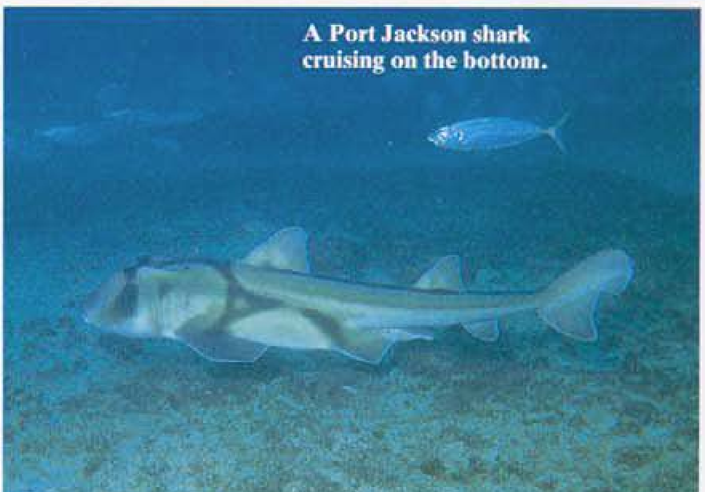
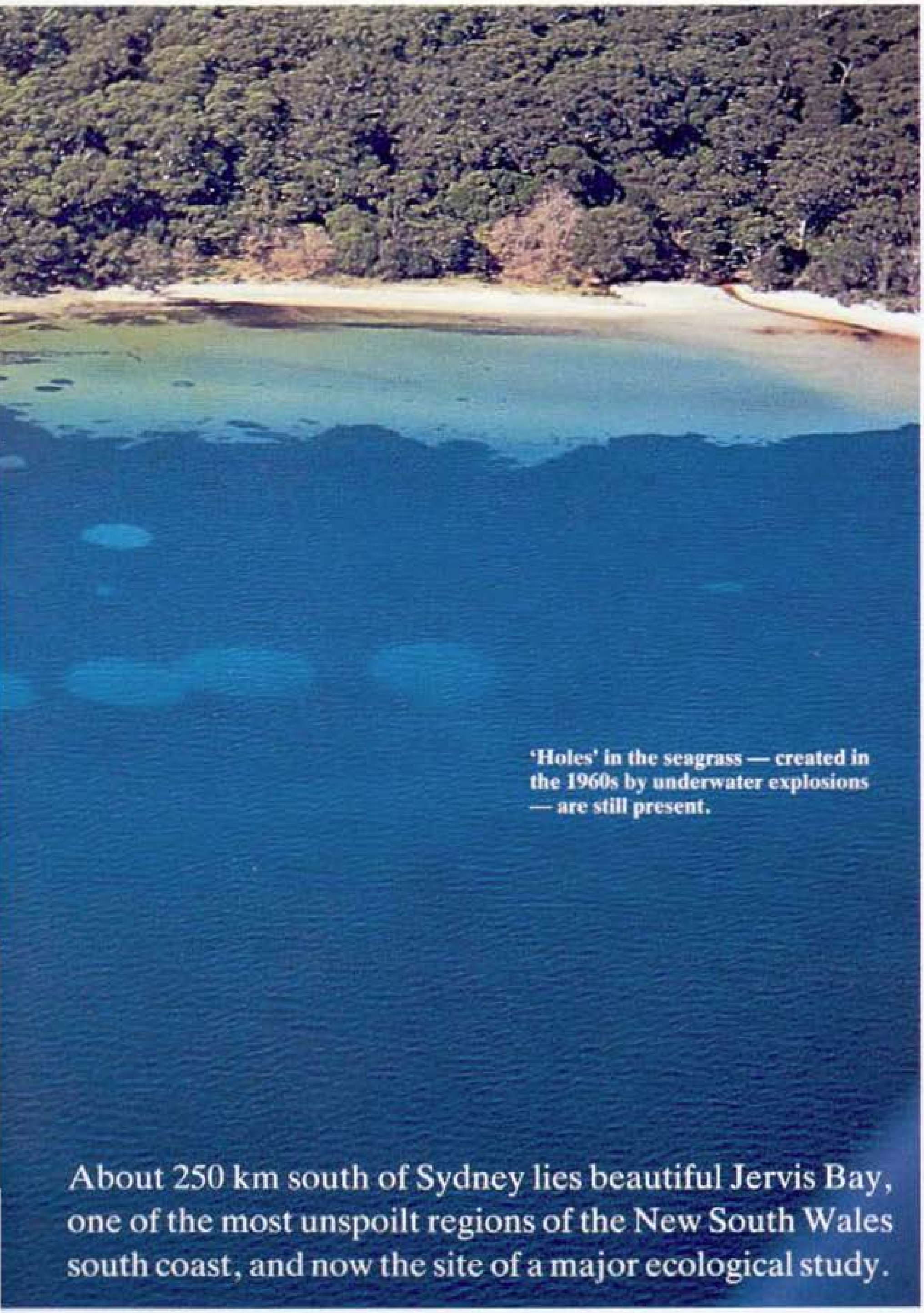
Beneath the waves of Jervis Bay

Counting tagged mangrove flowers.



A Port Jackson shark cruising on the bottom.



'Holes' in the seagrass — created in the 1960s by underwater explosions — are still present.

About 250 km south of Sydney lies beautiful Jervis Bay, one of the most unspoilt regions of the New South Wales south coast, and now the site of a major ecological study.

Sampling the fauna of shallow, sandy bottoms.

To measure the growth rate of the seagrass *Posidonia*, scientists punch holes in the leaves and their bases, and return at known intervals to measure the increasing distance between them.

There has been little research on the flora, fauna, and waters of Jervis Bay. Now the Department of Defence has commissioned a major study at a cost of $4·5 million. The Royal Australian Navy has long been associated with the Bay and uses its base there — *HMAS Creswell* — for training. It is also considering building an armaments depot on the northern shores.

Even if the armaments depot does not proceed, the Navy is likely to continue to use the region. The study, co-ordinated by CSIRO scientist Dr Trevor Ward of the Division of Fisheries, seeks to document present conditions in the Bay and collect an inventory of its inhabitants — providing a 'baseline' from which to monitor any alterations to the environment.

As an independent piece of research it will not just benefit the Department of Defence, for many other potential users of the area exist and further development of tourism and housing in the Huskisson/Vincentia region (see the map) also seems likely. It will help managers of this region ensure that any future developments are not at the expense of the Bay's environment and natural systems.

The 3-year study started at the end of 1988. By the time it ends, scientists from the CSIRO Divisions of Fisheries and Oceanography will have described the existing marine environment in detail, recording species and their distribution above and below the water. They will have charted salt-marshes, mangroves, and beds of seagrasses, and measured the abundance and variability in numbers of fish and mobile invertebrates. They won't ignore the physical environment either. They are monitoring the water quality, and developing a computer model of the Bay's water circulation and of how this interacts with the coastal waters beyond.

Although only 18 months of the study have passed, the scientists already have much to report. For example, the intriguing nature of the Bay's seagrass meadows, and their relation to fish, is starting to come to light.

Super-grass

Seagrasses, despite the appearance of their long thin fronds, are not 'sea-weeds', but flowering plants — like grasses on land — that just happen to like living under water, even as much as 20 m under. In the Bay, species of the genus *Zostera* live in the creeks and estuaries, while *Posidonia australis* grows at depths of up to 11 m in meadows out in the Bay proper.

Marine biologists have shown that seagrass beds provide a very important 'nursery' for young fish to grow up in — their dense leaves affording security from predators. Therefore, loss of the grasses may affect fish species of commercial or recreational importance. Seagrasses also help improve the water's clarity by stabilising sediment, and they are primary producers that provide food for many creatures.

Early results from the Jervis Bay study have highlighted a puzzle for the researchers. Sampling of sandy beaches to a depth of only 2 m — a rather unglamorous and comparatively poorly studied region for marine biologists — revealed that commercially and recreationally valuable fish were more abundant there than in the seagrass meadows sampled by the State Department of Agriculture and Fisheries.

Out in the Bay on a good day.

These results differ somewhat from the predictions marine biologists had made, and the researchers are currently trying to find out why. Seagrasses in the Bay remain important for fish — but are shallow, sandy areas equally so?

Another recent finding by Dr Hugh Kirkman and his team, also of the Fisheries Division, is somewhat disturbing. Their work found that the meadow seagrass *Posidonia australis*, despite producing large quantities of seed, doesn't colonise new areas very successfully.

All seagrasses flower under water, producing, like their relatives on land, pollen and seedling-containing fruits. What seems to happen is that young *P. australis* seedlings (up to 2 years old) are washed away by vigorous water movements, associated with storms, before they have attained a good anchor on the bottom. They simply grow too slowly to get a good root hold before a violent storm occurs. Mature plants, however, can generally withstand these traumas.

The species performs poorly in repairing damage in the middle of existing meadows as well as in colonising new areas. Like land grasses, the plants produce runners, or rhizomes, but these grow exceedingly slowly. The scientists have found that 'holes' (up to 20 m across) in some of the Bay's seagrass meadows — created during the 1960s by under-water explosions set off during the course of a seismic survey of the area — are still present today. (Contrast this with what happens if you dig up a small circle of grass in a paddock — rhizomes and new shoots soon infiltrate and close up the gap.)

Many tropical seagrasses are regularly dug up by dugongs and regenerate quickly and easily. But *P. australis* is the main seagrass of temperate Australia, with a distribution ranging from Shark Bay, W.A., to Port Stephens, N.S.W. Any substantial decline in its range is likely to have a major effect on the marine ecosystem, and hence on commercial fisheries. Because of its poor regenerative capacity we clearly need to take great care to ensure that all our existing meadows of *Posidonia* remain intact.

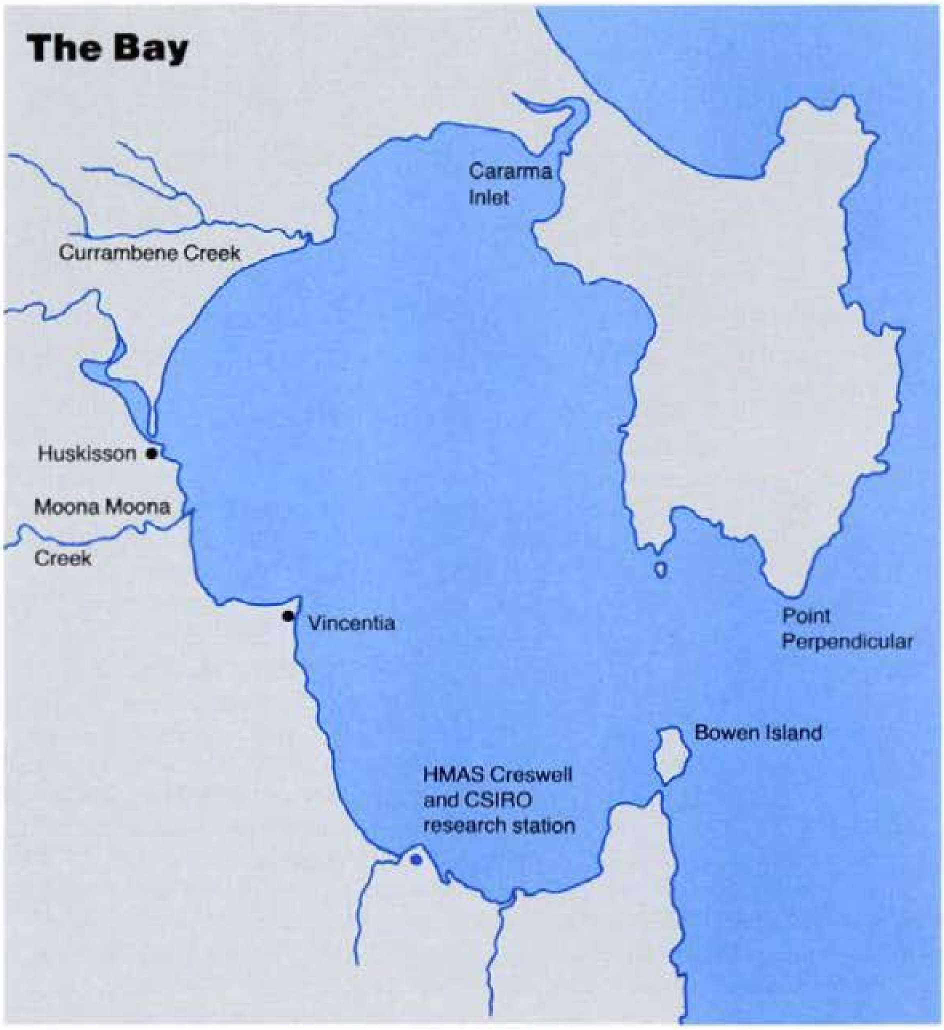
Pollution?

Scientists from the team have carried out analyses of the water quality in the Bay. The area has a reputation for good 'clean' seas, but little scientific sampling had been carried out — and natural cyclic variability occurring in so many parameters makes it important to sample over a long period of time.

'Water quality' is a difficult thing to define, but its assessment must include measurements of salinity and also the concentrations of nitrogen and phosphorus (important nutrients for phytoplankton), suspended solids, and chlorophyll. Measurements of chlorophyll give an idea of the degree of growth of photosynthetic organisms (plants and algae). The turbidity of the water affects the penetration of light.

'Good' water quality implies that the values for all of the above do not encourage excessive growth or death of any one group of organisms, and hence unbalance the whole ecosystem. Water with insufficient nutrients, for example, can support few living things; on the other hand, overabundance of nutrients creates problems of eutrophication, or the excessive growth of algae forming a scum that cuts down light penetration and diffusion of oxygen. Widespread death of fish can result. Also, high levels of nitrogen and phosphorus cause algae on the leaves of seagrasses to proliferate, slowing the grass growth by shading out the light. This causes most of the seagrass death that occurs around Australia.

Another factor in water quality is the emptying of creeks into the Bay. They can carry silt that, if excessive, will accumulate and change a sandy bottom to a muddy one. This, in turn, changes the species that inhabit the area. (For example, filter-feeding animals cannot survive large quantities of silt and clay particles in their feeding



Jervis Bay measures about 15 km north–south and about 10 km east–west.

apparatus.) At the moment, scientists don't know whether siltation is excessive here, but they cite the potential for it to occur if uncontrolled land-clearing for further development takes place in areas that feed the creeks.

Poor water quality can also be the result of external pollutants and, accordingly, the team measured levels of manufactured toxins such as organochlorine pesticides, polychlorinated biphenyls (PCBs), and tributyl tin — a pollutant from boats' antifouling paints that research in Sydney waterways examined recently (see *Ecos* 62).

Encouraging results

The analyses showed that, in general, the water quality in the Bay is good. Nutrient levels were comparatively low, as they should be in temperate ocean water. Evidently, the prevailing high-nutrient run-off from the land (generally derived from sewage or farming) that enters the Bay does not significantly alter its nutrient status.

The figure for suspended solids was rather high, but probably because of the heavy rainfall close to the sampling times — which only underscores the need to keep measuring to achieve the most meaningful results.

Tests throughout the Bay failed to detect any organochlorines or PCBs; however, tributyl tin was found in several locations, indicating localised contamination. The implications of this are not yet clear and the scientists hope to carry out further work on it. They are currently sampling fish for the presence of the organic toxins, which can accumulate in living things — especially those high up the food chain — even if present only in very low concentrations in the water.

Unexpectedly, during the winter the concentration of nitrates and nitrites in the water increased dramatically throughout the Bay. (Fortunately, although present in quite high concentrations, these nutrients were not in sufficient abundance for long enough to cause eutrophication and its attendant problems.) Possible explanations included the arrival at that time of a pulse of nitrogen-rich water from the open ocean, which washed right through the Bay. Such water has its source on the continental slope, at depths greater than 200 m.

This event seems very similar to the phenomenon of upwelling, best-known from the western coast of South America, where nutrient-rich waters from deep in the Pacific hit the continent and rise, giving the area a very rich fishery. Upwelling is rare around the eastern coast of Australia, and it has often been presumed that it just doesn't happen. If the Jervis Bay incident recurs in subsequent winters, we may have to revise some textbooks.

All this has significance for our commercial fisheries. It could be that similar events occur elsewhere around the country. Knowledge of them would aid greatly in fisheries management.

Novel techniques

Finding out what creatures (and how many) inhabit the flat and mainly sandy bottom of such a large bay is no easy task. Divers searching and recording can only cover tiny areas and do so very slowly and at considerable inconvenience. So the scientists are using a remote-controlled camera that rapidly crosses the depths, filming as it goes. Mounted on a sled, it is towed from the surface at a constant speed and for measured distances. Biologists can then peruse the film at their leisure, recording and counting whatever the camera saw, and slowing down and speeding up at will. That allows them to gather an enormous amount of information, and Dr Charles Jacoby, responsible for this part of the program, now has a great deal to analyse.

Early in the study, the camera revealed the sudden appearance of large numbers of Port Jackson sharks in the Bay during the winter in preparation for their mating there in early spring. In the summer, when most recreational divers are around, the sharks are not to be seen. Why they mate in the Bay and what the cue is that drives them there, nobody knows for sure.

However, the underwater video was mainly designed to let us know more about bottom-dwellers that don't move around much, including polychaete worms that build tubes to live in, mussels, starfish, sea squirts, and sea pens. Already, the results from the camera have enabled taxonomists to identify a new species of sea pen.

All such data-gathering is part of the process of building up a picture of the Bay's environment to provide us with a good inventory of what it contains. We take for granted in most of our land environments that at least we know what's growing there, giving us a baseline from which environmental assessments can proceed. For Jervis Bay, we still haven't touched that first base, but now we're getting closer.

Roger Beckmann