State NRM and Coastal Conference 2017

Tuesday, 29 August to Thursday 31 August 2017 at Curtin University, Bentley, Perth

The first Western Australian combined natural resource management and coastal conference took place on 29 – 31 August 2017, connecting people with shared interests and passion in WA’s changing natural world.

Working in tandem for WA’s environmental future, NRM and coastal experts, managers, practitioners, community members and volunteers met to share knowledge and experiences in the field, as well as discussing the future of Coastal planning and Natural Resource Management. The contributions of authors and presenters helped to make the conference as successful as it was.

The conference discussed themes of:

- Under pressure – balancing needs
- Risk Management and Adaption Planning
- Responses – on-ground management
- Successful engagement
- Structural response – governance capacity and resilience
- Moving forward: managing capacity and addressing gaps.

Operating in a world of changing environment, economy and society, conference attendees heard from speakers who have been successful in undertaking long term programs that improve coastal, land and water management, actively involve communities, and conserve natural resources.

These Proceedings will provide an excellent point of reference for those in the coastal and NRM fields, as well as providing an insight into the discussions of the conference.

We thank all authors and participants for their contributions.

State NRM and Coastal Conference Steering Committee

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Changing the world – together

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Abstract: As the world enters the period known as the Anthropocene we are experiencing levels of species extinction not seen for some 65 million years, unprecedented challenges in feeding a growing population and exponential growth in land degradation globally. Could be the climate is changing as well. While humans can be an adaptive species, our short history is littered with examples of how civilisations, organisations and industries collapse by responding to long term widespread change with short-sighted and narrow self-interest. But right now we need to achieve rapid and transformational change of behaviour focused on the long term collective interest. A common assumption is that the more we work together the easier this will be. So, in this talk I want to explore what we can learn from how effective West Australians, and a few others I’ve been fortunate to meet, have been at working together to repair their battered environments. The future will be different, but our behaviour in the recent past is all we must learn from.

Keywords: landcare, natural resource management, ambitious targets

1. Introduction

This paper briefly discusses a few global challenges and how they are being addressed by different communities and societies. Furthermore, some changes for our work programs in Western Australia that are necessary to remain meaningful in the face of those challenges, are discussed.

Firstly, the basic reality that life on Earth faces the biggest challenges seen for millennia is well documented. The geologic era known as the Holocene has been good to humans, with pleasant and liveable climatic conditions on much of the planet, enabling humans to establish the networks, institutions and structures we recognise as ‘civilisation’. However, as documented by Will Steffen and colleagues1 in their seminal work ‘The Great Acceleration’, humans have overdone things a bit. He shows that resource use has steadily increased since around 1750, and resulted in catastrophic damage to global ecosystems since the early 1950s. It is now generally accepted, by the world’s scientific community at least, that humans are entering a new geologic era dubbed the Anthropocene2. While models have predicted the characteristics of this coming era, the only certainty is significant change; it will have a far less favourable climate for humans and has already been established as the sixth greatest extinction event recorded3.

Even conservative scenarios for the next 100 years anticipate an increase in the global human population to 9.8 billion by 20504, a potential sea level rise of 1.9 metres by 21005, and estimates of a 5 degree Celsius increase in global temperature by 21006. This is combined with estimates of land degradation costing the world as much as $10.6 trillion every year, equivalent to 17% of global gross domestic product7.

Compared to this scale of change, the current Australian response to the environmental and human crisis we now face is somewhat puny. We are, perhaps at best, effectively pretending that some
mitigating tweaks to our current business as usual scenario will keep us on a comfortable trajectory. They won’t.

But as T.S. Elliot once observed “human kind cannot bear very much reality”.

Be that as it may, humans are an adaptable, creative and hard-working species. However, as documented by Jared Diamond in his book Collapse, we do tend to respond to catastrophic change too late to be effective. While this does seem to be the case with the current global crisis, we have no choice but to strive for change of a transformative level that will make a difference. Sadly, anyone working in the an environmental field, who is not working at a transformative scale, may be wasting their time.

2. An African perspective

One inspiring example of transformative change comes from our landcare colleagues in Africa. In December 2016 I was part of a small group of Australians who assisted in running a landcare masterclass in Solwezi, Zambia. Delegates from five countries attended, along with a solid core of local farmers, researchers and agencies. As well as assisting with the general training, my specific role was to assist in the development of a 5 million hectare regeneration proposal.

Africa is a continent on the move despite almost overwhelming poverty, conflict and some severe land degradation. Extremely impressive regeneration programs are underway, and I found myself amongst colleagues who were used to successful million hectare plus programs. We visited the examples of productivity and wildlife enhancing agroforestry that we have only dreamt about in Australia, but never achieved at scale. The project we were, and still are, working on is one of a number of genuinely ambitious programs that will collectively meet the goals of AFR100, in which African governments aim to achieve 100 million hectares of regeneration by 2030. This is a level ambition and precision target setting that I don’t see in Australia.

While a short period in Africa doesn’t make me an expert, I was impressed by what I saw and heard there. I make two key observations, which may not be wholly accurate, but are worth exploring further. Firstly, Africans are collectively pursuing ambitious programs across jurisdictions and scales, regardless of a diverse jumble of structures, cultures, capacity and circumstances. Secondly, there seemed to be solid on ground action, to enact the ambitions and visions from the highest levels - African countries are either too smart to bother with middle layers, or they just can’t afford them.

For this work of continental scale regeneration, Africa has a number of outside funding sources that can be tapped, which seems fair given the relative poverty of many of its countries. Australia, is a wealthy country and doesn’t need that level of outside support, however it doesn’t have that same ambition.

3. Down on the Ranch

I’ve been fortunate enough to meet, and sometimes to work with, other ambitious communities. One community I visited briefly, and that close friends have worked with, is the Malpai Borderlands Group in southern Arizona and New Mexico:
A grassroots, landowner-driven non-profit organization attempting to implement ecosystem management on nearly one million acres of virtually unfragmented open-space landscape in south-eastern Arizona and south-western New Mexico.

The Malpai Group involves ranchers, scientists, and key agencies working together. It formed from discussions that started in 1991 involving a group of ranchers who:

While not sure what we needed, we felt whatever it was should be driven by good science, should contain a strong conservation ethic, be economically feasible and be initiated and led by the private sector with the agencies coming in as our partners, rather than with us as their clients.12

While subject to the same organisational stresses of any community-based effort, over their long history they have a significant record of practical achievement.

Malpai are one of a number of ‘large landscape’ approaches to regeneration and conservation that have emerged in recent decades, and Malpai stand out as an especially well communicated and documented effort. One scientist who has been involved for many years, Charles Curtin, has brought together key lessons from their experiences, and from his involvement in other large-scale efforts with Maasai pastoralists in Kenya, the Maine Fishery. I highly recommend his book for anyone interested in how we can collectively, achieve change at scale, holds a number of insightful comments that I consider highly relevant to the Australian situation, including:

Sustaining successful collaboratives requires not just local engagement, but also strong external guidance . . . an ‘honest broker’ whose sole mission is to promote local interests from a much broader context. . . . the history of large NGOs suggests too often that such organisations are focused on their own interests, using local people and projects as flexible funding strategies to acquire resources that support the group’s overall infrastructure and mission. . . . The challenge therefore is to build a governance structure that empowers locally while being managed regionally.13

There is much in those words that resonate, for me following my own experience in establishing and managing the overall Gondwana Link program, from discussions with colleagues in other large landscape approaches, in the broader landcare movement and my own evaluation of the effectiveness of Natural Resource Management Regional Organisations (NRMROs) in Australia and perhaps particularly in those states where they effectively operate as NGOs (albeit government funded NGOs). I’ll return to that towards the end of this paper, but for now I’ll take another quote from Curtin’s book where, under the heading of “New Approach, Old Pathologies”, he makes the observation:

In a science of open spaces, to maintain large and complex systems, sustainability not only lies with designing effective science and governance, it also rests with managing social dynamics.14

4. Funders being brave

Another perspective we should consider, particularly if we are thinking of raising the ambition of restoration in Australia, is that of the funder. I’ve visited and worked with a program which covers virtually all of New Zealand north of Auckland. Reconnecting Northland15 started as an ambition
of the Tindall Foundation to lift their conservation effort to a more effective scale. The brief given to them by founder, Stephen Tindall, was this:

> It’s great that we are supporting a lot of passionate groups to do amazing environmental and biodiversity work in their own projects and areas of interest. We must keep doing that. But this seems to have reached a peak of effectiveness, and many parts of the overall environment are going backwards. In the meantime, there are lots of other people living in areas who could, and probably want to, be more engaged in planting native trees, restoring the environment and enhancing sustainable use of our land and water. Go find out how The Tindall Foundation can help change systems so we can start to make this happen.16

In recent years the Tindall Foundation has been supporting a number of what they call Environmental Systems-Change Initiatives (ESCs) with ‘Big Hairy Green Goals’ (BHGGs). They have also formally presented at several funder gatherings on the fundamental choices they’ve made, recognising that projects are compelling for funders, as they:

- “Have a degree of certainty
- Are compelling, easily understood
- Have narrow focus, can be fixed
- Have tangible immediate outputs
- Progress is made and measurable
- People can engage personally, feel they’re making a real difference
- They have safe limits on funder commitment ($$$, timeframes, outputs, KPIs, milestones, etc)
- They are marketable/brandable
- They have less risk and uncertainty
- Less chance for ‘donor fatigue’
- Most will do some good”

Whereas ongoing programs aimed at achieving ‘system change’ at scale are difficult, they:

- “Have high degree of uncertainties
- Can be really hard to understand
- Have broad focus, may not work
- Have elusive long-term outcomes
- Progress unsure, hard to measure
- People can struggle to engage and feel they’re making a difference”17

In the case of Reconnecting Northland, Tindall brought two additional major funders into the program, Foundation North and HSBC, demonstrating the cooperation between funders to underpin an ongoing program aimed at systems change. Five year tranches of program funding that are subject to regular hard-nosed but open program evaluations and the cooperation between funders has enabled cooperation between those being funded.

Reconnecting Northland was initially managed by two large NGOs, WWF NZ and the NZ Landcare Trust. The program has now entered its second five year tranche of funding and successfully managed the transition into a regionally run program, managed by a new independent entity ushered into existence by WWF NZ, a rare example of an NGO putting the good of a geographic program before its own organisational needs.
5. Egypt in Australia?

One country I haven’t yet had the pleasure of visiting or working in, but whose achievements loom large in my understanding of the Australian land management processes, is Egypt.

Whether or not Egyptian society and power structures were as stratified as this illustration portrays, Australian societies and power structures are not. Yet it often seems that a presumed hierarchy exists, and many of us view the various attempts to standardise natural resource management structures around Australia as a confused attempt to establish a tidy and dominant hierarchy on a world that is invariably dynamic, ever changing and with many overlapping management structures, arrangements and relationships.

I also face this challenge as CEO of the Gondwana Link program, where we overlap with the linear management structures of several large organisations and businesses, as well as a range of local organisations and the many different individuals involved. Even though we have steadily built the program for over 15 years, the arrangements we use are still far from perfect, and most likely always will be a little untidy.

Our approach partly reflects my long-standing concern that to progress effective environmental change we need to focus more on the ‘nett’ achievements rather than the ‘neat’ structures. For me the freedom to do that came with private funding focused on outcomes not outputs.

6. Western Australia

This conference has seen presentations on an array of programs and projects from the ‘NRM and Coastal’ worlds. I’d like to conclude with some observations on what I see as the way forward for both on-ground action and our structural arrangements.
6.1. Build from the geographic focus we currently have

To progress environmental repair and sustainable practices we need to encourage society to think and act more geographically, rather than through lenses of specific industries or functions. The early development of local Landcare groups and catchment based approaches was a good step in this direction, as has been the subsequent development of regional approaches to natural resource management. However, recent years have seen some strong resistance to further improvement. Should we stick with boundaries determined departmentally, largely based on the Agriculture Department regions, established over 20 years ago? Can we still afford the current structures, or would ‘sub-regional hubs’ be more cost effective? The staffing and structure of the original regional groups expanded and changed considerably from 2004 to 2009, when more government funding was available for this work than at any time before or since21. From that period on, the number of local groups in agricultural and pastoral areas declined22, and while other factors may be involved it’s unlikely to be a complete coincidence23. So as the ‘funding cake’ has got smaller, many local groups are concerned that regional arrangements are squeezing them out from the core funding. Unless we have an honest re-appraisal and re-configuration of the current arrangements, building from their strengths and dealing with their weaknesses, the geographically based approach, built up over many years, risks falling into disrepair and being discarded. If so, we may lose both the already weakened local groups and the regional approach.

6.2. Ambitious, clear and focused targets - signed onto

After a few decades of discussion and support for soil conservation, the Federal Government launched a national approach to Landcare that included the ‘Billion Trees’ program24. The current equivalent is the ‘20 Million Trees’ program, which shows a decrease in ambition over time, even though the need for revegetation has not decreased and we have the technical capacity to do far better25. Australia does not have inspiring and firm national targets, such as those adopted by national governments across the African continent. Instead, we are close to what I term ‘death by a thousand projects’, where energy, goodwill and social capital will be exhausted by stop-start funding timelines, the lack of clear endpoints or goals, ever-shifting priorities and the ongoing funding of activities, not outcomes.

6.3. Facilitation and integration through ‘honest brokers’

Earlier in this paper I quoted Charles Curtin on the need for honest brokers, “. . . whose sole mission is to promote local interests from a much broader context”. Similarly, Reconnecting Northland supports those local groups doing the local work. In Western Australia (WA), the critical issue impeding cohesion between local and regional scale approaches is the multiple roles the federally funded Natural Resource Management Regional Organisations (NRMROs) are allowed to fill. Effective facilitation across interest groups, whether it be of a room or a region, requires the facilitator, or facilitating organisation, to be neutral on the issues being discussed and decided. Yet over time regional groups have moved from their original roles to where they also establish and operate their own projects, often overlapping with the core functions of local groups and competing for funds against those groups.

This situation is worsened if you can appreciate that the main asset that many local groups hold is their project information and ideas. At present they are being asked to fully disclose those project ideas to regional organisations who then decide, through their Commonwealth funding bids, which they consider would be best done by themselves.
6.4. Clarity on who ‘we’ are

It’s not hard to get lost, and a little confused, amongst the overlapping terminologies that are used in the world of land management. Landcare was an early starter and a natural progression from the earlier focus on ‘Soil Conservation’. It then became fractured into the various cares – Coastcare, Bushcare, Watercare and so on. Eventually, the broader and more utilitarian term ‘natural resource management’ came into vogue, and rapidly evolved into the soulless acronym NRM, which is often used interchangeably for both the practice of natural resource management and the regional structures. It is also, of course, widely used by the mining sector. Now we are seeing the hashtags ‘#Landcare is NRM’ and ‘#NRM is Landcare’, which underlines the confused terminologies at play. It’s been great to see Coastal and NRM ‘sectors’ working together at the state conference and in these proceedings, but surely taking the NRM phrase at face value would suggest ‘Coastal’ is a subset of NRM? The reality is that virtually all of these nomenclatures were borne of administrative expediency at particular points of time, and those points of time aren’t relevant now.

Our current urgent need is to sell the sector more effectively to the general community. That can’t be done using confusing terminology, even if the insiders know what they mean by each. We cannot ask the general community to work in a more integrated way if the sector itself can’t even decide what it is called. Whatever label we choose, the critical choice is between ‘management’ and ‘caring’ – which phrase reflects who we want to be and which reflects what the general community can support with the most enthusiasm.

6.5. Supportive funding streams ‘beyond welfare’

The ‘Landcare/Coastcare/NRM sector’, whatever we call it, should have reached a degree of organisational maturity by now, given its origins in the early 1980s and almost a decade working on national soil conservation policy. Yet this essential work of repairing the continent’s physical health is still largely dependent on short term funding being achieved through a multitude of grant applications. Not only are the transaction costs and uncertainty of this approach unacceptably large, but it has created something of a culture of welfare entitlement. Indeed, it does sometimes appear that the Commonwealth is structuring its funding programs on organisational variants of the CentreLink model, where supplicants have to respectfully weave their way through a maze of very difficult forms and hurdles. I think we deserve better.

6.6. The various layers of government at least talking

The bizarre nature of the current government funding arrangements has no greater example than the fact that the WA and Commonwealth governments have not agreed on the way forward, and have had no such agreement since 2009, when the last bilateral agreement lapsed. Funding for NRMRO’s is now almost totally from the Commonwealth, while the WA Government continues to cost shift and reduce funding for its environment and land managing agencies, often leaving them to bid for operational funding at regional levels amongst a range of community-based organisations, with the Commonwealth setting the dominant priorities. Given the absence of ‘heads of powers’ for the environment in the Australian Constitution, and the Commonwealth’s reliance on other constitutional powers to operate in the environmental and natural resource management arena, it is all becoming slightly ridiculous.
Where is local government in all this? They certainly were not there when the state and Commonwealth squabbled over the lack of a bilateral agreement. There seems to be no cohesive approach that includes them at the policy level, or in budget allocations, though a number of local governments are very supportive of their local Landcare groups, sometimes directly funding them.

Landcare was built on the simple premise that all those involved should regularly meet, give a bit to get a bit and plan together, regardless of the scale of the landscape or the problems being tackled. A solid approach that we should return to.

6.7. Energy and excitement

I’m old enough to remember when there was lots of fun to be had doing Landcare, when many farmers found their Landcare group and its activities a welcome relief from their daily farm routine. I was once a passenger in a car that almost ran off the road in Perth when the farmer driving started laughing a tad too hard while regaling me with stories of his group’s latest exploits.

I’m not sure what measures of social engagement government is using nowadays, but I have friends and colleagues stressed by the task of supporting what remains of local group networks, as they deal with the overload of administrative requirements and exploding transaction costs for the multitude of project applications it takes to keep afloat financially, and do some good.

7. Where to now?

This brief overview, using a scattering of examples and the authors experience over the past 35 years, suggests that in Australia, government funded environment and land management efforts clearly suffer from a breathtaking lack of ambition, poorly integrated governance structures, a preponderance of competition rather than collaboration and more paper warfare than will get many of us out of bed in the morning – any morning.

From the movement’s perspective it’s partly our own fault, as we have been seduced by Landcare welfare for the past thirty years – grant writing however stressful has been habit forming. While government structures and processes seem deeply entrenched with little change in sight, we have a stirring example of change occurring with the efforts to reduce carbon emissions globally. After decades of the government’s little progress wrestling the so called ‘wicked problem’ carbon emissions presented, the major breakthroughs are coming from technology entrepreneurs, major firms taking responsibility, citizens using their own funds to switch to renewables and community, municipality and state governments ramping up collective efforts to meet ambitious targets.

That is the transformation Landcare and Natural Resource Management is starting to enter, and it’s not a tidy space.

References


11 AFR100. 2015. “African Forest Landscape Restoration Initiative”. Overview prepared by the World Resources Institute (WRI), New Partnership for Africa’s Development (NEPAD), and German Federal Ministry for Economic Cooperation and Development (BMZ) and the World Bank.


15 See [http://reconnectingnorthland.org.nz](http://reconnectingnorthland.org.nz)


NRM extension as an effective tool to improve adoption of NRM practices

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Abstract: To improve adoption of NRM practices, a model integrating the traditional Stages of Change model, developed by Prochaska and DiClemente (1983), and the adoption process (Pannell et al. 2011) was developed for a PhD study to identify stages in landholders’ practice change in the WA Wheatbelt, and the stages where extension interventions are most beneficial. In an online survey, respondents rated their stage of adoption of 13 recommended NRM practices at six stages of adoption, and the benefit of 17 methods of support at four stages of adoption. The results showed that a respondents stage of adoption was related to attitude toward how well private and public net benefits of a practice might help achieve their goals, and that as they progress through the stages of adoption their preferences for the methods of support changes. The above authors emphasise that many interventions are inappropriately targeted at the action stage and warn that interventions planned to progress change need to be applied at the appropriate stage to be effective. Therefore, identifying a landholders’ adoption stage during initial phases of planned interventions provides a clearer picture of their readiness for change. Combining this information with the most beneficial methods of support at each stage of adoption is a strategy required to ensure that the most appropriate methods of NRM extension are implemented at each adoption stage. It also enables NRM extension to act as a more effective tool to improve adoption of NRM practices.

Keywords: Natural Resource Management, extension, landholders’ attitudes, stages of adoption

1. Introduction

Landholders have undertaken considerable work through government National Resource Management (NRM) programs; however, it has not been sufficient to mitigate land degradation (Pannell et al. 2006). Researchers argue that policies continue to be developed and implemented with NRM support without fully understanding the diversity of landholders, the factors that influence their decisions and the challenges they face when undertaking NRM practices (Mallawaarachchi and Green 2013; Pannell et al. 2011, 2006). This study was designed to improve our understanding of how ‘extension’ influences and, in turn, is influenced by these issues.

‘Extension is the process of enabling change in individuals, communities and industries involved with primary industries and natural resource management’ (NRM) (State Extension Leaders Network 2006, 3). Substantial research has been undertaken in recent years to determine what influence NRM extension has on landholders’ adoption of recommended NRM practices, and what this means for extension. In 2010 (Ecker et al. 2012) and 2012 (Kancans et al. 2014) the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) undertook research to determine the key motivators driving this change. They found that financial, environmental and personal factors were key in the adoption of NRM practices and the
availability of support played an important secondary role. Based on their recommendations, a PhD study was undertaken to investigate the role that availability of support played in motivating the adoption of recommended NRM practices in Wheatbelt landholders in Western Australia (WA).

2. Theoretical framework

A literature review revealed that change occurs in stages (Parminter 2011; Pannell et al. 2006; Prochaska and DiClemente 1983). A model integrating the traditional Stages of Change model, developed by Prochaska and DiClemente (1983), and the adoption process (Pannell et al. 2006; 2011) was therefore developed with the assistance of staff from the Wheatbelt NRM regional group. The model was used to identify stages of change in WA Wheatbelt landholders’ practices and the stages where the methods used by those working in extension to encourage adoption of NRM practices were most beneficial. Six stages were used in the survey: precontemplation (not considering it in the next five years), contemplation (thinking about it), preparation (planning and trialling), action (currently doing), interest (interested but currently unable to) and rejection (done but found not worthwhile). As might be expected, people do not necessarily move through these stages of change in a linear process but will move backwards and forwards within this cycle as their circumstances change. The following figure demonstrates how these stages would be used in practice to measure respondents’ adoption.

<table>
<thead>
<tr>
<th>NRM practice</th>
<th>I am thinking about doing</th>
<th>I am trialling how I will do</th>
<th>I am planning how I will do</th>
<th>I am interested but currently unable</th>
<th>I am currently doing</th>
<th>I have done but found not worthwhile</th>
<th>I am not considering doing within the next 5 years</th>
</tr>
</thead>
</table>

Figure 1. Survey question construction to measure stages of adoption.

3. Methods

As part of a mixed method study an online survey was conducted from March 2014 to March 2015 with respondents ranging from Badgingarra in the northern Wheatbelt, Wagin to the south and Southern Cross to the east. The Stage of Adoption model was used to rate respondents’ stage of adoption for 13 recommended NRM practices at six stages, and the benefit of 17 methods of support at four stages of adoption. To determine attitudes toward the NRM practices, respondents were also asked how well implementation of the NRM practice achieved their main goals. The survey was also conducted by telephone and mail with around one third of the total respondents to ensure landholder’s without computer access were represented. However, the use of Wheatbelt NRM networks for accessing respondents may have resulted in some NRM bias. A combination of Qualtrics survey software and Excel were used for survey implementation and analysis. The study was not large enough to be generalised to the WA Wheatbelt landholder...
population. However, many relationships found in the study suggest a larger study would confirm the results.

4. Results

4.1 Stage of adoption

Overall, respondents’ stage of adoption was significantly related to the ability of the NRM practice to achieve their goals. This confirmed what Pannell et al. (2006; 2011) had said, that the NRM practice needs to meet landholders’ goals before it is widely adopted. Pannell (2008, 225) also highlighted the importance of considering the levels of public and private net benefits arising from adoption of an NRM practice. ‘Private net benefits refer to benefits minus costs accruing to the private land manager as a result of the proposed changes in land management’ (Pannell, 2008, 225). They do not include payments made as part of a policy intervention. ‘Public net benefits means benefits minus costs accruing to everyone other than the private land manager’ (Pannel, 2008, 225). They do not include the costs to landholders who undertake NRM practices. The extent of private and public benefits arising from adoption of NRM practices differs between individual landholders and their farms. The importance of identifying the expected private and public benefits of adopting an NRM practice is to provide an understanding of how farmers are likely to respond and enable appropriate government responses to be determined. These can include the use of positive or negative incentives, extension support, technology development or, in some cases, taking no action.
Table 1. Respondents’ stages of adoption, the methods of support most beneficial at each stage and their requirements for support at each adoption stage.

<table>
<thead>
<tr>
<th>Stages of Adoption</th>
<th>Practices with the most landholders in the stage of adoption</th>
<th>Methods of support most beneficial at each stage of adoption</th>
<th>Landholders’ requirements for support at each stage of adoption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-contemplation (not contemplating undertaking in the next 5 years)</td>
<td>Single or multiple species agroforestry (57%), cell or strip rotational grazing (49%) and controlled traffic farming (46%).</td>
<td>N/A</td>
<td>Their needs are quite broad in this stage. They are mostly seeking information and evidence of the benefits and disadvantages of the practice for others and assurance that further research may provide benefits of adoption for them and their farm.</td>
</tr>
<tr>
<td>Contemplation stage (thinking about)</td>
<td>Variable rate technology (14%), controlled traffic farming (12%) and setting minimum groundcover targets (12%).</td>
<td>Website (68%) and media information (65%) and field days and tours (65%) and group talks and assistance (60%)</td>
<td>So here we see the need for more local and individual support with the need to see the evidence of what other farmers are doing, to discuss the practice with other farmers and to get assistance to understand the practical applications of the practice and how adoption of the practice fits with their own farming system.</td>
</tr>
<tr>
<td>Preparation (planning or trialling)</td>
<td>Planting and encouraging native vegetation regrowth (7%), planting and maintaining deep-rooted perennial pastures (7%), variable rate technology (6%), single or multiple species agroforestry (6%) and setting minimum groundcover targets for long term (6%).</td>
<td>Workshops and forums (56%), trials and demonstrations (54%), and individual advice (54%).</td>
<td>More practical assistance and support is required at this stage such as financial support, assurance from their peers that they are doing what they think they should be doing and individual advice from experts to enable them to adapt the practice to maximise the benefits.</td>
</tr>
<tr>
<td>Action stage (currently undertaking, reviewing and maintaining)</td>
<td>Most landholders were addressing soil acidity (84%), undertaking no/minimum-till, including stubble retention (84%) and managing crop weeds and Weeds of National Significance (77%). A moderate number of landholders (63% &amp; 64%) were planting or encouraging regrowth, or fencing native vegetation to control stock access. Fewer were setting minimum groundcover targets (46%) planting grazing shrubs (41%) or practising periods of fallow (40%).</td>
<td>Financial assistance (tax exemptions 65% and financial grants 52%) support from peer networks (50%) field guides (44%) and individual advice (42%).</td>
<td>Here it shows that farmers still want to be part of the farming scene that undertake the practice, and kept up to date with current events and research even though they are currently unable or unwilling to undertake the practice themselves.</td>
</tr>
<tr>
<td>Interest stage (interested but currently unable)</td>
<td>Variable rate technology (29%), controlled traffic farming (21%) and planting or maintaining deep-rooted perennial pastures (15%).</td>
<td>Peer networks (27%), media information (25%), web information, case studies and workshops and forums (all 24%).</td>
<td></td>
</tr>
<tr>
<td>Dis-adoption stage (done but found not worthwhile)</td>
<td>Adopting periods of fallow (10%), agroforestry, planting native vegetation and perennial pastures (all 7%).</td>
<td>N/A</td>
<td></td>
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The respondents’ stages of adoption appeared to reflect the level of private and public benefits associated with the different NRM practices. For instance, Table 1 shows that nearly all respondents were practising reduced tillage and stubble retention and addressing soil acidity. These practices have both high private and public benefits. Respondents were also asked to rate their stage of controlling Weeds of National Significance (WoNS). However, after comparison with other studies, it is believed that many respondents included crop weeds in their responses which most likely produced the high response. Controlling WoNS has high public benefit whilst controlling crop weeds produces very few long-term public benefits. Practices
such as setting minimum ground cover targets for the long term, planting grazing shrubs and practicing periods of fallow appear to have more moderate net benefits which is reflected in the level of adoption of these practices.

Of note was that more than 60% of respondents were planting or encouraging native vegetation regrowth or fencing it to control stock access; practices that have high public benefits. However, these practices are difficult to measure as respondents may have been actively planting at the time, or have native vegetation present from earlier plantings. Considerable time and effort goes into conserving native vegetation, such as pest and weed control and maintaining fencing, and responses in this survey likely reflect these activities. Overall, the results showed a relatively even divide between the number of respondents who were in some stage of adoption of the NRM practices and those not considering undertaking the practice in the next five years, signifying there may be potential for increased adoption. They also showed a relatively small percentage of landholders were in the contemplation or preparation stages, suggesting the final adoption levels for these practices may have almost been reached.

4.2 Benefits of methods of support

Respondents were asked to rate the most useful stages of support for the 13 methods of support. Table 1 shows that overall, the most useful methods of support were workshops, practical demonstrations, peer support, financial assistance, website and media information and individual advice. The support method rated as the least beneficial was social media. For over half the respondents support remained important during the interest stage. The table also explains the general extension requirements for landholders at each stage of adoption and how this relates to the preferred methods of support at each adoption stage. These results confirm suggestions in the literature that there are two learning processes: firstly at the precontemplation and contemplation stages where information is collected, integrated and evaluated to assist decision-making and secondly during the preparation or trialling stage where ‘learning by doing’ and skill development occurs (Prochaska, Norcross, and DiClemente 2013; Pannell et al. 2011, 13). The findings clearly demonstrate that multiple methods for delivery of information are preferred, along with advice, and that as they progress through the stages of adoption their preferences for the method of support for adoption changes.

5. Conclusion

Overall, the results reflect the complexity of adoption as explained in the literature due to the limited private financial benefits and relative advantages of many NRM practices to achieving individual landholder’s goals. The results are consistent with other researchers who argue that providing information during the pre-adoption stages is important to influence decisions to proceed to trial and that financial resources and personal support during the action stages will assist to reduce the risks and stress of adoption and facilitate change (Sutherland et al. 2012; Pannell et al. 2011; 2006).

The recognition of distinct stages of adoption where NRM extension methods are relevant and beneficial has important implications for NRM extension services and programs. Researchers inform us an individual’s stage of change needs to be identified during the initial stages of planned interventions to provide a clearer
picture of their readiness for change. They also suggest that many interventions are inappropriately targeted at the action stage and warn that interventions planned to progress adoption need to be applied at the appropriate stage to be effective (Prochaska, Norcross, and DiClemente 2013). Therefore, identifying landholders’ adoption stage during initial phases of planned interventions provides a clearer picture of their readiness for change. Combining this information with evidence of the methods of support that are most beneficial at each stage of adoption gives a strong indication of the strategies required to improve the prospects for NRM extension to act as an effective tool to increase adoption of NRM practices.

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References


Overview: Nyoongar NRM Pathway (NNP) pilot

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1. Introduction

Investment in education for the future of Aboriginal communities in regional Australia must consider the role of Native Title. In the context of Aboriginal communities, and any future utilisation or benefit from Native Title, that education investment should also be guided by long term considerations of natural and social capital:

- Social Capital Investment: Education that fosters improved networks and community partnerships.
- Natural Capital Investment: Education that improves the ability for communities to maintain their natural assets, manage resources in a sustainable way, that supports economic independence and derives benefit from ecosystem services.

For Australia’s First Nation peoples, their social and natural capital is already deeply embedded within their culture through their cultural responsibility to care for country. Therefore, education pathways that support sustainable development and capitalising on Native Title must successfully weave culture, community and the natural sciences into the educational journey of future generations.

The NNP pilot seeks to establish education pathways that maximise the human and social capital within the next generation to assume the cultural, economic and ecological responsibilities of future land management. These pathways integrate local traditional ecological knowledge and cultural connections with education, scholarship, training and employment programs for local Nyoongar youths to develop them into future land managers, business owners and teachers who can take advantage of opportunities in agriculture, National Resource Management (NRM) and regional economies while maintaining their cultural ties.

2. Goals

The project seeks to harness four important assumptions:

1. **Caring for Country**: Participating in caring for country ties to improvements in social, economic and environmental wellbeing.
2. **Education**: Investment in education and skills is vital to sustainable and equitable economic development.
3. **Traditional knowledge and scientific knowledge are complementary.** They are not mutually exclusive and should be utilised together.

4. **Capacity and authority:** Local leadership, knowledge and partnerships are the necessary base for successful implementation.

Each of these assumptions is based on evidence from research both here in Australia and overseas, and we believe to be mutually supportive of one and other.

### 3. Approaches

The project will endeavour to instill cultural change within the Ballardong Nyoongar community by the following processes:

- The intergenerational transfer of traditional cultural knowledge from the elders to the young to ensure the protection of the Nyoongar culture.
- The cooperation and support of the local schools to include Nyoongar culture in curriculums during 2017 and 2018.
- The establishment of the Ballardong Elders Council which will encourage and support the Nyoongar NRM Pathway project.

### 4. Current pilot project interventions

1. Recruiting and engaging teachers, initially at Quairading District High School, to incorporate local traditional knowledge along with natural sciences into classroom activities and lessons.

2. Establishing links between schools, local organisations, university scientists and elders through:
   a. Forming the Ballardong Elders’ Council to guide activities, advise teachers and provide cultural authority to various regional development and NRM activities.
   b. Signing MOUs with local government, schools and businesses to secure ongoing support and participation.
   c. Class incursions and excursions with elders, academics and community leaders.

3. Establishing formal pathways across primary, secondary and tertiary education, including Muresk College, that:
   a. Support the retention of skills and employment opportunities in Ballardong country.
   b. Provide clear options and pathways to employment and tertiary education.
   c. Foster innovation, entrepreneurship and business skills in future Nyoongar generations.
Figure 1. The interventions designed to bring together the four key assumptions as outlined above.
Targeted community engagement and investment at a catchment scale – Mortlock Connections

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Abstract: Approximately 90 kilometres inland from Perth lay the Mortlock River East and South catchments. In 2013, Wheatbelt NRM embarked on a targeted landholder engagement project to provide improved landscape connectivity and increased potential for genetic exchange for native species. Work began with a desktop analysis to highlight priority conservation areas. The next stage involved getting out to talk to the community in the paddock, having a conversation around the types of activities their property would lend itself to and the support Wheatbelt NRM could provide. This methodology of approaching the community alleviates the pressure and technical barriers presented by the funding application processes that are so widespread in NRM. Of 190 conversations with the community, 94 project proposals were drawn up for community consideration. These resulted in 57 landholder agreements for on-ground conservation work. While this may, on the face of it, seem like a huge effort for 57 contracts; these landholders are achieving over 35,000 hectares of vertebrate pest management, have secured over 2000 hectares of priority remnant bushland from grazing pressure and over 600 hectares of native revegetation. Concurrently, Wheatbelt NRM was running region-wide grant rounds using a traditional application process. Analysing the landholder engagement process responses, we found targeted engagement more effective for conserving priority landscape areas through involving landholders that would not have participated in these activities otherwise. Furthermore, we demonstrated higher uptake in areas that traditionally showed lower engagement with Wheatbelt NRM. This paper considers the investment in community engagement with the return in on-ground activity.

Keywords: Community engagement, habitat connectivity, catchment management

1. Introduction

Figure 1: The Mortlock Project area in relation to the Avon River Basin Subregions
In 2013 Wheatbelt National Resource Management (NRM) received funding from the Australian Government to undertake activities that would improve habitat connectivity across 1,500 hectares of the Mortlock East and South catchments. The Mortlock Connections project was designed to meet the Australian government’s strategic objectives of ‘assisting land managers establish, manage and enhance native vegetation on their land’ and to ‘maintain ecosystem function and improve resilience to the impacts of climate change’.

The Regional Natural Resource Management Strategy for the Avon River Basin (2014) divides the Avon River Basin into five subregions that have their own unique characteristics and environmental issues. Roughly 80% of the Mortlock South and East Catchments fall within the identified Central Wheatbelt subregion (see figure 1). Of all subregions within the Avon River Basin, this has the highest level of clearing and salinity; while also containing the lowest percentage of remnant vegetation patches that are larger than 10 hectares. 94% of the subregion has been cleared, 94% of the remnant vegetation patches within the subregion are smaller than the recommended 10 hectares and 6% of the catchment is saline. While there are significant areas of primary salinity, particularly throughout the Mortlock East catchment, all sections of the Mortlock River East, and the majority of the Mortlock River South show signs of secondary salinity and waterlogging (Department of Environment 2005, Department of Environment 2004). Much of the connected remnant vegetation in the Mortlock catchments occurs along rivers and drainage lines. The increasing secondary salinity and waterlogging, as well as livestock grazing over the summer months, are having a significant impact on the quality and diversity of connected habitats available to native species throughout both catchments. This highlights the critical importance of protecting and enhancing the remaining habitats in the region.

The Wheatbelt NRM team developed site-specific management plans for each project location, providing a range of on-ground activities to protect environmental assets, including revegetation, fencing to prevent stock access, feral animal management and environmental weed control. Through Australian Government funding, we were contracted to deliver 1,200 hectares of reduced grazing pressure, 450 hectares of revegetation, 10,000 hectares of feral animal control and 70 people participating in on-ground conservation activities. Traditionally, Wheatbelt NRM uses an open community devolved grant round that allows any landholder within the Avon River Basin to apply for funding to undertake environmental activities to improve habitat in the region, providing they meet the criteria. This grant round is generally well subscribed across the region, however funding history has shown that using this engagement method would not have allowed us to achieve our contracted deliverables or help meet the funder’s desired outcome.

This meant an alternative engagement method was required to ensure we were able to both engage the landholders of the region and meaningfully contribute to the Australian Government’s biodiversity outcome.

2. Methodology
The three landholders from the Mortlock catchments who applied and met the criteria through our first Bushcare Grant round were contracted through the Mortlock Connections project. As so few communities from the project area had applied in the first round of devolved community grants, we decided a targeted approach was required to ensure we were able to engage enough landholders with priority assets to achieve the project outcomes.

In determining which landholders to target, a desktop mapping survey was conducted. Using a remnant vegetation extent layer and layers for the threatened flora and fauna as well as Threatened
and Priority Ecological Communities, we created polygons around large areas of remnant vegetation and those containing threatened species incidences where we might have the best chances of achieving effective habitat connectivity. A cadastral layer was then overlaid and those properties that had land within the target polygons were selected for one-on-one engagement.

Once all of the houses on our target properties had been identified, the doorknocking process began. This involved many weeks of driving around the Mortlock East and South, knocking on well over 400 doors, leaving information packages for those who were not home and having conversations with the 190 landholders who were. Several of the houses that we identified through the desktop survey were abandoned, while others turned out to be sheds. Where no house was located on a property, we used local phone books, google and local community knowledge to identify absentee landholders.

Our initial conversations with landholders conveyed no expectations nor judgements, even where landholders might be participating in activities that are known to be detrimental to ecological processes. As we are not a regulatory body and the success of environmental management activities requires neighbours to work together, we did not want to close off conversations or put landholders off-side, as it would potentially risk our ability to engage them in the future.

We arranged site assessments for those landholders who agreed to engage in the project to understand what sort of activities we could support on their property. As none of the landholders we reached through this method had put together a funding application, they had not necessarily decided or even thought through what it was they wanted to do. Prior to undertaking a site visit, we conducted a desktop survey to identify whether any threatened species had been recorded on or near the property, looking at the size of remnant vegetation patches and creating an ‘ideal’ property plan for them (from our perspective). These plans started by taking into account the fact that a production focus for the property is always a priority. Desktop planning allowed us to have ideas in mind and suggest options to the landholder when undertaking the site assessment in the context of the ground truthing the lay of the land. The ‘ideal’ project plan was never taken into the field, as we didn’t want landholders to feel as though they were being pushed into agreeing to a particular set of activities or for them to feel overwhelmed by the amount of potential work. It simply enabled us to arrive equipped to have conversations around a diverse range of potential on-ground activities for a specific property, with respect to meeting project outcomes. At some site assessments, the landholder had not formulated specific ideas, so our pre-planning allowed us to start the conversation around what could be achieved. For those landholders who had several ideas in mind, we would use the ‘ideal’ property planning process to suggest activities that they may not have thought of or in other cases, help prioritise the ones they had in order to improve the environmental outcomes of their project.

The ensuing conversation and subsequently negotiated ideas were turned into a project proposal in the office and sent to the landholder for agreement prior to contracting. In some cases there were several iterations as the conversation continued.

At the contracting stage for each proposal we were very clear that we did not want to commit the landholder to anything they could not achieve within the identified time frame. We knew that any number of unexpected events could (and did) occur that would delay contracted activities, so we ensured project end dates had elements of built in flexibility and that we had over-contracted on outputs to make up for activities that may not be finished in time.
3. Results

Over the four years of the project, a total of 7 landholders within the Mortlock East and South catchments applied for funding to undertake 9 different projects through our traditional Bushcare Grant rounds, confirming our thinking that the traditional grant rounds would not allow us to achieve our targets.

The initial uptake of funding offered through the door-knocking process was quite slow, however once we had contracted the first few landholders interest rapidly increased. Of the 190 face to face conversations we had with landholders through door-knocking and the recommendations passed on to neighbours, 85 landholders asked to have a site assessment on their property. This resulted in a total of 94 project proposals being sent out, including the nine that went to landholders who applied through the traditional process. This led to 55 landholders being contracted to deliver 57 projects across the catchments.

Because of the engagement process and underpinning education methodology, a total of 107 people were recorded as participating to deliver the following completed on-ground activities:

- 2,278 hectares secured from grazing by stock, with 150km of fencing
- 660 hectares of biodiverse revegetation
- 36,412 hectares of landscape scale feral animal control, of which over 8,000 hectares was remnant vegetation

Malleefowl protection
A landholder north of Koorda, who was contracted through the Mortlock Connections project, fenced 328 hectares of bushland on their property to protect it from the impacts of grazing by stock. The aim was to help protect the endangered Malleefowl who inhabit this bushland. Their site management plan included feral animal control to protect the Malleefowl from predation. Images: left, Malleefowl mound in the protected bush; middle, bush protected through this project; right, cat caught near the Malleefowl habitat.
In the context of community engagement, the resourcing required to generate momentum is greater than that to maintain it. At the end of the engagement process, there is lag between the final conversation and the final contract - meaning allocated project funding did not meet community appetite within the area of operations. Fortunately, we had access to alternative Australian Government funding to cater these additional projects. Further activities were also contracted to be completed by these landholders after the completion of Mortlock project and are therefore not counted in the above totals.

4. Discussion

Wheatbelt NRM ran two separate engagement processes concurrently over a four year period. The data captured through these two processes provides the opportunity to identify some differences in efficacy and reach between the two methodologies. A consistent approach was used across both projects to construct and deliver site specific on-ground work and activities. This supports the idea that the engagement methodology was the key difference in securing targeted environmental outcomes.

The intent behind all of our projects is to make support for NRM work accessible to the whole community within the Avon River Basin. Community engagement and education programs designed to support and upskill communities underpin all the Wheatbelt NRM’s work. With the consistency in on-ground delivery we can compare and contrast the two engagement methodologies and explore how each has contributed to program outcomes. This is helpful in identifying lessons which can be carried forward into subsequent programs. The devolved community funding round is accessible to all communities throughout the Avon River Basin, yet the Mortlock project area was clearly underrepresented through applications (see figures 2 and 3). Starting with a significant lack of potential project sites and ending with an extensive waitlist in such a short space of time highlights how effective one-on-one in-paddock conversations can be in terms of community engagement, managing expectations and environmental outcomes.
There are a range of factors that appear to deter landholders from applying for funding through traditional application processes. While the online application process was a barrier for some landholders, we did offer hardcopy applications and advertised these grants through a range of both electronic (Facebook and enews) and printed (locals newspapers and newsletters) mediums. Through on-ground conversations we learnt that a number of other factors were at play. These included landholders:

- being uncertain whether their patch of bush or project idea was likely to attract funding and not wanting to spend time on an application with this level of uncertainty
- being unaware of the grants
- believing they may lose elements of control or ownership of their land if they sign up to a grant
- not having prioritised their time to looking into potential grant opportunities

Having face to face discussions from the start during the Mortlock engagement process, helped us to break down some of these barriers. We were able to engage a much broader cross-section of the community than the traditional application process allowed. While carefully constructed grant guidelines can help channel people’s thought processes into what it is we can support, they do not replace the benefit of having an in-paddock conversation and jointly formulating potential on-ground activity. A devolved grant round provides limited opportunity for two way communication at the front end of the process, it is not a conversation and lacks the ability to allay any fears or barriers to participation.

Even though the landholders contracted through the targeted engagement approach had not taken the step of applying for funding themselves they still showed the same level of dedication to their on-ground activities. One Mortlock landholder, using 2 cage traps, caught 66 cats over a 6 month period. Living relatively close to a rubbish dump provided a good feeder population of cats, however this is still a very impressive achievement and shows real commitment. Another landholder engaged through the targeted process completed 12.7km of fencing to protect 328 hectares of bushland, home to Malleefowl, from the impacts of grazing by livestock. This suggests that a lack of motivation or care for the bushland are often not the main factors in landholders not applying for grants.
While potentially narrowing community engagement, the targeted approach allows us to achieve more cohesiveness around value adding to investments and complimentary activity within a localised geographical area. It clearly has positive implications for asset specific investment such as targeting threatened species in key habitats. The ability to sell projects and environmental outcomes in such a way that landholders are willing to participate goes a long way to ensuring people have a positive experience. This in turn generates further enthusiasm and momentum with the flow on effect being referrals to neighbours and other people in the area. Landholders promoting our project and its outcomes to other landholders is always going to be one of our most effective marketing opportunities to achieve practice change.

5. Conclusion

Using a significantly different engagement methodology to our traditional approach has resulted in a number of lessons that will be beneficial for the design of future projects. These include:

- Start small and break target areas in to achievable chunks to make the process feel less daunting
- As with other engagement approaches, you will need to target landholders at times of the year when they are less likely to be in the paddock. For example, in the Wheatbelt farmers are more likely to be contactable for initial conversations outside of seeding and harvest seasons
- This is an effective method for achieving asset specific management outcomes that have a clearly defined focus – for example managing key habitat for threatened species
- Give your landholders as much time to complete project activities as possible. This may mean you have a greater requirement for staff time early on in the project specifically for engagement. This provides the opportunity to contact as many landholders within your target area as possible early on. Having landholders on board early increases their ability to fully complete their contracted activities well within the project timeframe
- Plan for unforeseen circumstances and ensure you contract more outputs than your project requires. During the life of the project this region experienced a major flood event that had significant impacts on our community. One of these was to reduce many landholders capacity to focus on project activities, which subsequently pushed out scheduled completion. Landholders also faced a number of other challenges which affected planned timeframes, including personal illness and loss of skilled farmhands

Acknowledgements

The Mortlock community & Wheatbelt NRM Project staff.

References


Reflections: WA NRM and Coastal Conference, Curtin University Perth

29th August – 31st August 2017

Naomi Edwards¹ (Notes compiled by)
¹Griffith University, Ethics Approved: (GU Ref No: 2017/546).

1. Notes from presentations

1.1 Coastal sustainability made simple (Charlie Bicknell)

Quotes:
- Are we doing enough – no
- Issues we have been talking about for 10 years at these conferences are coming, and they are not far away
- Love it when we want to build seawalls around toilet blocks (sarcastically)

Involving communities in developing coastal risk management frameworks in Western Australia (Craig Perry)
I have concerns on their approach to engage and survey the community, the beach survey questions were too technical, not inclusive language (climate impacts, assets – will the people they survey have definitions for these terms?)

1.2. Planned and management retreat (Ben Bassett)

- Planning presentation on the enforcement planned retreat
- In theory this is the government approach, however, in practice is it possible?
- My question – where has this approach been successful? Southern Shores Coastal Program – Partnerships for restoring and protecting coastal environments on the South

1.3. Coast of Western Australia (Brett Dal Pozzo)

- You can make this work look like rubbish and roads to get local government to do coastal works
- Southern Shores Coastal Program – works across boundaries
- 26 sites across the south west
- Have a partnership approach to deliver on ground outcomes, e.g. work for the dole which they have employed 18 people, 50% are indigenous
- Code off the road project is really popular – sold out events, have maps and signage and looking into photo point monitoring

Community engagement in scientific assessment, management and conservation of marine biodiversity with the

1.4. Reef Life Survey Program (Paul Day Reef life program)

Was probably the most calm and charming presentation about the role and importance of citizen science
- Great story and example of showcasing the social and environmental impact that citizen science can achieve to improve our knowledge about coastal and marine systems
1.5. WA Coastal Zone Strategy by David MacLennan (my thoughts)

- In theory it is a strategy
- In practice it is a different story
- It is high level and won’t respond to local issues
- Lessons learnt from the eastern states
- Lack of funding for implementation (e.g. only $2million a year and need co-investment from local councils or other groups)

2. Notes from keynotes

2.1 Mathew Clarke (NSW Coastal Management Reforms)

- Legacy issues – developing too close to the coast, public and private infrastructure
- What has been the role and importance of coastal professionals – he replied, huge, they were able to provide the technical knowledge that policy makers do not understand, if you can provide clear statements that explain the broad brush objectives and how it impacts one person, it is helpful
- What are the benefits of having a storm coincide with releasing policy – it fast tracked investment
- NSW is the only state to have a climate change fund

2.2. Adrian Ward (Wentworth Group of Concerned Scientists)

- They have done a project that predicts Australia only needs $8billion a year to manage land and water resources
- Green infrastructure needs to be recognised as infrastructure
- We need to work together if we are going to scale projects and seek corporate investment for $100million

2.3. Keith Bradby (WA Landcare Network)

- We are now at a critical point in the history of our planet
- If we are not doing transformational change, we might be wasting our time
- We have lost integration across all sectors
- Need to bring hope and aspiration to 3-year program cycles

2.4. Nana Tseasewaa III (Queen of Gwira Akyinim)

- Need to reinvigorate traditional practices in institutions to respond to challenges
- The western way does not work

3. General conversations

- There is a skill shortage in WA, and when there are projects they tend to be mining or development. You cannot look green or else you won’t get any work. The small professional community hinders those who want to speak out
Everyone communicates differently, and everyone likes different things, so you cannot expect buy in from everyone to accept a blanket program

3.1 Comments from workshops

3.1.1. Coastal workshop: Understanding the recreational values of the coast (Gary Middle)

- Uses and values – they are different
- Uses of the coast: activity
- Values of the coast: environmental, cultural, social and economic values

4. My closing remarks

What are these guidelines for? “Building seawalls around toilet blocks”, was a remark made by Charlie, who brilliantly summed up the way that the practice is being lost. He set the scene with sharing this quote along with his story and passion for good coastal management. I agree with him that we are not doing enough but as an optimistic Queenslander, I’ll be flying home on Friday knowing that there are some kick-ass projects.

I really enjoyed Paul Day’s presentation on the Sea Life citizen science project. He brilliantly communicated the impact of citizen science. It’d be a great approach to follow to help fill the data gap of coastal processes along the Western Australian coast.

While, I don’t think I saw any projects or presentations that had what it takes to disrupt, I did get the vibe of a renewed energy and sense of collaboration, especially in the coastal future workshop. I think you do have what it takes to develop a coastal management act.

I thought Ben Basnett’s presentation about planned retreat was bold and daring to share. In theory it seems possible, however in practice you will need everyone to own the enforced special control zone ideas.

If we take what Keith Bradby shared in his keynote, that we need to trust each other and breakdown silos to successfully make Adrian Ward’s ideas on securing large investment, it is all possible.

Although if all fails we can Cha-Cha-Cha, like what Joanna said, as CHAPS create maps that can rap…

So, the essence here is to have fun!

What is missing, and it has given me some ideas for the future, is talking about the best ways we can engage our decision-makers and politicians, even media. Perhaps you could emphasis this at the next conference?

Thank you for inviting me to WA to be a keynote and engage in meaningful discussions, and special acknowledgement of women at the beginning of the conference was a nice touch.
Habitat restoration at the Houtman Abrolhos islands – status and future directions

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Abstract: Central Regional TAFE’s Batavia Coast Maritime Institute (BCMI) in partnership with the Northern Agricultural Catchments Council (NACC) have recently completed a project to restore native plant biodiversity at key sites on the Houtman Abrolhos (Abrolhos) islands. Activities included strategic restoration activities with local provenance native plant species and undertaking threat abatement measures. Over 28,500 local provenance seedlings were planted, with seed and plant propagation material collected from the islands before being propagated at BCMI’s Nursery Industry Accreditation Scheme Australia (NIASA) accredited nursery. In addition, priority weeds were mapped on 42 different islands/islets and more than 1,800 hectares were managed for Weeds of National Significance via mechanical and chemical control. A total of 3,745kgs of marine debris were also removed from 27 islands/islets, from a total length of 62kms of coastline. At the heart of this project were community volunteers and students (a total involvement of 471 people) who were involved in all project activities and were vital to its success.

Keywords: Abrolhos islands, Coastal Management, Habitat Restoration, Weed Management.

1. Introduction

The Abrolhos islands are a unique chain of 122 islands that lie approximately 70 km off the Western Australian (WA) coast. The Abrolhos islands are home to a diverse range of fauna, including a wide variety of birds, reptiles and mammals, many of which are endemic to the Abrolhos. Many of these species are threatened or endangered and are protected under State and Commonwealth legislation and international agreements (Department of Fisheries 2012). The islands are one of the most important breeding sites for tropical seabirds in Australia (Surman & Nicholson 2009a) and contain the largest colonies of Wedge-tailed Shearwaters in the eastern Indian Ocean. Five rare bird species (Australian Lesser Noddy, bridled and sooty terns, little shearwaters, and white-faced storm petrels) nest on only a few islands scattered throughout the chain. Over decades, invasive weeds and loss of habitat have placed immense pressure on bird species, as well as many other priority species using the islands; including the Australian Sea Lion, Abrolhos Painted Buttonquail, Brush Bronzewing, Abrolhos Spiny-tailed Skink, Abrolhos Dwarf Bearded Dragon and carpet python.

The Central Regional TAFE’s Batavia Coast Maritime Institute (BCMI) in partnership with the Northern Agricultural Catchments Council (NACC) conducted a four year project aimed at restoring native plant biodiversity at key sites on the islands, through undertaking strategic restoration activities using local provenance native plant species and by implementing threat abatement measures. The project aimed to protect vital seabird breeding habitat through control of Weeds of National Significance and state priority in high value biodiversity areas. Areas that have been highly impacted by weeds and/or land use practices were replanted (with local provenance native species) to enhance inter-connecting corridors between key biodiversity sites across the islands.

The environmental threats facing the Houtman Abrolhos Islands encompass both local and global issues, and one of the central focuses for the project was on education and volunteer involvement.
in on-ground works. Long established invasive weed populations, marine debris and degraded coastal habitats are major issues that fishermen, their families and local communities on the WA mainland should be informed about. Community workshops and training sessions were undertaken to pass on valuable knowledge surrounding these issues and how the community can get involved. Workshops included weed ID and management on Pigeon Island, micro-plastic sampling both at the Abrolhos islands and along Geraldton beaches, community beach clean ups with subsequent rubbish sorting to contribute to the Australian Marine Debris Initiative, as well production of Abrolhos island management plans with input from a range of local groups and governmental departments.

2. Methods

A review was made of the available literature (Harvey, Alford, Longman and Keighery 2001; Paling 2005; Surman and Woolle 1995; Surman and Nicholson 2009b; Department of Fisheries 2003; Department of Fisheries 2012; How, Pearson, Desmond and Maryan 2004) to determine priority sites and was supplemented by undertaking flora, fauna and site assessment surveys across the islands, the results of which were used to identify project sites.

Sites were selected for revegetation and at these sites seeds and cuttings of native plant species were collected and taken back to the BCMI to be propagated and grown up in an accredited biosecure nursery. Wallaby exclusion zones were implemented on North Island with the construction of a wallaby exclusion fence around two revegetation sites to stop the introduced Tammar Wallaby from impacting the success of revegetation activities. The tube stock was then transported back to the islands in early winter and planted within restoration sites at the islands to re-establish vital habitat and food for native animals such as seabirds, reptiles and sea lions.

The main weeds being controlled by the project were Weeds of National Significance, as well as state and local priority weeds. Weed management was conducted via hand removal and chemical control, including foliar spraying and the cut stump method. Two different erosion control treatments were trialled and assessed for effectiveness: 1) coir matting and 2) coir matting with coir logs.

Marine debris was removed from beaches and sorted, weighed, recorded and the data was submitted to the Australian Marine Debris Initiative.

A series of community workshops were undertaken throughout the project. Topics covered by the workshops included plant propagation, weed identification and management and marine debris. Participants of the workshops were community members including students and the fishing community at the Abrolhos islands.

3. Results

Activities were undertaken on 42 different islands over the course of the project. This involved undertaking 72 trips to the islands (17 flights and 55 multi-day boat trips).

Revegetation: Over 28,500 local provenance seedlings were planted across 9 islands, covering an area of approximately 10 hectares. The species planted included 18 local provenance coastal native species on 6 islands with white mangroves (*Avicennia marina*) being planted on an additional 3
islands. Survivorship of the coastal native species was 80-90% while survivorship of the mangroves was 81%.

**Erosion Control:** 6,500m² of erosion control matting was installed on three islands. To determine the effectiveness of the erosion control methods used, sand accretion/erosion was measured in nine quadrats (10m x 10m) at the revegetation site on North Island and the data analysed using a one-way ANOVA (n= 9). Results showed a significant difference between the different erosion control treatments (F = 7.959, df = 2, p = 0.0056). There was a difference in the amount of erosion between the plots which had an erosion control treatment compared to the control plots, however, there was no significant difference in the amount of erosion between plots with coir matting and the plots with coir matting and coir logs (Figure 1). There was no significant difference in plant survivorship among the different treatments.

![Soil levels after erosion controls ± SE](image)

**Figure 1. Results of erosion control trial.**

**Weed management:** Priority weeds were mapped on 42 different islands/islets and more than 1,800 hectares were managed for Weeds of National Significance via mechanical and chemical control. Approximately 11 tonnes of weeds were removed including 439 Prickly Pear (*Opuntia stricta*), 97 African Boxthorn (*Lycium ferocissimum*), three Tamarisk (*Tamarix aphylla*) and over 5,000kgs of succulents (primarily *Aeonium arboreum*).

**Marine debris:** A total of 3,745kgs (37,056 items, over 25m³ volume) of marine debris were removed from 27 islands/islets, from a total length of 62kms of coastline. Common items included: plastics, ropes and nets, cray pot remnants, broken glass and aluminium cans. The greatest quantity of marine debris recorded was in the category of “plastics” followed by “commercial fishing remnants” (see Figure 2). Uncommon items included a number of televisions and refrigerators, an office chair, ironing board and a washing machine. All items were weighed and recorded and the data submitted to the Australian Marine Debris Initiative.
Additional activities: Collaborative projects have been borne out of the strong partnerships established by the project; the Northern Agricultural Catchments Council and Abrolhos islands project staff have successfully organised and implemented community Beach Clean Ups on local Geraldton beaches to encourage a healthier environment and combat marine debris. The project has assisted researchers at University of Western Australia with micro plastic sampling along Geraldton and Abrolhos islands coastlines; collaborated with Bush Heritage Australia in training TAFE students in fauna identification, monitoring and handling; undertaken native plant tissue culture practices with guidance from Kings Park & Botanic Gardens; and initiated an extensive mouse (Mus musculus) eradication program in the Rat Island group in collaboration with the WA Conservation Council.

Community engagement: At the heart of this project are community volunteers and students (a total involvement of 471 people contributing 17,365 participant hours to the project) who were involved in all project activities and were vital to its success. The project worked closely with the Abrolhos islands Bodies Corporate who supported the project through jetty access, supply of water for the revegetation activities and the use of equipment. Thirty-four scholarships were awarded to study Conservation and Land Management at Central Regional TAFE. Seventeen community workshops were held with topics ranging from weed identification and management, the impacts of marine debris to plant propagation techniques.

Challenges surrounding land and jetty access, resources and shifting/transforming entrenched attitudes have been overcome by developing strong working relationships with the lobster fishermen and their families who inhabit islands at different times of the year. These relationships were built on open and honest communication, engagement and discussion of threats and issues facing the Abrolhos islands environment and demonstration of leadership and commitment to the projects key priorities by project staff and volunteers. By building capacity, repertoire and positive working relationships with fishermen, the Bodies Corporate, community groups, governmental departments, volunteers and community members the project has been able to successfully achieve its goals.

4. Future directions

Future directions for activities at the Abrolhos islands include continued:
• Threatened species monitoring
• Mangrove restoration
• Weed management
• Marine debris removal
• Invasive species monitoring (e.g. house mouse eradication in the Rat Island group)
• Community awareness and involvement

Acknowledgements

This project was supported by Central Regional TAFE in partnership with the Northern Agricultural Catchments Council and was supported by funding from the Australian Government.

References


Unseen invaders: aquatic pests of Mid West Western Australia

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Abstract: The Central Regional TAFE’s Batavia Coast Maritime Institute in partnership with the Northern Agricultural Catchments Council and supported by the Australian Government, have been working to establish current distributions of riverine invasive species in the Mid West in order to develop control strategies to inhibit further range expansion. To date, 329 trap surveys have been undertaken at 50 sites as well as 27 Tilapia environmental DNA (eDNA) surveys at 18 sites across the Irwin, Greenough, Chapman, Hutt, Buller, Bowes and Murchison Rivers representing a cross-section of aquatic habitats at different stages of invasion by aquatic pests. In total, 590,777 animals have been sampled and 394,784 pest fish (66.8% of catch) removed. Our current and comprehensive mapping of pest distributions in this area indicates a range expansion of three established pest species and detection of a potentially new invasive species.

Keywords: Aquatic Pests, Freshwater Fish, Tilapia, Gambusia, Mid West WA.

1. Introduction

Aquatic pests pose clear threats to river health and co-habiting native species through food and space competition, predation, aggressive interactions, disease reservoirs, potential hybridisation and habitat alterations through feeding, burrowing and nest building (Corfield et al., 2008; Rowe et al., 2008; Harris, 2013). The rivers of Mid West Western Australia contain a relatively depauperate native fish fauna, particularly in freshwater reaches (Morgan & Gill, 2004) and previous studies have shown a clear numerical dominance of the alien species Cherax destructor, C. cainii, Gambusia holbrooki, Oreochromis mossambicus, and Xiphophorus helleri in many of these rivers (Morgan & Gill, 2001; Morgan, Gill, Maddern & Beatty, 2004). Prior to this study, the region’s largest river and the second longest in the state, the Murchison River, was considered to be free of alien species (Morgan & Gill, 2004; Morgan, Allen, Beatty, Ebner & Keleher, 2014), however this has subsequently been rejected.

Accurate knowledge of alien species distribution is essential for correct site control activities and to implement control activities for new incursions before potential pests become firmly entrenched, widely distributed and problematic to control (Koehn & McKenzie, 2004). As with native species, alien species distributions are tightly controlled by environmental conditions imposing distribution limits (Russell, Thuessen & Thomson, 2012). A knowledge of these limits can aid in pest control both in prioritising areas for control and identifying sites of potential future incursions. These environmental limitations may also be used in developing control strategies. A wide variety of potential control strategies have been suggested and trialled for aquatic pests including: biological control, chemical treatment, intensive harvest, disease and genetic techniques, though as of yet no aquatic pest has been successfully eradicated from the wild in Australia (Koehn & McKenzie, 2004).

To combat the threats posed by these aquatic invaders, the Central Regional TAFE (CR TAFE), in partnership with the Northern Agricultural Catchments Council (NACC) has conducted a four year project aimed to define key baselines for native and alien fish populations. This project aimed to determine current distributions of aquatic pest and native species throughout Mid West rivers, develop and trial control strategies for the Tilapia population, prioritise and establish future
directions for control and research into Mid West aquatic pests.

2. Methods

Following a pilot study undertaken in the Chapman River in 2013 to optimise survey techniques, seasonal trap surveys were conducted in February, May, August and November across the Irwin, Greenough, Chapman and Murchison Rivers from 2014 to 2016. Additional single surveys were conducted in the Buller, Bowes and Hutt Rivers in March 2017 and at six off-stream locations within target river catchments from 2014 to 2016. Trap sets followed the standard protocol of White & Storer (2012), consisting of two fyke-nets set 100m apart with mouth openings facing away from one another as well as five large and five small baited box-traps positioned to represent habitats within the 100 m reach encompassed by fyke nets. Equipment was retrieved after 24 hours. Survey sites (fig. 1) were chosen to represent upper, mid and lower reaches of rivers with each site sampled seasonally for one year before an alternative site was selected for the following year.

In total, 329 animal sampling trips were conducted from 44 instream sites and six off-stream waterbodies. In addition, water samples were collected for Tilapia eDNA analysis from 12 sites across the Chapman, Greenough and Irwin Rivers in 2015 and six sites in the Wooramel, Murchison and Chapman Rivers in 2016 which reinforced the results of trap surveys.

![Figure 1: Survey site locations, trap sites: ◆ Chapman River sites, x 2014 sites, o 2015 sites, △ 2016 sites and + 2017 sites; eDNA sites: ★ 2015 sites, ● 2016 sites.](image-url)
3. Results

Through the course of this project 590,777 animals were sampled from 42 species including fish, amphibians, reptiles and crustaceans. Of these, 394,784 were introduced species comprised of: three fish species: Gambusia holbrooki, Oreochromis mossambicus and Xiphophorus helleri; two crustaceans: Cherax cainii and C. destructor; and an introduced freshwater turtle: Chelodina colleti. Overall, 393,134 alien fish and Yabbies were removed from Mid West rivers.

Native species included 18 native marine fish species found within estuaries, five native estuarine fish species penetrating significant distances into the freshwater reaches of rivers and three obligate freshwater native fish species. In addition, three frog species and the native turtle Chelodina steindachneri were also recorded in Mid West rivers and six native marine crustaceans were detected in estuaries.

Range expansions of three native fish species: Anguilla bicolor, Arenigobious bifrenatus and Hypseleotris compressa have been detected, with A. bicolor and H. compressa ranges extending south to the Chapman and Irwin Rivers respectively and A. bifrenatus extending north to the Greenough River. The ranges of native species (excluding Pseudogobius olorum) are currently constrained within local rivers by barriers such as weirs and road crossings in the lower reaches impeding migration and potentially aiding upstream dominance by alien species. Native species appear to be co-existing with pest species but may be in lower abundances due to competition for resources, however further research needs to be undertaken to determine what species-specific effects these alien species have on the local fish fauna.

Figure 2, Distribution of aquatic pests in Mid West rivers. River channels are colour coded for alien species present; ▬ Yabby and Swordtail, ▬ Yabby, Gambusia and Swordtail, ▬ Yabby and Gambusia, ▬ Gambusia, ▬ Swordtail, ▬ Tilapia, Gambusia and Southwestern Long-necked
Alien species were detected in all surveyed rivers except the Bowes River where no fish were recorded at all (fig. 2). Despite native species richness being higher than that of pests in rivers surveyed (fig. 3), mean pest abundance outweighed that of natives in both the Chapman and Irwin rivers. This indicates very few pest species (namely Gambusia in the Chapman and Swordtails in the Irwin) dominate the fish fauna communities in terms of sheer numbers. Swordtails accounted for 49.9% of the total catch in the Irwin and Gambusia accounted for 94.5% in the Chapman River. Tilapia (*O. mossambicus*) are currently restricted to just the estuarine reaches of the Chapman River by a combination of in-stream barriers, a long ephemeral region immediately upstream of the estuary and a winter flow regime whereby cold, low salinity inflowing water inhibits upstream dispersal whilst relatively low upstream salinities reduce cold temperature tolerance.

For the first time, Swordtails were detected in the Greenough River and Yabbies in the Murchison River. These range expansions are of particular concern as they represent incursions into new catchments and in the case of Yabbies, the first detection of any alien species in this river which was previously considered pest-free. In addition, an introduced turtle, *Chelodina colliei*, has been found in the Chapman River, potentially out-competing the native turtle species with which it may be hybridising and this is now the dominant animal in this river by biomass.

4. Recommendations

- Continuation of trapping and eDNA surveys in Mid West rivers.
- Intensive surveys around the Bilyoo Bridge site on the Murchison River and Arthur Rd site on the Greenough River to determine current range of Yabbies and Swordtails respectively and potentially remove the population through intensive trapping or poison.
• Completion of broodstock creation for Trojan Y Chromosome (TYC) Tilapia at the bio-secure facilities of the Batavia Coast Maritime Institute.
• Commencement of TYC field trial on Tilapia in the Chapman River estuary.
• Completion of genetic studies of Chapman River turtles to aid in development of a control strategy.
• Development of appropriate methodologies and a facility in Western Australia for eDNA sample processing for detection of all local alien species.
• Further examine the impacts of river barriers on native fish migration in Mid West rivers and explore opportunities to alter or remove these barriers to allow recolonisation of upstream areas by native fish species.

Acknowledgements

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References


Paradigms in the Management of Natural Areas in the City of Stirling (Presentation)

29 August 2017

W. Kolb

The committee members of Inaugral Stirling Coastcare (2005) reformed as Stirling Natural Environment Coastcare (SNEC) in 2009. The land manager of City of Stirling (CofS) agreed to allocate North Beach Headland to the group. Due to the degradation of adjoining areas, SNEC quickly realized that it had to look at the bigger picture to be effective.

SNEC manually mapped all degraded areas along CofS’s 6.85 km of coastal foreshore in 2008 onto aerial maps with 50 metre grid co-ordinates and 1:2000 and 1:500 scales supplied by the Department of Planning. In 2011 and 2012 SNEC engaged Fisher Research to digitally map the entire area using five (5) categories of weed density with 20% increments. This information was made available in OziExplorer and the City’s GIS system.

Using these maps, SNEC was able to prioritise its activities. It quickly commenced removing weeds that were in small numbers and also weeds that were easy to manage by hand weeding. These included all Victorian tea tree, palms, yucca, agave, coryledon, lantana, stock, statice and many others. At the same time SNEC, through CofS’s chemical contractors, started to contain and manage invasive weeds, reducing the overall list of 84 weed species both ways. Species were Brazilian pepper, sea spurge, couch, and all geophytes. In 2006 the group adopted working schedules of two hours, twice mid-week, for 11 months of the year, contributing 2,000 hours yearly for the 11 years since.

At the beginning, due to lack of resources, SNEC was limited to hand weeding. By the time funding became available, only Couch grass and Geophytes were left to be managed and that early work resulted in a more effective and economic use of chemicals. SNEC was spending state, federal and other funds it was required to justify the expenditure to the land manager. This was to ensure timely chemical weed management focusing where more intense effort was needed to ensure effective application over a shorter period of time.

SNEC has now revegetated 2.85 km of the Spearwood dunes and has reduced the use of chemicals to small amounts of ‘spot’ spray. SNEC planted 43 native species to mimic nature, with planting of larger plants at 1.5 m spacing and smaller plants at 1 m spacing. A framework of hardier plants had thus been established and infill planting was carried out in the following years to replace losses and add to biodiversity.

In 2010 an outbreak of lupin forced SNEC to engage in the Scarborough area. SNEC consequently sought funding for follow-up management and instead of only targeting lupin, Geraldton carnation weed, sea spurge, radish and turnip were added to the species to be managed.

In 2013 Perth Natural Resource Management (PNRM) was looking for projects to make a real difference, holding wide consultative workshops. They applied for a $2M regional coastal restoration project through the Australian government’s Caring for our Country initiative. SNEC had initiated a three year project to clean-up completely degraded areas adjacent to infrastructure along 1.1km of natural area from Peasholm Street (“Cambridge” border) to Brighton Road, Scarborough. That funding did not become available from PNRM, so SNEC applied for and received three (3) separate years of funding from Coastwest. Then, because SNEC’s volunteers were mainly occupied in the Spearwood dunes, SNEC carried out this project primarily with contractors and some assistance from corporate groups.
This project gave SNEC the ability to compare projects predominantly carried out using volunteers with projects mainly carried out by contractors. The subsequent decision to use mainly contractors was also based on discussions within SNEC’s committee regarding succession planning. Volunteer hours available for projects was variable, so SNEC looked at different ways to operate and achieve the same outcome.

These two ways of operating have since been developed into SNEC’s method of best practice in revegetation of natural areas. These methods can be used by any one successfully. The success of projects depends largely on good supervision, ongoing monitoring, reassessment and follow-up action.

SNEC has planted 8,860 plants in the 1.1km of Scarborough’s Quindalup dunes, starting gradually, planting from the best areas to the worst. In the 2.8 km of Spearwood dunes over Tamala limestone, SNEC has planted just under 40,000 plants over 11 years, from Beach Road, City of Joondalup’s boundary with City of Stirling, to near Karrinyup Road (Marmion Marine Park’s southern section).

The planting holes on steep slopes are augured to increase moisture retention and depth of planting. Plants are protected by plastic protectors with four (4) bamboo stakes that are removed before end of November. One (1) stake is left to indicate losses and where Summer watering is required. To minimise run-off on slopes SNEC prefers to ‘dish’ holes.

These are the main points of SNEC’s origins, progress, and current state that can be presented within the time allotted. Any questions are most welcomed.
Yangebup Lake WA: Solar Powered Nutrient Stripping Basin Trial

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Abstract: The aim of this project was to assess the effectiveness of using a solar powered pump in conjunction with a traditionally designed nutrient stripping basin and bio retention system to improve the water quality of Yangebup Lake by removing nutrients while at the same time enhancing the habitat value of a degraded site. Water samples were regularly taken from the inlet and outlet of the system, to test for total nitrogen and total phosphorus, to determine the system’s effectiveness in removing nutrients. Vegetation within the basin thrived, indicating good nutrient uptake, however water quality monitoring samples fluctuated with some samples showing increased levels of nutrients after flowing through the system. Further investigation revealed that the basin had intercepted nutrient enriched groundwater that was flowing toward the lake. The groundwater was tested and found to have levels of nutrients well in excess of the Australian water quality standards.

Key words: solar power, nutrient, water quality

1. Introduction

The City of Cockburn is a peri urban local government authority on the outskirts of Perth. Yangebup Lake is part of the Beeliar chain of wetlands which lie within the City’s boundary. Yangebup Lake is a surface expression of the groundwater in the area and consists of more than 82 hectares of open water. It has a maximum depth of 4 metres (ENV Australia 2008).

The groundwater regime in the area was affected in the past by a series of sediment precipitation ponds which were operated by the Jandakot Wool Scouring Company Pty Ltd until February 2000 to treat waste water from the wool scouring operations. The level of water in those ponds was above that in the lake resulting in a localised groundwater mound and seepage of contaminated water into the local aquifer system (Martinick and McNulty 2000).

Yangebup Lake is also the receiving point of the Water Corporation’s South Jandakot Drainage Scheme which is designed to control groundwater and stormwater in the southern suburbs such as Hammond Park.

Studies indicate that a large percentage of the phosphorous and nitrogen entering the lake comes from the groundwater and the sediment store (ENV Australia 2008) (refer Fig 1.).
As a result of past development and current drainage regimes, Yangebup Lake is highly nutrient enriched, to such an extent that it is considered hypereutrophic (ENV Australia 2008). As a result of the abundance of nutrients, algal blooms are common in Yangebup Lake. Often the blooms are localised to certain parts of the lake and this is generally dependent on wind direction and can contain cyanobacteria (Figure 2).

Bio retention systems are either grassed or landscaped swales which promote infiltration of stormwater and, when vegetated, increase the uptake of nutrients. When vegetated they are commonly referred to as nutrient stripping basins, which is the term that will be used throughout this paper.

Nutrient stripping basins are very effective in treating stormwater and reducing the levels of nutrients entering wetlands. Numerous examples of nutrient stripping basins can be seen around the Perth metropolitan area (DoE 2004).

Many nutrient stripping basins rely on rainfall, as drains or constructed water courses direct stormwater flow, generally from road runoff, into nutrient stripping basins.

The key aim of the solar powered nutrient stripping basin was to reduce levels of N and P within the wetland. The City of Cockburn determined that such a solar powered system may be useful to help improve the water quality within wetlands that currently exhibit poor water quality and issues predominantly related to eutrophication caused by excess nutrients.
2. Methodology

Yangebup Lake is a hypertrophic system because it contains elevated levels of nitrogen (N) and phosphorus (P) (ENV 2008). Given the size of the wetland and the scale of the treatment system, localised improvements in N and P values were considered indicators of the systems effectiveness. If the system demonstrates capture of N and P, in theory, the application of this type of solar powered nutrient stripping system could be expanded to treat more of this wetland and other wetlands on the Swan Coastal Plain.

The nutrient stripping basin was constructed on the northeast side of Yangebup Lake, near the site of the past wool scouring industry.

Figure 3, Aerial photo 2000 showing wool scouring industry. Source: City of Cockburn.

Nutrients are subject to a wide range of biological processes that can convert them between multiple organic and inorganic forms. They are also influenced by a range of climatic and biological factors. Filter media, vegetation, microbes and saturated zone (where present) can remove pollutants from stormwater runoff through physical, chemical and biological processes.

Zinger et al (2007) observed total nitrogen (TN) and nitrate removal rates of about 50% at the base of conventional bio retention layer in vegetated systems. Water by Design (2009) indicated that denitrification can be maximised by including a submerged anoxic zone (anaerobic) with a carbon source such as woodchips.

Figure 5 shows a rudimentary basin design was provided by a local engineering consultancy.

Figure 5, Basin design drawing. Source: David Wills and Associates.
Using this design an experienced machine operator was engaged to re-contour the chosen site. A variety of levels were created and a considerable amount of sandy soil mixed with coarse woody mulch was transported to site and used in construction. The additional sandy filter media and addition of carbon into the system, was intended to enhance the removal of N and P from water.

Re-contouring involved the construction of deeper anaerobic sections and higher shallow ledges to maximise surface area and slow water flow to enhance sediment deposition. Rock and log riffles were created to slow flow stabilise banks and aerate stream flows.

The basin itself is approximately 325 metres in length.

2.1. Water Transfer

The solar powered system was designed to supply a continuous water flow throughout the year with no dry periods. The system shuts down and the water stops flowing when the sun goes down, but this has benefits, as it allows sediment to settle and assists with nutrient uptake by the plants. No dry periods reduces risk of a nitrogen recharge event on re-wetting of the basin.

Water is taken from the lake by a submersible solar powered pump from a point approximately 80 metres from the shore. A filter is attached to the pump at the inlet to prevent it being clogged by algae. The water is pumped via a 150mm pipe to the shore and then into a 300mm pipe then runs approximately 60 metres inland from the lake edge.

The solar panels that power the pump were mounted on a pole approximately 5m high and located approximately 10m from the water edge, well above the high water level, and 20m south of the outlet. Power is transferred via underground and underwater cables to the submersible pump. The panels were located in an area where shading would not impact their output.

The pump used is a Lorentz PS 1800. It is powered by 8 x 170 watt solar panels which are mounted on a Solar Terrace III ground mount array which is then mounted on a 5m pole. In optimal conditions the pump has the capability to deliver 650 litres per minute or 327,600 litres per day. The average was estimated at 210,600 litres per day. The total dynamic head based on 110 mm pipe is 4 metres. The pontoon which supports the submersible pump is 4.5m X 4.5M X 0.80m and has been constructed from PN10 high-density polyethylene pipe.
The inlet basin is approximately 2.5m above the lake water level but this can increase or decrease depending on the water levels within the lake. In winter water levels are higher, while in summer water levels can drop by up to 2 metres. Water leaves the system via a grated sump and travels approximately 40 metres in a 300mm pipe before discharging into the lake via a small vegetated stream which has two channels, each of which runs parallel to the shore for approximately 5 metres before flowing into the lake.

2.2. Plant selection for performance

Wetland plants can improve water quality by encouraging sedimentation and filtration of nutrients and pollutants (through stems and leaves), oxygenating their root zone, providing shade and using nutrients in the growth phase (DoE 2004).

The selection of plants suitable for this system was largely informed by the Vegetation Guidelines for Stormwater Bio filters in the South-West of Western Australia (Monash University 2014). The use of vegetation has a number of advantages over an un-vegetated system for nutrient removal (Department of Environment 2006). Beyond nutrient removal, additional benefits are soil stabilisation, improved hydraulic capacity, aesthetics and in this case, biodiversity. Nutrient removal varies broadly across plant species (Read et al 2008; Bratieres et al. 2008). In a laboratory experiment using low-nutrient media, a range of native grasses, sedges, rushes and trees from Western Australia and Victoria were all significantly more effective at nitrogen removal compared to non-vegetated systems. All planted bio-filters also effectively removed phosphorus (Monash University 2014).

The Monash University guidelines indicate that a relatively wide range of plant species can be effectively used in nutrient stripping basins. This approach supported the City’s intention of providing a system that removed nutrients from water and increased biodiversity and habitat values.

The aim is to have long lived vegetation that is resistant to decomposition while providing a fibrous root system to maximise nitrogen retention.

Permanent nutrient removal can be achieved through harvesting of plant biomass however this may not always be economically feasible. The City selectively harvests weedy species such as *Typha orientalis*, which grows vigorously in the system and which has the potential to become the dominant vegetation.

Plant selection and placement considered the need to allow for continual flow and not clog the system. Species selection included a range of WA native sedges which have extensive, fine, fibrous root systems and a range of taller shrub and tree species which will provide shade and deeper root penetration along with improved infiltration and habitat.

Some of these plant species also contribute carbon to the system such as *Carex appressa*. Sedges and rushes are known to be excellent in nutrient stripping systems as they accumulate significantly more nutrients in stems and rhizomes and allow bacterial transformation of nutrients and pollutants (Monash University 2014).

Inclusion of a range of species generally optimises all aspects of the function of the bio filtration and retention system.

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<th>Vegetation type</th>
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Table 3. Plant species within Yangebup Lake nutrient stripping basin.

2.3. Macroinvertebrate Assessment

Macroinvertebrates communities within wetlands act as good biological indicators of wetland health.

A baseline macroinvertebrate assessment was undertaken in the spring of 2015, principally to determine whether the aquatic macroinvertebrate community within Yangebup Lake was representative of a healthy community. Past development and more recent applications of pesticides where thought to have impacted the community.

The macroinvertebrate community within the basin is also to be sampled regularly at spring time. Data collected during the spring surveys will provide an indication of baseline ecological conditions in and around the nutrient stripping basin.

The macroinvertebrate assemblage that is currently present in the lake is indicative of a system experiencing eutrophic conditions. This is also supported by the results for the water quality sampling.

Seventeen macroinvertebrate families from 11 orders were collected during the spring monitoring period (Ecological 2016). The highest diversity within the lake was 12 taxa recorded. Four taxa occurred at all five sites, with most other taxa occurring only at one or two sites. The nutrient stripping basin had the lowest diversity of all sites within the lake but only marginally with 8 recorded macroinvertebrate families in the basin. This was expected as the system was still quite young and assemblages are expected to increase as the vegetation and system becomes established.

Higher macroinvertebrate species diversity is generally found at the sites with complex habitats (Crowns et al 1992). To improve the ecological health of a lake, macrophytes and fringing vegetation can be established, including the introduction of occasional logs and other habitat features. This recommendation reflects the type of elements incorporated within the nutrient stripping basin.

Recorded midge larvae density within the basin at the time of spring sampling was low (18/m² as opposed to other parts of the lake which had densities as high as 551/m²).

2.4. Water Quality Sampling

One (1) litre water sample bottles, supplied by Marine and Fresh Water Research Lavatories (MAFRL) are labelled with permanent marker on the side of the bottles and lid, one with Yangebup- Inflow/ date the other with Yangebup Outflow/ date).

Samples are taken from the inflow basin and outflow basin every two weeks during summer and at irregular intervals during winter. Any flotsam was carefully pushed away from water surface at the inflow/ outflow point of sampling. A small amount of water is used to rinse the bottle before the sample is taken. When taking the sample, the bottle is submerged just below the water’s surface.
and filled to about 9/10th of its capacity. The lid is tightly replaced and placed on ice in a cooler to keep chilled during transport to MAFRL at Murdoch University. Each delivery is supported with a chain of custody outlining who it was delivered by, date, time and what the sample was taken and what it is to be tested for. It takes approximately two weeks for the results to be supplied. Water quality samples of groundwater were also taken at three points close to the nutrient stripping basin. Holes were dug using a spade to a depth of 1.2m at each sampling point and left for 10 minutes to allow groundwater to accumulate. The procedure used to take samples is the same as described above.

3. Results

The solar pump has been very reliable and continues to deliver water at a rate that ensures good flow through the system. The original filter has since been replaced and the system has worked continuously without fault. Water quality results from sampling in the nutrient stripping basin (Table 4) and groundwater (Table 5) are presented below.

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Table 4. Water Quality Results Yangebup Lake Nutrient Stripping Basin.
4. Discussion

The solar pump has proven to be very effective in delivering water to the nutrient stripping basin. It has proven to be a viable option to extend the usefulness of bio filtration systems that would otherwise only function during rain events. There have only been two issues with the pump that have since been addressed.

The water quality monitoring results indicate that on many occasions the levels of TN and TP recorded prior to the treated water being returned to the lake are higher than those taken from the inlet basin. Rather than seeing a reduction in nutrients, we are seeing greater levels of nutrients being returned to the system.

This can be explained by the high levels of nutrients found in the groundwater that is likely to be entering the system. The creation of the nutrient basin appears to have intercepted the groundwater that would normally be flowing toward the waterbody.

At points where the groundwater was sampled, water or damp soil is often noted to have seepage, particularly in winter, indicating that the groundwater is quite close to the surface at this point. It is also upslope of the drainage basin, almost 1.5m higher than the basin channel. The high levels of nutrients in the groundwater can be explained by the sites proximity to the wool scouring drying ponds. The drying ponds would have had some influence on the groundwater in the area. It is likely that the contaminants, such as nutrients still exist at high levels the groundwater.

The flow of nutrient rich groundwater into the basin is certainly influencing the readings taken at the outlet. However the groundwater readings are higher, by a factor of 10 at least, than the TN and TP readings of the water flowing into the basin from the lake. Given the relatively low readings taken at the outlet in comparison to the readings taken for the groundwater, it seems that the nutrients within the groundwater may actually be treated and removed to some extent by the system.

Further studies will need to be undertaken to determine if this is the case.

5. Conclusion

The use of a solar powered pump has been proven to be very effective at delivering water from a wetland to a nutrient stripping basin. The location and, in some respects, the design of the nutrient
stripping basin impacted on the systems effectiveness to treat and remove nutrients from the water and deliver water of a better quality back to the wetland.

Either the redesign of the nutrient stripping basin by lining it or relocating it to another area, not likely to be impacted by groundwater, would likely show improved results and further highlight the effectiveness of this type of infrastructure to enhance wetland water quality while providing other benefits such as habitat and enhanced amenity. The City intends to develop another trial using a solar pump in another location on the edge of Yangebup Lake.

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The South West Group’s Natural Areas Management Forum: A multi-stakeholder collaboration achieving improved NRM outcomes in the southern metropolitan area

P. Nash

Regional NRM Facilitator, South West Group

Abstract: The South West Group’s Natural Areas Management Forum is a collaborative initiative involving 10 local governments and 5 state government agencies cooperating to achieve better Natural Resource Management (NRM) outcomes in Perth’s southern metropolitan area. The Forum was initiated and is facilitated by the South West Group, a Voluntary Regional Organisation of Councils. It operates at both the on-ground (operational) level and management level and is supported by an Agreement of Cooperation. The Forum fosters and facilitates collaboration, knowledge sharing and skills development and is delivering collaborative action on key issues of common concern. The paper describes the need that initiated the forum, the way in which it functions and the way in which it is addressing issues of common concern including weed and feral animal control, fire risk mitigation, post-fire recovery, illegal rubbish dumping, biodiversity conservation, illegal access and inappropriate use.

Keywords: Collaborative action, fire, weeds, feral animals, biodiversity conservation

1. Background

The South West Group (SWG), formed in November 1983, is a Voluntary Regional Organisation of Councils. It comprises the Cities of Cockburn, Fremantle, Kwinana, Melville, Rockingham and the Town of East Fremantle. The SWG is managed by a board consisting of the mayors and CEOs of its member cities local governments.

The SWG works with these six local governments, and through cooperation with industry, community and other spheres of government, a wide range of opportunities are exploited to enhance economic growth and support a diversity of quality lifestyles whilst servicing and sustaining cohesive, productive communities in an enviable environmental setting.

In 2013, the SWG developed and adopted a Regional Natural Resource Management (NRM) Strategy, and in late 2013 established the role of Regional NRM Coordinator to facilitate the implementation of the strategy. In 2014, the SWG undertook a detailed study of the region’s remnant natural vegetation to better guide future management actions. In addition to these guiding documents, SWG member Councils have each developed and are implementing a variety of environmental strategies and plans, including biodiversity strategies and management plans for parks and reserves.
2. The SWG Natural Areas Management Forum

The SWG Natural Areas Management Forum (hereafter referred to as the Forum) was established in late 2014.

2.1. What initiated the Forum?

Responsibility for land management in the southern metropolitan area is complex, with land being owned by all levels of government (Commonwealth, State and Local) and the private sector, and the management of government owned land being subject to a variety of vesting arrangements and management agreements. Additionally, a significant percentage of the region’s remnant bushland and modified natural areas (e.g. parks, public open spaces, road and rail corridors etc.) remain sufficiently interconnected to ensure that the way in which any parcel of bushland is managed will directly impact others connected to it and the businesses and homes surrounding these areas. Weeds, root and foliar diseases, feral animals and fire are all examples of problems that can spread readily across boundaries. Thus, the way in which one parcel of land is managed can very directly impact those adjoining it.

To maximise NRM outcomes across the region as a whole and to minimise the encroachment of weeds, feral animals, fire etc from surrounding land parcels into local government owned and managed lands, the SWG member Council environmental officers desired to work more closely with other land managers, particularly state government agencies, to cooperatively and collaboratively address key NRM issues. Given that the former Department of Parks and Wildlife (now Dept. of Biodiversity, Conservation and Attractions (DBCA)) manage a large area of land in the region, a workshop involving DBCA Regional Parks staff and SWG member Council environmental officers was held in late 2014 to assess opportunities to collaborate more closely.

The outcome of this workshop was an agreement for:

- Terms of Reference for the Forum to be established
- DBCA and member Council on-ground staff to meet 3-4 times per year to discuss common issues and identify opportunities to collaborate (e.g. to undertake coordinated fox trapping)
- DBCA and member Council managers to meet 1-2 times per year to strategically align NRM activities wherever possible

Following the inception of the Forum, the SWG Regional NRM Facilitator then actively engaged with other state government agencies charged with managing significant areas of bushland in the region to encourage their active participation in the Forum. This led to the former Department of Planning (now Dept. of Planning, Lands and Heritage), former Department of Lands (now Dept. of Planning, Lands and Heritage), the Water Corporation and Main Roads joining the Forum.

The Forum grew further to include the Cities of Canning, Gosnells and Armadale and the Shire of Serpentine-Jarrahdale, which abut the SWG member Councils to the east.

<table>
<thead>
<tr>
<th>South West Group Member Councils</th>
<th>City of Cockburn</th>
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<tr>
<td>City of Fremantle</td>
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<tr>
<td>City of Kwinana</td>
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</table>
Other key land managers still to be invited to participate in the Forum include those managing the land on which the rail, electricity and gas networks are located and Landcorp.

### 2.2. The Agreement of Cooperation

Soon after it was formed, and before the other local governments shown in Table 1 joined the Forum, an Agreement of Cooperation was developed by the SWG Regional NRM Facilitator and signed by each of the SWG member Councils, the former Dept. of Parks and Wildlife (now DBCA), Main Roads and the Water Corporation.

The Agreement of Cooperation is a non-binding, voluntary agreement which commits the signatories to, insofar as each is physically and financially capable:

- maximise the strategic alignment of land management programs, plans, projects and activities with that of other signatory organisations
- communicate regularly and openly on planning and management issues
- develop and actively implement processes to share information, knowledge, expertise and resources
- identify and pursue opportunities to collaboratively seek grants, sponsorships, subsidies, material, voluntary labour or other such external resources
- coordinate the nature and timing of land management actions with that of adjoining land managers
- engage with other key land managers not yet party to the agreement and seek their active involvement and participation in the Agreement.

The Agreement has proven to be an important tool through which Forum members recognise their moral obligation to collaborate and cooperate with their neighbours and has proven useful in leveraging cooperation between signatories. It is planned to revisit the Agreement to expand its geographical coverage to enable the other local governments listed in Table 1 to formally enter into the Agreement.

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**Table 1, SWG Natural Areas Management Forum members (as at September 2017).**

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<thead>
<tr>
<th>Other Local Governments</th>
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</tr>
<tr>
<td>City of Rockingham</td>
<td>Department of Planning, Lands and Heritage</td>
</tr>
<tr>
<td>Town of East Fremantle</td>
<td>Main Roads Western Australia</td>
</tr>
<tr>
<td>City of Armadale</td>
<td>Water Corporation</td>
</tr>
</tbody>
</table>
2.3. How does the Forum operate and how is it supported?

The Forum operates at two levels: on-ground (operational staff) and strategic (management staff). The former is known as the Operational Group and the latter as the Management Group.

The Operational Group, made up of operational-level staff from member organisations (e.g. SWG member Council environmental officers and Bushcare team members; DBCA regional parks operations officers etc.) meets 3-4 times per year to discuss common issues and identify opportunities to collaborate. An average of 35 officers attend each meeting.

The Management Group, made up of management-level staff (e.g. SWG member Council environmental managers; DBCA regional parks managers etc.) meets 1-2 times per year to strategically align NRM activities wherever possible. Around 8-10 officers attend each meeting.

Management Group meetings are agenda driven, while each Operational Group meeting has a core theme (e.g. feral animal control, weed management, fire risk management or fauna relocation practices etc.). Operational Group meetings generally feature presentations from invited experts to build knowledge and capacity, followed by facilitated discussion (led by the Regional NRM Facilitator) to identify opportunities for member organisations to collaborate and cooperate.

While the core group of officers that attends each Forum meeting is relatively stable, the theme of each meeting dictates whether invitations are also extended to other officers from different portfolios. For example, the intent of the November 2017 Operational Group meeting is to establish better relationships between environmental officers and planners. Planners from state and local government member organisations will therefore be invited to attend.

When the Forum was initiated, it was envisaged that the Forum’s member organisations would take responsibility for initiating and running meetings in rotation. However, it soon became evident that a single individual needed to assume this responsibility so the SWG Regional NRM Facilitator now works with the Forum member organisations to; set meeting agendas; identify and recruit subject experts to address meetings; commission any required training; facilitate each meeting; and compile and circulate meeting outcomes and action lists. Forum member organisations host meetings in rotation, providing a meeting venue and catering.

3. What is the Forum achieving?

3.1. Building and strengthening relationships

A significant driver for the establishment of the Forum was the desire of SWG member Council environmental staff to build and/or strengthen relationships with officers in key state government agencies and neighbouring local governments who were responsible for managing land within or abutting member Council boundaries. The SWG member Council environmental staff wished to develop direct connections with these officers to facilitate cooperation on issues of common concern. The Forum has delivered this outcome very effectively and it also insures against those relationships being lost when officers leave and are replaced. The Forum provides incoming officers with an established, outcome-focussed structure through which to immediately engage with their counterparts from other organisations. Additionally, the relationships between
organisations are maintained via the Agreement of Cooperation, independent of the status of individual officers’ positions.

3.2. Cooperation and collaboration

A primary role of the Forum is to facilitate collaboration and cooperation between members to achieve improved NRM outcomes. The Forum members recognise that a landscape-scale approach is essential to achieving good NRM outcomes and that in the current tight economic climate, every dollar is precious, so all available funding must be used efficiently. Active collaboration between land managers is essential if these things are to be achieved.

Forum meetings held to date have focussed on the following key themes, seeking collaborative action between members.

Cat management
Management of feral, stray and nuisance domestic cats is a high priority for most Forum members and this has been the focus of a several meetings. Subject experts from Murdoch University, the Invasive Animals CRC and local governments actively controlling cats were engaged to address the Forum. Six of the Forum’s local governments have since collaborated with Murdoch University and the University of South Australia to implement a coordinated cat-owner education program that will encourage cat owners to confine their cats by highlighting the welfare benefits of confinement.

Fox control
Forum members collectively spend a considerable amount annually trapping and euthanizing foxes. Consulting ecologists experienced in tracking and trapping foxes were brought in to update the Forum on the latest research into fox behaviour in metropolitan Perth. This company has now partnered with seven of the Forum’s local governments to implement a project to fit foxes with GPS collars to track their movement and feeding patterns. This information will be used to better target future fox trapping. The project is now awaiting the outcome of a State NRM Program grant application before commencing.

Illegal rubbish dumping
The City of Kwinana worked with fellow Forum members (Department of Lands, City of Rockingham) and other key stakeholders (Brookfield Rail, the Bunbury-Dampier Pipeline and local developers) to collaboratively address illegal rubbish dumping in the Leda Nature Reserve in the City of Kwinana. Dumping in the reserve is rife, despite the City of Rockingham operating a landfill site immediately adjacent to the reserve. Motion sensing cameras were installed in the reserve to record instances of dumping and offenders are being prosecuted.

In a partnership approach, a fence was then constructed by the City of Kwinana and funded by the Department of Lands. Rubbish was removed using the City of Kwinana’s equipment and disposed of by the City of Rockingham at its landfill facility. Brookfield Rail upgraded gates at key access points and assisted with removing rubbish within the rail easement and private developers currently developing nearby parcels of land contributed cash to the project.
Fauna relocation practices

Fauna relocation is a common mitigation strategy to conserve species when bushland is being developed for urban or industrial use and is often required by developers as part of development approval conditions or offsets. Relocations have become more common in recent years with the scale of urban development. The Department of Biodiversity, Conservation and Attractions (DBCA) is the primary agency regulating fauna relocation and DBCA reserves are the most commonly used repository for relocated animals, however there is a strongly held belief that relocations practices and procedures could be improved. The one key concern about current practices is that baseline data is inadequate to be able to determine:

- what fauna is being relocated and to where
- survival rates of relocated animals
- the impact of relocated animals on the flora and fauna of the reserves into which they are relocated, including the genetic diversity of existing populations

Forum members consulted with private consultants engaged in fauna relocation and with DBCA staff, and from this 11 recommendations were developed to improve fauna relocation practices and procedures. The recommendations which were provided to the Director General of DBCA call for improvements in the processes and procedures that govern fauna relocation planning, provision of advice, protocols for trapping and handling, reporting on translocations, monitoring of survival rates of relocated animals, monitoring of impacts on the recipient locations and for fauna relocators to be required to have specified qualifications and experience.

3.3. Training and capacity building

The Forum provides an effective mechanism for the delivery of NRM related training and capacity building activities applicable to both local government and state government officers. Where training needs to be outsourced or specific training commissioned, the Forum also enables that cost to be shared across a larger number of organisations, delivering cost-efficiencies.

Training and capacity building activities undertaken to date include the following:

Management of bushfire risk and post fire-recovery

Bushfire risk mitigation and post-fire management are issues common to all Forum members. Increased urbanization and recent changes in planning legislation have increased the need for urban land managers to actively manage fuel loads to minimise the risk to life and property from bushfire, while at the same time trying to preserve ecological values. It was identified that there was a need for officers from the Forum’s local government and state government member organisations to receive training in fire behaviour, fuel load assessment, fuel load management and fire ecology. The South West Group’s Regional NRM Facilitator undertook to source this training and consulted with DBCA, the Department of Fire and Emergency Services (DFES), the Office of Bushfire Risk Management (OBRM) and the Local Government Insurance Scheme (LGIS) to determine the suitability of available training. Finding no suitable training available, the Regional NRM Facilitator worked with private consultants to develop training that met the needs of Forum
members and that training was delivered to 33 officers from 7 local governments and 2 state government agencies.

In order to ensure that any fuel reduction burns were undertaken in such a way as to preserve or enhance ecological values, at a subsequent ½ day event, experts in fire ecology and fire risk management addressed the Forum. A third stage of training is planned that will target both volunteer and DFES fire brigades to ensure that best practice is used by these organisations when undertaking fuel reduction burns and when responding to bushfires.

Feral, stray and nuisance cat management
Management of feral, stray and nuisance domestic cats is a high priority for most Forum members and this has been the focus of a number of meetings. Subject experts from Murdoch University, the Invasive Animals CRC and other local governments actively controlling cats have addressed the Forum to upskill members on the latest research and management practices.

Weed management
Weed control is a significant cost for the majority of Forum members. Weed ecologists have been brought in to address Forum meetings on a number of weed management issues and Forum members also shared their organisations’ weed prioritisation rankings. This was done to develop an understanding of why organisation ‘A’ for example expended significant effort to control a particular weed, while across the fence, organisation ‘B’ did not actively target that particular weed, leading to re-infestation of organisation A’s land. This raised awareness of the need to strategically align weed control measures wherever possible.

4. Conclusion
The South West Group’s Natural Areas Management Forum is an effective mechanism for fostering and facilitating collaboration, knowledge sharing and skills development in local government and state government agency staff responsible for managing remnant bushland and modified natural areas. The Forum is delivering collaborative action on key issues of common concern including weed and feral animal control, fire risk mitigation, post-fire recovery, illegal rubbish dumping, biodiversity conservation and illegal access and inappropriate use.

The non-binding Agreement of Cooperation entered into by the majority of Forum member organisations is a valuable symbolic indicator of each organisations intention to cooperate.

However, experience has shown that to maintain momentum, the Forum requires the assistance of a dedicated officer to set meeting agendas; identify and recruit subject experts to address meetings; commission any required training; facilitate each meeting; and compile and circulate meeting outcomes and action lists.
Coastal oceanography for life guards and beach lovers: Development and application of a mobile phone app for swimmer safety

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Abstract: The beach has always been a major attraction for people to spend their free time, and many beach goers enjoy spending time in the water. However, the ocean is a highly dynamic environment, and the local conditions (e.g. rip currents, waves) may vary greatly over relatively short periods of time. Therefore, swimmer safety is traditionally one of the major concerns for local governments and life guards. This paper describes the development of a mobile phone app that shows live predictions of ocean currents and beach width. The app is currently being used by the lifeguards at a Dutch beach, and is found to be a handy tool in enhancing swimmer safety. The generic setup and the global availability of numerical models and other data sources provide great opportunities to extend the application in functionality and to other regions in the world.

Keywords: ocean, rip currents, hazards

1. Introduction

The beach has always been one of the most popular places to spend free time. Many locals and tourists enjoy going for walks, playing sports or simply relaxing on the beach, as well as cooling down or going for a swim in the coastal waters. Although during sunny summer days the water is often calm, there may be times that currents can put swimmers at risk. These currents are sometimes offshore directed (e.g. rip currents) and may transport swimmers far offshore. Fortunately, many beaches around the world are supervised by life guards that dedicate their time to making sure everyone on the beach stays safe. They rely mostly on their local knowledge of the coastal waters, and often know which areas of the coastal waters have a higher chance of developing dangerous currents. However, the ocean is very dynamic environment where the local conditions (e.g. waves, currents) as well as the local topography may vary continuously. Computer models for the ocean have advanced enormously over the past decades and are now able to accurately predict coastal currents and waves. By coupling computer model simulations to a mobile phone app, the predicted currents can be made accessible to anyone (comparable to a weather forecast). This paper describes the development of a mobile phone app for swimmer safety.
2. How the App works

The mobile phone app was developed by Deltares in the Netherlands and combines a number of freely available global data sources as well as locally obtained data with a detailed computer model. The global data includes tidal levels, offshore wave predictions and meteorological predictions (blue boxes in Fig. 1). The local data includes detailed bathymetry data and photographs from a coastal video monitoring system (red boxes in Fig. 2). The data is used as input for the computer model (Delft3D), which provides hourly forecasts of the beach width and coastal currents 48 hours in advance. The predictions are updated every 6 hours to include the latest and most accurate global predictions. More technical details about the computer model can be found in Hoekstra et al. (2017).

3. Application: the Sand Engine, the Netherlands

A major part of the Netherlands is situated below mean sea level, so the country depends heavily on its coastal engineering infrastructure and yearly beach nourishments to stay dry. Since the 90’s millions of cubic meters of sand are nourished along the North Sea yearly. In 2011 a pilot project, the Sand Engine (Stive et al., 2013) was initiated in which a large volume of sand (so-called ‘mega nourishment’) was placed along the coast. The aim of the project is to generate knowledge for sustainable and economic management of coastlines, integrating different functions of the coast, including safety, nature and recreation. Two aerial photos of the Sand Engine are shown in Fig. 2.
The size of the nourishment raised public concern with regard to swimmer safety, and this motivated the development of an information platform to support the local lifeguards in their work. In order to predict the ocean currents, a computer model (Delft3D) was developed. To ensure easy access for the life guards and general public, it was chosen to couple this model to a mobile phone application. The app is currently being used on a daily basis and includes predictions of ocean currents, beach width and beach population density. Yearly evaluation sessions with the board of lifeguards verified that this is the optimal way of presenting information for the purpose of swimmer safety: clear, low-profile in use, up-to-date and reliable. An overview of the app with some typical snapshots is shown in Fig. 3. A demo version of the app can be accessed via http://zandmotorapp.deltares.nl/ (in Dutch).

![Figure 3. Overview of the Sand Engine Swimmer Safety App.](image)

4. Conclusions

This paper describes the development of a swimmer safety app that is currently being used by life guards at a beach in the Netherlands. The generic setup and the global availability of computer
models and other data sources provide great opportunities to extend the application in functionality and to other regions in the world.

Acknowledgements

The author would like to thank all organizations involved in this project, in particular the local life guard brigade in The Hague, as well as colleagues from the Deltares Netherlands office: R. Hoekstra, C. Swinkels and B. Stengs.

References

