THE ECOLOGY AND VULNERABILITY OF ESTUARINE MANGROVES

Bruce Wallner

I will discuss the importance of a coastal ecosystem, the mangrove ecosystem, in fairly general terms, and then point out some of the common anthropogenic pressures that have been exerted on these systems. I have been working in Gladstone for about two and a half years on an oil shale project funded by Esso Australia. I have been employed there on environmental impact work.

Mangrove ecosystems have a commercial importance. It has been estimated that about 60% of the fish and fish products that are caught in southern Queensland are in some way dependent upon the mangroves, either for food or for their prey or shelter. Further north where there is reef and coral fishing the percentage of fish product drops off a bit. Mangroves are a very big wood resource. In Malaysia and other countries they are harvested for charcoal and building timber. In Australia they are a big floral resource for honey production. I am concerned with their ecological importance.

The have an enormous and very vital role in providing safe breeding refuges for all, or many of our commercial species of fish, and the tangled thickets of roots provide an ideal shelter for many of the younger fish. Many species breed and rear their young in this protective environment. Mangroves are also fairly nutrient-rich and therefore there is a lot of food floating around.

Not all the animals live there full time. There is a large migratory population at certain times of the year. Some are migrating and feeding on the way, others are breeding and rearing their young. In addition to fish, there are also turtles, birds, bats and all sorts of insects and crustaceans that inhabit the mangroves. It is a very prolific cross-section of nature that goes about its living business in the mangroves.

Mangroves are a very important shoreline stabiliser. All those roots bind the very soft mud together and prevent it from being washed away by the tide and deposited in our valuable harbours.

The main reason for their importance is that the mangrove ecosystems have an enormously high primary productivity. This is the productivity which is produced by the trees from sunlight, so it is virtually free. The studies that we have been doing have shown that about 12 tonnes of leaves per hectare per year get dropped by the mangroves. Further north, up by Hinchinbrook Island, which is up towards Cairns, the amount can go up as high as 28 tonnes. That is a lot, as the typical dry sclerophyll eucalypt forest only drops about 3 or 4 tonnes a year. All these leaves and other bits of vegetable matter drop into the water. They contain an enormous reserve of nitrates and phosphates and carbon compounds. These are released into the sediments as the leaves decompose. The various microbes in the soil cause them to rot. Then the tides distribute the nutrients around the place.

A satellite height look at things shows up sediment and mud and plants. Sediment carried in the water reaches a fair way out to sea even into Barrier Reef waters. So despite the fact that the mangrove ecosystem on the coast at Gladstone is about 50 miles away from the Reef, it has a very large input in terms of nutrients for the Reef. This is particularly so in Australia where there is a fairly shallow Continental shelf which does not receive any great amounts of upwelling, which occurs in more oceanic areas, to bring nutrients into the reef systems. There are about 46,000 square km of mangrove coastline just in Queensland alone, so the total of the nutrient input is enormous.

After telling you why they are so good, I will show you what we do with them. The fact that they are sheltered, coastal and proximal means that they often come into competition with man's activities. Man desires coastal space for urban, port and industrial development. At Gladstone, they have just finished dredging an enormous new harbour and so the areas of mangrove are being constantly pressurised out of existence. The Gladstone water frontage was once a fairly prolific mangrove area. The mangroves have been eliminated by dredging the main shipping channel and dumping it all on the mangroves to make lovely flat land to build on for the port facilities and large industry, such as Queensland Alumina, the largest bauxite refinery in the world.

Another thing is that we seem to like to put our rubbish dumps in Gladstone in the middle of the mangroves. The last one became a soccer field and the current one is coming up for residential development. Mangrove areas are considered less desirable than most other areas of coastline, because they are full of insects and very muddy and swampy and generally not terribly picturesque, they seem to become receivers for our effluents and industrial by-products and chemical waste.

The Gladstone power station, which supplies 60% of Queensland's power, is obviously a very essential thing, but it is fairly disastrous ecologically. It produces an enormous diversity of waste. The smoke is very high in sulphur and ash. It also produces a lot of hot water which pumps out into the creek. This hot water washes up and down with every tide and it has had a pretty bad effect on the fringe mangroves. Also, just the bulldozing of the coal heaps mobilizes a fair bit of coal dust into the air. The particulate emissions from this sort of industry, the dust and so on, can have an effect on the leaves by clogging leaf stomata through which the leaves transpire. This means a very slow and painful death for a tree, equally lethal but not quite as dramatic as bulldozing them.

Sewage has always been considered a fairly desirable thing to pump into the water. It is full of lots of good nutrients, but it causes a rather paradoxical problem in that too much nutrient goes into the water. This causes a phenomenon called eutrophication. There is an enormous multiplication of aerobic bacteria, which are madly gobbling up all the nutrients. The bacteria use up all the oxygen in the water and the water becomes largely anoxic to most of its inhabitants. This eliminates most of the animals as there are very, very few animals that can survive in anoxic water.

Another damaging factor that has taken a long time to be noticed, is the dangers in the changing drainage pattern. A road was built, against all advice, to be the quickest way between point A and point B. It was built right across the middle of the mud flat, which was considered to be fairly expendible. As a result quite a lot of the mangroves have been cut off from the tidal flow. Only the very peak tides can get in there. The road acts like an enormous bund wall trapping the tide. On the wrong side of the road there is a big patch of dead trees standing in a large pool of stagnant water. It took quite a few months for this phenomenon to come about.

The run-off increase that comes from annual burn-offs and the clearing of land for cattle grazing and mining, all increase the rain water run-off into the creeks. This can increase the sediment load enormously. Mangroves have pneumatophores because the mud is so fine that it becomes anoxic about 5 or 6 cm down and so mangrove roots grow laterally and poke up little pneumatophores every now and again to enable them to get a breath of air. Large volumes of sediment settling can smother them, even abrade them to such a degree that they cannot work any more.

Even events remote from the coast can have an effect on the coastal system as a whole. Building a dam quite a long way upstream can cut off the normal flow of the river and inhibit the flushing out of the nutrients.

Mangroves are receivers of a lot of land nutrients which they, with the aid of sunlight, turn into plant nutrients, which they then pass onto the rest of the marine system by dropping their leaves. These are consumed by microbes and small detrital feeders such as crabs and worms which then become food for fish and bigger fish eat the fish and so on up the food chain.

A fairly recent problem is a pathogenic fungus called a phytopra. This causes “die back”. It is a fungus that lives at a fairly low population-level naturally in the soil. But when we disturb the soil and the tree becomes stressed by man-made activities, it seems to take over the tree and causes its death, probably due to a lower resistance to cold and so on.

The area we are studying is fairly big. We have adopted a strategy for studying of the mangroves. There are essentially three stages in the study. The first one is an assessment of the impact which is largely educated guesswork where we analyse the effects that the type of operations could have. In this case it was a large open cut oil shale mine, so we can expect everything from mechanical damage by clearing for road access to effluents, air, water, and dredging, and so on, including chemical pollution. The next phase that we got off to was the establishment of a base line. This involves cataloguing the biological and physiochemical parameters of the ecosystem and setting the normal relationship in the undisturbed system. We also establish bench mark sites which are control areas, so that we can compare areas when they are eventually affected to the areas which have not been affected. The base line serves as a bench mark comparison so that we can just go back and check, year in and year out, in a monitoring programme, which is the final phase; when the thing is actually operating. We can then tell whether damage is being done or not and perhaps rectify it.

With the Rundle project, just off Gladstone, we have finished phase one and finished phase two. The project is about to be closed up because the process is not really quite cheap enough for it to be working yet. So they are just sitting back to see what will happen to the oil market.

The first thing we did with the trees being very important, was to establish study plots. Because mangroves are fairly impenetrable, we scattered around a whole heap of leaf catching devices, consisting of a little shade cloth and a frame. We caught the leaves and collected them monthly. From this we did dry weights and counts. We analysed the normal rate of leaf fall. With the addition of stress you might expect that these trees, living in a fairly harsh environment anyway, having to deal with enormous osmotic problems living in the salt water, would tend to drop more leaves. This particular family of trees we were studying produce an interpetiolar leaf spicule. They produce one for every new leaf. We were able to do a budget of leaf loss and leaf production, whether or not the tree itself was declining or growing. Some mangroves are vivaparous and the fruit actually germinates while it is still on the tree.

The second area that we dealt with was the animals that live within these systems. The range of animals included plankton and fish and all sorts of things. We dropped a grab over the side of the boat and pulled up a big bite of sediment. Then we sieved it and extracted all the animals in it. The bottom dwelling things that live in the sediment are actually very good indicators of the state of the environment. They do not move very far and if there is any pollution present, they generally get hit with the full force. The area is a big mud crabbing area. We tried to get an idea of what the population was like. We did a population study which involved tagging these crabs, fairly formidable beasts. We caught them and plugged little plastic tags into them and did a fairly involved statistical ploy on the computer. As a result we were able to come up with the approximate population count in various creeks. We can go back in ten years time and check on this. In addition we learned a lot about mud crabs, especially what they taste like.

All this information is fairly useless unless one can compare it against what the normal physical and chemical environment is. To this end we have a meteorological station which did very regular water sampling, allowing us to correlate what animal and plant populations are doing with normal changes in physical and chemical environment that they live in. So now we can detect additional changes over and above that induced naturally by the weather or the temperature or the seasons.

The amount of scientific research that has been done on the past ten years on mangroves is quite fantastic. Before that they were considered to be not worth the effort. We have now realized that they are very important not only in their own right, but in terms of the fact that they have a large bearing on all the other marine life paths. Even the Great

Barrier Reef is not its own little oyster, and wiping out the mangroves may even effect the Reef. The State Government in Queensland has recognised this by passing legislation which has protected all the trees. This is a step in the right direction, but unfortunately the same government tends to overlook their own legislation fairly frequently. They like to adopt a policy of exploitation of natural resources and development of big industry. So despite the fact that there are laws protecting mangroves they often destroy the trees. A lot of the impact on the mangroves is often second or third hand.

Dr Chris Acott

This is not really a question, but that photograph of the road that you showed - there were no stubbies* by the road. It must be the only road without stubbies north of Brisbane.

Bruce Wallner

That photograph was taken not long after the road had been completed, and it had not been used that much. It was built purely as access for workers to get to the landing. An environmental study was done before the road was built and recommended that the road should go around the mud flat. Not only for environmental needs, but also for engineering reasons. They had a lot of trouble building the road. Another reason that there are no stubbies is that the road is about 20 feet above the land, so the bottles roll off into the swamp.

* For readers outside Australia. A stubby is a non-returnable 375 ml bottle of beer.

MEIOU!!

Coincidentally (with starting the Diving Medical Centre) we combined with some civilian physicians and formed the South Pacific Underwater Medicine Society. The abbreviation SPUMS, was specifically chosen because of its similarity to certain other subquatic pleasure loving organisms. Like them, it had far reaching consequences. We nurtured a kitten and it became a tiger. Both Bob and I were greatly relieved when we managed to let go its tail.

Carl Edmonds in *PRESSURE*, June, 1983.

SUDDEN DEAFNESS IN DIVERS

Noel Roydhouse

Over the past fourteen years I have collected a series of about 70 cases of sudden sensorineural deafness occurring in scuba divers. Some of these have been actual rupture of the round of oval windows but the majority of them appear to have been intracochlear membrane damage without any damage of the oval or round windows. That these windows have been intact in these cases has been slightly in doubt until recently when I opened up the middle ears of two cases whose story was not as typical as the other cases. These two cases are described:

Case One

A 27 year old male diver, with one year's experience including 80 dives, attended because of a "blocked" left ear which had a humming sound. He had been seen one year previously, with a left haemotympanum from diving from which he had made a full recovery. The present symptoms had come on after surfacing from a 4m dive fourteen hours previously, during which dive he had experienced some difficulty in equalising his middle ear pressures. He had a five second dizziness on surfacing, with a minor rotary element. His hearing on the right was normal and on the left there was an average 55 decibel loss for frequencies of 0.5, 1 and 2 kHz. He was admitted to hospital for medical treatment of sudden deafness which was unchanged after four days. His middle ear was opened, searching for a round or oval window rupture. No fluid was seen to come from these regions when compressing the jugular veins, but the round window membrane was seen to bulge. One week later the tinnitus was a quieter ringing, and the hearing 40% better. Two weeks after treatment he gained his permanent hearing improvement, which left him with normal hearing apart from a 40 decibel loss in the 0.5kHz note, a hearing handicap from 9% to 1.7%.

Case Two

A 19 year old female with three months experience was seen two days before Case One. It had been her third dive since her diving course and she had made a quick ascent. She developed vertigo for 24 hours, deafness and ringing in the right ear, and loss of balance for three days. She consulted me on the tenth day post incident and was admitted to hospital for medical treatment, but the deafness and imbalance continued. Under general anaesthetic her middle ear was inspected and no abnormality seen. One week after the operation her balance was normal and the hearing loss continued at the 70 decibel loss for the 4, 6 and 8 kHz notes noted pre-operatively. One month later she had the same deafness in the affected ear, with normal hearing in the unaffected ear.

The diagnosis in both these cases was a Labyrinthine Membrane Rupture. ie. damage confined to the intra-cochlear region.

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