Transcript 3

Participants:
Simon West (SW), interviewer
Sam (SAM), a mathematician and population modeler in the ecology department at the University, and co-leader of the Wildlands adaptive management (AM) project
Val (VAL), a statistician and population modeler in the ecology department at the University, and co-leader of the Wildlands adaptive management (AM) project

Location and timing:
Interview conducted over Skype, about six months after the field trip

Transcript:
SW: So first of all, I just wanted to hear from your perspective how it has been over the last six months – what the process has been since we last met? Which I think at that stage you were beginning to think about putting together the report, but you hadn't met Robin [from the Authority] yet to discuss what the report would actually be…

VAL: Yeah, I think that's more or less where we left it. And to be honest we spent quite an intensive period to hand in the report, which was due end of September. Was it end of September Sam?

SAM: Yeah, we handed in the first draft to them on the last day of September, which was the official due date, and then we had a month where we held it open for a range of people to give us feedback and handed in the final version to them on the last day of October.

SW: Right.

VAL: So as you can see the last six months have actually been the last only three months of actual work on this.

SW: Right. And what happened in the meetings that you had with those guys? Especially the one in the summer. I think you had a meeting with Robin in July to discuss what would be in the report?

SAM: Yeah, so I guess that was the meeting that we had at the Authority in the city, Val?

VAL: Yes, yes.

SAM: So at that meeting I think we had worked together to make a skeleton draft of the report, with the headings, and discuss what kind of material would be in it. To

check that what we were producing for them was roughly in line with the kinds of questions that they wanted answered, and in a format that would be useful for them. And we got reasonably positive feedback at that meeting, but made a couple of adjustments as well.

SW: Yeah. What were the adjustments that you made?

SAM: Well the Authority has their own very particular way of thinking about adaptive management – so there's a particular diagram they have on their website, for example – and if you've got the report in front of you Simon, that'll be the one in the introduction – and so we had this other one by the researcher Michael Runge, the second figure in the introduction, that is a really good fit for the way that Val and I think about adaptive management, and I guess it's particularly focused towards people who do the quantitative modelling aspects of adaptive management. And so I think we were hoping to use roughly what was in that Runge report as our set of headings. But we found a way to use the Authority version as our main headings and then introduce the concepts of Runge's version beneath that [as] sub-headings. So we really got the message from them that it was fine for us to use both of these things, but we really needed to make clear that we didn't think the Runge one was better than the Authority one necessarily [laughs], but that they were consistent and complementary with each other and different ways of expressing the same ideas.

SW: Right. And what do you think were the main differences between them?

VAL: Subtle I guess, to some extent. I mean at the end the concept is the same. But they wanted to have – there was something about monitoring being, what was it? Part of management? While in Runge's diagram it's a block that has its place … So it's essentially the same thing, but there are some messages they want to push through the Organization, like monitoring is part of management, which maybe the other diagram is slightly better for that, but it's not really – I mean it wasn't difficult to fit what we wanted to say in their headings. What do you think Sam?

SAM: Yeah, I agree. So certainly what we heard from Leslie in person was that the message they wanted to push was that monitoring is necessary and integrated into several of the steps in the Authority diagram. Whereas I think it stands out as a separate clear entity in the Runge report. And I guess the Authority one, it sort of has – it squishes a lot of quantitative work implicitly into one box. I haven't got it in front of me right now, but there are three words: one is apply, one is adapt, and there's a third … Maybe it's analyse?

SW: Analyse, yeah …

SAM: And I think that kind of condenses a lot of the modelling work into one place where as we would spread it out and into a bunch of different compartments itself.

VAL: I think their diagram is probably more conceptual than the one in the Runge paper which really – it tries to set the steps that you have to actually do, in the order in which you have to do them.

SW: Sorry, Val, the signal just cut out at the start of your sentence there. Do you mind repeating the last…

VAL: Sorry, I was just saying that I think their diagram is more conceptual, and the one in Runge's paper gives us the steps that you have to follow when you're actually doing it. Yeah, in the order in which you have to do it, essentially. So that's why the analytical steps are more explicit in Runge's diagram.

SAM: I think … Yeah, just the one other thing I would say about that is perhaps the strength and emphasis in the Authority one is that it thinks more about the people involved in adaptive management. I think the sharing and the learning steps are very clearly about community consultation, whereas the way that the word 'learning' is used in a Runge context is more specifically about statistical improvements and refinements to your model.

SW: Right …

VAL: I think the Authority's diagram is a communication tool essentially.

SAM: Yeah, I agree.

SW: Communicating to …

VAL: Communicating with stakeholders, within the organization, and so on, while the Runge diagram is literally a diagram of the steps you have to follow to do the analytical part. As Sam was saying it's more concentrated on the analytical things.

SW: And what do you think are the main implications for the Wildlands project in those two different framings of adaptive management?

VAL: I think they suit their roles. I think within the organization they have to communicate these things, for Wildlands and for other projects that the Authority does with adaptive management. And the other one suited more our piece of the cake, which is … I mean we don't need to worry about communicating with stakeholders. It wasn't our role. So the other one fitted more what we were actually doing, I think. While the Authority's diagram is probably a good tool for them.

SW: Were you going to say something Sam?

SAM: No, almost exactly what Val has just said. We were in a situation where we were interacting with some of the managers, but a broader set of interests with respect to that kangaroo control programme were outside of what we needed to do. That was a stakeholder engagement job for other people within the Authority. And so yeah, we tended to concentrate on that more analytical component, whereas the Authority's job for the kangaroo project is that broader communication job.

SW: Right. And I was actually going to bring up a few of these issues in the questions so I'm just trying to figure out where I should go next … But one of the questions I wanted to ask was about expectations of adaptive management, and whether you felt different expectations with what you had going into the project and what the Authority had, and whether there were any mismatches or things that you had work out with regard to how you thought adaptive management should or would play out in that situation?

SAM: To be honest I have found it difficult to work out what their expectations have been. So I guess we have tried to – for example with that meeting in July or August – give them fair warning to see what we are going to do, to check that we are meeting their expectations or delivering what they are interested in, but the kind of feedback they have been providing for us in the past, sort of three to four months, has been vaguely positive, but not very detailed. So I'm unsure whether we have got it right for them, or whether we've got it wrong and they are quietly withdrawing, but not directly offering us criticism about it [laughs]…

VAL: Yeah I agree, and I guess we should also let Simon know that the Authority is currently going through a very strong restructuring and job cutting process, which is stressing them quite much, has grinded the organization to a halt in some aspects, because they are reorganizing who manages what across the state. And the people that manage the national park – Wildlands – are going to be different, they are going to be sitting in a different place. So that may have contributed to the fact that they were a bit more vague about things. Because first of all they have bigger worries than this project right now. Although they have said that this is still a priority and it is understood as such, but it, yeah, I guess it takes their attention to some other more important things like keeping jobs and so on.

SAM: Yeah that's absolutely right, and we have witnessed that in our interactions with them I think over the two and a bit years that Val and I have got to know these people, that if you had – I imagine when we spoke at the time of the fieldtrip, Simon, that I felt very optimistic and positive about this project, and about our potential to have some impacts for the management organization. That was around the time that the situation changed within the organization, so probably our three key contacts were all unsure whether they would still have jobs at the end of this year. And so they had a lot of personal stress for the remainder of the year, and in fact one of those three people is someone we have lost contact with now who has been shifted to a different

part of the agency. So yeah, I think that has really impacted on this project and the potential for this project to have impacts in the next year or so. They're sort of pausing or even taking a step back at the moment, and hopefully this time next year they will have a new structure and be into the swing of things and be ready to reconsider this kind of work.

SW: So was that … I was interested to hear how you left it in the meeting you had – was it yesterday? – and what state the project was in, so maybe it'd be a good time to talk about that.

SAM: Sure, so I think at the meeting yesterday they did express interest in us taking this work to that regional office. So the place that is a bit closer to Wildlands than the city office, where decisions will be made about the kangaroo programme, but – so they need another month or so to figure out who the person is who will be in that role longer-term, and so once their restructure is completed and that person is comfortable in their role, that we will travel out there, give a presentation, and discuss this work in more detail, and to share the value of our work with them. And we also talked a bit about the potential for future research projects – so after we get a bit of feedback at that meeting too, we'll probably be writing a two-page project description for potential future funding. Things we have just ready, sitting in the drawer, waiting for that moment when funding opportunities arise in the future.

SW: Right, and will that be … Sorry, Val?

VAL: No, no, carry on …

SW: In regard to the personnel responsible for the project, will the people that you were dealing with, have they all been removed from working within the sphere of this project?

SAM: Our two contacts at the Authority's city office seem to continue to be part of the project, but the particular champion that we had out at the regional Authority office nearest Wildlands, Taylor, their role has changed completely, so we've lost contact with them.

SW: Right. And you mentioned there was going to be a new entity responsible for Wildlands management, is that right?

VAL: It's a new structure. So the Authority is just getting a new structure, so for example the focus will – there won't be an office specifically for the Wildlands region, but I understand it's a bigger area, and the central office management is going to be further away from the Wildlands region than it is now … So I was saying before that this whole process what there are going through and what we are witnessing is quite an interesting example of this aspect of adaptive management. That adaptive

management requires time – a very long time, sometimes – and it requires some sort of institutional stability, otherwise you get these sort of blips where everything can be dropped and just sort of thrown away. Hopefully not, but yeah.

SW: Yeah. So just going back to the process over the summer again. So you had that meeting in July, and you had that feedback about the adaptive management structure, and then what were the next steps after that?

SAM: We just pulled it out as quickly and as thoroughly as we could [laughs]. Yeah, there were bits that we had reasonably well prepared beforehand. So for example we knew that the objectives and some of those early sections would come from the workshop that we had held very early in the project. We had good conversations around the time of fieldwork to start writing up that vegetation monitoring section, and I had additional conversations with Logan and Alex as I was working on that section. And you'll see that there are two vegetation reports that I draw on heavily in that bit. So those were kind of my main sources for writing that section. Leslie said something really useful in the meeting with the Authority, sort of like a hierarchy of monitoring, and so that was something I worked on a little bit, the five different purposes of monitoring. Yeah, Val spent a bit of time on the catch-per-unit-effort stuff around then, you might want to talk about that?

VAL: Yeah, this was the first year where we had data on the culling process that included the time they take as breaks between the cull. So we could actually apply this catch-per-unit-effort approach for removal sampling that Jackie and Blair had proposed, where as you cull you can still refine your estimates of the population abundance, so I was analysing this year's data, the culling data, using that just as a test, or showing how that could work. And that highlighted the fact that for that to work properly – the assumptions of that sort of modelling to be met – they may have to change that culling protocol. And that's something that they'll have to consider, and it's definitely not the best time to propose changes to things now because of all these processes and the uncertainty in the organization. But yeah, they eventually will have to think about this. And that's something we highlighted in our report.

SW: In what ways would it need to be changed?

VAL: Essentially leaving a bit of time between culling nights, consecutive culling nights. Now they just do four in a row and that's it. So they hire some professional shooters, they come to the Park, they spend four nights until they reach the quota and then they leave. And ideally they would come one night, and then, I don't know, maybe a week later come again, spend one night, but that has bigger costs, essentially.

SW: Right, and it's the costs and the hassle that you think would be a stumbling point for doing that kind of work now?

VAL: I think right now they can't consider proposing any changes at all because they don't even know who is going to be there. And so it's just out of the question. And then changing procedures, I guess, has some process, going through all the official documents … But they will have to think about it, because otherwise the estimates, the refined population estimates, may not be very valuable.

SW: Right. And I'm just trying to figure out how to use the rest of your time, because I've got a bunch of questions on the catch-per-unit-effort model, but I might come back to that later and just follow the process through to the meeting with Robin first, and then we can delve into some specific questions about the report, maybe, if that sounds good?

SAM: Yeah!

SW: So you had another meeting I think, after you'd had that meeting with Robin and gone back to the report to try and produce it, there was a process where you presented the report and had a stage of feedback, is that right?

SAM: So we submitted it to them electronically, and then we had a month where everyone was permitted to read it and provide feedback. So there were no in-person meetings at that point.

SW: Right. And did you get much feedback in that month?

SAM: We got a little. So Robin gave it a read through, and clearly thought about it carefully, but didn't offer any major structural changes or anything like that. Most of them were small corrections and a few nice suggestions for alternative ways of wording things that were more consistent with the way people thought in the Authority. Using terms or encouraging us to bring in real examples that would help an Authority staff member to read and understand the report. So it was very minor corrections and a few suggested rewordings. And we had feedback from some other people as well, so for example I think from my perspective, Morgan– who is a researcher within government who wrote one of the key vegetation reports that I cited. I had the good luck to meet Morgan at a conference during September, and sent the report, and Morgan gave back quite detailed and thoughtful comments about the vegetation monitoring aspects that were in there, that I was extremely grateful for. Sort of about Morgan's in-field experiences and about the traditions of vegetation sampling, and how they fit together.

SW: Right, and what kind of things did Morgan suggest?

SAM: So, I guess there were a few bits where I had cited Morgan's report, and it was good to have it checked over by them that I was interpreting their work correctly. And in fact in one place in the original draft I had said that authors of that report *may* have

had this particular hypothesis – so they were making recommendations about when monitoring should occur, and they said, "aw, it should be regular, at least every five years, and additionally, under a certain set of weather circumstances," I think it was good autumn rains, or something like that – and I made this interpretation that they had a hypothesis that there would be more seedling recruitment at that time, and Morgan was able to confirm that for me [laughs], that my assumption of what was going on in their heads was right. And I guess there is also a couple of different ways that you could advise people to run a survey, about how you chose sites in a landscape, and I think it depends on which purpose you have, as to which site selection is the one that you want to do. And I think Morgan and I maybe at the end of it didn't one hundred percent agree with each other, but I think we understood each other well enough. And I felt more comfortable and confident in my interpretations after having Morgan look over them. Yeah.

SW: And what was the key difference there?

SAM: I think the key difference is whether you select sites completely at random within the pine-ironwood woodlands, or whether you select sites specifically to capture some of the seedlings that are already there. And I think your choice between those two things depends on what you purpose is. So if you care about all of that pine-ironwood woodland, and you want to understand what the overarching state of that entire woodland is, I think you need to pick sites at random across that landscape. And the reality is, as I think we saw in that fieldtrip in April, is that if you go and do that you probably won't capture any or many seedlings at all. They're quite rare in that landscape. But if you want to understand the state of that entire woodland, then that's what you have to do! The reality is that there are very very few seedlings there at the moment. But by contrast, if your purpose is to understand something specific about the seedlings, then you probably want to bias your sample. So you're not sampling at random across that landscape, but you're making a selection towards the places where some seedlings exist at the moment. And I think Morgan's perspective is coming from that angle, that's what Morgan sees the most value in. And there's good reasons for that, because they are researchers and the seedlings are what we want to see long-term success in, so that's where they wanted to concentrate.

SW: Right. And did you have a different perspective from an adaptive management perspective?

SAM: Yeah, well I think if we were able to draw out some good hypotheses about seedlings, that might very well be the right thing to do. I just think that what is in our report hasn't got to that stage yet, where the specific alternative hypotheses have been articulated yet.

SW: Right. And I was interested the last time we spoke before I came back to Sweden, you were talking about the process that was coming up of writing the report,

and you thought it was going to be tricky to draw everything together in a coherent framework for the report. And I wondered whether you felt that you managed to do that in the end?

SAM: Yeah, I think that there were indeed difficulties. Val and I had several conversations about: "what are the alternative strategies and what are the actions?" So, is the action simply 'choosing a kangaroo quota' or is it the more nuanced rule that you use to choose the quota? So, yeah, Val has written a nice list in that report of the different ways that you could be running that program, and so yeah, there were a few grey areas like that where we weren't sure which heading to put some of the material under, but I think we managed to get everything in there that was important to us, and found somewhere that was reasonably logical to put it, even if there were two or three potential places to put those things. I think Val's work on catch-per-unit-effort was important too, where we knew it needed to be in there but we weren't quite sure which heading was the right place for it. But the 'alternative actions' section, the 'deciding on actions' section, the 'implementation' section – I guess because this is in some sense a modelling project, those three sections were a bit vague for us and open to interpretation as to what went where.

SW: Right. Because I was interested that the report is providing in some sense an adaptive management framework for the Authority, but it is also structured, like you say, in this adaptive management framework, tracking your activities. So the catch-per-unit effort is your implementation stage. And this was something that I was going to bring up later on – whether you'd found that slight shift a tricky thing to manage in that report?

VAL: I'm not sure I follow, could you say it again?

SW: Yeah, so the way I was reading the report is that you were providing an adaptive management framework for the Authority, for them to structure their activities and their management structure going forwards, but it also seemed like you were interpreting your activities also within an adaptive management framework. So for instance fitting the catch-per-unit-effort effort model within the 'implementation' phase. I was wondering whether that was a tricky thing to manage in that you were providing a framework for adaptive management framework but also interpreting your activities within an adaptive management framework. I don't know whether that makes sense or not?

SAM: I think I at least half get what you're saying! [laughs]. And I think for me, because I had experience with adaptive management concepts prior to this project, it was very natural for me to interpret my actions that way throughout the process, and to continually question myself, or our activities, and ask "how is that contributing to this project?" and "how does it benefit that adaptive management process?"

SW: Right. And to wrap up that process of feedback and producing the report, I just wondered if we could go back to that meeting that you had yesterday with Robin, which I imagine is a kind of endpoint of the process in a way, or a waypoint in the process. I just wondered if you could describe what happened in that meeting? We've spoken a bit about it already …

VAL: OK, so Robin gave feedback, Leslie hadn't really had much time to look at the document carefully. And I guess Leslie is under quite a lot of stress at the moment with all this restructuring. And Robin gave useful feedback but it was generic, so not specific to the structure of the report or specific questions, from memory. And then we talked about the difficulties of implementing these things right now, with the uncertainty in the organization. And then at some stage we sort of talked about – as Sam mentioned – that we could think about having new research agreements to continue some of the specific aspects of the project, like setting up a monitoring scheme for specific vegetation that serves the purpose of the adaptive management project and things like that. But we all understand that, as Sam said, it's gonna have to wait at least a few months, probably more than a few months. So I think that was pretty much the process yesterday, because we couldn't really – they couldn't really commit to anything right now, essentially.

SAM: Yeah, I think there was implicit agreement at the meeting that report was completed and this specific project had run its course. But Robin is very keen for us to travel out to the regional centre once their restructure is finished to communicate this work to them and hopefully that they can see the importance of this into the future. So yeah, that aspect of it has been left open – about how to communicate this and how to work towards adoption in the future.

SW: Yeah, it's interesting to me reading the report, the options that are laid out. There's quite a few different ways that you could move forward from this point, and it's not – to me it doesn't seem to prescriptive in that sense, it seems like there are a few potential avenues you could take. I wondered whether there was much discussion yesterday about particular next steps? You mentioned the monitoring regime just then …

SAM: Yeah that's right. I think one of the things that Blair in the research team [at the University] is keen on, but also Leslie and Robin at the Authority see value in, is continuing down that path with the vegetation monitoring and working out a protocol on the ground for what that might look like. What ongoing vegetation monitoring might look like for the Authority. So that would involve a researcher who is well-versed in the vegetation monitoring design and counting methods on the ground, but it would also require commitment from the Authority that they have staff on the ground that are ready to be trained and ready to do this, and that the Authority might have the capacity to continue that monitoring themselves into the future. So there might be a

small research project for a year or two in that kind of work. The second thing that Leslie expressed interest in is issues of remote sensing data, so estimating the grass biomass, which is a key issue for the kangaroos. You know, depending on how much grass biomass there is there might be enough grass that they don't eat the seedlings at all, or if grass biomass is low then they will tend to graze on the seedlings, and that's when we might have problems. So sort of using satellite imagery and analysis and that kind of thing to understand the state of grass biomass and use that to help decide the kangaroo cull quota. That was the second path that he expressed interest in.

SW: And would the first half … I just had a couple of follow-up questions with the vegetation monitoring … And would that be designed to feed in to the decision about whether to cull or how to cull?

SAM: It would feed more into the bit about: "are we meeting our objectives successfully in the long-term?" So at the moment they have this system where they make decisions about the kangaroo cull based purely on the estimates of the kangaroo population size, which is OK as far as it goes, but they don't – the whole purpose of this programme is to improve the vegetation – and they don't have consistent monitoring through time to witness whether the vegetation is improving or not.

SW: And I was also going to ask what kind of monitoring that came under in terms of the five types of monitoring that you mentioned in the report?

SAM: Yes. So the vegetation monitoring would be the one that's about objectives. Yes – 'monitoring outcomes' is what the heading is.

SW: And so these things are up in the air in a sense, I guess, at the moment, until you and Val take your work to the regional centre next year at some point?

SAM: Yeah that's right. They just need to get their own house in order and regroup after the restructure. At the moment they're just trying to get through this season's cull, which I think is occurring next week. And if they manage to uphold the standard that they've had in previous years then I think that will be success enough for them at the moment, yeah.

SW: Right. And what do you think influences their decision to pick 'monitoring outcomes' as compared to the other four [monitoring] options there that they could potentially pick?

SAM: Mm, yeah. I think – well it's clear that they are doing 'monitoring operations' very well already. And they already – they have, for point four, 'monitoring to trigger future actions,' they have something in place at the moment that does that for them. So yeah …

SW: And is this Jo's kangaroo population survey and the Rainfall Model?

SAM: Exactly right, yeah. So they already have that. They have something that could be improved upon but something that does that already for them, so I think that's two of them down. Out of the other three, 'monitoring response to operations' is something that I think probably came up quite late in the project. When we had that meeting in July or August that's the first time that that concept had arisen for me, specifically. And so possibly that one just hasn't been explored by the group in enough detail yet, to evaluate whether it's worthwhile or not. And point five, 'monitoring to test model assumptions,' that's the sort of more aspirational or more future part of adaptive management as far as this group is concerned. Like 'monitoring outcomes' is right in the middle there. They're doing a great job at number one, none of us have really thought about number two really enough to work out its value, number three we know that they're not really doing it at all, and they should be, so that was kind of where we landed I guess in this project.

SW: Right. And I was interested in the role of practice in the project, and how activities get chosen – I think Logan mentioned it once when we out that he'd noticed that in general that the Authority activities or management actions get done because they've always been done, and they know how to do them, and I wondered whether you'd experienced that in the project? Whether there was this reluctance to change practices and to follow these more traditional practices that they already do?

VAL: I think Leslie and Robin have mentioned a couple of times that the staff on the ground in Wildlands are actually keen to change the system by which the quotas are currently calculated, because they have that feeling on the ground that it is not working to actually change kangaroo populations. So they've said that to us a couple of times. So in that aspect there would be support, but again, Robin and Leslie have mentioned a couple of times also, when there was discussion about changing something, that changing things is difficult sometimes. So I don't think we've experienced that first-hand, because the times we've been dealing with the site staff, it's been quite – I mean they've been showing us around and so on – but we haven't really been trying to force ourselves, you know, trying to force changes on the way they are doing things ourselves. You know, we make recommendations to the Authority and then it's up to them to take them, so I don't remember seeing this opposition directly. But it is true that Leslie has mentioned a couple of times that changing some things in protocols are, can be a bit difficult.

SAM: Yeah that's right, that's a good reminder. I guess one of the challenges is that this is a system that is highly variable from year to year. Most years we'll get very little rainfall, some we may have a drought, occasionally there'll be big rainfall events, and it's very natural for a kangaroo population to bounce dramatically up and down as a result to those conditions, and yet they have – their budgeting system is not very adaptable. So each year they ask for a certain amount of resources to get the job

done, and there's no extra money for them to draw from really, and if they don't use it all up by the end of the year it disappears. So the idea of saving up resources for a crucial year, and then low use of resources in other years, is not something that's really accommodated by the budgeting system in the Authority. So that's a challenge for the way that they go on. And I absolutely agree with what Val just said. Robin especially, and also Leslie, have repeatedly said through the project that the mood in the national park is that they want to see change and improvement in the kangaroo programme. I get the impression of the culture there though that there is a bit of a disconnect between the strategic level versus the on-ground level: that the frustration for the people on the ground is that they want the process to move faster so that they can act more quickly. They are very action focused – they want to perform the cull and they want to get on with it, where as at the strategic level, they feel that they need more monitoring so that they can justify their actions. So some of what we've come up with, so for example we spent a lot of time on that monitoring outcome, which is the vegetation, and that we think an adaptive management programme like this needs very careful justification and tracking of that vegetation, and I don't know whether people on the ground will see value in that. They might feel that they are just going out and measuring things when they want to do something more active.

SW: Yeah, sure. And you think that search for justification is one of the main motivators of the Authority to engage with this adaptive management project?

SAM: Yeah, I think they see that need to be seen as accountable for the work that they do. So at that strategic level, they see that if they are going to be carrying our actions, they need to demonstrate that those actions are the right thing to do, and they're seeing the positive environmental outcomes that they intended.

SW: Yeah. I wanted to ask about uncertainty, because when I was reading your report to the Authority uncertainty comes up a lot – obviously, being adaptive management – but I found it quite difficult to conceptualise because it seems quite intangible and quite difficult to grasp. And I was wondering firstly how you guys think about uncertainty – I was reading the Michael Runge paper that you cite in the report, where he is talking about the value of information analysis and stuff like that, and he talks about uncertainty with the 'known unknowns' – and I was wondering whether that was a way that you conceptualized uncertainty within the Wildlands project or whether you were conceptualizing it in a different way?

SAM: Yeah, that sort of system that Runge would have written about would be very similar to the way that I would have been educated in adaptive management, and the way that I tend to think about things is, yeah, it's very easy in a project like this to get overwhelmed with all the things that we don't know and we can't specify perfectly, and that Runge approach is about getting specific and rather than saying 'we don't know,' what are the different possibilities that could be happening? And articulating that carefully for ourselves. So for example, we don't know – maybe we don't know

enough about seedling recruitment in Wildlands, and it's like, "well, what are the possibilities?" Maybe seedlings are germinating every single year, but they're getting grazed. That's one hypothesis. A second hypothesis is, "maybe the germination conditions are very rare, and they're only germinating every five to ten years." That's a second scenario about what is going on. And I'm sure if we got the right experts to hand they could draw up a dozen different stories like that. But maybe we could, you know, get down to three or four crucial possibilities, and really carry through carefully what the implications are for those and draw up an adaptive management plan that took those into account quite explicitly.

SW: Yeah, it was interesting you just mentioned those kinds of uncertainties in regard to the intricacies of the budget and the financial capabilities that the site staff have on the ground, and how they structure their monitoring activities and their culling activities and so forth. Because as I was reading the Runge paper I was trying to apply it to the Wildlands case and see how you might think about picking relevant uncertainties at Wildlands. And I found it interesting to think about, you know, if you're picking a particular method to monitor, how you would take into your relative capabilities to monitor that thing over the long-term and how you would think about what you could use that information for in the Wildlands case?

SAM: Yeah, if I understand you correctly that's kind of what I'm playing around with in trying to write an academic paper about this – is sort of, if we do have a crucial uncertainty about when it is that kangaroos shift onto woody seedlings, do they eat them all the time, or is it rare situations that occurs? And what does – how do you make a good culling decision? Taking into account that uncertainty and also considering different monitoring regimes. So we know that they're great at monitoring operations, and they're not monitoring anything about the outcomes at the moment, what can we expect to play out in that situation? And if they are monitoring outcomes, what improvements could they potentially be making if they did that? So in a very simplified modelling context I'm playing around with those possibilities at the moment.

SW: Right. And I wondered if you could just clarify a couple of things in relation to the language in the section where you talk about uncertainties in the report. I've just noted down here that on page 27, in the 'sharing and learning, updating models' section …

SAM: … that was probably me I think, Val?

VAL: Yep, I think so!

SW: … you mentioned that uncertainties should be conceptualized as "worded alternative hypotheses describing different action-consequence relationships and alternative action-consequence equation structures representing different possible

mechanisms, or probability distributions describing uncertain parameters in a known action-consequence equation." I wondered whether you'd be able to explain that in terms of Wildlands – what that would mean in a practical sense?

SAM: Yeah OK, so I guess worded alternative hypotheses is very much like what I was saying before. So we might have different ideas about how seedlings – what the seedling dynamics are in this system: "Are seedlings germinating – are our woody species germinating every single year and then getting grazed down to nothing or are they germinating only occasionally?" So that's – we could sort of write worded alternative hypotheses like those and perhaps get into more specific ecological language about that if we had the right ecological experts in the room. The second, 'alternative equation structures,' that would be thinking about what the mechanisms are – rainfall, for example. So if seedlings – maybe we'd have a structure where the germination of seedlings depends on sufficient rainfall, and that number that is 'enough rainfall,' is different for each of these different seedling scenarios. So if seedlings are germinating every year, or most years, then the rainfall threshold is very low. Rainfall only has to be bigger than a very small number in order for regeneration to occur. So we could write an equation that says that. And then the second alternative is that the threshold is high: seedlings only germinate when rainfall is high. And we might be willing to put a number on what 'high' is. Like two hundred millimetres per year, or something like that. And so then the final bit of a probability distribution describing an uncertain parameter, I guess the case I just described is one where the uncertain parameter is, 'what's the crucial rainfall threshold?' And we might not know what that rainfall threshold is, and we could draw a probability distribution to describe our belief in that threshold. Yeah, so, we might think that – if we have absolutely no idea, that distribution might look flat, that any rainfall between zero and three hundred millimetres per year is equally likely. I think we probably know a bit more than that, we might be able to get a bit more specific, but just as an example.

SW: Great, thanks for that. And the other point of clarification was a bit further on, on page twenty-nine, where you talk about "where uncertainty has been well quantified as a set of belief weights, then Bayesian statistics can be used to integrate disparate sources of evidence such as data, models and expert opinion." And I was just interested if you could just give an example of that in terms of Wildlands as well? And especially the terminology of belief weights because I haven't really come across that before …

SAM: OK yeah. So belief weights is this idea that if we have different alternative hypotheses, one, we need to state clearly what those different alternatives are, how they work. So 'seedlings germinate pretty much every year,' versus 'they germinate rarely.' And in order to come up with recommendations in an adaptive management framework, we need to attach a belief weight to each of these. Because a belief weight will show our learning over time. If we have no idea which of those two hypotheses is true at the start, we might attach a fifty percent belief weight to each of those two

options, because they're both equally likely and we have no idea which is true. And then as we collect data in the system over time, that data will give us hints as to which of these two things might be happening, and so we can use a statistical framework to say, "well we have witnessed this in the past year through our monitoring, and it gives slightly more support to the rare seedling hypothesis compared to the common seedling hypothesis." And there are statistical ways of updating those belief weights. So we might tip from a seventy percent to a thirty percent case, and that's a way of tracking through time our collection of data and what we're learning from it. How it's helping us to tell the difference between those two hypotheses and get at the truth in the long-term.

SW: And in regard to using different sources of evidence, and you had those three things, in theory if that was to happen and you did have this kind of set-up [in Wildlands], would you then be having to apply weightings to these different sources of evidence as well? So which ones would be worth more in the analysis …

SAM: Yeah that's right. And usually with scientific, on-the-ground monitoring methods, usually you can do that. The appropriate weighting arises out of the approach you take – we know that if we only take a small number of samples then our work will not be very precise, and if we take a large number of samples then our work will be more precise. And so there are statistical ways of working out what the appropriate weighting is based on the reliability of the data that you collect. And when it comes to eliciting information from experts, my understanding, from some of the social scientists in our research groups, is that there are ways of quantifying the uncertainty around people's expert knowledge as well. And I know a little bit about how to obtain that information from people but not a lot. So the really important thing – I haven't got that sentence in the report in front of me right now, but it was something about 'well-described expert elicitation' I think – yeah, so expert knowledge needs to come in in a very particular way so you also have those error bounds around it and have a sense of the error bounds around the expert knowledge. And when you have those the relative weight to put on data versus expert elicitation comes out of that for you based on those error bars.

SW: Yeah. And in a practical situation would a bigger error bar mean that someone wouldn't implement a particular action? Do those error bars translate into …

SAM: Yeah, so bigger error bars translate into a lower weighting when you are weighing up the evidence, I guess. Whereas narrow error bars indicate that you are quite sure that this is reliable, and therefore it has higher weighting and higher influence on your inference. Yeah, what you actually follow through with your actions depends on your whole system – your objectives, and what is the best outcome based on that overall weighted system.

SW: Yeah I was trying to get my head around how that conceptualization of uncertainty would enmesh with uncertainty of the actual practices in the management regime. Say for instance the stuff that you've told me just now with the restructure and things like that affecting what kind of monitoring and what kind of management is actually possible. And I was wondering whether – I mean there's this idea that adaptive management progressively reduces uncertainty over time, and I was wondering whether you still can conceive of that in this project? You can conceive of uncertainty being progressively reduced over time …

VAL: … Simon, really sorry but I think I'll have to drop – I have another meeting at uni…

SW: No problem at all, thanks for taking the time, it's really appreciated, and I hope you have a good holiday period as well.

VAL: I'll try. Same to you and good luck with processing all this information! And let me know if you need any further clarifications and so on.

[Val leaves]

SAM: Yeah, so I think when people talk about adaptive management reducing uncertainty, or at least within the research world that I'm familiar with, they're thinking specifically about, I guess, scientific uncertainties within the system. So things like this ecological process of seedling recruitment. We don't know a lot about it at the moment, but we can conceive of experiments and ways of managing that system that would give us information and allow us to learn more about that ecological process. But there are other kinds of uncertainty too. And we've talked about these institutional uncertainties with regard to who is managing this kangaroo project and what are the budgets going to be like from year to year, and those are different kinds of uncertainties that adaptive management is not necessarily going to be able to reduce over time. There is institutional stuff at play at the Authority that we're not going to get around – if we could define them well, there's potentially the possibility to take them into account in the decision-making process, I mean you could build into the model, in theory at least, "hey, there's a twenty percent chance we'll have a high budget this year, there's a thirty percent chance our budget will get cut dramatically, and you know, the remainder is that our budget will stay roughly the same." And you could sort of build those possible outcomes into the decision-making process as well. But yeah, there's these different kinds of uncertainty at play. Some of which adaptive management is well-equipped to reduce over time, potentially, and others which it can try to accommodate but realistically we cannot really reduce over time.

SW: Right, yeah and I wanted to talk a little bit about the list of the important questions that you have – the questions that you envisage will affect the capacity to

manage effectively at Wildlands on page twenty, I think. And it seems like – well, I was wondering first of all, where do you approach that list from? How do you choose a question to address? You mentioned the value of information analysis as a tool that you could use, and I was wondering whether – well it seems like you'd need to know quite a lot about those questions before you can do a value of information analysis, in some ways …

SAM: In some ways, yeah, I guess that's true. So I guess you could perform a value of information analysis on any one of these six things at a time. If you were a courageous modeller you might try and put more of them into one model, but yeah. I guess the idea is that, as we talked about before, articulating those alternative hypotheses really carefully is the key thing you'd need to do to perform a value of information analysis. So, point one there is about, 'under what conditions do mature pine and ironwood trees produce viable seeds.' So we'd need to write in words or in equations what are those different possibilities that are all plausible to us at the moment. So it might be, one, mature trees produce seeds all the time, number two, they produce viable seeds only in places that have not been affected by fire recently, number three, the mature trees produce viable seeds only when there is no recent fire and rainfall is higher than a certain level, and so on. You know, you've got to write out what these specific options are. And if you want to do a value of information analysis you need to say, 'well, if the first hypothesis is true, what's the best management that we could do in this system?' And 'if the second hypothesis is true, what's the best management we could do in this system?' And go through all of them like that. Yeah, so in theory you don't need a lot of current knowledge about how the system works to perform a value of information analysis, but you have to be prepared to say in very specific details what are the different possibilities, and what are the consequences if that possibility is true? Yeah, so you don't have to know a lot but you do have to be prepared to say something firmer about the consequences for the system.

SW: Yeah, and do you see something like that happening in Wildlands, performing a value of information analysis like that?

SAM: I think – I'm trying to work towards a very basic one to show to some of the people there, centred around that idea of, 'when do kangaroos switch to eating grass only to eating grass plus woody seedlings?' And so because it's a – a value of information analysis is a moderately complex analysis to perform, and it is challenging to communicate to managers. I kind of want to put together a toy one with some results to show them the point of it, and to find out if they see value in it. I think it's something I can write an academic paper about so it fulfils my needs as a researcher, but also I'd like to have a complete but simple one to share and communicate with the managers to find out if they, if that's a tool that's interesting to them.

SW: Yeah, and in regard to the value of information analysis, but also the rest of the report, I was wondering whether it has always been apparent, or whether you've always had this structure in mind from the beginning of the project or whether these tools – like the value of information analysis and things like that – have emerged in importance as the project has developed?

SAM: I couldn't speak for Val but for myself I've probably had them in mind the whole time. Because of my previous experience in other adaptive management projects, I've had that set of headings of things like objectives, process models, monitoring and updating, and even the value of information analysis – they're all concepts I've been carrying with me from the start, and trying to work out how the Wildlands project fits into that adaptive management context. But the relative importance of one bit versus the other is something that has emerged as I've learnt more about the problem. So as I've learned more about the problem I've realised that the monitoring outcomes is a really crucial issue in this particular context, and the need for a process model as well, that – yeah, I think I've carried those concepts all the way through but the specific context of Wildlands has steered us as to which bits are the really important ones to concentrate on in this report.

SW: Right. And there's a couple of clarifications on that same page with the list of uncertainties that I just wanted to check with you as well. There's a point where you say that monitoring and management actions should be intrinsically linked and planned simultaneously. I was interested to hear from you why, in the Wildlands context, it is essential that they should be intrinsically linked?

SAM: Yeah. So partly I know that at least some of the people at the Authority are highly aware of this. So Leslie for example sees the value of monitoring as a really important part of a management framework. It probably comes back to that idea that I talked about before that the people on the ground at the national park can get impatient and want to do stuff, and they don't see monitoring as an active 'doing' activity – as a very active way of going about their work – whereas someone strategic like Leslie sees it as an absolute: we need to document what we do on the ground and what results we see from it to work out whether we are successful or not. And I guess that's the high level – they need to be intrinsically linked because we need to work out if what we're doing is working or not, and monitoring is the way to work that out. So – and the gap that everyone sees for the Wildlands project is that they're lacking consistent vegetation monitoring. So we know what the kangaroo cull is doing for kangaroos but we don't know what it's doing for vegetation.

SW: And there's also a point where you said that resolving these uncertainties – that list of six uncertainties – may or may not affect our ability to decide on appropriate actions and achieve our objectives. I was interested to hear from you why you thought it was important to state that?

SAM: Yeah, I guess this is sort of a really crucial part of adaptive management. As researchers, in particular, but also sometimes as other ecologists, there are all sorts of things about ecosystems that we don't know or don't understand, and some of them affect our ability to manage a system and achieve what we need to, and some of them don't. Maybe it's possible that some of those uncertainties we talked about, such as the uncertainty about when mature trees produce viable seeds, maybe the kangaroo management action we take is exactly the same regardless of what the truth is about viable seeds. And if the management action is the same under all those different possibilities, then we don't actually need to know the truth about viable seeds. We can go ahead and manage kangaroos and be comfortable knowing we're doing the right thing. So a tool like the value of information gives us that hint: are viable seeds a crucial uncertainty where knowing the answer will improve our management? Or is it something where knowing the answer doesn't actually improve our management decision at all?

SW: Yeah and that links, I think, in my reading of the report, to the very last paragraph of the report, where you provide a caution to the Authority and you say that, "we caution that any modification of the cull protocol has to be carefully considered by the Authority since some of these recommendations involve trading off an increase in capacity to predict kangaroo population density for a reduction in efficiency in conducting the management action of culling to achieve a target quota." And I found that quite interesting because it sounded a bit like a warning when I was reading it [laughs]. I was wondering whether that was how it was intended?

SAM: Yeah, that'll be something that Val wrote so you may also want to follow-up contact with him to find out what exactly his intentions were. But I think I understand his intentions so I can speak a bit about it too. So with this catch-per-unit-effort modelling that Val did in the report, it shows that – he's looked at the cull data that they collected last season, for example – and the cull data shows that the shooters are very efficient at their job. They know how to move around the landscape and cover the landscape well, and to maximise their chance of finding kangaroos. So they know how many they need to kill in total because it is set by the Authority, and they know how to get out there and do it as quickly and as efficiently as possible, and not waste anyone's resources. And that's what the current situation is, which I think is really great for the Authority. But the Authority is interested in potentially moving in the future towards this catch-per-unit-effort modelling, where the cull is not just an activity that removes kangaroos, but that the rate of removing kangaroos gives them statistical information about how many kangaroos are out there. So if you are able to find kangaroos very quickly, that's a hint that there is a very high density of kangaroos out there, whereas if it takes you a long time to find kangaroos, that gives you a hint that they are at low density. And there are statistical methods you can use to back-calculate "what is the density of kangaroos out there, based on the rate at which I'm finding them?" The thing is that if you use that statistical method it has a bunch of assumptions that come with it about kangaroo behaviour, about how quickly

they move around the landscape. So what Val has found when analysing the data is that there is this crucial assumption about – if you go out there and you cull some of the kangaroos and you remove them from the population, and you're removing them from one spot, what are the movement behaviours of the rest of the population such that they move around and mix and even out in density again? At what rate do they move back into that area where you just took some out? And the – if you're gonna go with those assumptions of the statistical method, you need to leave enough time between the culls to allow the kangaroos to move around and redistribute themselves across the landscape. And if your cull programme is every night for four nights, you're not giving them time to redistribute themselves. So it's a really fast and efficient method of hitting their quota, but it means that the statistical inference about kangaroo densities is unreliable at the moment, so I think what Val – the caution in the section here is, what you are doing serves the Authority's purposes for an efficient cull right now, but if you want to add this statistical inference aspect to the cull programmes, you'll have to redesign the programme with these rest breaks so that the kangaroos can move around.

SW: Yeah, and that kind of weighing up the benefits and the potential costs to the Authority in moving to these different practices is really interesting I think …

SAM: Yeah, yeah, and I think it's completely up to them as to what they prefer. Whether they want a quick, efficient cull, or whether they want to space it out a bit more and get this extra information. That's a value judgment for them to make.

SW: Yeah, and would it also be – if they were going to gain information about the total number of kangaroos in Wildlands from that method as well, they'd be able to shift from Jo's population survey to a catch-per-unit-effort style?

SAM: Exactly. Yeah, so that's one of the options available to them. If they want to change the way they perform the cull into this statistical approach, they might do away with the Rainfall Model and this will be the way they do it instead to work out the stopping time.

SW: So that involves them weighing up the relative uncertainties but also the efficiencies I guess with each of those methods.

SAM: Exactly.

SW: I just wanted to wrap up with just some reflections from you on the practice of adaptive management in general. It was actually something that Val said to me, so it's a shame Val had to go, but in the first interview we had together I was asking you guys whether the Wildlands project had made you reflect much on the theory of adaptive management. And what came out was that it hadn't made you reflect so much on the theory of adaptive management but more so on the practice. And I just

wanted to follow that up and ask you to reflect on what the Wildlands project has changed or reinforced about your ideas on the practice of adaptive management.

SAM: Yeah. I guess there's plenty of papers in the literature about the challenges of implementing adaptive management and in the last six to twelve months we have really seen those institutional challenges of holding the knowledge and holding the enthusiasm inside the institution to persevere with it when it is a long-term commitment. And yeah, having the consistent resources within the Authority to persevere with it and the vegetation monitoring is still something that – if they want to have a comprehensive adaptive management programme, they have to have vegetation monitoring, and they know that but there's still no guarantee of that in sight, that they can enforce that as part of their regular practices. That's a really big challenge of adaptive management in practice at Wildlands.

SW: What do you think is the main reason for that, not being able to enforce that?

SAM: Yeah, when we talk to Leslie and Robin it's about resources, about having money and staff time available to commit to that activity every year or every five years when it is needed. I think that there are also – that there will be challenges in appropriate training and knowledge. So yeah, I think that to get a statistically reliable result that can detect changes in the landscape, that'll take quite a bit of survey effort and quite a bit of knowledge of species and life-forms during the survey process that may or may not be present within the Park. They may or may not be able to commit the appropriate training into that work.

SW: And that reminds me of a question I was going to ask earlier which was – you talk a lot in the report and in the project as a whole about this aim to create these explicit links between the vegetation and the kangaroo cull. I wanted to check that when you say 'explicit links,' do you mean something that is showing a causal relationship?

SAM: Yeah that's right. So the monitoring on the ground is the number one thing they need to get done, but if they want to adapt their cull practices – the way they are setting the cull quota – what they probably also need is a model that says "hey, when the kangaroo density is this much, you can expect this much vegetation to get eaten." You know? When then are this many kangaroos and this much grass and this many seedlings, the kangaroos will eat this much grass, this many of the seedlings. And to actually have a predictive model that actually shows that cycle – a predictive model of kangaroo dynamics and vegetation change through time.

SW: Right. And what worked and didn't work about the process that you've embarked on in this project?

SAM: I think what worked well was that Leslie and Robin at the Authority's central office, they did make themselves quite available to us. We had useful meetings with them quite regularly throughout the entire project. That was a useful thing and I think that helped manage everyone's expectations about what we were going to achieve, and if there were any alterations along the way then everyone was made aware of them. We kept in good contact with each other throughout the project. What else was good about it? Oh, we encountered many really helpful experts along the way, so the workshop that we held quite early in the project, and for example the fieldtrip that you came along on, the contributions of people like Alex and Logan were – they were essentially offering their professional time to us for free, very generously, and the project really benefited from that. And likewise I mentioned Morgan who I ran into at a conference right at the end of the project was another expert in the field who was very generous with their time. So people who are knowledgeable and also passionate about vegetation systems worked – that was really great that there are champions, enthusiastic people throughout this process. And that really kept it going. I think particularly because Val and I – I'm a mathematician and Val is a statistician – and although we have some ecological training it is a bit limited, so that needs to draw on expertise from other people, was a really important part of how this project came together. And that had its disadvantages too – I mean that was one of the problems potentially, was that Val and I had a lot of learning to do. We had to catch up on how vegetation works.

SW: Do you feel that that affected the outcomes of the project?

SAM: Umm. I think – I guess it's the multidisciplinary nature of any adaptive management project that you need to draw that expertise from lots of people and not really on one person for everything. But I think that perhaps if there had been a vegetation expert in addition to maths types like Val and I maybe some things would have been achieved faster. Because Val and I had to do a lot of reading to get up to speed, to know how to ask the right questions of our experts. Yeah.

SW: And the expertise for adaptive management – you talk about the multidisciplinary nature of the project – do you think that is something that is inherent to adaptive management or particular to Wildlands?

SAM: I think – maybe it's not inherent to adaptive management, there might be adaptive management problems that don't need experts in many things, but I think it's probably very common to adaptive management. You need people that are good at facilitating, bringing the structure together, you need however many stakeholders are involved to have an interest in the project to help articulate those objectives, and you might need a group of technical experts to build the predictive models. So in our case the stakeholders are this range of people from the general public through to the people managing the park, through to experts on vegetation communities. And then the people who need to build the predictive models are almost entirely the ecological

experts, so people who understand how kangaroo populations work, people who understand how vegetation changes over time. So all – site staff have valuable knowledge in that respect too, it's not just people in academic institutions.

SW: And what were the things that you didn't think worked so well?

SAM: Yeah, I think perhaps the research team was a bit unbalanced. We had good adaptive management knowledge and good modelling knowledge, but we didn't have a vegetation expert who was assigned to the research team for the whole life of the project. We were just borrowing that expertise from people as we could along the way. I think that was probably something that didn't work well, and obviously, as we talked about earlier, the institutional restructure at the Authority really set back our progress I think in the past six to twelve months. And our hope about this work being adopted into the future, that is delayed as well as a result of the staffing restructure at the Authority.

SW: And these issues, particularly with regard to the vegetation expert, do you think that's something you could have known at the start of the project or do you think that only became apparent through actually doing the project itself?

SAM: It was not something that I knew at the start of the project, but it probably became quite clear to me within the first six months of the project. But within that time period the hiring decisions about the project had been made and made by people more senior than me, so it was out of my hands and we made the best of what was available.

SW: Was there a particular event that made you realise or was it a cumulative factor?

SAM: It may have been during the process of preparing for and running that first workshop, which I think was sort of, May, of what year? 2013? Yeah probably in the process of preparing for that workshop and trying to work out what are the questions that we are going to ask this group and what are the activities that we will have them do? And what is the pre-existing knowledge in this expert community? Val and I only had the capacity to read so much and prepare up to a certain point whereas I think someone with vegetation expertise possibly would have had more background knowledge and could have possibly cut to the more important topics much more efficiently than we did.

SW: And I was wondering what, given these problems – or not problems but challenges that you have been going through – I wondered if there were any norms or standard operating procedures that emerged for you in the project? What kind of practices amongst your team were necessary to keep the project going?

SAM: Yeah. I think something that I try to put into practice with this kind of interdisciplinary work is regular communication. That's the big one. So making sure that at least once every two months, if not more often, that we had contact with our Authority colleagues, so that they were reassured that we took the project seriously and we were making progress, and also to obviously receive feedback from them that progress was in a direction that was relevant to them, and going to benefit them. Um, let me think more. Other norms. No that was probably the big one. The project went through very different phases at different times – at the start it was about an expert workshop, and at a different point when you came along it was about fieldwork, and thinking about survey design, and at different points in the process we were thinking about statistical modelling. Like there were quite different phrases and angles that we were taking on the project at different times, and I guess they lent themselves to different approaches.

SW: Yeah, it very much seemed that way to me when I was reading through the report, I was thinking what are the standard operating procedures, or the ongoing business, what are the norms that are going on here? And it is almost, like you say, the communication is important because you're negotiating through these quite different stages of work, trying to figure out how all these stages fit together. Do you think that might be one of the reasons why communication was important, to be able to have this negotiation between your objectives and what you were producing?

SAM: Yeah absolutely, because we were moving through these different phases and different activities, and calling on different experts or different knowledge types at different points. Communication among the group who had to be a part of the project from start to finish, so that was two or three people at the Authority and three or four people on the research team, yeah, just regular communication throughout because we were calling on different experts and different techniques at those different times.

SW: And you hear a lot in the literature about the need to apply adaptive management in the proper context, and you read these articles warning against misuse of adaptive management. I was wondering whether you felt in this situation that the tools that adaptive management provided you did fit the situation you were working in?

SAM: I think they did fit the situation. This is a situation where there is a very clear action that the Authority is taking, which is the kangaroo cull, and it's a decision that they are making repeatedly through time. Although the circumstances might change slightly from year to year, the nature of the decision that they need to make is very similar, which offers this opportunity to learn and to adapt through time, because of that repetition. So I could see that this system was quite a good fit for the concepts of adaptive management. The reality in a project like this one is that we aren't necessarily going to finish with a complete, comprehensive, fully-functioning adaptive management programme. It's the first stage of fitting their existing challenges into that framework. And sort of show the opportunities for them into the

future if they want to continue with this kind of approach. Yeah, certainly I can appreciate that there are systems that don't fit the adaptive management style; we were exposed to this problem in such a way that there was not major conflict in the objectives. If you've got a situation with multiple stakeholders who have profoundly different interests, and they just cannot trade them off with each other, that's a case in which adaptive management is really tough. And we did not have that situation. People were quite – people that we were exposed to at least were quite united in their desire for vegetation restoration. You know, the interest in kangaroo culling under certain conditions – a humane cull that is not excessive. Among the group that we were exposed to there was widespread acceptance of that idea. And also it's an ecological system where there were scientists that knew about that system and could provide us with expertise, but at the same time still articulate the uncertainties that still persist. So I guess that it's a single agency making this single decision that they have complete control over, the decision-maker was clear, the objectives were quite well agreed to across the groups, the different stakeholders, yeah, it was a good fit.

SW: And what do you think, given the situation now with the Authority, what do you think is the biggest contribution of your approach and adaptive management in this situation? How do you think it will contribute to the management of Wildlands?

SAM: Hopefully, I think – I hope the biggest contribution is that it gives them that grounding framework that shows them how to be accountable. And that was a word that Leslie used in our conversation yesterday, about the need for accountability in their agency – that when they take actions, they can provide evidence that these are useful actions and they are producing positive results, positive outcomes. And I think the purpose of our report was to link the different components of management together and show how they can improve that accountability into the future.

SW: Sure. And the final question is about the way that the project has developed over time, and I was wondering whether you had this vision of how the project would unfold or whether you have experienced rapid – or changes in what the project has been or will produce at the end? I remember, I think at the – I can't remember which interview it was, it might have been the last one that we had – you said that you hoped to provide initially some monitoring data in the report to the Authority but having gone on the fieldtrip that we went on it became apparent that you wouldn't be able to provide what you initially thought you'd be able to in the report. And I was interested to know how you have the experienced the evolution of the project through time?

SAM: Yeah absolutely. And I think there would have been multiple points of evolution and changing expectations for me. I guess for me, hired as a mathematician on this kind of project, at the start I imagined that I was being hired to do a lot of mathematical modelling. So I expected that my time would be spent building models and computer simulations, and working out new advice about the kangaroo cull quota, using desktop simulation type stuff. And as you'll see in the final report there's very

little of that at all in the final version. And I think I sort of got the message from Blair, as the project sort of moved on, six to twelve months old, after we'd got to know the context and we'd ran our first workshop, Blair sort of expressed to us that the goal with this project was much more about getting some real monitoring happening on the ground. So at the time when I was speaking to you and we were doing that fieldtrip, that was probably what was in my head – this idea of gathering vegetation data, and performing a scientifically rigorous vegetation survey. And yeah, again that changed. The reality when we were there on that fieldtrip was that seedlings were – the woodland was very patchily distributed and seedlings were very rare within that woodland, and it would take much more time and thought to perform a scientifically rigorous vegetation survey. And really it was just that pilot – that trip served as a pilot study or, what's the word? … Anyway, just getting ourselves oriented at the site to understand the context and what the needs would be for future surveys. So those were sort of two key expectations that changed along the way. And again, for the final report, even after I let go of the idea of doing computer simulations of the entire system, I was still envisaging for a while that we would build mathematical cause-and-effect relationships for that process model which might be Figure Three and appears in the Executive Summary as well. Yeah it is Figure Three. Yeah in the end we do not have numerical responses at all for what is in the diagram. And it was probably only in June – June of this year – that I realised, that I accepted we didn't have the time or capacity to do that.

SW: And I was looking at the differences between the conceptual model in the first [workshop] report, and the conceptual model in the final report. I was wondering whether there were any important changes for you?

SAM: Sorry, what is the initial report?

SW: Sorry, the workshop report. So we have this conceptual model where you have two boxes – the natural system on one side and management decision-making on the other side. It's on page thirty-five of the final report.

SAM: Yeah, so that diagram in the initial report is something that Val drew, and Val probably had very in mind that idea of computer simulations as well. Also that diagram is intended as a description of adaptive management as a whole, so it's got the natural system as you said, the management decision-making, and you can see through the middle there that it has got these monitoring components like estimating the kangaroo population, estimating grazing pressure, articulating knowledge of our system, and those kinds of things. So that was a very holistic view of adaptive management for a natural system. Whereas the Figure Three in the final report is probably intended to be mostly a view of the natural system with the exception of the blue box of management controls at the top. The rest of it is essentially a more complex representation of the natural system than the initial report. So yeah, it doesn't have that holistic adaptive management aspect to it, Figure Three, it doesn't sort of

describe the monitoring processes or our knowledge of the system, those processes that are important for adaptive management.

SW: Were you aware of that when you were drawing it?

SAM: Yes, I think what I had in mind when I was drawing Figure Three was about which things would we need if we were to progress this in the future, what would we need mathematical equations or cause and effect relationships for?

SW: I just remembered the question that I missed looking at this page and that was about timescales. And at the beginning of the report you mention the three timescales for vegetation objectives, and you have the short-term, medium-term and long-term. And I was wondering whether they were quantified in some way, or whether that was a subjective description in terms of short term, medium term, and long term?

SAM: Um, it's pretty subjective, but there is a report that was an Authority report that would be about ten years old, that talked about short, medium and long-term goals, and did put timeframes on them. So short-term is less than five years, medium term is five to fifteen years, and long-term is more than fifteen years. I wonder if there is anything explicit in the initial workshop report?

SW: I had a look – I couldn't see anything, but I might have missed it.

SAM: No, if you didn't see it it's probably not there.

SW: And do you know if the short, medium and long were based on ecological timescales or management, human timescales?

SAM: I think that they were based on ecological timescales, based on what we could – what kind of ecological response we could realistically expect in that timeframe.

SW: And is that Authority report a management plan or is that something else?

SAM: It was a conservation objectives report – a report describing conservation objectives for the parks in the broader Wildlands region. So it was an internal Authority document. It was not widely distributed, but they shared it with us because of this project.

SW: And has your involvement in the project finished now, or will you be doing stuff related to it?

SAM: Yeah, so Val and I both have contracts that continue for just under eighteen months. So that gives us plenty of leeway to write academic papers out of this work,

and we have additional research commitments as well as this. So thankfully this doesn't mean the end of our salaries just yet.

SW: That's good that your salaries haven't ended as well as some of the Authority guys.

SAM: Yeah that would have put the continuity right out of the window!

[End of interview]