

Symposium Presentation No. 3

Management of temporary aquatic habitats in an agricultural landscape

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Note: this transcript is best read together with the powerpoint.

I pay my respects to the long-term custodianship of the Indigenous people of the landscape for millennia before white people arrived, to the Wadawurrung, the Djab Wurrung and the Keerray-Woorroong people who lived on the landscape and modified it to suit themselves but in the process retained a lot of its values for us.

I live on a farm in Western Victoria, just down the road near Lake Bolac. The farm I live on is a proper commercial farm. We grow crops, we grow sheep, and we needed to both recognise what we had and try and manage it. I moved there about 20 years ago and, because I'd been working on wetlands and water plants, I started looking at our local swamps and getting interested in how best to manage those. And [charophytesⁱ](#) are just a part of what I do.

I live in a landscape with a Mediterranean climate and seasonal [playa wetlandsⁱⁱ](#). There are few natural, permanent wetlands in my region. Wetlands are really important in this landscape.

The values of wetlands

The wetlands are important repositories of biodiversity and they provide habitat for a whole lot of organisms. The biomass of the different organisms in these wetlands is related to the diversity of the organisms in them. The most diverse things are the primary producers, the plants, and also the algae and the blue-green algae. Being temporary freshwater habitats, the swamps that I'm talking about have a really high diversity of plants and algae. These are consumed by herbivores - the bugs and tadpoles - and they in turn are consumed by birds, snakes, frogs and so on. And the whole system is driven by the input of water, sunlight and nutrients.

These systems are mediated by the amount of water and when it occurs, and that is mediated by rainfall and evaporation. Flooding drives all of the processes that occur in these wetlands; the germination of plants and algae and the hatching of invertebrates and

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the migration of frogs and turtles, snakes and water birds across the landscape. The wetlands don't look like very much and you might have driven past them a million times. But there's a whole lot of processes that are associated with these wetlands that are really important.

They provide a really diverse and interesting habitat. Pine Swamp is probably one of the ones that Sam Wallace used in her study (see talk by Don Driscoll). When it has water in it, it teems with life. These wetlands have high biodiversity values: there's about 100 species of angiosperms and other plants and 150 algal species (we haven't looked in very many of these swamps for their algal diversity but 100 species occur in Pine Swamp alone). There's lots of macro-invertebrates and lots of water birds visit them when they've got water in them. And they have all those frogs, a couple of snakes, kangaroos, and occasionally swamp rats. So a broad representation of organisms are associated with these wetlands.

And the wetlands have a number of ecological roles. For example, they have a role in pest control. To raise and keep frogs in a fish tank in the house you need to catch a whole lot of insects for them - they eat a lot of insects. I grew some frogs with my son when he was in primary school and, by the time they reached maturity, the swamp had dried out. So I had to feed them through the summer and into the next winter before the swamp filled up. And it was every day, getting out with a net trying to catch spiders and bugs and things that they needed.

The wetlands are important in carbon cycling. They act as a fire retardant; the western plains is one of the most fire prone landscapes in the world and swamps and wetland areas can potentially act as fire retardants. They are important for ground water recharge. And they have huge cultural values.

In 1835 the district was settled. How has it changed since then? Well, there's been extinction of many marsupials while some other mammals have increased and a lot of exotic species have come in. The soil conditions have changed as well. When Major Mitchell and his mob came through they talked about horses sinking up to their fetlocks in the friable soil and there being a lot of swamps and their way being blocked by swamps. So there's been a huge amount of soil compaction occur in the landscape. There are also higher nutrient levels now, particularly after World War II when superphosphate was introduced. Lots of topsoil has been lost through wind erosion in cropped paddocks. And rising groundwater due to clearing of trees and other perennial vegetation has increased salinity in some areas.

Responses of wetlands to rainfall cycles and management

I did a modelling exercise to see if I could use rainfall records to determine how often these swamps are filled. Local knowledge said that they fill seven years in ten. I wanted to check and see if that fitted with the modelling. Over the decades since 1918 when good records began, I found the number of times each swamp filled per decade. The time between 1918

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and 1927 was a time of some significant drought. As it was between 1998 and 2010. The records showed that the average number of times swamps fill each decade is about six or seven, but usually they're only dry for a year or a year and a half at a time. So they're reasonably seasonal swamps. The longest dry period in each of those decades was about two or three years. It's changing now. They are less frequently wet, they dry out faster and they're dry for longer. The seasonality is changing as well; sometimes they will fill in the summer which is quite different from the past.

To put this into a theoretical context using the state and transition model and a cup and ball analogy: In one model, when we change things we push the ball into another cup and it's quite hard for it to get out of that cup. That's a transition from one state to another state. And the second state makes it hard to return. The state and transition model is about changing the environment to a new state that will require a lot of energy to make it go back. Are we there? In model 2, the ball is in equilibrium. You can push a system upwards and outwards but it will roll back to a more stable state again. This may apply with the grazing of wetlands.

So, in a theoretical sense, that's what we're looking at in terms of change and wetland responses. Are wetlands capable of just returning when the pressure is off to where they were before, or have we put them into a completely different state where we'll have to put a lot of energy into making them return to where they were before?

Management studies of wetlands

The places I'm going to talk about are along the Wannon River and in the Western District swamps in the vicinity of Lake Bolac. This is a Mediterranean type climate with seasons; we get wet winters and dry summers. So most of the wetlands and even the streams are seasonal as well. That seasonality is changing, and the duration of wet times is lower than it was.

The Wannon River is a very seasonal river and it's very flat along its bed. It's probably a good model for a lot of the streams through Western Victoria in that they come off the mountains and spread out and flow across the landscape and into large swamps, then drain through steeper ground closer to the coast. When it's wet, it's full of life and when it's dry you can drive your car across it. And there's not much there to look at, no real channel. And yet it supports a whole variety of species. Including charophytes, sorry, I can't give a talk without mentioning charophytes. Two species endemic to the Western District wetlands that I've been talking about are *Chara karolii* and a species of *Nitella*. They are part of the diversity of the micro-algae that exists in swamps. And they all, of course, support those things that hop around. (It makes me so glad I work on plants because obviously you have trouble finding these animals again. Or even knowing what they're doing because they all behave in different ways and they make choices, whereas a plant is growing where a plant is growing. And you can go back and you can measure it again afterwards).

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We have several management systems in relation to these wetlands. Under Indigenous use they were grazed by kangaroos and emus and Indigenous people used fire. Broad acre set stock grazing by sheep and cattle began in places in about 1840. More frequently now, people are removing rocks and debris and getting rid of lignum and cane grass, and they're sowing pasture through swamps because they dry more often and they will grow pasture. And, more recently again, people are cultivating the soil and growing crops.

We could also just leave them alone and see what happens. Or we could modify the grazing regime to see if we can enhance biodiversity. I did the seed bank study on a crop in Scale Swamp (which is one that Mark Bachmann and Nature Glenelg Trust have now restored near Dunkeld). I found that it actually had some water plants in the seed bank. It had been cropped but because it flooded, the crop wasn't harvested; it was just pressed into hay bales which they stacked on the swamp.

Another site was on the Wannon River in an area that's really heavily grazed. It is a Gahnia Sedgefield. Gahnia grows tall and it's pretty unpalatable but you can feed grain to sheep and they will eat Gahnia as well because they require a bit more roughage. So it's possible to graze these things fairly heavily.

I'm going to talk about four investigations that I've undertaken over the last several years.

- The first was a vegetation survey and seed bank study of cropped and uncropped wetlands. Because I could see that wetlands were becoming cropped and I didn't have any answers as to what the consequences of that would be. I thought it was bad but I wanted to find out, so I did a seed bank and vegetation study to see if cropped swamps were any different or could recover after being cropped from ones that were uncropped.
- I was also funded to do a vegetation survey and seed bank study on the Wannon River, which is a river that connects the lower Grampians to the Glenelg River so it has the capacity to become a corridor between those two places.
- Part of that was a grazing reduction trial where farmers took their sheep off the floodplain when it was wet and then only grazed it when it was dry. And that was a before/after control/impact study.
- I was also employed to undertake a study on the incidence and extent of cropping in swamps. As you drive around the landscape you see people cropping swamps but how many swamps are being cropped - is it 1%, is it 10% is it more than that? So I did a study with Anthony, my husband, to look at how much is occurring and whether it's changed.

Study on the effects of cropping on seed banks in wetlands

In the first study we looked at the effects of cropping on swamp seed banks and we found that there is a difference. Cropping is a complicated process, you don't just put seeds in the ground, there are a whole lot of things that happen. It also affects the quality of the seed bank in the wetlands and it results in a reduced diversity and density of plants. But the plants in swamps have the capacity to put up with disturbance. So they retain some resilience to the effects of cropping.

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Farmers drive their machinery straight through the swamp. Of course it is dry when they sow the crop. In one example, the crop germinated and then there was a little bit of water and, because it was in 2011, then there was a lot of water. So that place was not acting as a swamp or a functional swamp very much anymore because it didn't have all of the capacity to respond to the flooding. But neither was it a very good place to put a crop. So that's basically what happens, when a cropped swamp is flooded. On one side of the fence you've got a *Poa labillardieri* wetland and on the other side you've got a fouled crop. So there are high risks involved with cropping swamps. Why would anyone do it?

Study of the effects of land use on the Wannon wetlands

The second study was the effects of land use on the Wannon wetlands where I had 19 sites all with different management and different managers. And when you're looking at linear things like rivers you can expect there to be changes that occur just because of the position in the landscape: the headwaters are going to be different from what's down on the lower end of it. There will be changes that just occur with the run of the river and it will be to do with species diversity (species that are differentially dependent on water), and substrate (it will be rockier up the top and sandier down the bottom), and potentially salinity input towards the bottom. So some species in the plant community did respond to the run of the river in the number and cover of salinity tolerant species and the number of structural species. You get more big plants further down the river, but more river red gums further up. There were some confounding effects in this study related to the run of the river, but there were also other things that varied in relation to channel characteristics (whether it was steeply incised or whether it was very flat and broad) and varied in relation to the land use around it.

Sites that were continually grazed throughout the study formed a discrete group of plants, independent of their location along the river. Sites that were ungrazed all the time also formed a discrete group; their plant communities were more similar to each other than other sites, independent of the location on the river. And those sites that were grazed in the dry season fell into two groups related to the intensity of grazing. If a site was lightly grazed, it formed a particular plant community. If it was heavily grazed, it formed another plant community. So land use does affect what occurs on the river floodplain.

I also looked at the seed banks in the channel, at the top of the bank and on the floodplain as well as along the seven sites along the river. There was connectivity between the sites along the river as you'd expect, but also across the floodplain. There was quite a degree of similarity in the species that germinated from the seed bank from in the channel to high on the floodplain. Which indicates that this particular system had a reasonably healthy flooding regime.

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Study of dry-season grazing on the Wannon River

In the dry season grazing study, the sites that had been grazed since the 1830s still had a functional wetland seed bank. But when we reduced and restricted the grazing pressure it improved habitat value in both the floodplain and the top of bank areas. The in-channel area remained relatively similar all the time, so sheep grazing on the in-channel area didn't make much difference to the sorts of vegetation that could establish.

Grazing is a fairly natural event, not always by cattle and sheep, but grazing has a lot of consequences and it's something that plants are adapted to. Generally grazing results in a changing plant community structure. So we can expect there to be detectable consequences for grazing in wetlands.

Study on the incidence of cropping in wetlands

The fourth study was about the incidence and extent of cropping in swamps. There were three questions that I can answer today: what's the current incidence of cropping in swamps, what were the consequences of cropping in swamps, and what are the future risks with cropping?

People undertaking the Index of Wetland Condition monitoring in 2011 found that about 1% of swamplands were cropped, using their methods. We looked at areas with high densities of wetlands (the heat map that shows the density of wetland with darker areas having more abundant individual wetlands in the landscape). The focus was on western Victoria. There are two other regions, associated with floodplains, one in Gippsland and one associated with soaks and riparian wetlands near Ruffey in central Victoria. Because we were looking at temporary wetlands where cropping was an option, we decided to keep away from those other areas. The areas we did look at in more detail were in the West Wimmera, the Eastern Grampians and Corangamite region around Warrnambool and Portland.

The land use map around the East Grampians cluster of swamps around Lake Bolac generally showed that mixed farming and grazing is the predominant land use. It showed that general cropping occurred in just a few sites, so the maps we had were inaccurate to say the least.

Because there were so many swamps in the landscape and we wanted to assess which ones were and weren't cropped and what proportion were cropped, we divided the East Grampians cluster up into grids and then randomly selected seven of those grids to give us about 500 swamps. When I say random, they are reasonably random: one landed on our farm and we thought that was just too close to home. Each selected swamp in those clusters was looked at using aerial images mostly from Google Earth. We assessed the status of the swamp in relation to cropping.

You can see what we do to the landscape from space. The wetlands GIS layer indicates the presence of wetlands, but they look different from the sky. The wetland polygons aren't completely accurate but they're fairly good, generally speaking. We could detect the

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presence or absence of cropping in the landscape. You can see one where there is no cropping at all. One has a dam in it, that's pretty typical. Some have been cropped right through; clearly it was dry enough at the time. Others have been cropped separately from the surrounding landscape; even though they may be bigger swamps with red gum trees around them, it's still a good place to put a crop. And some are cropped around the edges; perhaps it was wet at the time of sowing, or perhaps they value their swamp and didn't want to crop it. Some swamps have two different landholders, one who thinks it's a good spot to crop and one who doesn't. And some were only partly cropped.

We wanted to know what the incidence of cropping was, so we thought the best way was to stick a point in the middle of one of the grid squares and say how far is the nearest cropped paddock. That gives an indication of the incidence of cropping in the landscape, how much cropping has become just part of what people do in the Western Victorian landscape. And if you're used to driving through the place you'll know there are fewer sheep, more crops. People are taking out fences and trees and putting crop in.

So cropping has increased. Our assessment of this Grampians cluster showed that about 45% of all the wetlands that we looked at in those randomly-chosen blocks were cropped or had some incidence of cropping at least around the edges. And that's compared with the data collected in 2011 when just one swamp was cropped. So it's pretty significant land use change that's occurring in these areas.

Google Earth has a temporal feature where you can actually look at things back over time. In one randomly-chosen locality in 2012, the low areas are pretty much tadpole shaped with a long tail, the swamp. There's a little drain that removes the water from the tail area into the head part of that swamp. You can even see swans' nests from space, indicating that the swamp was deep enough to have nesting swans. You can also see fence lines, a dam and the tracks that sheep leave, because sheep are creatures of habit and they all walk in a line behind each other when they're going to water. You can see all this from space. In 2014, there was a change in land use from grazing to cropping, but they had left the swamps. In 2015, it was a bit drier and so they've managed to crop most of the swamps as well. And that's the sort of thing that's happening in the Western District swamp landscape.

The places where swamps are vulnerable to cropping is where there's high density of swamps in an agricultural landscape. Where the surrounding land use is pasture and/or conservation areas, there's a low probability that the swamp will be cropped. But where the surrounding land use is cropping, it's quite likely that the next thing to happen is that the swamp will be cropped.

Water source doesn't seem to impact. The water regime, well you can't crop a permanent swamp except when it's completely dry and that doesn't happen very often. If you've just got a temporary, intermittent or seasonal swamp it's quite likely to be cropped. People don't crop saline swamps. And it doesn't matter whether there's a drain or a dam or no modification to the swamp, it's still equally likely to be cropped or non-cropped.

Where vegetation condition scores have been made using Index of Wetland Condition, it doesn't make a difference to whether or not a farmer decides to crop it or not. So even what you call high quality vegetation is not recognised as being a hindrance to cropping. Really large wetlands are less likely to be cropped than small ones. But if the farmer has a conservation ethic then it's less likely to be cropped. whereas if they don't have a conservation ethic it's highly likely to be cropped.

The impact of cropping and the resilience of wetlands

The work that we've done and literature we've reviewed indicate that if you want to obtain a successful mono-culture, which is what a crop is, then you need to apply herbicide, remove impediments, sow seed, undertake cultivation and application of soil ameliorants. And this results in species death, targeted and non-targeted, habitat destruction and changed soil conditions. So if you're a frog there's nothing to shelter under and there's no reedy plants around.

With cropping, there is removal of the autotrophs, the primary producers, and an increase in detritivores. This is particularly apparent in the populations that inhabit swamps that are being cropped and then flood. We get a lot of mosquitoes and midges and not a lot of mayflies. There is a modified food web from what was an autotrophic system to a somewhat more heterotrophic system if the wetland floods.

But swamps are resilient, as I mentioned before. They have a seed bank that requires integrity - that needs to be complete and have all of its constituent parts to function properly, but they do have a seed bank. Because they're adapted to intermittently wet and dry conditions and all sorts of disturbances such as burrowing animals, some seeds are pretty resistant to being killed and will still germinate. Seedbanks can be easily demonstrated. You collect a lot of dirt and put it in trays, and lots of plants come up. That's what a seed bank does. And there's a huge diversity of species. If one species doesn't get established, another one will and maybe undertake the same role in the environment.

Grazing has an impact on individual plants, particularly with high grazing pressure. But grazing particularly affects the more abundant – and dominant – species and helps the community to maintain its diversity.

In a landscape where there's lots of swamps, with some of them in good nick and some of them in poor nick, there is connectivity between those swamps and so there can be migration of species. Frogs obviously get around a bit, fish not so much, that's why wetlands don't have many fish. But if you take some of those swamps out, you lose that connectivity, and that results in consequences for the animals that live in the swamp. If we just crop the edges of swamps (people are doing it anyway) it still reduces the connectivity because it makes them further apart from each other. If you remove a sub-cluster of swamps (which happens because different landowners own swamps), then you can remove some of the

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connectivity. The effect depends which sub-cluster you remove; if you remove all the middle ones, then you lose a lot of the connectivity.

Recommendations

So the recommendations in terms of retaining connectivity and retaining biodiversity values and retaining swamps are:

1. retain the water regime where possible and reinstate it if possible.
2. conserve the seed bank by just not wrecking it, and
3. control exotic species.

Possibly the best management of wetlands in western Victorian agricultural systems is grazing. To investigate that I'm currently taking part in a project called the Wetland Intervention Monitoring Program funded by DELWP and managed by ARI (see [here](#)). Catchment Management Authorities are facilitating the program by giving us contacts with farmers who own swamps. And our question is: what are the consequences of grazing differently, crash grazing or seasonal grazing or excluding altogether, on the biodiversity values of swamps?

The program is taking place throughout Central and Western Victoria so far. The trials are set up within a swamp where a farmer has a fence through it already or is willing to allow us to put fences up, and where they're willing to impose different grazing regimes. We're going to be checking the consequences of different grazing regimes on biodiversity values in these systems over the next couple of years. We'll also have time lapse cameras up there, which take a photo every six hours, so that we can get some estimate of the cover on the swamps and also get an estimate of the actual grazing intensity on those swamps.

I'm an independent consultant working on swamps, not exactly a common job, and I am supported by a lot of other people. Thank you.

Questions and answers

Q Has anyone done the economics for the farmers on whether or not they should bother. I mean they have to go in straight lines with their machines, we all know that, which is why they just keep ploughing through them I think, a lot of the time. So has anybody done some sums for them to say maybe it's not economically viable?

MC You're right, farmers are very responsive to economic conditions and it is certainly one of the things that lead them to choose to crop swamps. There are physical constraints and there are economic constraints and basically cropping is an option when cropping will result in a net profit. But sometimes economics doesn't matter. I see people removing rocks from their swamps, spending hours with a bulldozer and a digger and those things are hundreds of dollars per hour, thousands of dollars. And yet they do it anyway, partly because there's a motivation to clean up the place and make it all productive and partly because that's what they choose to do and they have got enough money to do it. But

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basically, the only lever we have on getting people to choose to crop or not under the existing physical and economic factors is whether or not cropping results in a net profit. And people keep doing it when it does.

The other motivations that people have for choosing to crop or not crop a swamp are more social and that's about social norms in a local district. It's about whether they value the flora and fauna, it's about whether they think it's going to result in damage. It's about whether it's against the law and whether that law is enforced. Currently all these wetlands are listed under the EPBC Act as critically endangered so it is against the law. But there isn't a lot of enforcement. So those are the levers we can pull on. I think economics is one thing, but social levers are going to be more important in trying to get people to modify what they do.

Q Michelle, with the land use change you said that's happening, is the CMA or someone else doing any planning on a regional basis, so the farms all acting as one on a regional area?

MC I'm a Board member of the local Glenelg Hopkins CMA which comes right up to Ararat. The Wimmera CMA is on the other side of the hill. The CMA is restricted in its activities in relation to government priorities. They get funding from state and federal government to undertake projects that are of value to the community as decided by state and federal governments. There's been quite a lot of lobbying taking place because these are in highly utilised agricultural landscape and they haven't been seen as having high natural values. They do but they haven't been recognised as such. So there's been a lot of work being done to highlight the value of these systems and to gain interest in funding these systems. Getting them listed as critically endangered was pretty handy. Having rare and endangered species in them is also handy.

And so yes, I'd say in the last four or five years, there's been a lot more interest and capacity from the CMA to undertake management or to direct funds towards management of these systems and towards getting people on board and recognising what they are. It's happening, but it's just like dragging your feet through mud, so to speak.

ⁱ Charophytes are six distinct groups of mostly freshwater green algae that are related to modern land plants.

<https://www.sciencedirect.com/science/article/pii/S016953470400285X>

ⁱⁱ Playa wetlands are seasonally and temporarily flooded wetlands at the low point in a catchment, often dominated by emergent plant species. http://forestandranger.org/new_wetlands/playa_wetlands.htm