FISH BITE AT NIGHT AFTER RAINFALL

CHRISTOPHER DOYLE

Bream in an estuary near Sydney become nocturnal following rainfall, adding to the growing body of evidence that environmental changes can influence the behaviour of species.

Animals usually display distinct activity patterns or rhythms that allow them to be classified as either diurnal (active during the day), nocturnal (active during the night) or crepuscular (active at dawn and dusk). These activity patterns have generally been considered inflexible – deviating from the normal pattern of behaviour was thought to put the animal at some sort of disadvantage. However, scientists are now discovering that, for some species at least, certain environmental factors can cause an animal to switch from nocturnal to diurnal activity and vice versa.

If these rain events are changing the behaviour in these animals so drastically, what is going to be the impact of future changes to rainfall?

Adding to that body of evidence is a team of Australian scientists who have recently discovered that rainfall causes yellowfin bream (*Acanthopagrus australis*) to switch from primarily diurnal to nocturnal activity. The scientists found that these estuarine fish remain nocturnal for up to a week following rainfall before switching back to their normal diurnal activity.

Dr Nicholas Payne, a postdoctoral research fellow at the University of NSW, in collaboration with scientists from the NSW Department of Primary Industries and the University of Tasmania, made the discovery while monitoring the behaviour of yellowfin bream in the Georges River estuary in the south of Sydney. It is the first reported example of rainfall causing a reversal in an animal's activity rhythm. "It is a stark reminder that rainfall is a pretty big deal for aquatic animals," Payne says.

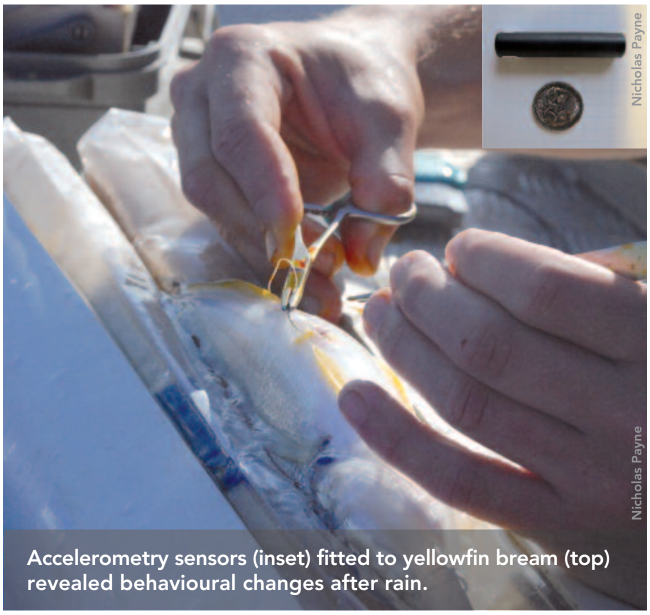
It has previously been difficult to study the behaviour of aquatic animals at night due to the challenges associated with working in such environments. To overcome these difficulties, the researchers used accelerometry sensors to monitor the activity levels of the fish, and Dr Payne puts the success of the project down to the use of this novel technology. "It is not really a surprise that this is the first time it has been found," he says. "This technology is quite new, and it really requires this kind of technology to allow us to get at these types of questions."

The accelerometry sensors measure changes in the amplitude and frequency of a fish's tail beat, giving a relative measure of its activity levels. The sensors also record information about how deep the fish is within the water column.

The sensors were surgically implanted into six fish immediately after their capture to minimise any negative effects from the tagging. "The whole surgery technique from when we catch them to when we put the tags in and release them is generally not much more than 10 minutes," Payne explains. "There is a lot of evidence that holding them for extended periods in a laboratory or in an unnatural setting can be a bit detrimental to their health and behaviour, so we generally get them back into their natural habitat as quickly as possible."

Weighing only 7 grams and measuring 66 mm in length, Payne is confident that the tags had little or no impact on the behaviour of the fish. "In a 300 or 400 gram bream they represent a very small percentage of their body mass, so we think that they didn't have too much of an influence on their natural behaviour," he says. "The pattern in the first four or five days after we release them is not very different to the rest of the time series. If there was to be any artefact of the tagging we would expect it to be isolated to the first day or so."

Once inserted, the tags transmitted information about the activity of each fish to electronic receivers stationed at various places within the estuary. Whenever a fish came within 300 metres of a receiver, the data from that fish was transmitted to the receiver via an acoustic signal.



Accelerometry sensors (inset) fitted to yellowfin bream (top) revealed behavioural changes after rain.

Payne and his team used a total of 34 receivers, with a distance of just over 1 km between each receiver. While this meant there were periods when the fish were out of range of a receiver and therefore not being monitored, Payne is confident that the sample of activity received when the fish were in range was a good estimate of their overall activity patterns.

"Every time we pull up and download one of those receivers we have a huge time series of data, often tens of thousands of bits of information that are all time-stamped down to the nearest second and sub-second. So we know at this time, on this day, what each particular fish was doing," Payne explains. "So we were confident this gave us a good estimate of their activity patterns."

Handling and analysing all that data proved a challenge in itself. "You're talking several tens of thousands of pieces of information and we try to link those bits of information from the fish to things that are happening in the environment. It is certainly not something you could do in an afternoon over a cup of coffee."

Payne and his team monitored the activity of the bream for a period of 4 months, during which time a number of significant rainfall events occurred. It was clearly evident that the fish were switching to nocturnal activity following each rain event.

Why exactly rainfall caused the fish to switch to being nocturnal is not entirely clear, although Payne believes it is related to the decrease in salinity that accompanies significant rainfall events. "When there is a change in salinity, similar to what you get after rainfall, their energy requirements increase and that is really driven by the costs of osmoregulating," Payne explains.

The influx of freshwater following rainfall causes a reduction in salinity, meaning the fish need to work harder to maintain their internal salt balance. In addition to this, rainfall causes dramatic increases in water flow, placing additional energetic demands on the fish. As Payne notes, increased water flow "is like putting the fish on a treadmill to make them swim faster".

In order to meet the increased energetic demands, the fish need to acquire more food, and Payne believes the bream achieve this by switching to foraging at night when their prey is most abundant. However, this also places them at a greater risk of being preyed upon themselves.

"The potential predators of these fish – sharks and even mulloway – are generally considered to be more active at night," says Payne. "So what might be happening is that normally the bream choose to be more active during the day because they can acquire all the food they need and they can avoid predators by resting at night time. When it rains, it might be that the bream are forced to forage more at night time and expose themselves to more predation pressure."

Payne notes that while the findings add to the body of evidence concerning the plasticity of activity rhythms, they also have implications with respect to climate change. Rain events are predicted to change dramatically in the coming decades, both in terms of frequency and magnitude, and this may place yellowfin bream, as well as other estuarine animals, under additional stress. "It makes you ask the question: if these rain events are changing the behaviour in these animals so drastically, what is going to be the impact of future changes to rainfall? What is going to happen to the behaviour of these fishes?"

Funded by an ARC linkage grant, Payne and his team are now using accelerometry sensors to monitor the behaviour of several other fish species in the Georges River estuary. "We are trying to not only look at how rainfall affects their behaviour, but also look at interactions between species and whether when one fish changes behaviour, does another species do something different or something similar?"

As for the accelerometry sensors, Payne believes they will be used more in the future to study the behaviour of aquatic organisms. "People are beginning to understand that these tags can really provide interesting information for a lot of applications. I guess we were lucky to be one of the first ones to get them and get some interesting data back for a free-ranging animal."

Christopher Doyle is an environmental biologist and freelance writer.