Linking Waterscapes Symposium
Ararat, June 2018
Biolinksalliance.org.au

Symposium Presentation No. 2

Frogs in agricultural landscapes

Professor Don Driscoll

Director, Centre for Integrative Ecology, School of Life & Environmental Sciences, Deakin University, Burwood, Vic

Transcript edited by Dr Peter Mitchell, Biolinks Alliance

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

TechnEcology and the video trap

I want to start with a little advertisement about something that I'm involved in, with Deakin University. I'm leading a research network called the TechnEcology Research Network. It's a cross-disciplinary network that involves a bunch of ecologists, but we're also working with people from health, arts and education, engineering, IT and economics. Our goal is to generate a wildlife monitoring revolution that engages the community, but also has quantifiable benefits. And we aim to do that by taking new technology for monitoring wildlife and putting that technology in the hands of citizen scientists. This has two benefits. It enables us to collect data across broad areas where you couldn't afford to collect data using just a standard research funding grant, and it also engages people in the nature on their properties. By taking this approach, we expect to have benefits for nature conservation, through understanding more about where wildlife is in the landscape and how it's responding to the way we're managing it. And it will also have health, wellbeing and economic benefits for the people involved in those projects.

A quick example of the sort of thing we're doing in TechnEcology: we've engineered a video trap. You're probably familiar with commercial camera traps. They're triggered by infrared so that, when a mammal or bird goes past, it has a different temperature to the background and will trigger the camera, and you'll get a photo or a short video. I'm particularly interested in frogs and reptiles and they often have the same temperature as the background, so don't trigger those sorts of cameras. So we've built a trap that uses constant video, but has on-board smarts that allow us to delete the video with nothing in it so we don't have hours of video with no animals. It's a day/night constant video recorder. It doesn't have the thermal trigger. It deletes the video with no movement. It's customisable, so we can add sensors, we can get it to link to actions if something happens and we want something else to happen as a consequence. And it could be terrestrial or aquatic.

With the machine learning technology that we've got, we can identify what's inside the video. It's able to detect where the animal is moving and, with a little bit more work, we'll be able to work out what species it is that's gone past. We can already do the part about ditching video with nothing in it. The next steps for us are to automate species recognition and we're going to collect a big data set over the next few months, particularly focusing on reptiles and frogs, and we hope to be able to distinguish among the different species.

The other challenge, which I think is quite a big challenge and we won't solve it in this next iteration, is to automate individual recognition. And, if we can identify individuals in these sorts of videos, then there's capacity to do mark-recapture studies without ever marking an animal and that would be really quite revolutionary. So, the future applications are to automate wildlife monitoring, to engage the community in collecting data about their properties and then, through our networks, to be able to evaluate that engagement to say "did it actually have health benefits?" "what were the economic benefits of doing that?" If anybody is interested in automating monitoring on their properties or within their groups, have a chat to me about that.

Biodiversity and the intensification of agriculture

We are in a period of massive global change and this is particularly true for our biodiversity, where we see this close relationship between species extinctions and our growth in human population. These are not coincidental. With this increase in human numbers, there's growing demand for resources. The predictions are that agricultural production is going to have to increase by 50% by 2050. One way to achieve that, without clearing more land, is through agricultural intensification. So, that means trying to produce more crop from the same area. But we know that a lot of our wildlife live throughout these agricultural landscapes, so while you may be able to do that, what would be the cost for biodiversity?

A recent study by Egli *et al.* (2018) looked at this problem from a global perspective. They compared agricultural intensification level with the likelihood that a particular kind of species will persist in the landscape, given that amount of intensification. The study showed that forest-dependent species are quite sensitive to intensification and they'll drop off really quickly as intensification increases. On the other hand, species that regularly occur in croplands survive for quite a while as you increase intensification, but still drop off with very high intensification.

They colour-coded the combinations of the production gap across the globe. So, if there's a high production gap, it means there's likely a high benefit of agricultural intensification, but this was cross-coded with biodiversity lost. Their maps show that, where there's substantial incentive to intensify, there are also big consequences for biodiversity. In fact, if you intensified all the cropland that's available, you'd end up with a 37% loss of biodiversity, so the stakes are high at a global scale.

There's a real imperative to understand how our species are using agricultural landscapes, so that we can be forewarned – so we can know what the risks are and can figure out ways to solve it, like using these small farm dam bypasses mentioned by Nick Bond.

Frogs in agricultural landscapes

I want to present some results from three case studies, where we've looked at how frogs use some of these agricultural landscapes. I'm going to talk about two studies from New South Wales, in a fairly dry cropping landscape and in a mid-rainfall grazing landscape. And then I'll talk about a case study that we've done over the past twelve months on the frogs of the basalt plains to the south of here.

Case study 1

The first case study is Nicole Hansen's PhD work (see here). She looked at habitat use and movement in dry cropping farmland by frogs. She used eleven sites in NSW, spanning from Young across to nearly Griffith. Each of her sites had four transects that extended from remnant vegetation into an adjacent paddock, and she compared transects extending into four different types of paddocks: into a cropped area, into recently planted areas, into pasture, and into what we call woody debris (actually eucalypt mulch, so it's fine woody debris - the stuff that you feel fairly comfortable spreading onto your wheat paddock because you know you're going to have to plough it up afterwards). You don't really want coarse woody debris there). She surveyed before and after the crop harvesting. Each transect was four hundred metres long, and included a bunch of pitfall traps and funnel traps. We were also interested in reptiles in this study, but I'm just going to talk about the frogs, today.

The frogs didn't actually respond very much to that whole experimental design. They seemed to be pretty robust to what was going on in these landscapes. One of the significant results was with the high total abundance of frogs at the edge of remnant vegetation and in the farmland. The only real difference between treatments was in the plantings; there's some evidence that frogs accumulate or use plantings in this dry farming landscape.

The species remaining in these landscapes are robust, but there are also twelve species that are known to occur in the area, but weren't trapped at all in this study. It's possible that there's a lot of species that have already gone from the landscape and that the reason we didn't get much response to our study of frogs is that we're really just looking at the robust species that are left.

There were some other interesting idiosyncratic responses of individual species showing that some individual species are responsive to the way we manage our landscape. Smooth toadlets *(Uperoleia laevigata*) had higher body condition and higher abundance at the edge of the fine woody debris treatment. In a transect going from remnant vegetation into a paddock where we've added fine woody debris, these frogs have found a place at the edge of that where they're doing better than everywhere else. I don't actually know why they're doing better there than everywhere else. We need some more information. We need to know more about what the frogs were actually doing there. Where were they moving, what were they eating, what are their resources there? It's interesting that the manipulation of habitat provided this unexpected resource for frogs in that particular spot.

Another interesting result for the smooth toadlet was to do with how they responded before and after the harvesting. The key difference was that, in the cropped transects, where you would expect a before-to-after harvest effect, they actually had better body condition after the harvest. So these little frogs, in a paddock that's just been harvested, seemed to be doing better than they were before the harvest or in the other areas. We are talking about a pretty robust species in this landscape.

Case study 2

The second case study was Stephanie Pulsford's PhD work (see here and here). This study was slightly further towards the coast than Nicole's work. She worked in a higher rainfall area. It had smaller paddocks, it had more trees in the landscape, it was grazed, and it wasn't cropped. She also compared rotational grazing and continuous grazing, but that turned out to not really have a big effect on reptiles or the frogs in this landscape. Her design was very similar to Nicole's; she had four transects extending from remnant vegetation into paddocks of different kinds. And the four paddock kinds that she used were pasture, coarse woody debris (where she actually added firewood to the landscape), fences , and plantings. Similar to Nicole's study, I think she found only a few responses from the frogs, but the ones that she did find were quite interesting.

She found more uncommon frog species in remnant vegetation when it has longer grass, so that is when it hasn't been grazed a lot. If you graze remnant vegetation, it reduces the number of uncommon species back to about the same level as you would get in a paddock. The interesting thing is that, even if you have longer grass in your paddock, it doesn't have that same benefit for the uncommon species.

The other interesting result was that the total abundance of frogs was negatively related to distance to water. So, the closer you are to a farm dam, the more frogs you get. So, that's the answer for Nick's suggestion: yes, farm dams are good for these common frogs.

The model said there was a slight difference between remnants and paddocks in the abundance of frogs related to distance from water, but the confidence limits are really wide and we'd take that with a grain of salt. But, it's interesting to wonder why there might be this difference between the remnants and the paddocks. If that's a real effect, it might be related to the way frogs are using these landscapes.

Frogs breed in farm dams, then they head off across the landscape. And maybe there are different motivations among individuals. Some frogs go to remnant vegetation and, when they get there, they stay there. Remnants that are further away are less likely to get a frog arriving. Whereas, some frogs just seem to want to go off across paddocks, and they keep going, so you might end up with slightly more frogs further away from water in paddocks compared with remnants. So, a behavioural difference could be inferred here - an interesting one for another project.

Conclusions

So, key lessons from these two studies about how frogs use landscape elements. First of all, linear plantings are potentially quite important in that dry country; we didn't see a particular role for them in the wetter country. The frogs use the paddocks really frequently and that was quite a contrast to the reptiles, which didn't go into the paddocks very often. And, for some species, the frogs were better off in the paddocks. There's some evidence that they may accumulate along linear features, particularly along plantings. Importantly, remnant condition and proximity to water are important. And we think that there's a bunch of habitat specialists that might already be gone from these landscapes.

Case Study 3

The third case study was Sam Wallace's honours project. She did this with Anthony and Michelle Casanova. Sam asked "Do frogs care if their swamp is cropped?" Anybody already know the answer? Well, nobody said "It's obvious, do not waste your time doing this experiment". The swamps are on the basalt plains just north of Lake Bolac. There are lots of these little swamps all over the landscape, so obviously you'd expect this to be quite a good frog habitat. I remember, years ago, driving down to Lake Bolac at night, and I've never seen so many frogs on the road.

In these areas, there is pressure to increase agricultural production and we've seen, of course, almost the entire loss of the native grasslands that used to be across these landscapes. And there's increasing pressure to crop the swamps, so you can squeeze a bit more out of it. So, the questions that Sam asked were: Does swamp cropping influence frog occurrence? Do frogs need refugia near swamps? Does vegetation quality influence where the frogs are? And does the proximity to neighbouring swamps benefit frogs? If you've got a swamp that has a lot of swamps nearby, does that mean you're likely to get more frogs in that particular swamp?

I said to Sam: "What I want you to do is go and survey around a hundred sites, three times". And she went out and did that, so absolute full credit to Sam. It's a marvellous data set that she's managed to collect. She surveyed ninety-four swamps spanning an area around Lake Bolac. The sites also spanned a range of conditions; some swamps were in good condition with a bunch of native vegetation still in them, others were cropped and looked more like little muddy puddles. She went out at night-time, surveying each of these places for fifteen minutes and surveyed them three times. The great thing about surveying it multiple times is that you can take into account the detection probability. If you just go and survey once, you might miss it, even though it was there. If you survey it three times, you can actually model what the probability of detection was and take that into account, so you get a better estimate of occupancy.

Sam also measured a whole bunch of detection co-variates: date, air temperature, cloud cover, rain index, relative humidity and wind speed. All things which we thought might influence our ability to detect frogs. Then, she measured a bunch of variables related to the site. We wanted to ask about the proportion of the swamp that was cropped, to assess the effect of swamp cropping. We also wanted to know about the vegetation condition, so she measured the percentage cover of vegetation groups: bare ground, leaf litter, average vegetation depth. And she converted those to principal components, which takes into account the correlations among those different variables. And she measured a bunch of things about the surroundings of the swamp: the number of swamps within one kilometre, the distance to the nearest swamp, the number of refugia - stuff that frogs can get under like logs and old building materials, upturned cars and whatever else was within two hundred metres - and distance to the nearest refuge.

Five frog species were common enough for us to analyse individually. The nightly detection rate for the common eastern froglet (*Crinia signifera*) was 85%; if you go to a swamp on any night, you'll detect it 85% of the time on average. Nightly detection rates for the spotted marsh frog (*Limnodynastes tasmaniensis*) was 69%, for the southern brown tree frog (*Litoria ewingii*) was 67%, the common spadefoot toad (*Neobatrachus sudelli*) had only 33% chance of detecting it on any one night, even though it's there. And the pobblebonks (*Limnodymastes dumerilii*) were similarly only a 28% chance. If you look at the overall occupancy, common eastern froglets were everywhere, spotted marsh frogs and southern brown tree frogs were quite common. But, the spadefoots and pobblebonks were much less common across the landscape.

Coming first to detection. What are the things that influence the detection of these frogs? There was no effect of temperature, cloud cover or relative humidity. But, we did find a bunch of variables that influenced detection of some species. Nothing seemed to influence spotted marsh frogs; they were detected regardless. Date was important. We know that you don't hear frogs all year round; there's a particular calling season when you'll hear them. Detection of common froglets and spadefoots declined over the study period; we started the study at the peak of their calling season and then they were less inclined to call as the season went on. Pobblebonk detections increased, so they have a later calling season.

Pobblebonks were also influenced by wind speed and rain, so the higher the wind is, the less likely you are to detect them. So, perhaps they know it's windy and they're not going to waste their breath competing with windy conditions. Interestingly, they're also less likely to be detected if there's more rain within the past twenty-four hours. That surprised us because, if it's raining, you think frogs are going to be going for it. My initial guess is that pobblebonks are probably more active after rain, but maybe they're active doing stuff other than calling, making them less detectable.

Coming to the actual variables that influenced occupancy - what influenced where they are across the landscape, not just where we can detect them. We found no effect of the number of swamps within one kilometre, or the distance to the nearest swamp, or the distance to the nearest refuge. You typically expect the number of swamps within a kilometre of where a frog might be calling to influence where it is. But maybe, in this landscape, there are so many swamps at roughly regular intervals that there wasn't much variation in how far it is and how many swamps were within a kilometre.

But, there were some other factors that influenced some of the species. We didn't find anything that influenced the occurrence of the eastern common froglet because it is common and widespread. However, we also didn't find anything for the common spadefoot toad. It only occurred at around a third of the sites, so, presumably, it's responding to things other than the ones we thought frogs should respond to. So, somewhat enigmatic.

But, let's look at the results that are the ones we particularly wanted to test. The brown tree frog had a negative relationship with the percentage of a swamp that was cropped. So, the more you crop a swamp, the less likely a brown tree frog is going to be able to survive there. Agriculture intensification is going to drive declines of the brown tree frog.

For the pobblebonk, we saw a positive relationship with the number of refugia, so the more bits of stuff lying around a swamp, within two hundred metres, the more likely pobblebonks are going to be able to find somewhere to burrow and survive during the non-breeding season. So, refugia seemed to be critical for pobblebonks, and if you tidy up around that area, it's going to be less good for pobblebonks.

The occurrence of pobblebonks is also related to the vegetation axis, and it's highly likely to occur when you've got high rush cover, low herb cover and low bare ground. So when you've got swamps in good condition, you're very likely to get pobblebonks and, if that condition declines, then they're likely to disappear.

And for the spotted marsh frog, we see a negative relationship with one of the other principal components, relating to amount of bare ground, grass cover and litter cover. Again, meaning that high-quality vegetation cover in the swamp is important because you get high occurrence where you've got low bare ground, high grass cover, high litter cover.

As with the other studies, these results are based on the species that are still present. Species more sensitive to the changed conditions may already have been eliminated. This includes growling grass frog (*Litoria raniformis*, detected at one site only), southern toadlet (*Pseudophryne semimarmorata*), Bibron's toadlet (*Pseudophyrne bibronii*), eastern smooth frog (*Geocrinia victoriana*) and smooth frog (*Geocrinia laevis*).

Conclusions

The three studies show that vegetation quality matters, both in swamp and in remnant vegetation, frogs may use linear plantings more often in dry country, individual species respond to different landscape features, and structures and vegetation in the landscape matters for frogs.

But the most important take-home message, particularly from the third study, is that agricultural intensification, by cropping those swamps, changes the vegetation structure and that causes frog declines. Agricultural intensification is on the way across the world, and it could have an enormous impact on biodiversity if we don't plan for it. I finish by reiterating that there is an imperative to understand how our wildlife use farming landscapes so that we can put measures in place to ensure they continue to survive as farming practices change towards more intensive production methods.

Note: the Q&A session was held but not recorded after this talk

References

Egli, L. *et al*. (2018). Winners and losers of national and global efforts to reconcile agricultural intensification and biodiversity conservation. *Global Change Biology DOI: 10.1111/gcb.14076*. See here.