(right) Traditional owners of Kakadu will sometimes harvest live incapacitated fish

Toxic plants

A number of plants have long been used by Aboriginal people to harvest fish in isolated pools, late in the Dry season, by poisoning the water. Chemicals leached from fallen leaves and bark of these trees by early rains clearly have the potential to cause fish kills in receiving waters. However, large kills resulting from this effect have not been recorded.

3. Disease

Fish suffering from disease are commonly seen in billabongs at the end of the Dry season. It is assumed this is partly a result of increased stress from higher water temperatures (and hence lower oxygen levels), and crowding from declining water levels. External lesions, often diagnosed as red-spot disease (Epizootic Ulcerative Syndrome), are common on barramundi and catfish. This often causes disorientated swimming, blindness and death. Disoriented fish have also been diagnosed with internal disorders but no visible external problems.

Fish death from disease is usually on a small scale at any one time and sudden mass kills caused by disease have not been reported.

Diagnosis procedures for fish kills

When ***eriss*** staff are notified of a fish kill they assess whether it is close enough to the start of the event for there to be some trace of the conditions that caused it.

If so, they will visit the site to record the number and species of fish involved. They determine the physico-chemical structure of the water body near the kill by measuring depth profiles of temperature, conductivity, pH and dissolved oxygen at intervals along the length of the site. This often shows evidence of a pulse of water with either elevated BOD or chemical contamination having entered the water body.

If the time elapsed is long then this will have passed through with little trace. Water samples for chemical analysis are taken at several locations in the site (inflow, outflow and at location of contaminated water). Specimens of dead fish for pathology testing need to be very fresh and hence are rarely available.

All information about dead fish is useful!

If you see dead fish, note these things:

- How many fish are dead or apparently dying (up to 10, up to 20, 20 to 100, more than 100)?
- What kinds of fish. Size, shape and colour can help if you don't know what they are.
- Any strange fish behaviour.
- Location: River system, name of waterhole, distance from named location.
- Date and time.

Who to contact

In Kakadu notify Park management at Bowali Visitor Centre (ph 8938 1100), or the nearest Ranger station, or ***eriss*** on 8979 9711 or 8982 9100.

Elsewhere, notify NT Department of Primary Industries and Fisheries on 8924 4166.

eriss

Environment Australia
Department of the Environment and Heritage

eriss *carries out scientific research for the protection of people and the environment in places that are highly valued by the Australian community.*

Contact Officer

Bob Pidgeon Ph +61 8 89829104
e-mail: bobp@eriss.erin.gov.au

Environmental Research Institute
of the Supervising Scientist
Locked Bag 2 Jabiru NT 0886

eriss notes

NATURAL FISH KILLS

NATURAL CAUSES OF FISH KILLS IN TOP END WATERWAYS

Fish kills are the sudden death of large numbers of fish. These events are very common in inland waters of the Top End. It is a rare year when at least one kill is not reported and in some years there are many reports. Most of these fish kills are the result of natural causes. However, it is well known that such kills can also result from pollution of water by urban, agricultural and industrial effluent.

Why study fish kills?

It is important to distinguish between natural events and those caused by human activity so we can determine if remedial measures are needed to address the cause and prevent future fish kills. This is particularly important for mining operations, which could be the first to be blamed when a kill occurs downstream from a mine.

For this reason ***eriss*** has been examining fish kills in Kakadu National Park to help us understand the natural environmental processes that cause them. This will also help determine the causes of future fish kills. It also provides some idea of the potential ecological impact should such processes result from mining activity.

Causes of fish kills

The common factors causing sudden natural fish kills are:

- *Lack of oxygen* in the water (anoxia). The majority of natural kills are caused by this problem.
- *Naturally toxic water.* Acidic water containing toxic levels of aluminium leached from acid-sulphate soils has been identified on the floodplains of Magela Creek and Nourlangie Creek.
- *Disease,* especially red spot disease, often kills fish but this only rarely results in a large number of deaths at one time.

Where and when

Most fish kills are reported from waterbodies on the floodplains of Top End rivers. However, they can also occur in billabongs and large waterholes in channels upstream in the lowland zone of rivers.

Fish kills most commonly occur early in the Wet season, often after the first flush of water into the waterbody following large storms. This can happen from November to January depending on the start of significant rains.

They can also occur late in the Wet season after the monsoon rains have finished and water levels on the floodplains are receding. This is most likely to happen in April or May and, again, they generally follow late storm events.

Dead fish floating in a Kakadu billabong after a large fish kill

Natural processes causing fish kills

1. Lack of oxygen

The most common cause of natural fish kills is lack of oxygen in surface water. Lack of oxygen can asphyxiate most susceptible fish species within a few hours. Depletion of oxygen in water can result from natural processes and storm events are very often involved.

Storm wash of organic matter in the water

Early Wet season storms sometimes wash large amounts of organic matter and other soil materials into water bodies, which can raise the Biochemical Oxygen Demand (BOD) of the water. This can deplete the water of oxygen creating *anoxic* conditions. This effect is most likely to occur in waterholes and billabongs in the lowland river channels.

Storm wash of oxygen-depleted water

At the start of the Wet season, surface water on the floodplain can have a high BOD caused by organic matter leached from the soil and surface plant material. Storms can wash this anoxic water into billabongs where it depletes all the dissolved oxygen with its high BOD.

Similar effects occur from late Wet season storms that wash floodplain swamp water, depleted of oxygen by the decomposition of dead plant material, into billabongs. Fish kills result when fish can't move away to escape this water.

In situations where there is insufficient water on the floodplain for fish to leave the billabongs to escape oxygen-depleted water, asphyxiation causes the death of most susceptible species within a few hours.

Storm induced mixing of the water

Late in the Dry season, the upper layer of water heats up and the deeper water can become depleted of oxygen. Wind and rain can cool the surface layer and mix the water, reducing the oxygen levels. The mixing also stirs up organic matter from the bottom, further reducing oxygen to critical levels (fig 1).

Plants and oxygen consumption

During the day, aquatic plants and algae produce oxygen as a by-product of photosynthesis, raising the levels of oxygen in the water. At night, the oxygen is used up by respiration of all the aquatic biota, reaching a minimum level at dawn (fig 2.) The decay of dead plant material at the end of the Wet season can aggravate this effect. With high temperatures and declining water levels at the end of the Wet and the Dry season, there may be little or no oxygen left in the pre-dawn period. This causes oxygen stress to the fish and can result in deaths.

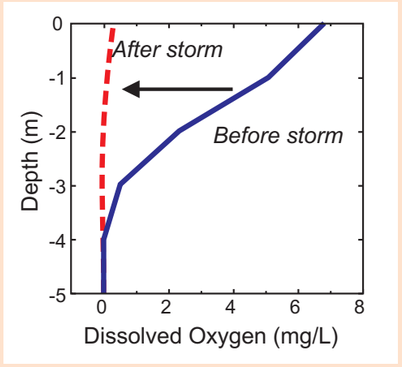

Figure 1 Anoxic conditions formed in a stratified billabong by storm action

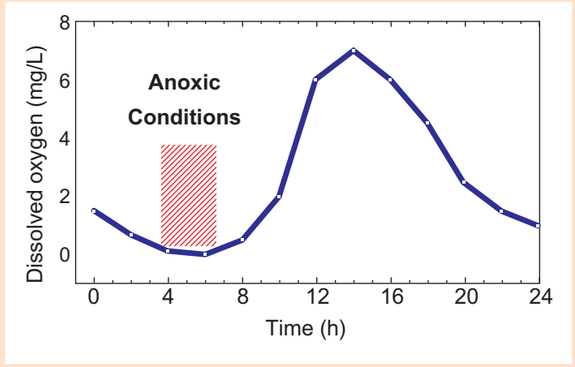

Figure 2 Diurnal change in dissolved oxygen in billabongs and swamps, with dense vegetation creating anoxic conditions just before dawn

A plume of acidic water entering a billabong from an adjacent floodplain wetland

Fish behaviour under oxygen stress

The fish of tropical waterways in Northern Australia appear to be extremely tolerant of low oxygen conditions in comparison to temperate zone freshwater fish. They are generally untroubled by oxygen levels around 1mg/L and many species only show signs of stress when there is almost no oxygen left.

Response to low oxygen include: stop feeding, breathing just under the surface or by gulping the surface film, jumping out of the water, disoriented swimming, lying on the bottom and gasping, and finally death.

2. Naturally toxic water

Acid-sulphate soils and aluminium toxicity

Some of the floodplain soils of Top End rivers are acid-sulphate soils formed under tidal conditions less than 10 000 years ago. In some places these soils can be exposed to air at the end of the Dry season. This allows sulphides in the soil to oxidise to sulphate, and acid run-off can result after the first good Wet season rains.

The acid water can leach aluminium, iron and other potentially harmful heavy metals from the soil, producing a toxic broth. If it is not diluted to safe levels and the fish cannot avoid it, this toxic water can cause fish kills when it enters waterways. Under acidic conditions, dissolved aluminium affects the gill membranes of fish, reducing their ability to extract oxygen from the water (this effect was one of the concerns about acid rain in northern temperate regions).

Water contaminated with acid-sulphate leachate often turns a vivid green colour

Fortunately, however, locations prone to this effect seem to be few. In the Top End to date, fish kills from this cause have been recorded only in Kakadu National Park.

Disturbance of acid-sulphate soils by native magpie geese digging for bulbs of water chestnut (*Eleocharis dulcis*) on floodplain swamps has been implicated in facilitating acid generation in these soils. Digging by feral pigs could have similar adverse effects.

It is also possible that factors such as dissolved organic matter and dissolved silica can affect the toxicity of aluminium and this is being examined by ***eriss*** in laboratory studies.

Surface respiration by stressed salmon catfish at dawn

These barramundi jumped from anoxic water to an 'aerobic' death on the bank