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On TRaCK

Tropical Rivers and Coastal Knowledge

Finding fishy facts about flows

By Jenni Metcalfe

The sooty grunter is a stocky blackish-purple fish, commonly found in northern Australia's rivers. Also known as black bream, they are highly sought after by Indigenous people living along the Daly River in the Northern Territory. They are considered particularly tasty after being roasted in hot sand.

Wagiman traditional owners refer to sooty grunters as *binkan* while the Wardaman call them *bin.gan*. Historically, Aboriginal people caught the fish by 'poisoning' the water with selected plants and stunning or suffocating the fish.

Jabal Huddlestone told TRaCK researchers that the wattle tree was commonly used to 'make him [the fish] little bit drunk. Make soapy water. People pick em up and cook em up'. The fish is now caught by line, and Wagiman people pass on stories of past practices to their children at annual cultural camps.

The researchers are finding that sooty grunters are typical of many of the 50 or so fish species found in northern rivers such as the Daly River in the Northern Territory. They are typical in that their lifecycle story—their diet, habitat, reproduction and migration up and down waterways—is neither simple nor straightforward.

At their larval stage, sooty grunters need shallow riffles and rapids if they are to develop into larger fish.

If the river flow is too great or too low, their growth is stunted.

'These fish often use intermittent streams for their initial development', says TRaCK researcher Dr Brad Pusey from Griffith University. 'But once they're adults, the majority move rapidly into the more permanent streams and rivers.

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Sooty grunter, also known as black bream, *binkan* and *bin.gan*

Photo: Neil Armstrong

On TRaCK this issue

Sandy Billabong, Fitzroy River

Photo: Steve Hamilton

Australian Government

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TRaCK brings together leading tropical river researchers and managers from Charles Darwin University, Griffith University, The University of Western Australia, CSIRO, James Cook University, Australian National University, Geoscience Australia, Environmental Research Institute of the Supervising Scientist, Australian Institute of Marine Science, North Australia Indigenous Land and Sea Management Alliance, and the Governments of Queensland, Northern Territory and Western Australia.

Foreword

Associate Professor Michael Douglas
TRaCK Research Director

Welcome to the second issue of *On TRaCK*.

One thing that sets the rivers of Australia's wet-dry tropics apart from most rivers in the country is the strong annual cycle of wetting and drying. Every year, the region experiences wet-season deluges that flood the landscape and every year this is followed by a period of drought.

Another point of difference is that strong connections still exist within the region's river systems. Most of the rivers flow freely from their headwaters to the sea and every year the wet-season rains connect the river channels to vast floodplains and waterholes. The riverbank vegetation is largely intact and this helps to maintain the direct connections between the rivers and their catchments. The people who live in these catchments are also strongly connected to the seasonal cycle of the river systems—it directly affects their livelihoods, their lifestyles and their culture.

The research featured in this second issue of *On TRaCK* explores these themes—understanding these patterns from different angles is one of the unique features of TRaCK's integrated approach.

TRaCK is providing new insights into how much water is in these systems, where it is at different times of the year (above and below the ground) and how this directly affects things that people value in these systems, such as productive fisheries and internationally recognised biodiversity.

The stories here also demonstrate the high level of involvement of local people and the end-users of our research. Governments, Indigenous groups and industry groups are all contributing to our research. This is an important part of making sure that TRaCK research will inform decisions about managing land and water resources in northern Australia.

Wagiman women look at the Daly River fish poster produced with Aboriginal, common and scientific names for 25 fish.

Photo: Michael Douglas

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'Their diet also changes with this journey from shallow pools and riffles to deeper rivers. They start eating small insect larvae, then move onto prawns and large aquatic insects and the occasional smaller fish and, as they mature, they move to a more vegetarian diet of algae and fruits from riverbank trees such as figs.'

It is this sort of information that can better inform water planning decisions in rivers like the Daly, which is under agricultural development pressure due to its large and permanent river flows and relatively good soils.

'The Daly, like most northern rivers, is largely unregulated by dams and barriers', says Dr Pusey. 'We need to take a whole river system approach to understanding and managing this river from its tributaries to its mouth, its floodplain and out into the marine environment.

'This approach needs to consider all species of plants and animals, not just fish. It can't just focus on a single species.'

Water allocation planners in the Northern Territory are relying heavily on TRaCK's environmental water research.

'We prioritise environmental water in all our planning processes to ensure that environmental and cultural water needs will be met if water is extracted for development', says Ian Lancaster, Director of Water Management with the Northern Territory Department of Natural Resources, Environment, The Arts and Sport. 'While there has been some work done previously on what water the environment needs to sustain its activities, this did not result in any significant and justifiable requirement for environmental water. The TRaCK work will better inform the entire process.'

While planning decisions need to holistically focus on the big picture of river flows and their effects on all plants and animals, TRaCK research is using the sooty grunter and other species such as barramundi as model fish species for better understanding the relationships between flows and fish populations.

'Despite these fish being iconic species of northern Australia, there is surprisingly much to be learnt about their biology', says Dr Pusey. 'Our work with the local Indigenous communities is helping to fill this gap in our knowledge. In particular, we need to know how the amount of water within a river and the timing of flows in the river meet the needs of the animals and plants that depend on it.'

For the sooty grunters living in the Daly, it seems that just after the wet season their numbers are high, but they drop quickly in the dry. Scientists speculate that this could be due in part to the reduced dissolved oxygen in the water as the water temperature rises, making fish more vulnerable to disease. Competition and predation probably play an important role too.

'On the other hand, some species do well as the water contracts in the dry. Bull sharks, for example, thrive because fish are concentrated in the shrinking habitat'.

This sort of information is being included in predictive models about sooty grunters and barramundi. The models, known as 'Bayesian Belief Networks', provide scientists with a tool to include quantitative data

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about fish, such as that collected at the 55 study sites on the Daly River system, as well as scientific and Indigenous knowledge.

Water planners can use the models to predict the consequences of changes to river flows on the fish populations.

'These models are just beginning to be used in Australia to investigate the outcomes of various river flow management strategies', says Dr Pusey.

An important part of this project has been the direct involvement of local Aboriginal people, especially the Wagiman and Wardaman traditional owners.

'The involvement of these people has been critical for our project being able to better and more quickly access waterways, more efficiently sample them and to better understand them', says Dr Pusey.

The Wardaman people were able to confirm the presence of a garfish species at the Flora River site over many years, despite researchers only collecting one specimen of this species across all 55 sites.

'This new information on where and when species breed is especially important for us', says Dr Pusey. 'It provides us with a much richer and more accurate perspective of fish communities in the Daly.'

Having young men and women from Indigenous ranger groups help with sampling river sites using electro-fishing techniques has been mutually beneficial—it has helped some of these young people meet their TAFE study requirements and has meant extra help for researchers.

One product of this ongoing collaboration has been a Daly River fish poster that includes traditional names for the fish, common European names and scientific names.

'The poster demonstrates that Wagiman people know their fish', says TRaCK researcher Dr Sue Jackson from CSIRO. 'Twenty-four of the 25 fish on this poster have a traditional name and are very familiar to people, particularly older people who grew up on Wagiman lands.'

One fish that people had not seen before was a freshwater sole found when electro-fishing at Claravale Crossing.

'This fish was so small and well camouflaged that the Wagiman group we worked with didn't know it existed', says Dr Jackson. 'They were fascinated to find it and to learn more about its features and behaviour.'

The TRaCK team has found at least one species of fish that is only found in the Daly River system.

A type of gudgeon, it is found in the shallow stony pools in the upper reaches of the Katherine River.

'We're analysing the genetics of this fish to see how it is related to other gudgeons in this region', says Dr Pusey. 'Another species, the exquisite rainbow fish, is also found in a series of isolated areas and these types of fish could be particularly vulnerable to any sort of development or change in flows.'

Dr Pusey says there are still major gaps in Indigenous and Western science knowledge about fish populations, movements and diet during the wet season, especially during big wets.

'This is a time when the waterways are largely inaccessible. The rivers also aren't as clear as in the dry season, so it can be difficult to see what's happening beneath the water's surface.

'Another gap in our knowledge is about where fish move.

We don't know where they go and when, how far they travel or how long they stay in different parts of the river.'

The TRaCK project is looking for answers to these questions and will continue to monitor its sites in the Daly into the future. It will also extend this research to other regions in northern Australia as it tries to unravel the complicated yet critical relationships between fish and river flows.

Freshwater sole, *Brachirus selheimi*

Photo: Julian Olden

Lizzie Sullivan fishing at Claravale, Daly River

Photo: CSIRO

Not just a pretty map

Two new ways to usefully distinguish one type of river from another

by Mary O'Callaghan

With around 1.2 million square kilometres of land within the TRaCK research area, much of it remote and inaccessible, it's easy to see why scientists can't visit each river reach.

For this reason, TRaCK research is focusing on four catchments—the Daly in the Northern Territory, the Fitzroy in Western Australia, and the Mitchell and Flinders in Queensland. But how do we know whether we can confidently apply the findings from fieldwork in one catchment to other catchments across the north?

'There are some fundamental differences between, for example, the Mitchell and the Daly Rivers', says Dr Andrew Brooks from Griffith University (see Box). 'So, it's important to get the message across that, just because we've done a lot of detailed work on the Daly, for example, this doesn't necessarily mean that it's applicable across Australia.'

Dr Brooks and his team set out to develop a method for describing the similarity, or dissimilarity, of the region's riverine landscapes, as part of a method for legitimately extrapolating (or not!) information from one segment of river to another. What they've come up with is a way of classifying rivers that Dr Brooks believes could make other classification systems redundant.

Overcoming scale and subjectivity

In the field of geomorphology—understanding landscapes—there is a long history of classification systems. 'Just about every government program doing research over large scales uses some sort of classification', explains Dr Brooks. 'The problem is that in any classification system there's a lot of subjectivity; and they are often designed for a specific purpose.'

Understanding that different people use classifications for different reasons, Dr Brooks and colleague John Spencer thought they could develop a better, more flexible approach using large spatial data sets.

Driven by the users' needs

What John Spencer has developed is an interactive GIS-based tool where you select a specific segment of river, choose one or more variables—such as stream slope, valley width, catchment area, drainage density, geology—and you are presented with a measure of similarity between your river segment and all others. For categorical data, such as geology, where there are no degrees of similarity, river segments that are the same show up in red on the map; those that are different show up in green. For data that is continuously variable, such as elevation, the river segments that are similar are shown in varying shades of colour that reflect the degree of similarity. From there you can define how many classes you want and, at the click of a button, the system will generate your user-defined classification.

And, unlike most GIS-based classifications, you can save the specification for how you made it, in case you ever want to run it again or compare it to another version. You can also download the underlying layers of data that the classification comprises.

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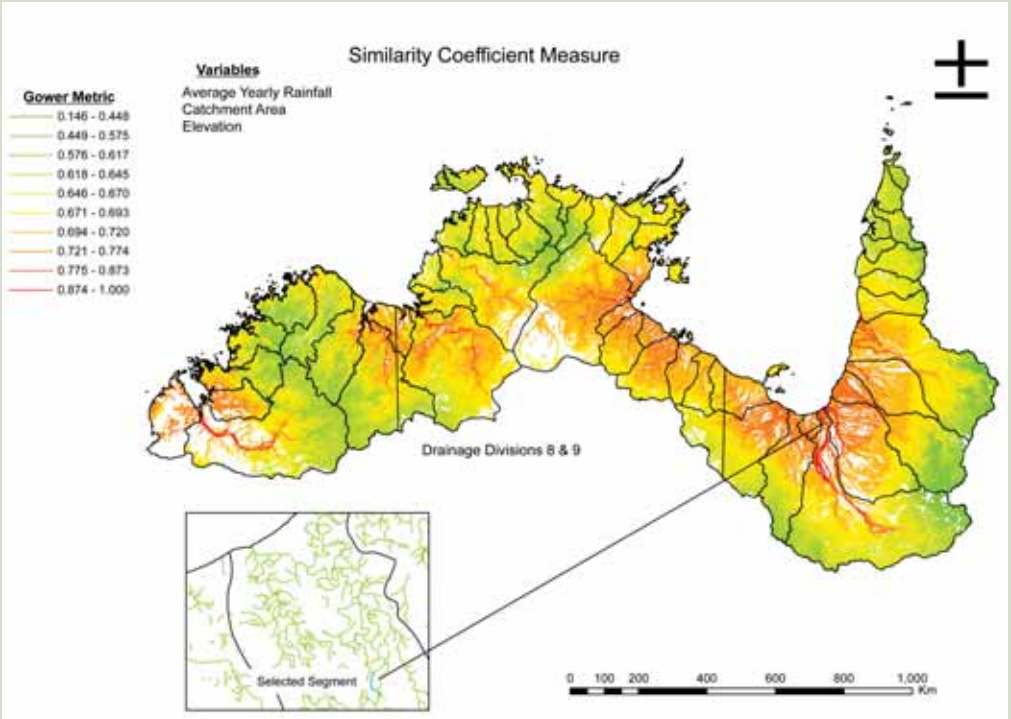

Figure 1.
The GIS-based geomorphic classification tool highlights that there are major differences between rivers in the Southern Gulf country and in the Kimberley. In this example, streams that are similar to the selected section of river are shown in red. Streams that are dissimilar are shown in green.

The Mitchell and the Daly – two very different rivers

The Mitchell has a 1.5 kilometre-wide channel in its lower reaches which flows through an alluvial floodplain, but which is choked with sand, and can shift sideways by 50–100 metres in some years. Large pools (up to several kilometres in length) form one year and disappear the next.

By contrast, the lower Daly has a relatively narrow (about 100 metres wide) and stable channel, largely bounded by bedrock. Pools in this river tend to 'stay put'.

Not just another classification

According to Dr Brooks, this is not just another classification: 'It's dynamic and flexible, and allows people to explore the data. It really is a quantum leap from other classifications. To my knowledge this is the first time anyone's developed such a system anywhere in the world.

'And you can build on it—that's the beauty of it. It's not set in time, which is the major constraint with a lot of other classifications. We can update it as new data becomes available.'

The system is already providing insights. 'It is obvious that there are major differences between the Southern Gulf country and the Kimberley—really fundamental differences that people need to understand', says Dr Brooks (Figure 1). 'If you've got a study on the Flinders River floodplain, it's probably not going to be a lot of use to someone in the Kimberley.'

Dr Mark Kennard, a fish ecologist and senior research fellow at Griffith University, says the system's advantage is its flexibility. 'There is no single correct classification as it really depends on the particular environmental features the user is interested in; so being able to do things on the fly and then quickly try again with a different combination of variables is great. I think it's a really useful tool for the public, for scientists and for people doing field surveys where they need to stratify sites, comparing like with like.'

Because it's so flexible, Dr Brooks is keen for different groups with different objectives to try it out. The plan is to make the system available on the web so that people can run it from anywhere. 'We need to know it is meaningful on the ground, that we are not just generating pretty maps. It has to be able to usefully distinguish one type of river from another.'

Flow regime and ecology – the relationship

In a separate TRaCK project aimed at understanding how flow variability can affect aquatic habitats and biota, Griffith University's Dr Brad Pusey and Dr Mark Kennard have classified all rivers in Australia by ecologically important flow characteristics —a first for Australian river research. Dr Pusey suggests that Dr Brooks' physical classification and the flow regime classification can be used together to help determine whether data can be extrapolated from one catchment to another: 'For example, you could say: river A has a flow regime X but geomorphology Y. What does that mean to ecology?'.

Allocating water for environmental flows, testing scenarios, analysing the risks of management options, and planning for the impacts of climate change all need to be based on predicted changes in flow regime. So we need to understand how much flow regimes vary between rivers and regions and the extent to which the variation affects plants and animals.

Flow regime is affected by combinations of climate, catchment geology, topography and vegetation, influencing habitat for aquatic and riparian (streamside) animals and plants, refuge availability, food distribution, movement and migration, reproduction and recruitment.

Dr Pusey analysed daily discharge data from 830 stream gauges across Australia to come up with 12 classes of ecologically important flow regimes (Figure 2). Like the physical classification, all the data underlying the flow regime classification are available for analysis.

While this is a static classification —if there's no stream gauge, there's no data—the team has developed a decision tree to help you to determine what class a new stream gauge falls into, based on either its key environmental or hydrological characteristics.

Dr Pusey explains how water managers and people responsible for allocating water will find the classification useful: 'They can identify rivers that require special consideration or aspects of regime that typify those rivers they manage. Up to now there has been no quantified rigorous way of putting rivers into context with other rivers; there have just been a lot of case studies.'

'It will also be useful for aquatic ecologists', adds Dr Kennard. 'We can put our study area in a context and hypothesise about differences in ecology due to differences in flow regime, design studies to test those hypotheses or validly use the results of other case studies.'

The flow technical report, including the classification, is available for download from Land & Water Australia at **http://lwa.gov.au/products/pn22591**

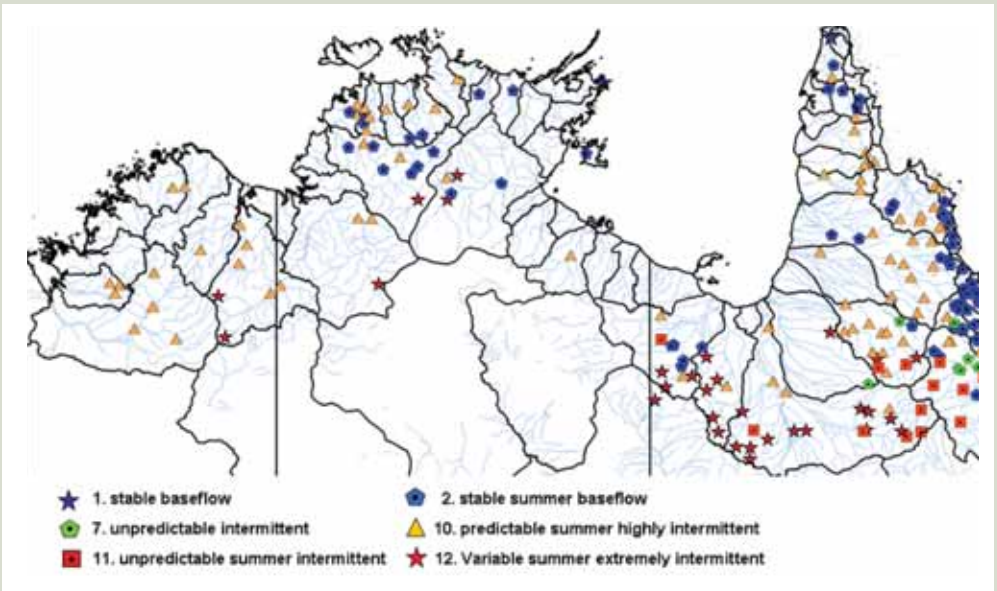

Figure 2. The six classes of flow regime in northern Australia
This figure incorporates data which is copyright Commonwealth of Australia (Geoscience Australia)

Raptis & Sons fishing fleet during Karumba flood, January 2009

Photo: Michele Burford

Estuaries bring fishing bounty to the Gulf of Carpentaria

By Melanie McKenzie

In the Gulf of Carpentaria, one of Australia's most productive fishing regions, estuaries are valued as more than just a place where the river meets the sea.

TRaCK researchers, local communities, water planners and the commercial fishing industry are working together to show how the estuaries at the mouths of the Norman, Flinders, Mitchell and Roper rivers support finfish and shellfish production in the Gulf.

The area is prone to floods and cyclones during the wet season due to the tropical climate and low lying lands. Located between Arnhem Land in the Northern Territory and Cape York Peninsula in Queensland, the Gulf of Carpentaria has a truly unique environment.

'Because there are so few people and so little industry, the Gulf is one of the most environmentally healthy ecosystems in the world', says TRaCK researcher Dr Michele Burford from Griffith University.

Yet researchers know little about our marine waters, including northern Australia's estuaries. One reason is that the Gulf's remoteness makes research difficult, especially during the wet season.

'In terms of research, we've only just scratched the surface', says Dr Burford.

'Estuaries have enormous economic and environmental value as a nursery ground for fish and prawns, but they are also home to a wide variety of bird life and mangroves. They are home to animals and plants that we have not even described yet.'

Until recently, estuaries were not considered in decisions about water planning. Now water planners want to know how much water can be extracted from a river before it affects the estuary.

'We want to know which flows are important, how big they need to be, when they need to happen, and how often they need to happen in a particular season to sustain the fisheries in the area', says Julie Coysh, a senior policy officer with Queensland's Department of Environment and Resource Management, a TRaCK industry partner.

'The TRaCK information will inform our water resource planning and future decisions about water allocation in that area. If there were to be a proposal for a dam, we would have information about the types of environmental flow releases needed to support the fisheries downstream.'

Low levels of resource development in the Gulf allows researchers to find out how productive estuaries function in a natural system.

'This is a unique opportunity to find out how the estuary functions before any significant water resource development takes place', says Coysh.

Dr Burford believes that many other tropical estuaries have suffered serious environmental degradation due to pollution and population.

'With more people come dams, water extraction for irrigation and pipelines to towns and cities, nutrients from fertiliser on the land, and herbicides and pesticides from crops', she says.

Researchers are gathering data from the Gulf on how freshwater flows affect barramundi and king threadfin—two of the region's most commercially fished species. Knowing the numbers and sizes of fish in different age groups, and the relative timing of freshwater flows, will help the researchers determine how important fresh water flowing into estuaries is for the survival of juvenile fish.

One important factor is fish age, which researchers are determining by looking at the fish's otolith, or ear bone. The otolith contains concentric growth rings, like in a tree, that can tell researchers how old it is. When the fish come out of winter, in October and November, they have a growth spurt and another ring is laid on their otolith. Using lasers, researchers can look closely at the chemistry between the rings to determine whether a fish has been living in salt or fresh water, and how many times it has migrated from salt to fresh water over its lifetime. Researchers can also estimate how large a fish was by the size of its jawbone.

TRaCK researcher Ian Halliday from Queensland Primary Industries and Fisheries, says the local communities in the Gulf, including the commercial and recreational fishers, have been invaluable to the project.

'We couldn't do our research without them—particularly in areas that are difficult to access', he says.

'For example, the Kowanyama community has a Deed of Grant in Trust over the lands in the Mitchell River delta and non-Indigenous fishing is restricted during most of the year.

Without the help of the local Aboriginal fishers in this area, we couldn't get the samples that we need.'

It's a win-win scenario for both the researchers and the communities involved. The cost of collecting samples is relatively low because Halliday's team only needs the heads of the fish to measure their ear and jaw bones. Samples are frozen onsite and shipped to the research laboratory in Brisbane. The researchers are using what would ordinarily be a waste product, they are paying the fishers for it, and they are building strong relationships with the communities.

'Communities need good information to make their choices. For example, if a community knows that a dam will reduce their fish catch, but that they will have jobs on farms, then that's a decision they can make', says Halliday.

But more freshwater into an estuary does not necessarily mean more fish.

'We can't say that an increase in freshwater flows is the reason fish production goes up. To do that, we need to understand the food web and how nutrient input from the land, freshwater flows and fish interact', says Halliday.

In another TRaCK project in the Gulf, Dr Burford is using banana prawns to understand how food webs are affected by freshwater flow. She says that while it is common knowledge that the banana prawn industry relies on freshwater flows, finding out why or to what extent is complicated.

From previous work, the researchers know that when it rains there is an increase in freshwater and the salinity in an estuary drops. Prawns normally live offshore, but the larvae move to

Karumba in flood, January 2009
Photo: Andy Revill

estuaries for a number of months to feed and grow. When salinity in the estuary drops to a level that the prawns cannot tolerate, they move out to deeper waters where they are caught in the fishery.

'Depending on how much rain you get, you should be able to predict how many prawns you'll catch', says Dr Burford. 'But that isn't always the case. Rain is one of the cues, but there must be things about flow other than the salinity.'

Not only does that freshwater flow provide nutrients that run off from the land, it also floods the saltpans. Algae on the saltpans grow, providing another food source for the prawns.

If a river is dammed or has water taken out for irrigation, less fresh water reaches the estuaries. Fishers want to know what this will do to their livelihoods—will the prawns still have enough food to eat and will there be enough fresh water to 'push' them out to sea?


Norman River Photo: Ian Halliday

Researchers have been collecting prawn samples in the area for six months over the last wet season, coping with crocodiles, extreme heat and biting insects. Dr Burford says that the work her team is doing in the area could not happen without the support and local knowledge of Raptis & Sons fishing company. Michael O'Brien, manager of the company's northern operations, says they were keen to jump on board the project.

'We're big supporters of science—it provides the basis for sustainable fishing', says O'Brien.


Photo: Michele Burford

Research assistant Matthew Whittle and PhD student Melissa Robinson collect mud samples to look for animals and algae that live in the mud.

'We want a very good knowledge database on how water flows affect banana prawns. The northern prawn industry is recognised for its sustainable practice. We've spent a lot of money and gone through hardship to get it that way. Where we used to run 300 fishing boats, now we run 50. It's not just about economic yield anymore—it's about maximum sustainability.'

Mr O'Brien sees potential changes in the pipeline. He has heard talk over the last five to 10 years about agricultural developments such as cotton growing and damming in the catchments near Karumba. He is concerned about any sort of agriculture that uses a lot of water because it puts more pressure on the fishing industry.

'So many of the pressures on our fisheries are land based', says O'Brien. 'We have to make sure that, in the catchment areas where a lot of water comes through in a very short period of time, contaminants from the land do not wash into the Gulf.'

Dr Burford says that it is a trade-off between the environmental, commercial, and social values of the estuary, and developing the land.

'It isn't just a matter of saying that developing the land is bad. There are different types of development, with different effects. Some will be more serious than others and decisions need to be made about the trade-offs.'

The social value of estuaries can sometimes be overlooked, but commercial and recreational fishing is what keeps many of the Gulf communities going. And TRaCK research is showing the importance of estuaries to the whole river system.

'In looking at impacts of freshwater flow, we tend to focus on reefs—but estuaries are the ecosystems most under pressure', says Dr Burford.

'We don't understand enough about the relationship between estuaries and freshwater flows, but we do know that water running out to sea is not wasted.'

Mutton Hole Wetlands, Normanton

Photo: Jenni Metcalfe

Untangling the watery food web

By Michelle Riedlinger

In the largest study ever conducted on food webs—the networks of 'who eats what'—across catchments, TRaCK researchers are finding that waterholes and floodplains may be more important for the health of plants and animals in northern rivers than first thought.

Early research results are showing the importance of taking a whole-of-catchment approach to river health.

'We have one river system, or landscape, that the plants and animals rely on so we need to think about it as one system in our understanding and management of it', says Dr Danielle Warfe from Charles Darwin University.

Researchers have collected plant and animal samples from 70 sites along small streams, main channels, waterholes and floodplains over three catchments—the Mitchell River catchment in Queensland, the Daly River catchment in the Northern Territory and the Fitzroy River catchment in Western Australia.

Samples include potential food sources such as algae, leaf litter and large aquatic plants (known as primary producers), and animals further up the food chain such as insects, shellfish, fish, crocodiles, turtles and birds.

The widest variety of plant and animal species samples were collected from sites where the rivers widen from small streams, and the researchers are waiting for the results of the sample collection to know what the results mean for the survival of the plants and animals living there.

The scale of the project, crossing three catchments, means they will be able to see how the food web changes over entire river landscapes and between the different seasons.

'Food webs in tropical river systems are tied to cycles of the wet and dry seasons and the movement of water, organic matter and animals between rivers, waterholes, floodplains and estuaries', says Dr Warfe.

During 2008, the researchers collected their first samples from waterholes in the three catchments. They visited the sites early and late in the dry season and are now analysing what they have collected.

'The waterhole samples will give us important information on the food web just after the "boom" period of large water flows and then after the long and difficult dry phase', says Dr Steve Hamilton, a visiting research fellow with Griffith University.

'The dry phase is the ecological bottleneck for many aquatic animals. Some fish and reptiles fast in the waterholes for much of the dry season and bide their time until the next wet when their food resources increase dramatically.'

In the dry, waterholes are a refuge for freshwater fish, several species of turtle, crocodiles, prawns and freshwater mussels.

'We've even seen wallabies in water up to their necks feeding on aquatic plants in waterholes at the end of the dry season when there was almost no green vegetation left', says Dr Hamilton.

Waterholes are also important for the survival of local people. In Willinggin country in the upper reaches of the Fitzroy River catchment in Western Australia, the locals catch black bream and perch in the waterholes every day. They harvest the roots of the waterlilies growing in the waterholes and roast them on coals before eating them.

The waterholes also have spiritual value for the Indigenous people in the area.

'People visit the waterholes to hold ceremonies up to once or twice a month after the wet season', says Andrew Wungundin, a Wunggurr Ranger working in Willinggin country.

'They smoke these places and talk language to let the spirit know they have come back to visit them and to check on the place to make sure it is still the way they left it.'

Large inputs of new water in the wet season, which can vary in volume from year to year, are important for the health of plants and animals that rely on waterholes.

'Any alteration to river flows also needs to consider the impact on waterholes', says Dr Hamilton.

While waterholes keep the food webs going in the dry, flooding and the floodplains keep them going in the wet. Many fish and bird species move onto the floodplains in the wet to breed and return to rivers and waterholes when the waters recede. They time their migration and breeding to when food is available, which, in the north, is the wet season.

Researchers are collecting plant and animal samples from the three catchments in both the wet and the dry to understand the movement of nutrients through the food web.

'While other studies show that algae are very important to the food web as a food source, we are also looking at large aquatic plants in the floodplain—grasses and lilies—and their role in the food web. Most of the carbon in the wet season is locked up in these plants', says Dr Neil Pettit from the University of Western Australia.

Floodplain plants such as grasses and lilies provide structure for algae to grow on and habitats for animals that move onto the floodplains in the wet season. In the dry season, birds such as magpie geese move onto the floodplain and feed on wild rice seeds and the tubers of the water chestnuts that have grown there during the wet season.

Danielle Warfe sampling algae on the Daly River

Photo: Steve Hamilton

'In the dry season, the geese hang around the waterholes and banks of the river; but without the floodplains they wouldn't breed', says Dr Pettit.

Larger floodplain plants are home to invertebrates, such as dragonfly and mayfly larvae, and algae. Land-based insects such as grasshoppers feed on these plants and are a possible rich source of nutrients for insect-eating fish.

'We are harvesting some of these plants on the floodplains during the wet season and collecting the algae growing on them to get an estimate of the carbon contained there', says Dr Pettit.

TRaCK researchers are collaborating with Aboriginal rangers in all three catchments and are helping them get a better indication of the health of the plants and animals living there.

'This work is showing us what the animals living in our rivers need from the river to survive', says Lloyd Nulgit, one of four Wungurr Rangers working along the Hann and Barnett Rivers under a program managed by the Kimberley Land Council. Both rivers flow into the Fitzroy River catchment and the health of the whole Fitzroy River catchment relies on the health of this upper catchment area.

The rangers identify threatened plant and animal species and develop management strategies to help protect them. During the last dry season, Mr Nulgit and fellow ranger Andrew Wungundin took researchers through the upper catchment area and helped them collect samples of plants and animals.

'We've learnt how to do aquatic surveys and this is helping us look more closely at the rivers we swim and fish in', says Mr Nulgit.

Knowing whether the fish they have sampled are mainly relying on plants growing on land or aquatic plants will help researchers understand where in the catchment the fish are getting their food and what they need to survive.

'It is interesting to watch how the scientists follow the fish we eat so we can then know what the fish eats', says Mr Nulgit.

Water 'detectives' on the move

By Jenni Metcalfe

The TRaCK hunt is on—with the help of helicopters, satellites, sensors and schoolchildren—to find out how much water is where at any given time in northern catchments. Armed with this knowledge, we can understand better how to manage the area's rivers and estuaries.

Little is currently known about the interactions between groundwater and surface water and how these change between the wet and the dry season.

Dr Rebecca Doble from CSIRO is seeking to find out how groundwater flows affect river flows in the Fitzroy River system in north Western Australia. This is the first ever study into the links between regional groundwater stores and the Fitzroy River.

'It is clear that rivers that continue to flow in the dry season are sustained by groundwater flows; however, we're not clear on what role regional groundwater stores have during the wet compared to wet season floods', says Dr Doble.

Dr Doug Ward from Griffith University is using satellite technology and water sensors to check out what happens to water in the Mitchell River in northern Queensland over a full season, from the flood events in the wet to the water's retreat to waterholes in the dry.

'We're really interested in understanding the connectivity of the water over the seasons', says Dr Ward. 'This tells us a lot about how biota [animals] may move out into the floodplain during the wet and then take refuge in waterholes in the dry.'

In the Daly River in the Northern Territory, researchers are looking at what happens to water on three different land types adjacent to the river: an improved pasture site, a cleared site with native and introduced grasses and an uncleared site.

'The aim of our project is to look at how water drains, runs off or evaporates from this site', says Dr Lindsay Hutley from Charles Darwin University. 'We're taking measurements using special towers and soil moisture pits and then entering that data into models that can tell us more about what happens to water falling on this land and what that means for river health.'

All three projects are providing TRaCK researchers with a better understanding of how water cycles between the ground, the rivers and the atmosphere.

'This research provides us with a "water budget" for catchments', says TRaCK project leader Dr Peter Cook from CSIRO.

'Such water budgets don't currently exist for northern Australia. But they are essential for understanding how river systems are linked or isolated in a catchment and how other materials such as sediments and nutrients move through the catchment.'

Water planners and policymakers also see this sort of information as important for making decisions about future development in the catchments, including water extraction.

The Western Australia Department of Water was directly involved in TRaCK's Fitzroy River project, collecting samples and providing data.

'The chemistry analysis provided by TRaCK helps us to understand how groundwater feeds into the surface water river system', says Louise Stelfox, a hydrogeologist based in Kununurra. Stelfox is working on a three-year surface water – groundwater interaction project in the lower Fitzroy River valley. 'This work complements the work we're doing with flows in the Fitzroy and gives us a better feel for what's happening where.

'It's essential for us to understand how and where groundwater interacts with surface water if we are to develop a water resources allocation plan for the Fitzroy that recognises cultural and environmental needs for water, as well as the needs from socio-economic developments.

'In particular, we need to know the likely impacts of water extraction from the Fitzroy on the needs of Traditional Owners who want to maintain their bush tucker supplies, which are dependent on the wet and dry season cycles.'

Last year, at the end of the wet season, TRaCK researchers took water samples from 20 locations along the Fitzroy River, from Willare to Fitzroy Crossing. They travelled by helicopter, hovering

Photo: Rebecca Doble

Kulkarriya Community School students collect water samples from the Fitzroy River. Left to right: Kane Rivers, Trichelle Laurel, Leetroy Skinner.

one metre above the water's surface to pump out water samples.

'Our aim was to test the chemistry of the water and track where groundwater was flowing into the river', says Dr Doble. 'Our early results show relatively low levels of groundwater flows into the Fitzroy River along much of its length. But it looks like the most groundwater flows into the river system where the Cunningham River meets the Fitzroy, and around the mouth of the river.

'This suggests that at the end of the wet season the Fitzroy is getting most of its water from fresh water stored in the banks of the river during the wet season's flooding.'

Researchers can tell where groundwater is entering the river by testing how much radon and salt is in the water. Groundwater tends to have more radon and salt than fresh water.

Using helicopters, researchers can get to remote and inaccessible areas quickly. While this allowed Dr Doble to sample 20 locations in a day instead of a week, she admits it was a bit scary the first few times.

'When you're hovering one metre above the river, it is a bit nerve-racking', she says. 'But it only takes two to three minutes to drop down a pump at the end of a hose and get the sample of water. And the pilots are very experienced.'

Photo: Rebecca Doble

While the helicopter provides a means of finding out what happens along the Fitzroy River's length, TRaCK researchers also want to find out if the amount of groundwater flowing into the river changes with the different seasons. For this part of the project, they have enlisted the help of the Kulkarriya Community School and the Fitzroy Crossing District High School.

Photo: Rebecca Doble

Late last year, Dr Doble visited the schools to talk about the TRaCK project and show students how to take water samples and measure the salinity of those samples with an electrical conductivity meter.

The students are taking surface water samples every two weeks at Noonkanbah and Fitzroy Crossing over a one-year period from November last year.

'The students were very keen to get involved', says Dr Doble. 'The Fitzroy River is very important to Indigenous communities living along it and most of the students belong to these communities.

'It is wonderful from a research perspective to engage with the communities that live on the river and for whom it is most important. We also learn a lot from this interaction.'

Luke Royes is the teacher from Kulkarriya Community School who is coordinating the 14 students collecting samples for TRaCK.

'The project has opened up new opportunities and ideas for students when they look at the river', he says. 'The ecology material provided by TRaCK has also helped me to better use the river as a resource for teaching. Our school is right on the Fitzroy River and in the afternoon you'd find half of our students at the river.'

Dr Doble is excited about analysing the results from the school samples and further analysing the helicopter samples.

'It will give us a picture of these northern rivers, which we already know are quite different to southern rivers', she says. 'If we just rely on the research and models done on non-tropical rivers, it's likely we'll over- or under-predict the importance of floodwaters on dry-season river flows or on waterholes.

'We need to understand what's really happening in our tropical rivers before any development. We need to avoid using too much of the water that fish and plants rely on, especially during the dry period.'

Above left: Duncan Palmer from the WA Department of Water sampling water from the Fitzroy River.

Joseph Kemei (left) and Richard Weinmann measure soil moisture in a benched pit on a cleared site with native and introduced plants regrowing near the Daly River.

Photo: Cuan Petheram, CSIRO

Dr Ward agrees that there is an urgent need to find out more about our tropical rivers.

'We're using satellites to map floods on the Mitchell. But these don't work very well when it's very cloudy so we're also looking at microwave technology which can penetrate clouds', he says.

But, while a satellite makes daily runs over the site, the microwave technology only runs every 16 to 30 days. So the clear skies of the dry season make satellite data much more useful in showing how much water there is at the end of the dry season.

'Some of the waterways are still full of water at the end of the dry, while others are dry', says Dr Ward. 'Some of the waterholes have clear water across a number of years and others are always extremely muddy'.

Dr Ward believes the clarity of water is likely to influence the diversity of animals and plants that are likely to live in such water. A network of independent sensors placed at varying depths across the Mitchell floodplain are also providing information about the duration and depth of water on the floodplain, supplementing the satellite data.

'We know so little about water during the wet season', Dr Ward says. 'This will provide us with more information to fill in the tropical rivers jigsaw.'

Daly River update

Fish sampling

Our researchers have done another two seasons of fish sampling on the Daly River, visiting seven permanent sampling sites in June and October 2008. The sites are on the main channel of the Daly and on the Fergusson and Katherine Rivers. Sampling continues this year, bringing it to four continuous years of sampling fish at these sites. This longer term data is important for understanding how fish ecology and annual flows are related.

In previous years, the Wagiman Rangers helped our researchers to collect data, and last year the Wagiman women welcomed the research team to sample at Douglas Hot Springs. The fish sampling team will continue to work with the Wagiman during the coming sampling trips.

Not all plants and animals go with the flow

Research investigating seasonal changes in food web structure is well underway. This research will assist with identifying potential flow cues triggering the movement of plants and animals. Dan Warfe, Neil Pettit, Erica Garcia and Peter Kyne are sampling regularly in Bonrook Creek and the Edith, Fergusson and Cullen Rivers—tributaries of the Daly River which vary in the length of time they flow.

Photo: Danielle Warfe

Andrew Raith samples water on the Fergusson River.

Already some of the data are indicating definite differences in what is moving upstream versus downstream. Invertebrates living on riverbanks are much more abundant (and potentially being used in aquatic food webs) much more than expected. Zooplankton (animals that rely on water currents to move) may also be more abundant in the river system than expected.

Simon Townsend and Andrew Raith have been out collecting algal samples over much of the recent wet season. This sampling will indicate the degree to which tributary headwaters contribute to the Daly River's productivity during the wet.

Scoring the health of rivers and wetlands

A health check of the Northern Territory's relatively undisturbed rivers and wetlands has begun as part of the national Framework for the Assessment of River and Wetland Health. This includes field trials in the Daly which started late last year. They are being conducted by TRaCK researchers Ian Dixon, Ruth Duncan and Simon Townsend.

The framework is being implemented across Australia so river and wetland health will be comparable across the country. The health of the rivers and wetlands will be scored between zero (disturbed) and one (undisturbed and relatively pristine).

'Northern Territory rivers should have a score that reflects less disturbance than other rivers in Australia', says Simon Townsend. 'The challenge will be to develop on the framework so that impacts to river health, such as development, can be detected early, and can be distinguished from natural influences.'

April Mirindo (a research assistant working with Anna Straton) interviews William Shaw at Gillarong community near Fitzroy Crossing.

Fitzroy River update

Between October and December 2008, researchers from three TRaCK projects did field work in the Fitzroy River catchment

As part of an assessment of the economic value of Australia's tropical rivers, Dr Anna Straton, assisted by two local research assistants, interviewed 90 Aboriginal residents in the catchment, face-to-face, over six weeks. A sample of non-Aboriginal residents received a questionnaire by mail. The results of this survey will be available later in 2009.

Dr Rebecca Doble visited two schools at Fitzroy Crossing and Noonkanbah community to talk about their interest and availability to participate in research. Dr Doble is researching the connection between groundwater and rivers, in order to understand where the water in the rivers comes from when it is not raining. Over 2009, the senior

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Courtenay Mills, Kate Masci and Dominic Valdez process samples taken in the Mitchell catchment.

Mitchell and Norman Rivers update

Activity was intense in the Mitchell catchment at the end of 2008 as TRaCK developed processes for working with local Aboriginal people.

The culmination was a forum at Mt Carbine in November. What an exciting and successful weekend! More than 90 Traditional Owners attended and eight researchers presented overviews of our current and planned activity in the Mitchell. We have had a follow-up meeting with the newly-formed Mitchell River Traditional Custodian Advisory Group and will continue to work in partnership with this group to map out a process for Indigenous engagement in the catchment.

The last half of the dry season saw major field campaigns in the Mitchell. The three food web projects were collecting samples and setting fish traps on the floodplain in readiness for the wet season. Depth loggers were also installed on the floodplain to help us map the extent of floodwaters. Andrew Brooks, Gary Caitcheon and their teams were also out collecting river sediments to trace where they come from and where they end up.

In the current wet season, both the food webs and sediments teams are out around the bottom end of the Mitchell and the river mouth to learn more about what happens during the wet season. Needless to say, the logistics of getting people, boats and equipment out on flooded rivers are nightmarish and we are greatly indebted to some of the local station managers and the people at Kowanyama for their support.

TRaCK's Queensland activity is not limited to the Mitchell. Michele Burford's team is doing intensive sampling of water quality and prawns in the Norman River estuary near Karumba until March 2010, with research assistant Matthew Whittle based part-time at Karumba. They are hoping to gain a better understanding on how prawns respond to changing river flows.

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classes are collecting weekly water samples from the Fitzroy River.

Dr Marcus Finn and Emma Woodward, who are researching river flows and Indigenous socio-economic values, returned to the Fitzroy River catchment for a fortnight to work with people at Fitzroy Crossing and outlying communities in mapping the different places where they fish, hunt and collect plants.

In November 2008 Assoc. Prof. Michael Douglas, Director of TRaCK, presented an overview of TRaCK and its Kimberley activities at a Fitzroy Catchment (FitzCam) project meeting and met with the Deputy Director and Principal Legal Officer of the Kimberley Land Council.

The first researchers back in the field in 2009 were Dr Marcus Finn and Pippa Featherston. After delays in Broome with wet weather and lost bags, they arrived in Fitzroy Crossing to work with six river communities to quantify the river and wetland species that the communities consume. Based in Fitzroy Crossing until late March, they have been collecting this information through a household survey.

TRaCK continues to work closely with the FitzCam project. This year, Marcus and Pippa will be among the first presenters to speak at a FitzCam-instigated training program on cultural and natural resource management to be run at the Karrayili Adult Education Centre in Fitzroy Crossing.

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Contact us

Visit www.track.gov.au

Phone +61 (0)8 8946 7444

Email track@cdu.edu.au

Mail Floor 3, Building 31, Charles Darwin University, Darwin, NT 0909, Australia

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About TRaCK

TRaCK was established in 2007 as a research hub under the Commonwealth Environment Research Facilities Program to provide the science and knowledge that governments, communities and industries need for the sustainable use and management of Australia's tropical rivers and estuaries.

The research consortium is led by Charles Darwin University, CSIRO, Griffith University, Land & Water Australia, the North Australia Indigenous Land and Sea Management Alliance and the University of Western Australia.

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