritime polution. See 'Looking Through the Surface' on page 41.

A unique network links volunteer groups and regional herbaria with the CALM flora database. See 'Name That Plant' on page 35.

COVER

Western Australia is aptly described as the Wildflower State. Some 12,500 different species are known from the wild, with a huge range of colours, shapes and characters. But many species once found are lost again, and it's always an event when a species thought to be extinct is rediscovered. See 'Lost Jewels in the Bush' on page 23.

Illustration by Philippa Nikulinsky

FEATURES

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