Submissions received on Enhancing Bower Park and Lake Kate Sheppard, June 2025

Organisations / Businesses

ID	Submitter feedback	Name - Organisation
35468	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Yes **What do you like about the plan for Bower Park sports fields and why?** Great idea, very exciting, bringing together various sports codes in the area, off street parking long overdue, user, whanau, community friendly, playground upgrade great and the great amenities to coincide with "The River Walkway". **What don't you like about the plan for Bower Park sports fields and why?** Don't understand why toilet block would be tucked away when there would be more beneficial to either leaving current location (with upgrade) or moving to New Brighton Road/Wattle Drive #17, which is next to #7 & #19. This would service people using the Otakaro River Corridor Walkway and cyclist as well users of the park. I understand that the toilet block is next to the playground so could the playground not me moved over to this site as well #17. Being next to Bower Park the last 35years, I know first hand the level of vandalism, unsocial behavior, gatherings and have concerns that being tucked away to the back of the park this would encourage this type of behavior, whereas being close New Brighton Road, its more visual and provide an extra level of safety and protection. For not only the public, but for the equipment as well.	katrina hargen - THE BOWER
35517	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Yes **See attachment**	Chris Ford - Disabled Persons Assembly (DPA) New Zealand
35545	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Yes **What do you like about the plan for Bower Park sports fields and why?** We like that multiple codes are being considered at this park, and would like the opportunity for our baseball community to be able to use it as well. Our junior grades play on a similar sized diamond to senior softball, so we would appreciate some input into the field and fencing layouts, as well as development of the site. **What don't you like about the plan for Bower Park sports fields and why?** We would like to be part of the process in taking this from the concept level through to construction. **Is there anything else the Waitai Coastal-Burwood-Linwood Community Board should consider?** In-depth consultation with Canterbury Baseball Association and Christchurch Astros as to how to incorporate baseball usage and needs. It's unclear at this stage what the fencing/netting proposed along the norther boundary would be like. Foul balls from the senior softball area are likely to go into the backyards of the close by neighbors if not adequately fenced/netted. Would on site storage be available for softball/baseball storage (e.g., bases)? Would the field be grassed or a skin diamond? Or artificial turf?	Jim Dabkowski - Canterbury Baseball Association
35577	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Yes **What do you like about the plan for Bower Park playground and why?** Spokes supports all the changes in particular the bike track and skills area. **What don't you like about the plan for Bower Park playground and why?** Spokes would like to see suitable bike parking located where parent can see the bikes that is suitable for a range of bikes including cargo and children's bikes **What do you like about the plan for Bower Park sports fields and why?** Spokes supports improving access to Bower Park, and creating easy and interactive pedestrian and cycle connections through the Lake Kate Sheppard area	Anne Scott - Spokes Canterbury

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	What don't you like about the plan for Bower Park sports fields and why? Spokes would like suitable cycle parking that also fits cargo and children's bikes **What do you like about the plan for Lake Kate Sheppard?** Spokes supports: • Putting in new shared pathways • Working with the wetland to enhance natural drainage • Planting focused on enhancing and expanding the existing natural vegetation in a way that keeps the paths open for use. • Does not have a strong opinion of the path options as they both start and end at the same place. **Is there anything else the Waitai Coastal-Burwood-Linwood Community Board should consider?** Spokes strongly support the shared cycle / pedestrian paths that provide access to Travis Road and QEII Drive	
36019	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Somewhat **What do you like about the plan for Bower Park playground and why?** We like the focus on a natural look that connects to the regenerating wetlands in the area. The rocks and log steppers through the swales and dunes look like they will be interesting pathways for children, particularly if there is surrounding planting which gives the feeling of going on a journey or being 'hidden'. It's nice to have the log climbers and other wooden cimbing and balancing elements. **What don't you like about the plan for Bower Park playground and why?** We don't love the use of rubber soft fall matting. We understand that it is being used to ensure accessibilty, however, most of the equipment that is being planned is not particularly accessible for someone with mobility issues anyway. Rubber matting not only poses concerns for human health but also environmental consequences. The fact that this playground is set into wetlands makes us wonder if there will be an issue longterm with contamination. Rubber matting also isn't a great safety surface as it has less impact attenuation than loose fill materials. If rubber matting is the chosen safety surface than we wonder about only using it where soft fall surfacing is required (fall zones around equipment) instead of as a surface throughout. The areas between could be planted and/or use other materials like sand or pea gravel which has interesting sensory qualities for children with pathways, boardwalks and/or bridges linking the play areas. It would be great to include water play in this space as it's something that children are always drawn to. There's a playground one of our trust members has visited in Vancouver which is on the edge of a wetland. The layout and materials and the play creek that runs through the centre of the space is really beautiful. Here's a link if you'd like to see some images. https://space2place.ca/portfolio/gardencity It's nice to see the use of climbing and balancing elements as well as the mound and tower platform with slide. But it would be great to see opportunties for other types of play - particularly those that are often seen when children play in natural settings. Educational theorist, David Sobel, outlines seven design principles that can be considered when we plan for children's play: adventure, fantasy and imagination, animal allies, maps and paths, special places, small worlds, and hunting and gathering. These may be able to be included by having space for children to move natural materials to build huts or engage in imaginative play. Secondary pathways like the log steppers could possibly be used more with tunnels or other pockets (enclosed areas with planting) for play or rest, particularly for those children who may get overwhelmed in spaces with lots of movement and noise.	Emma Woods - Play Preservation

Individuals

ID	Submitter feedback	Name
33698	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Yes **What do you like about the plan for Lake Kate Sheppard?** generally speaking it's great what you are planning	Ben Liebing

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	What don't you like about the plan for Lake Kate Sheppard? The pathway should offer a circle track, in example people could connect a Travis Wetland walk with a stroll through this wonderful small park and then back to Travis Wetland. At the moment its more of an in-an-out. Maybe a circle track closer to Lake Kate Sheppard. But overall it's great to see. **Is there anything else the Waitai Coastal-Burwood-Linwood Community Board should consider?** not really. Great idea what you are doing	
33733	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** No **Is there anything else the Waitai Coastal-Burwood-Linwood Community Board should consider?** We're in a cost of living crisis, this is a nice to have. Why do it now? I don't see the logic.	Barry Livermore
33739	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Yes **Is there anything else the Waitai Coastal-Burwood-Linwood Community Board should consider?** However I don't want the houses behind my house being built. I think this part is absolutely crap. We have an amazing house that is built high with the earthquake regulations we don't want house behind us looking into our property, or even worse state houses. Love all the other ideas.	Rochelle Horwell
33740	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Somewhat **Is there anything else the Waitai Coastal-Burwood-Linwood Community Board should consider?** Recently purchased a house with the assumption that the red zone would not be rebuilt on and this was a major factor in our decision to purchase this home. Due to the house being built post quake the foundations are high so any property built would see straight into our property. Attached is a photo of the view we fell in love with when looking for a home. **See attachment**	Anthony Horwell
33743	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Somewhat **What do you like about the plan for Bower Park playground and why?** Nice concepts and serves a broader demographic than specific sports. **What don't you like about the plan for Bower Park playground and why?** N/A **What do you like about the plan for Bower Park sports fields and why?** Nothing. **What don't you like about the plan for Bower Park sports fields and why?** The entire area is traditionally a wetland and mahinga kai. Taonga species require a critical mass of habitat to return to healthy sized populations. You are not taking the opportunity afforded by surrounding reserves to enhance the overall critical mass of habitat of the OARC, Estuary, Travis Wetland etc Taonga species should not be existentially compromised by something a mere portion of the human population does for a spot of fun when decent facilities are nearby in more developed areas. I think this is a cop out proposal. Levelling an area, sowing grass seed and keeping it mowed is probably more straightforward and cheaper than overseeing authentic ecological restoration. **What do you like about the plan for Lake Kate Sheppard?**	Paul Peryman

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	This area is a taonga and a basic acknowledgement of this in your proposal is a good start. **What don't you like about the plan for Lake Kate Sheppard?** Doesn't go far enough in rewilding the area. **Is there anything else the Waitai Coastal-Burwood-Linwood Community Board should consider?** You ought to consider the restorative expertise and interests in the OARC - the fantastic remediation work at Bexley and in the Dallington Red Zone by Te Pā o Rākaihautū is internationally recognised. There is coal tar under the remnant roads in the area and you have said nothing about your approach to this contamination.	
33808	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Yes **What do you like about the plan for Bower Park playground and why?** Great idea and very exciting. This area has been under developed for some time so it is great to see this proposal. My kids are super excited and are asking for the playground to take into accounts older kids with activities such as big swings, flying fox and a climbing wall. **What do you like about the plan for Bower Park sports fields and why?** Looking great. Love the idea of the fitness circuit, it it could be covered / sheltered that would be great. Many sports team play on the ground and bring bbqs and etc while watching games. A picnic / bbq area would great. **What do you like about the plan for Lake Kate Sheppard?** Great idea and layout. Super excited. **Which pathway option do you prefer?** Option 1	Hugues Terrier
33888	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Yes **What do you like about the plan for Bower Park sports fields and why?** The parking for the sports fields are great. So to are the surrounding pathways **What don't you like about the plan for Bower Park sports fields and why?** There needs to be consideration of where the current cricket pitch is. I play for New Brighton Men's team. At the moment the pitch is a lot closer to one side and not an idea circle. The boundary closest to the new proposed play area is very close, while the boundary on the Bower road side is quite far away. Please consider moving the pitch to be closer to the centre of the park for safety and to benefit the quality of cricket games for senior teams that play here. **Is there anything else the Waitai Coastal-Burwood-Linwood Community Board should consider?** Please consider my feedback to centre the cricket pitch in the middle of the park.	Henry Goman
34356	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Yes **What do you like about the plan for Bower Park playground and why?** Love the plan for Bower Park playground, especially blending it with the natural environment and the pedestrian connections to the Lake Kate Sheppard nature reserve/wetland. This will be further enhanced with connections to the City to Sea Pathway. **What do you like about the plan for Bower Park sports fields and why?** Multi-use sports fields seems like a really sensible use of this area. **What do you like about the plan for Lake Kate Sheppard?** The pedestrian connections to the surrounding areas and links to cycleways. Option B looks like it will provide a bit more space for the wetland and in turn might provide more	Samuel Leonard

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	stormwater attenuation in times of heavy rain. **Which pathway option do you prefer?** Option 2 **Is there anything else the Waitai Coastal-Burwood-Linwood Community Board should consider?** Assuming that the area will be used by pedestrians and cyclists in particular to connect to the City to Sea Pathway Safe access to and from the City to Sea Pathway on the other side of the River will be really important.	
34435	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Somewhat **Is there anything else the Waitai Coastal-Burwood-Linwood Community Board should consider?** All seems ok. Would like more walking access through the areas (wetland) if possibile. Concerns are cars and motorbikes have been driving in the park. Currently park outside housing at the back of circa 48-71 Bower Ave. So gates appreciated. Covered picnic/spots watching other side of park with shade/planting etc appreciated. Also, please note, some properties have been burgled by people jumping over fences + the bush+ planting outside the fences only provides cover for this activity . I would appreciate minimum planting because of this! Ps. not silver birch trees. Just for your considerations.	D Brabet
34437	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Yes **Is there anything else the Waitai Coastal-Burwood-Linwood Community Board should consider?** To open up unused land and allow access to a community-based area. It would bring a boost to our environment and make the area safer to walk around.	Sonya Wilkie
34439	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Yes **Is there anything else the Waitai Coastal-Burwood-Linwood Community Board should consider?** We love the whole concept. We live beside Bower park and enjoy the fact that it is a dead end. However, in cricket season, our end of street is super congested with vehicles parking on the berm. Question are the current gabion baskets going to be replaced with a gate? If so, who will have access and would that mean that vehicles would be driving straight through? Question - will the dead trees in Bower Park be removed?	Tania & Malcom Grose
34444	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Somewhat **Is there anything else the Waitai Coastal-Burwood-Linwood Community Board should consider?** Encouraging activity and socialising. No dogs signs to be utilised. Nofreedom camping. The trial housing is wrong it should be the picnic & parking area. No more housing in this area.	Garry Robinson

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34597	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Yes **What do you like about the plan for Lake Kate Sheppard?** It is great to see that Council is looking to restore this area. I like the broader concept of expanding indigenous wetland vegetation communities. The area is currently converting to wetland and this should be enhanced, taking care not to overplant or harm existing natural regeneration. The habitat that is created will be a significant additional benefit to a range of wetland species, in particular fernbird (potential reintroduction), marsh crake, spotless crake, and bittern. **What don't you like about the plan for Lake Kate Sheppard?** The plan suggests planting trees in a number of areas, but as sea level and saltwater inundation is going to be an issue then planting forest in this area may be a relatively short lived. **Which pathway option do you prefer?** Option 2	Scott Butcher
34746	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Yes **Is there anything else the Waitai Coastal-Burwood-Linwood Community Board should consider?** It will be a nice smallish park especially for bird watching in the wetland area. Seems all ages are catered for except elderly walkers, i.e., no seats.	Kay Collyer
35081	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Yes **What do you like about the plan for Lake Kate Sheppard?** I fully support getting projects done in the red zone which increase biodiversity and recreation as per the The Ōtākaro Avon River Corridor (OARC) Regeneration Plan. This looks like a fantastic amenity to the city and our wildlife, and is another step towards a bird haven in the red zone. I chose option 2 (or B?) as it looks like it dedicates a bit more space to native species, but either option would be great. **What don't you like about the plan for Lake Kate Sheppard?** Nothing, it looks great! **Which pathway option do you prefer?** Option 2	Stephen Ashley
35114	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** No **What don't you like about the plan for Bower Park sports fields and why?** Why does the car park have to be at Willryan Avenue, it will cause a nusiance to residents. When you bring in people to an area you get people problems such as illegal vehicle access , fly dumping and if there are toilets there you will get the homeless and campers living there causing a nusiance like they do in most of the parks in the East. I will definitely oppose any building trial or building in that area to the left. That area should be set a side as recreation for the community as you have taken away our green space such as the school and made Willryan an ugly medium density community having to fit into existing infra-structure with less green space. Why can't the park be accessed from New Brighton road, if you can't walk from your car then why bother playing sport. I oppose this because you have only thought about young people, not everyone plays sport. We are an ageing population and you haven't considered other users of the space such as dog walkers etc.,. Why do you need cycle access, there are ample cycleways such as a long the rivers at expense of other users eg. dog walkers. Mixing pedestrians and cycleways don't work because cyclists generally disrespect pedestrians. When you bring people in there will be even more litter and people vandalising trees such as what happens now when the school kids from the high school use the space like a rubbish dump. **What do you like about the plan for Lake Kate Sheppard?** It looks to me what is presented is quite vague so can't comment. **What don't you like about the plan for Lake Kate Sheppard?**	Lora Peacock

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	I have used this red zone space for ten years and walked off lead, generations of dogs and watched the sun set on the mountains and its been my quiet place. I know this area backwards, every nook and cranny and I know it seasonally. You haven't considered people that walk their dogs in the area, are dogs going to be banned? I do not want to drive to the run down and badly maintained Rawhiti dog park, its gone to wrack and ruin- it's never maintained. Looks like the council is going anti- dog with draconian bylaws and preventing people with dogs accessing green space. I will oppose and protest against any trial housing or building houses in the area to the left in the diagram presented, that area is wet constantly and should be for the community. I'm generally supportive of re-vegetation etc., but when I'm excluded because I own dogs then I won't support it. I also pick up litter and look after the trees in this area, not everyone respects the space. In summary, no matter what happens to the space I will continue to walk my dogs off-lead there, like I have done for the last 10 years though it probably won't be a quiet space anymore- such a shame. **Is there anything else the Waitai Coastal-Burwood-Linwood Community Board should consider?** Actually I'm disappointed that we got less than a month to put in a submission, some of us might have needed more time . The information in the hard copy put in our our letterbox is different to what is presented online and there has been little effort to engage with the community on what their needs are, just one meeting on the 18th May, I only got a weeks warning and I couldn't attend it, otherwise I would have been at this meeting.	
35150	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Somewhat **What do you like about the plan for Bower Park sports fields and why?** The plans for Bower Park , and sports fields are fine. **What don't you like about the plan for Bower Park sports fields and why?** I am the last house before the red zone, the water table on my property is very high and the adjoining roads flood, and it does not take a lot of rain for this to occur. The road and parts of the park can at least be a foot under water, I have photos on my phone. I would be very concerned having the trial housing in the red zone for the above reason. I have lived in my house for over 10 years and know the area. If someone would like to come and see me I can show them my photos and the areas at the park and roads were the flooding occurs. **Is there anything else the Waitai Coastal-Burwood-Linwood Community Board should consider?** The drains on Willryan Ave are cleaned by my neighbor and I before rain.	Nicola Smith
35260	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Yes **What do you like about the plan for Bower Park playground and why?** I like the overall concept of the play space and its integration with surrounding nature. Will be great for imaginative play and exploration. Maybe add a sensory path running adjacent to the main path for kids to explore texture? Or add some playful elements on the paths? :) **What don't you like about the plan for Bower Park playground and why?** Could you please run this by the park rangers that will have to maintain the play space! I believe, especially the planting within the play area (as indicated for the mound), may be very challenging to maintain and it would be good to seek their feedback on this. There are known issues with seeds distributing throughout play spaces which can be a huge issue due to the limitations on spraying weeds. Also, it is unclear whether you are proposing wet pour, bark or sand as safety surface? Wet pour might be best as you indicate a very large area for the play space and it'll be costly to top up soft fall and sand. Maybe you could consider condensing the space a bit more?	Barbara Heise
35355	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Yes **What do you like about the plan for Bower Park playground and why?** I really like the idea i think it is a great use of the space **What don't you like about the plan for Bower Park playground and why?** I think you should do some gold coin BBQs this would be a great place for families to do picnics or dinners! More shaded areas for summer time would be nice	shania fox

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	Is there anything else the Waitai Coastal-Burwood-Linwood Community Board should consider? I think you should approve the plans	
35382	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Yes **What do you like about the plan for Bower Park playground and why?** Amazing! As new parents to a 10 month old we are really excited about the prospect of a new park. The current park is basic and rundown with limited possibilities for young tamariki to explore. I love the idea of it being a natural environment! Also very keen for picnic areas etc. I would love for this area to be enhanced as we would 100% use it more as a whanau! **What do you like about the plan for Lake Kate Sheppard?** Just generally excited that this area is getting some love. It's such a great space. We use it nearly everyday to walk our two dogs as it's just outside our doorstep. With that said - please ensure it continues to be dog friendly. Our two boys LOVE exploring the red zone safely off leash. It's a true asset for us as dog owners! **What don't you like about the plan for Lake Kate Sheppard?** Having only the one pathway. Like I said we walk our dogs here often, I like how currently there's a lot of areas to explore, and you can take your dogs away from other people and dogs easily, or walk more distance. **Which pathway option do you prefer?** Option 2 **Is there anything else the Waitai Coastal-Burwood-Linwood Community Board should consider?** Please approve these plans!!! It would be such a significant enhancement to our area and one that our whanau would really benefit from!	Zingara McDougall
35385	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Yes **What do you like about the plan for Bower Park playground and why?** Please make an array of playing elements to keep kids entertained. Also a pump bike track would be amazing! Christchurch has so much potential for better children's playgrounds and pump tracks spread out around the city in its many green spaces but alas existing playground are pretty dull / falling apart and suburbs which lack in playgrounds could and should all be given new ones along with bike tracks. Kids love them! **What don't you like about the plan for Bower Park playground and why?** Doesn't include a pump track	Becky Buxton
35392	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Yes **What do you like about the plan for Bower Park sports fields and why?** This may already be included but i would like to see the path surrounding the park etc to be sealed to allow for running in wet weather **What do you like about the plan for Lake Kate Sheppard?** I love the plantings and width of the track. I would like to see the track paved or sealed to ensure dry feet during wet weather **Which pathway option do you prefer?** Option 1 **Is there anything else the Waitai Coastal-Burwood-Linwood Community Board should consider?** I would like to see a sealed track that can be used for running	Nicola Benzie
35412	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Yes	Hayleigh Brereton

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	What do you like about the plan for Bower Park playground and why? I like the dune towers, being about to integrate the kids ability to look and be part of nature is great. Bird watching towers or information would be great to include to link to the surroundings and help them value what a special place Lake Kate Shepherd is. Great to have the bike track, and great to ensure the walking, cycling and scootering connections are well thought out and usable. I would also encourage that some thought is put into the size of the playground and that there are elements that create risk in kids play. I really like the metal slide in the image and I hope that the quality of the equipment chosen does reflect the imagery shown in the consultation. **What don't you like about the plan for Bower Park playground and why?** It would be great to incorporate swings into the playground somewhere, including a baby swing as often playgrounds don't cater to smaller children who are with siblings. If at all possible in the nature play area of the playground it would be cool to incorporate ways for kids to play with water, even if its a water pump similar to the one at the sandpit at Spencer park playground. I would like to have confidence a high quality playground will be installed, and that the elements aren't overly repetitive, like the Avon Park Playground (which has great consultation images but a different playground delivery. **What do you like about the plan for Lake Kate Sheppard?** I like the way it create pathways and connections through this area. **What don't you like about the plan for Lake Kate Sheppard?** I think it would be great if it formed some sort of loop pathway. I realize this is possible by crossing SH74 and accessing the pathway on the other side of the road, but the connections on New Brighton road aren't upgraded yet. I don't like that its gravel, it makes things much harder when pushing a pram or a child on a scooter, trying to get to the new playground. **Which pathway option do you prefer?** Option 2 **Is there anything else the Waitai Coastal-Burwood-Linwood Community Board should consider?** I think this is a great addition to the area and encourage you to invest in a high quality plan. I can't see the way this connects to the city to sea pathway and it would be good to see some connection and linkages, and to the pathway (and red zone) on the other side of SH74. I know this is a wet area, but I would like to see some consideration to how plants are watered and kept alive and provision made for the longer term maintenance. I have seen other areas with significant planting investment not survive due to lack of watering and become scruffy quickly with a lack of ongoing care and maintenance. I also wonder if some consideration needs to occur in terms of lighting and safety, as this area won't have a lot of passive surveillance, given its largely away from houses and the road.	
35460	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Somewhat **What do you like about the plan for Bower Park playground and why?** I love the new look to be. But location should be New Brighton Road end of park, by existing toilet block. **What don't you like about the plan for Bower Park playground and why?** Location. If the playground was New Brighton Road end with existing toilet block it would allow the rest of the grounds for sports fields. Rebuild toilets and add shower block and certainly more rubbish bins. **Is there anything else the Waitai Coastal-Burwood-Linwood Community Board should consider?** Practicality off location of toilet block and play ground.	Joanne Cook
35490	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Yes **What do you like about the plan for Bower Park playground and why?** Looks good **What don't you like about the plan for Bower Park playground and why?** I don't want a road extension to Willryan Avenue	Patricia Crawford

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	What do you like about the plan for Bower Park sports fields and why? Great for the community **What don't you like about the plan for Bower Park sports fields and why?** Have access off New Brighton rd keep Willryan Av as a no exit **Is there anything else the Waitai Coastal-Burwood-Linwood Community Board should consider?** I've lived here for over 51 years the roads are narrow don't need more traffic Really built up here now lots of dogs need to be exercised in the red zone, lots of speeding vehicles at times	
35498	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Yes **What do you like about the plan for Bower Park playground and why?** Everything looks awesome. Nice to see common sense has prevailed here with an updated children's playground to be built. Wish I was young enough to play in it upon the equipment. **What do you like about the plan for Bower Park sports fields and why?** Everything looks good. Nice to see common sense has prevailed here with Bower Park being expanded & developed. **What do you like about the plan for Lake Kate Sheppard?** Everything looks wonderful. Nice to see common sense has prevailed here with the land been preserved as a nature reserve while people can use it to relax in. **Which pathway option do you prefer?** Option 1 **Is there anything else the Waitai Coastal-Burwood-Linwood Community Board should consider?** On a deeply personal note: it's nice to see the land my parents' house was on i.e. the home I was brought up in to be converted to a children's playground. I have fond memories of playing on that ground, etc. as a child that other children for years to come will enjoy, too. It's also great to see Bower Park being expanded for similar reasons, too. It's all very heartwarming for me. Thank you.	Alan Mitchell
35504	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Yes **What do you like about the plan for Bower Park playground and why?** Looks inviting and adventurous for kids. **What don't you like about the plan for Bower Park playground and why?** Light colored matting will get dirty over time. **Is there anything else the Waitai Coastal-Burwood-Linwood Community Board should consider?** Please ensure good lighting over the park and playground for safety. Please install ample rubbish bins so litter doesn't end up in the wetlands. Please have no smoking/vaping signs around the playground area. Thank you for consulting.	Teresa Blackbeard
35505	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Somewhat **What do you like about the plan for Bower Park sports fields and why?** I cannot understand why it is still here, and expanding. Considering the neighbouring wetland plan, I see no mention of adaptivity in the planning to account for seasonal and occasionally tidal inundation.	Kathryn Bates

	In this particular area, please place natural values ahead of human values. Please reduce car access from New Brighton Road, and place any carparking over on Willryan Ave to allow a good sized buffer for reduction of contaminants to the river/wetland. **What don't you like about the plan for Bower Park sports fields and why?** I worked in Anzac Drive Reserve with the Avon Ōtakaro Network for four years, so I know this area well. This area is a natural river floodplain/tidal saltmarsh area (Orchard, 2017), and every wet season it is often submerged. I don't understand why it was even recovered as a sports field after the quakes, since there are sports fields, including QE2, Donnell Sports Park, and Bexley Park all within 1500m of this site. If the Council were really wanting to enhance this area, then it would remove the sports field aspect altogether to create a bigger wetland which will be more resilient to increasing climate change challenges. However, my biggest concern is that sports fields are notorious for fertiliser use and the use of ecocides to reduce weeds, fungi, bugs. Every time these fields are submerged, those chemicals drain away into the river. Use of the fields for team sports in winter when they are saturated will create mud = sediment. As the plan points out, Lake Kate Sheppard is a significant spawning habitat for īnaka, but so is this part of the river, near Bower Park. These chemical, nutrient and sediment loads are incredibly detrimental to aquatic life, and expanding the size of the sports field will only increase the amount of toxins entering the river. Assuming that the fields are already a given (since they already exist), I strongly recommend that a wide (>20m) wetland riparian margin between the fields and the road/river be incorporated into your plan design. A vegetated wetland margin may help to sequester and reduce the amounts of chemicals entering the river, as well as providing connected areas of habitat. A further suggestion, and considering the area is often submerged, raised wooden pathways would allow year-round use of the park/playground, and enhance ecosystem connectivity by allowing unencumbered movement of water and fauna underneath. Reference: Orchard, S. (2017). Floodplain restoration principles for the Avon Ōtākaro Red Zone. Case studies and recommendations. Report prepared for the Avon Ōtākaro Network. Christchurch, New Zealand. **What do you like about the plan for Lake Kate Sheppard?** I worked in Anzac Drive Reserve with the Avon Ōtakaro Network for four years (2014-2018) so I know this area well. I am glad that you understand that this area is an incredibly significant īnaka spawning habitat. The area also contains several freshwater springs which must be recognised and protected. It's fantastic that someone had the foresight to recognise that the area east of the lake has reverted back to wetland and to protect. I watched several families of wading birds, including stilts, tōrea, godwits, pukekos and ducks, bring up their offspring here. However, I also watched in horror several times as the mowing contractors mowed over this area obliterating nests and emerging wetland vegetation. I like that you will remove the old roads and create a new pathway. I chose option B (or 2?). I recommend that some parts of the pathway are raised wooden pathways that would allow year-round use of the park/playground, and enhance ecosystem connectivity by allowing unencumbered movement of water and fauna underneath. Whilst working in the reserve, we partenered with mana whenua to enhance mahinga kai opportunities. Things to keep in mind: The harakeke in this area is excellent for weaving, so that must remain. An expert on rongoā Māori from Ngāi Tūāhuriri advised against creating a mara rongoā in this area due to the traffic noise that significantly reduces rangmārie/peacefulness of the area. Raupō in this area grows rampantly, which would be good if there were no restraints like drainage pipes that it tends to block, however they are often a good indicator of freshwater springs. The Avon-Ōtākaro Network planted a great deal of trees and shrubs here,with a focus on enhancing and expanding the existing natural vegetation. Many survived the varying water and salinity levels and these established plants account for a considerable part of the existing vegetation. Please don't remove these to make way for the path. I like that the plan will create recreational open space areas within the dryer area on the residential side of the site, but I have reservations about the use of swales (See below - what I don't like) **What don't you like about the plan for Lake Kate Sheppard?** Option A (or 1?) is problematic for several reasons. Having a pathway alongside the waterway is going to (a) increase runoff into the stream (b) reduce instream and riparian habitat (c) be prone to inundation almost daily from tidal or seasonal flooding. See my recommendations for option B above. I am concerned that the plan includes the construction of swales "enabling effective draining". Please stop with the idea that this area needs to be drained. This is a tidal wetland connected to Travis Wetland to the north-west and the Ōtākaro River to the south-east. Drainage in this area reduces that connectivity - even in the drier areas. It all looks dry in summer, but come down here in the middle of winter and almost all is underwater because the ground water has risen, and needs a place to go. On every king tide, especially in tandem with a rainfall event, many parts of your pathway will be inundated. As I have said earlier, I recommend that some parts, if not all, of the pathway are raised wooden	

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	pathways. This would allow year-round use of the park/playground, and enhance ecosystem protection and connectivity by allowing unencumbered movement of water and fauna underneath. If you do build them, encouraging play in swales is not a good idea. The point of them is to retain water when the area floods. Sediment (and chemicals bound to sediment) usually drop out of standing water, therefore, at the bottom of swales, making the contaminant risk to kids playing here much higher. Creating a large mounding to create a lookout through to the Port Hills will only further reduce the flood plain area, disturb ground-surface water interactions, and be very out of place. There is already a clear view to the Port Hills from here. If you want to enhance it, build a fire tower structure or a high bridge over areas that are more affected by tidal inundation. **Which pathway option do you prefer?** Option 2 **Is there anything else the Waitai Coastal-Burwood-Linwood Community Board should consider?** Please read the rest of my submission, but please keep in mind that: 1. A lot of work has been done in this area to enhance it ecologically and for the community - the ones nearby and the ones who had to leave. Remember this. 2. Ngāi Tūāhuriri has been involved previous development ideas in this area (these may be different to the folk the CCC has been working with on this plan) 3. This area is a natural flood plain and salt marsh which is incredibly important for the healthy functioning of the river, the estuary, and Travis Wetland. 4. Elevated wooden pathways would allow free movement of fauna and water. Solid aggregate pathways block water movement, will be inundated by tidal/ flood water, and will require on-going maintenance to repair flood damage. 5. Putting new housing here (even trial housing) is insulting to the people who had to leave the area, who could not rebuild. 5. This plan is 6 years old. Things might have changed. Have you checked? **See attachment**	
35511	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Yes **Is there anything else the Waitai Coastal-Burwood-Linwood Community Board should consider?** It's a great environmental benefit to expand wetlands. Making a good use out of a bad situation, i.e., earthquake damage. Suggestions/Questions: -Will I still be able to walk my dog through this area? -I pressure you're already aware the sports field needs, greatly improved drainage. -Sadly at the moment, I don't often see many local children use the playground. Is this likely to change? Does it warrent such expensive development? -It is possible/practical to put in an extra Walkings path through the wetland area itself, e.g., Where I've show on the map in red.	Kevin Pasco
35522	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Yes **Is there anything else the Waitai Coastal-Burwood-Linwood Community Board should consider?** It's brilliant! About time something was done to enhance the area concerned, especially the underused Bower Park. Thank you	Graham Patridge
35529	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Yes **What do you like about the plan for Lake Kate Sheppard?** Great the land is being restored as an Eco option . **What don't you like about the plan for Lake Kate Sheppard?** I think there should be a loop track. Even if similar to Travis Wetland Board walk and get closer to the lake .Then the walk will be constantly used not as just a walkway connecting to a playground. It could be call The Kate Sheppard track. Another new small carpark could be near the new pump station and feed onto the loop track . The carparks near the sport grounds could be too busy and people coming to access the track could park here.	Daniel Simpson

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	Is there anything else the Waitai Coastal-Burwood-Linwood Community Board should consider? It might cost a bit more now for the loop track but is best to be done in this first submission as the ecological damage later and expense is much more in the future	
35536	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Yes **What do you like about the plan for Bower Park playground and why?** I like that children are being considered in plans **What don't you like about the plan for Bower Park playground and why?** I don't like the lack of color of the playground. Color is much more appealing to children **Which pathway option do you prefer?** Option 1	Doug Sekone-Fraser
35562	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Yes **What do you like about the plan for Bower Park playground and why?** I especially like the formed paths as it provides accessibility and another safe place for people to walk and take children to play. **What do you like about the plan for Bower Park sports fields and why?** It's great to have more options for organised sports. **What do you like about the plan for Lake Kate Sheppard?** We often go for walks and the more choices the better. This looks well planned and is much better than the current wasteland. **Which pathway option do you prefer?** Option 1	Laurie Freeman
35566	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Yes **What do you like about the plan for Bower Park sports fields and why?** It is great to have planned a number of different sport fields in one space utilising the space available. **What don't you like about the plan for Bower Park sports fields and why?** I would have loved to have seen an area for the many skating families in Christchurch. There are a huge amount or roller skaters and inline skaters in Ōtautahi in these growing sports and nowhere for people to enjoy the sport safely. All that would be needed is a nice wide, smooth (not gravel) loop pathway which could be incorporated into the plans, this would allow the many different types of skaters the opportunity to practice and skate in their sport. Not to mention the other people who would benefit including scooters, bikes, boards etc. **Is there anything else the Waitai Coastal-Burwood-Linwood Community Board should consider?** The whole area looks really great. We would just love to see areas included which are currently not provided for in Christchurch.	Alexandra Stock
35567	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Yes **What do you like about the plan for Bower Park sports fields and why?** I am in full support of more sports fields for the city even though I feel there are already many, many places to play certain sports and only a few places to play others. **What don't you like about the plan for Bower Park sports fields and why?** There are so many places in town to play softball. Do we really need 4 more fields? They already have an entire complex to themselves which they refuse to share with the baseball	Nathan McKinley

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	community even though the field dimensions are exactly the same. The baseball community plays at 1 park in Christchurch with a total of 2 diamonds designed for adult grade. The diamonds have no electricity for any training equipment, water fountains or seating for spectators. In order to grow the game of baseball in the city, it would be great to have a second location and a dedicated field just for youth baseball. This can be fully accomplished by setting up the diamond to play both softball AND baseball but the real key is the council stating that the fields are for both sports. That is currently something we do not have.	
35571	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Yes **What do you like about the plan for Lake Kate Sheppard?** I have no problems with the plan **What don't you like about the plan for Lake Kate Sheppard?** What I don't like about it is. I am sick of tired of seeing native grass, flax bushes, and cabbage trees. Wherever we look we see the same boring plants. How about planting some Kowhai it will attract bellbirds. Manuka there is nothing better walking through bushland and smelling the manuka. The problem with flax and cabbage trees there leaves are not able to be composted plus cabbage trees are messy	kyle haskell
35573	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Yes **What do you like about the plan for Bower Park playground and why?** I love the design as it promotes various gross motor skills and sensory experiences using natural materials following the Māra Hūpara concept. It would be even better if we could have a section of native bush, with climbable trees that are not too closely planted, allowing children to explore the section of ngahere, collecting sticks, leaves, making huts and nests. **What don't you like about the plan for Bower Park playground and why?** I prefer a natural landing surface, such as bark, rather than the safety mat for the sensory experience and for environmental reasons.	Naomi Ishihara
35575	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Yes **What do you like about the plan for Bower Park playground and why?** I support the cycle track and skills area as part of the playground and the way natural elements are being incorporated. **What don't you like about the plan for Bower Park playground and why?** I would like to see cycle parking and a water fountain. **What do you like about the plan for Lake Kate Sheppard?** I support the plan including working with the wetlands, the native plantings, and the new shared paths. I do not have a strong preference for either Option 1 or Option 2 for the pathways, **Which pathway option do you prefer?** Option 2 **Is there anything else the Waitai Coastal-Burwood-Linwood Community Board should consider?** I support the shared cycling / pedestrian paths through this area and the planting of appropriate native species in the developing wetlands area.	Anne Scott
35589	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Yes **What do you like about the plan for Bower Park playground and why?** Good. **What don't you like about the plan for Bower Park playground and why?** Parking.	Cyril Townsend

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35794	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Yes **Is there anything else the Waitai Coastal-Burwood-Linwood Community Board should consider?** I fully support the proposed plans for Bower Park and Lake Kate Sheppard. The mixture of areas, well thought out play area, and expanded multi-discipline sports fields will be a valuable recreation asset for the area.	Andrew Brown
35809	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Yes **Is there anything else the Waitai Coastal-Burwood-Linwood Community Board should consider?** I have just looked over the plans for Bower park playground. There are some lovely things in there, thank you. My own piece of constructive feedback is that it would be fantastic if there was some kind of food/drink facility there. The playground is great for kids but not for the parents trying to socialise with other parents. When I meet up with other parents it is always themed around getting a coffee etc with some time for the parents to enjoy themselves as well as the kids.	Elizabeth Moffatt
35850	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Yes **What don't you like about the plan for Lake Kate Sheppard?** Concerned about the distance between the back of my property and the proposed pathway **Which pathway option do you prefer?** Option 2 **Is there anything else the Waitai Coastal-Burwood-Linwood Community Board should consider?** Wouldn't not make sense to consider the existing road as the pathway?	Mel Kenna
35961	**Overall, do you support the plans for Bower Park and Lake Kate Sheppard?** Yes **Is there anything else the Waitai Coastal-Burwood-Linwood Community Board should consider?** Thanks for sending the information about proposals for Lake Kate Sheppard and Bower Park. We live close to Sandy Avenue, and use this area a lot for walking and sports at Bower Park. We are very supportive of all of the proposals, we see how widely used the area is, and the improvements sound sensible. The former roads around the Lake Kate Sheppard area are great for walking in summer, but already this winter they are too waterlogged to use. So we are very supportive of the suggested drainage mitigations to make this a year around recreational area. Also supportive of enhancing and protecting the beautiful environment here. We don't mind either pathway option, but think perhaps option A will be more scenic, being slightly closer to the green space and further from housing. Bower Park is a significant asset for the east, used year around by thousands of people, so we support all the improvements proposed. Thanks again for the information in our mailbox, bring on the work!	Linda and Scott Bennett

Contribution ID: 33740

Contribution ID: 35505

Avon-Otakaro Network
Manaaki Whenua, Manaaki Tangata, Haere whakamua
Care for the land, Care for the people, Go forward.

AVON ŌTĀKARO NETWORK

Floodplain restoration principles for the Avon Ōtākaro Red Zone

Case studies and recommendations

Avon Ōtākaro Network

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ERO Report 1
Floodplain restoration principles for the Avon-Ōtākaro Red Zone. Case studies and recommendations.

ERO Report 2
Restoration opportunities assessment for the Avon-Ōtākaro Red Zone using a local knowledge approach.

ERO Report 3
Integrated assessment frameworks for evaluating large scale river corridor restoration.

Copies of the reports are publicly available on the Avon Ōtākaro Network website.

Front cover: Lake Kate Sheppard in the lower Avon Ōtākaro river corridor.
Photo credit: Shane Orchard

Floodplain restoration principles for the Avon Ōtākaro Red Zone

Case studies and recommendations

Prepared by: Shane Orchard
Avon Ōtākaro Network

A project funded by the Tindall Foundation

in collaboration with
Avon Ōtākaro Forest Park and Greening the Red Zone

LIST OF ABBREVIATIONS

AOFP	Avon Ōtākaro Forest Park
AORZ	Avon-Ōtākaro Red Zone
AvON	Avon Ōtākaro Network
CBD	Central Business District
DEM	Digital Elevation Model
DOC	Department of Conservation
DRB	Danube River Basin
DSE	Department of Sustainability and Environment
ERO	Ecological Regeneration Options
EU	European Union
EWA	Environmental Water Allocation
GI	Green Infrastructure
GIS	Geographic Information System
GtRZ	Greening the Red Zone
ICPDR	International Commission for the Protection of the Danube River
KRRP	Kissimmee River Restoration Project
LiDAR	Light Detecting and Ranging
LVD	Lyttelton Vertical Datum 1937
MfE	Ministry for the Environment
MHWS	Mean High Water Springs
MDB	Murray-Darling Basin
MDBC	Murray-Darling Basin Commission
NIWA	National Institute of Water & Atmospheric Research
NZCPS	New Zealand Coastal Policy Statement 2010
UNEP/GPA	United Nations Environment Programme (UNEP) Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA)
VEAC	Victorian Environmental Assessment Council
WWF	World Wide Fund for Nature

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1. Introduction

Why are floodplains important?

Floodplains are an integral part of river systems created and maintained by fluctuating water levels and flows (Junk et al, 1989; Ward et al., 1999). Interactions between the hydrological aspects and the landscape typically support a rich range of ecosystems associated with a complex mosaic of riparian landforms and biological communities (Jungwirth et al., 2002; Ward et al., 2002). Key physical drivers structuring these ecosystems include the dynamic characteristics of climate, periodic flooding, and associated natural disturbance effects (White et al., 2007). They may occur in all geographical areas and at many points along the river corridor continuum (Tockner et al., 2000).

The many different biological communities found in floodplain landscapes include a wide range of aquatic and semi-aquatic wetland communities and periodically flooded forest types, all reliant to some degree on their connection to the river. In these dynamic environments, interactions between physico-chemical and biological process operate at many different spatio-temporal scales with the natural disturbance aspects ensuring regular turnover (Tockner et al., 1999). Hydrological connectivity facilitates exchanges of materials and energy in addition to providing dispersal pathways for biota (Phelps et al., 2015; Thorp et al., 2006). Interplay between the dynamic and connective aspects fosters a continual evolution of ecotones that promotes a high diversity of ecological niches. In turn this supports high levels of biodiversity (Amoros & Bornette, 2002; Ward et al., 2002). In New Zealand as with elsewhere, floodplains provide habitat for many iconic and threatened species, some of which depend on these systems for critical components of their life cycle (DOC & MfE, 2000; UNEP/GPA, 2006). In addition, they support many societal values and uses including a wide range of commercial, cultural and recreational activities.

Across the world many floodplains have been degraded by human activities and continue to be lost under pressures from multiple stressors (Tockner et al., 2010; Wohl, 2011). However, the primary causes relate to hydrological alterations because of the many interests in rivers. These include their use for navigational purposes, energy generation, and as a source of water for agriculture (Benke et al., 2000; Nilsson et al., 2005; Tockner & Stanford, 2002). In combination with their disposition towards periodic flooding and its potential impacts on human activities, this has resulted in the regulation of many rivers through engineering designed to control characteristics of water levels, direction, and flows (Hauer & Lorang, 2004; Kuiper et al., 2014; Nilsson et al., 2000).

These alterations often promote the expansion of human settlement and intensive land uses in floodplain landscapes that were previously untenable due to natural river dynamics (Jungwirth et al., 2002). Even where remnant floodplain ecosystems may be found, the disruption of the frequency, magnitude, and timing of flow events and their associated natural disturbance regime are key factors leading to the degradation of floodplain ecosystems worldwide (Ward & Stanford, 1995). As a result floodplain ecosystems continue to be a highly threatened ecosystem type and are typically high priorities for conservation (Arthington et al., 2010; Poff et al., 2007; Tockner & Stanford, 2002). In New Zealand, this same pattern has emerged due to anthropogenic pressures on floodplains and other lowland ecosystems (DOC & MfE, 2000). In addition, they are areas of high importance to the traditional lifeways of Māori due to the many cultural values they support (Beatty, 1920). These values include rangatiratanga, manaakitanga, and mahinga kai (Tau et al., 1990; Jolly et al., 2013).

Introduction to the Avon-Ōtākaro Red Zone

The sequence of strong earthquakes experienced in Canterbury during 2010 - 2011 caused widespread damage and included four earthquakes exceeding magnitude M_W 6.0, all on previously unrecognised faults (Beavan et al., 2012). Surface deformation effects included liquefaction, lateral

spread, subsidence, cliff and bank collapse, rockfall and alterations to hydrological regimes (Allen et al., 2014; Quigley et al., 2016). Following the Canterbury earthquakes many thousands of homes were acquired by the government for demolition on the basis that the land was too badly damaged to be economically remediated for immediate residential redevelopment. A large tract of the land acquired, some 535 ha, runs eastward from the Christchurch CBD along the banks of the Ōtākaro / Avon River (Figure 1-1). This 'red zoned' area is known by various names including the 'Residential Red Zone' and Avon-Ōtākaro Red Zone (AORZ) as used here. Future uses of this land provide the context for this report.

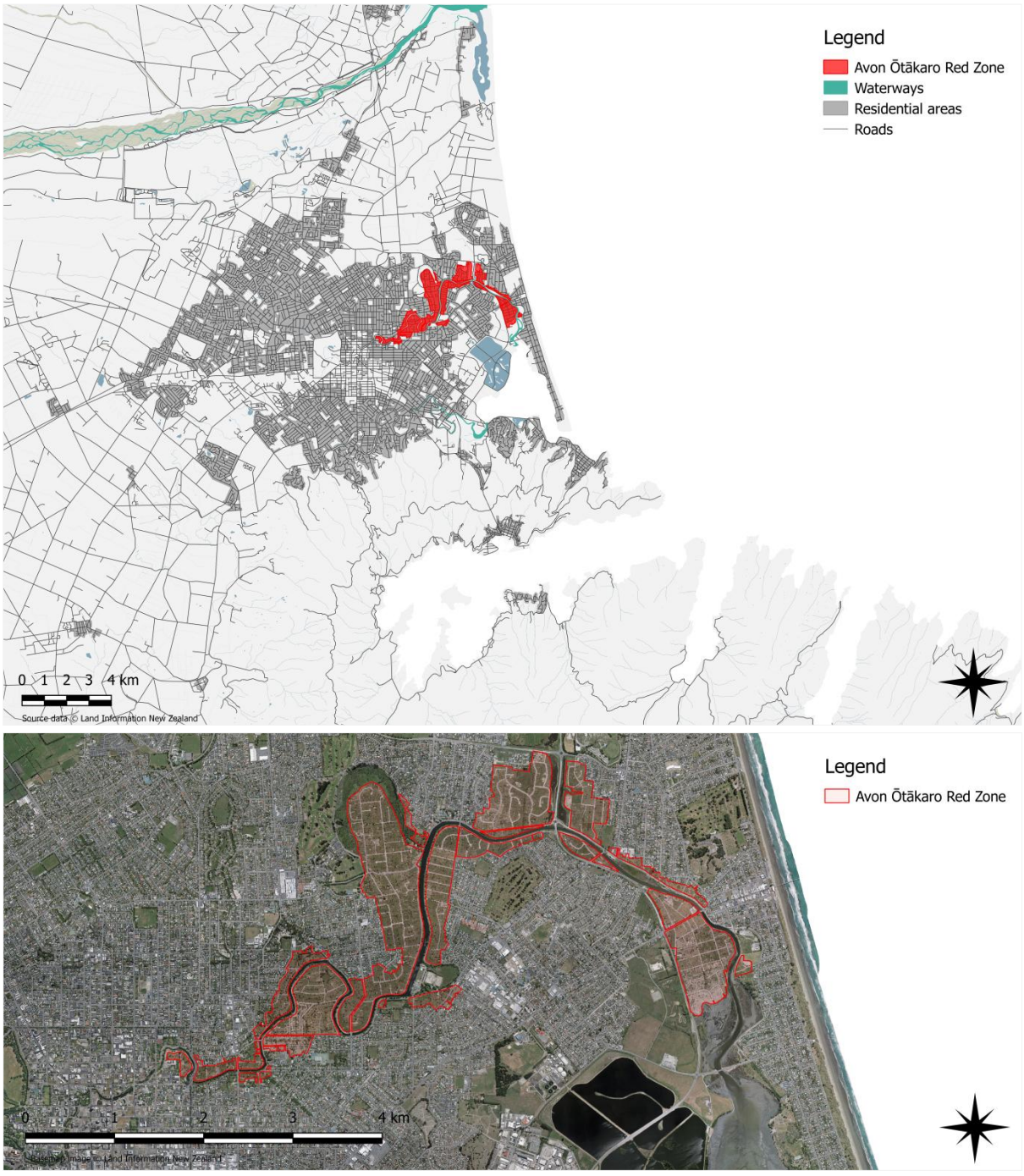

Figure 1-1. Two views of the Avon-Ōtākaro Red Zone.

Historically, the area now occupied by the AORZ was part of an extensive network of riparian floodplain wetlands supporting a rich mosaic of indigenous ecosystems. The pre-European distribution of ecosystems was relatively well documented in the Black Maps of 1856 (Figure 1-2). In addition, a description of historically occurring ecosystems together with their characteristic species assemblages was prepared by Lucas et al. (1997) based on land systems (Figure 1-3).

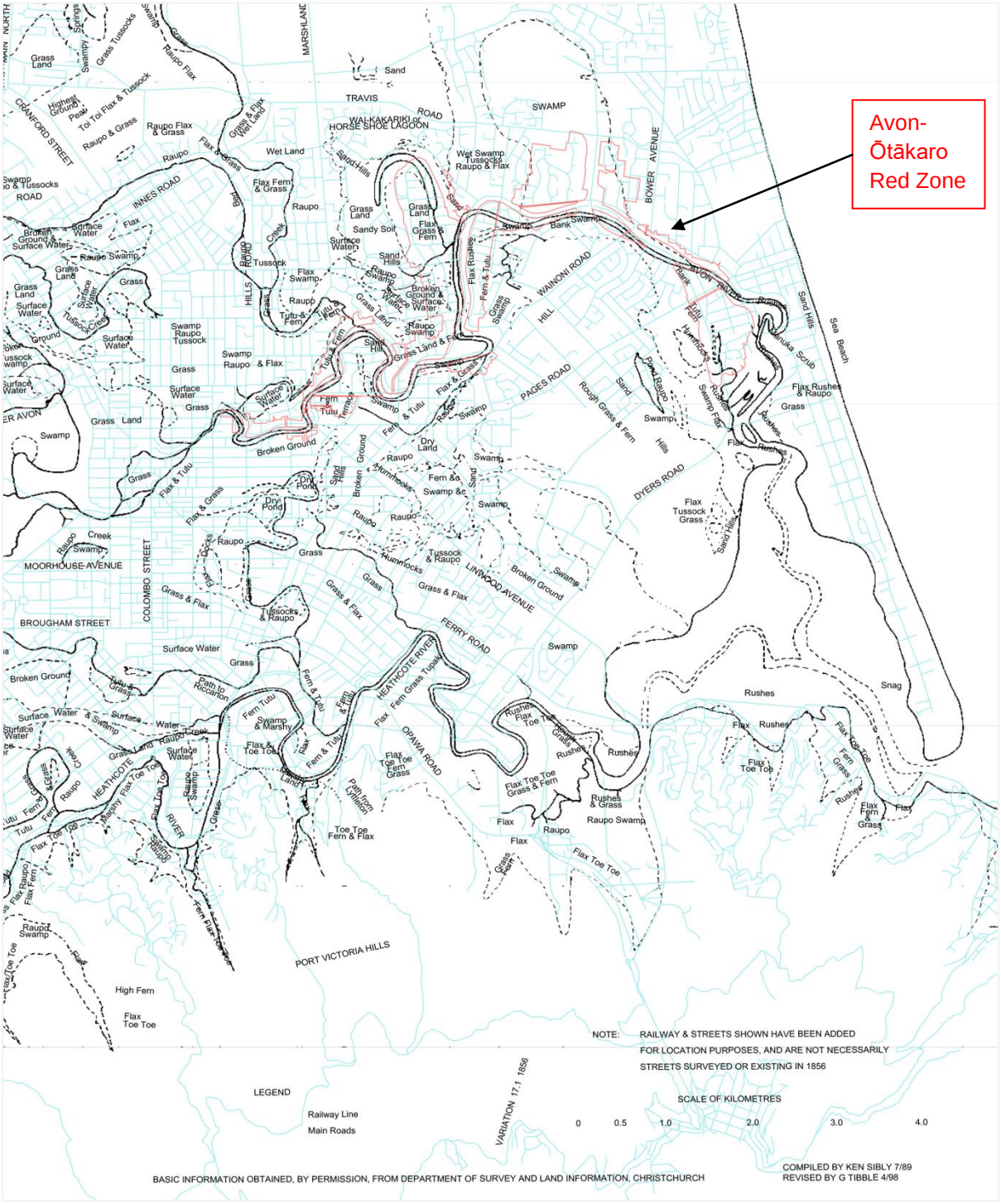

Figure 1-2. Excerpt from the 1856 Black Maps with the approximate position of the AORZ shown as an overlay. Note changes in the position of waterways channels (in black) in relation to the position of modern day roads (in blue). (Black Map courtesy of Christchurch City Council).

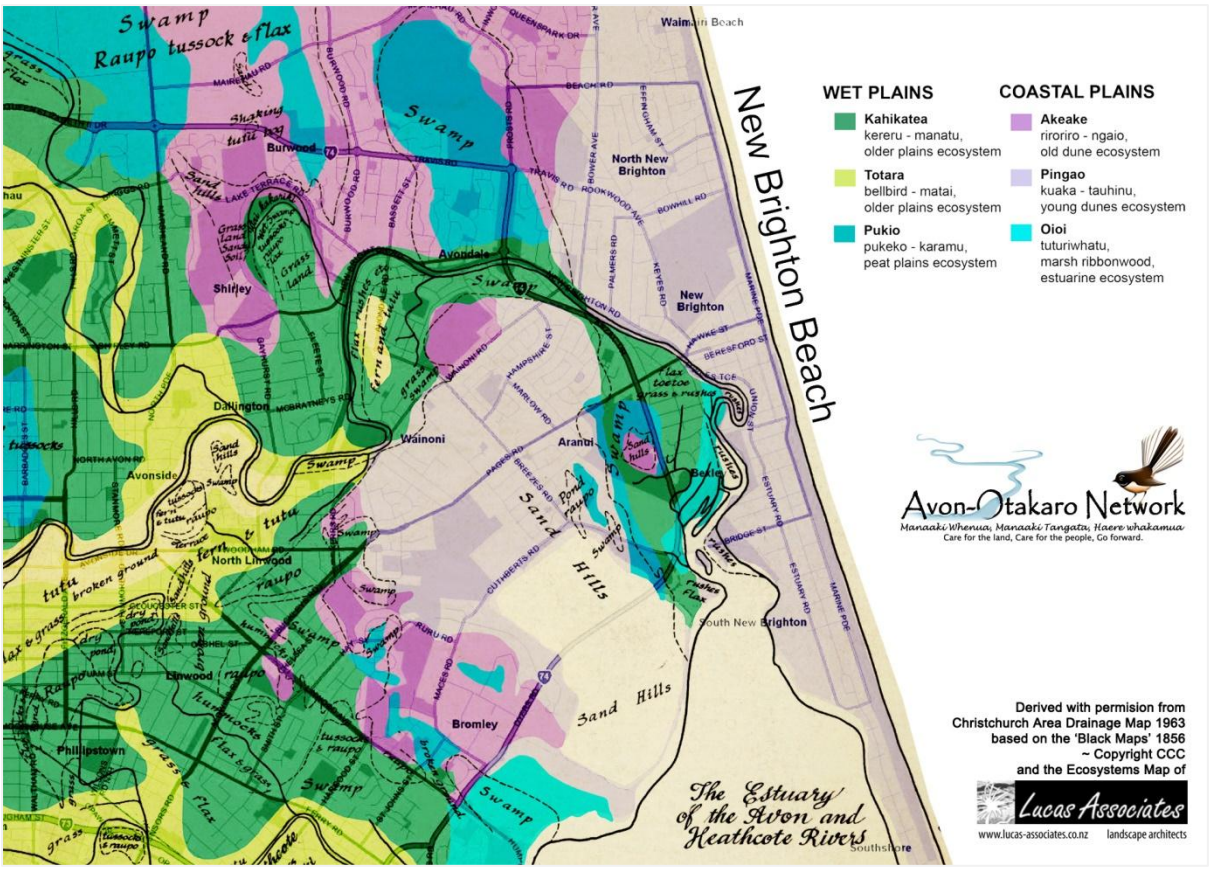

Figure 1-3. Ecosystems of the lower Ōtākaro / Avon River catchment based on the 'Black Maps' and 'Indigenous ecosystems of Ōtautahi Christchurch' (Lucas et al., 1997; Lucas Associates, 2011).

This historical information highlights the underlying floodplain landforms that characterise the majority of the AORZ area. This information also provides a potential baseline for assessing the impacts of land-use change on the previous pattern of indigenous ecosystems. However, the underlying land and waterscape has now been altered by the earthquakes. Consequently, these information sources are best regarded as descriptions of reference systems that could be potentially re-created in the future. They cannot be directly used to ascertain the potential distribution of restored ecosystems, or to identify those that could be restored, without additional information on current biophysical conditions. Alongside the consideration of ecological regeneration in the AORZ, there is also a need to understand the effects of removing or re-engineering past modifications. Fortunately, there are a growing number of river restoration projects that have addressed similar contexts worldwide. These provide opportunities to test re-assembly hypotheses and improve the basic understanding of river re-engineering proposals and their likely effects.

Earthquake recovery and regeneration planning

Formal planning for the regeneration of the AORZ area is being led by Regenerate Christchurch, an entity established under the Greater Christchurch Regeneration Act 2016. Regenerate Christchurch has a range of functions including to "develop visions, strategies, and Regeneration Plans" and "provide independent advice on regeneration activities to the Council and the Minister". Key components of the planning process to date include preparation of an 'Outline for the Ōtākaro / Avon River Corridor Regeneration Plan' (Regeneration Plan), and completion of initial community engagement activities including public visioning workshops to establish community needs and values. A single Regeneration Plan will be developed for the whole of the AORZ and some adjacent lands

representing a total area of 602 ha. It will include areas occupied by waterways and their margins (Regenerate Christchurch, 2017). The planning process is expected to result in a clear vision for the area, a spatial plan identifying the location of future land uses and activities to achieve the vision, and identification of key actions required for its implementation within a temporal plan.

Background and objectives of the study

The Avon Ōtākaro Network (AvON) is one of many community-based organisations that has formed since the Canterbury earthquakes. Since 2011, AvON has been working towards the creation of a multiple-purpose river park as an outcome of the earthquake recovery process. The vision of the organisation is “to promote the future use of the Ōtākaro/Avon River and the surrounding red zone lands as an ecological and recreational reserve for the community”.

The specific aims of the group as found in the AvON Charter are:

- to establish a community-driven, science-informed living memorial to rejuvenate and nurture the long-term environmental, economic, community and spiritual wellbeing of the eastern suburbs and greater Christchurch.
- to create a place of hope and inspiration for the people of Christchurch by restoring health and vitality to our river and its lands (Avon Ōtākaro Network, 2013).

Alongside the work of AvON many other community groups have developed projects or proposals for land uses in the AORZ. Collectively these initiatives have mobilised a high level of interest in the future of the area. A prominent aspect of AvON’s role has been to facilitate networking between the various proposals to explore the potential for synergies and encourage integration. Although many current land-use proposals are compatible with ecological restoration to some extent, very few are focussed towards restoration of a natural river corridor from the CBD to the sea despite this being a cornerstone of the AvON vision. Exceptions include the proposals developed by Avon Ōtākaro Forest Park (A-OFP) and Greening the Red Zone (GtRZ). Following commencement of the formal planning process by Regenerate Christchurch an important information gap was identified by AvON, A-OFP, and GtRZ, that is relevant to identifying and assessing the full range of options and opportunities for future uses of the AORZ. The information sought was specification of the ecological restoration outcomes that could potentially be created together with how they might be implemented. These may include opportunities to address legacy degradation issues, develop highly cost-effective land-uses, or create novel ecologically engineered environments with high societal benefits, and combinations thereof.

To help address the wider opportunities for river corridor restoration in the regeneration planning process, the Ecological Regeneration Options (ERO) project has been developed in collaboration with the above groups. The purpose of the project is to inform Regenerate Christchurch and other groups involved in planning for future uses of the AORZ. Therefore, potential audiences include Regenerate Christchurch in the context of their integrated business case assessments, proposal proponents in embedding restoration principles and synergies within their designs, and the wider community of interests in the opportunity presented by the AORZ. A key aspect is to encourage and facilitate comparisons between restoration opportunities and other land-use proposals. Better knowledge of these opportunities is expected to be useful for the identification of trade-offs and beneficial co-uses of the land and other natural resources. This information may be incorporated into many of the developing proposals for regeneration of the AORZ and will assist the integration of green, blue, and built infrastructure opportunities in both time and space.

his study is the first of three in the ERO series. The purpose of this report is to provide: (a) an overview of the floodplain characteristics of the AORZ, including consideration of potential inundation effects under sea level rise, (b) a review of international experience in large scale floodplain

restoration relevant to the AORZ, (c) a synthesis of key principles for the identification of floodplain restoration opportunities in the AORZ.

2. Methods

This study has been conducted in two parts. Firstly a coarse level analysis of current surface elevations and hydrology in the AORZ, including post-quake changes, was conducted to characterise the study area for subsequent interpretation against floodplain management and river restoration literature. The methods used literature review and document analysis of recent technical studies in the post-quake literature and GIS-based analysis of available datasets using overlay techniques. Data sources are cited in the relevant figures.

Secondly an extensive literature review of international experience in floodplain restoration was conducted to identify principles relevant to the AORZ context. Based on the review findings, three examples were chosen for preparation of case studies. The first two case studies were chosen on the basis of similar historical degradation patterns, adjacent land uses, and river regulation context. These cases are the lower Danube and Kissimmee Rivers. The third case, the Murray River in Victoria, was chosen for its relevance to innovative environmental assessment approaches in support of flood plain restoration and planning. Transferable principles were identified through case-case comparison and used to inform recommendations for floodplain restoration approaches that could be applied in the AORZ.

3. Post-quake characteristics of the Avon-Ōtākaro Red Zone

Earthquake effects on surface elevations and hydrology

The Canterbury earthquake sequence is one of the best documented tectonic events in New Zealand history (Quigley et al., 2016). LiDAR data was acquired after each of the major earthquakes. Together with other remote sensing and field studies a detailed picture of land movements may be derived. Compared to pre-earthquake ground levels, the dominant trend in the AORZ is subsidence, together with lateral movement especially in the vicinity of waterway channels (Allen et al., 2014). Subsidence predominates across all of the major areas within the AORZ (Figure 3-1) despite some variability (Table 3-1) with the average subsidence across in the entire AORZ being 0.48 m based on a 5 m DEM. A difference map (Figure 3-2) illustrates the wider pattern in the context of adjacent lands. Note that the effects of a 5.7 M_W quake in February 2012 are not accounted for in these data.

Table 3-1. Summary of pre-2010 to post-2011 ground surface subsidence in the AORZ.

AORZ areas	Area (ha)	Elevation change (m)		
		min	max	mean
Avon Loop	3.67373	-1.2391	0.0607	-0.5247
Linwood	12.72408	-1.8935	0.8501	-0.3917
Richmond	16.26356	-1.6400	0.5913	-0.5219
Avonside	48.96481	-1.5441	0.4875	-0.5517
Dallington	131.8225	-1.7252	0.9879	-0.5395
Wainoni	8.897279	-1.3211	0.5069	-0.4241
Avondale	48.84491	-1.5411	0.0860	-0.5852
Burwood	55.25861	-2.5357	1.9030	-0.2509
New Brighton	42.03767	-1.7656	0.5706	-0.5194
Bexley	68.06241	-3.2755	1.0990	-0.4913

† negative values are subsidence and positive values uplift relative to pre-earthquake ground elevations.

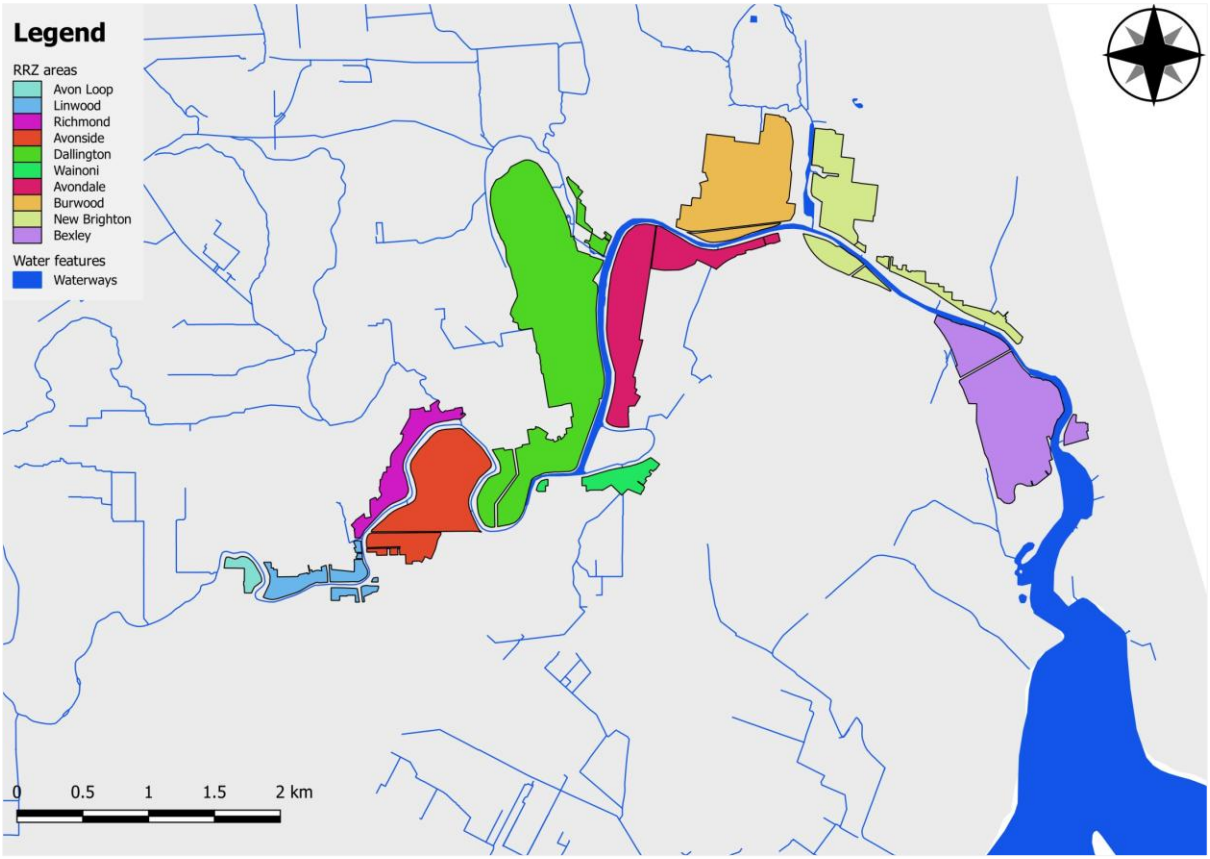

Figure 3-1. Major areas for regeneration within in the AORZ.

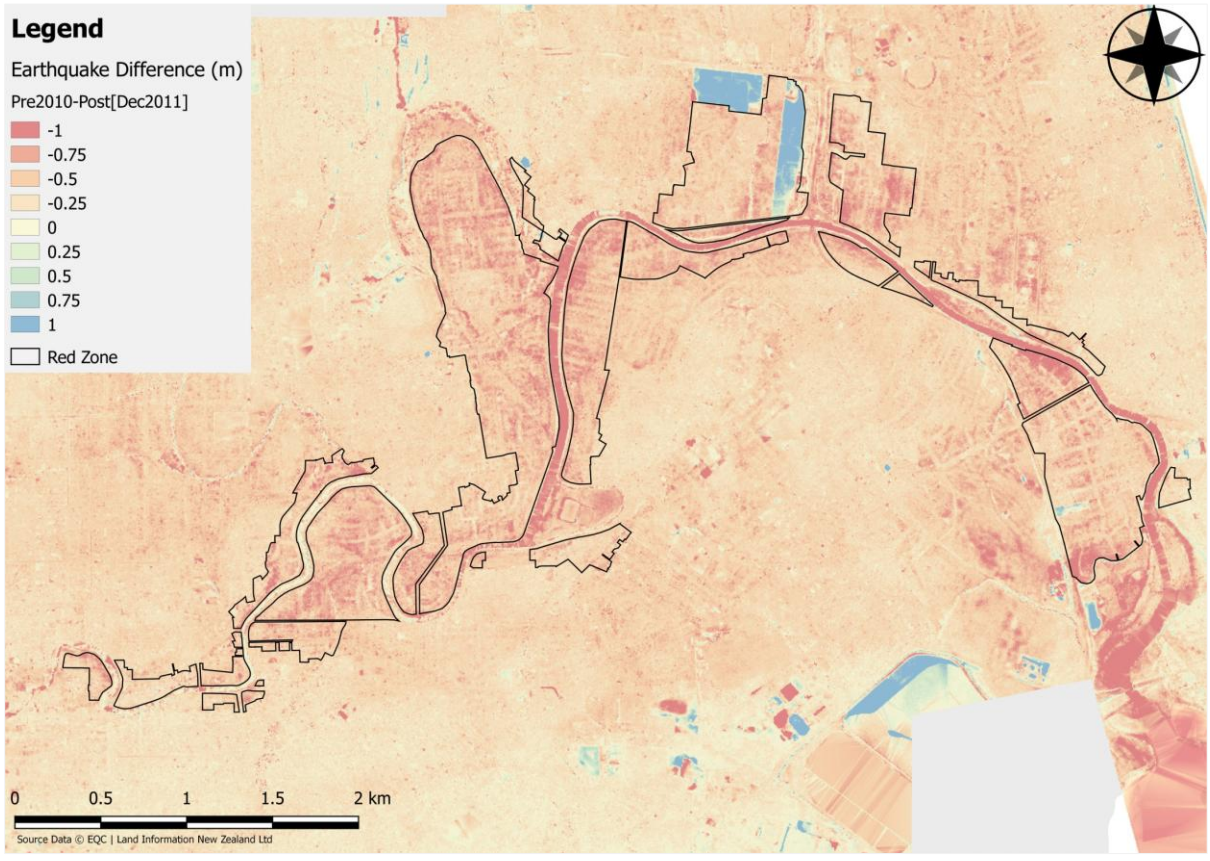

Figure 3-2. Elevation difference map showing pre-2010 to post-2011 ground level changes derived from LiDAR data.

A consequence of land subsidence in the lower Ōtākaro / Avon is greater exposure to flooding including coastal inundation and the potential effects of sea level rise. Particularly in the downstream reaches of the river corridor, this has resulted in heightened connectivity to the sea. For comparison the inundation extent of a 1.15 m LVD event on ground surface elevations derived from 2012 LiDAR data illustrates that a substantial area of the AORZ in Bexley is exposed to tidal inundation if water control structures were removed (Figure 3-3). Additionally, much of the AORZ is exposed to inundation within a 100 year planning horizon based on an expectation of 1 m sea level rise (Figure 3-4). Under the NZCPS decisions on new infrastructure require climate change considerations to be addressed for at least a 100 year planning horizon. Despite that investments in ecological restoration are nature-based entities, they represent 'green infrastructure' that also requires a sound business case (Cohen-Shacham et al., 2016). Future-proofing of the expected benefits of ecological restoration must therefore be secured by design. This may be accomplished through a combination of attention to the targeted restoration objectives, and the design of implementation strategies to address ecological succession and resilience to climate change.

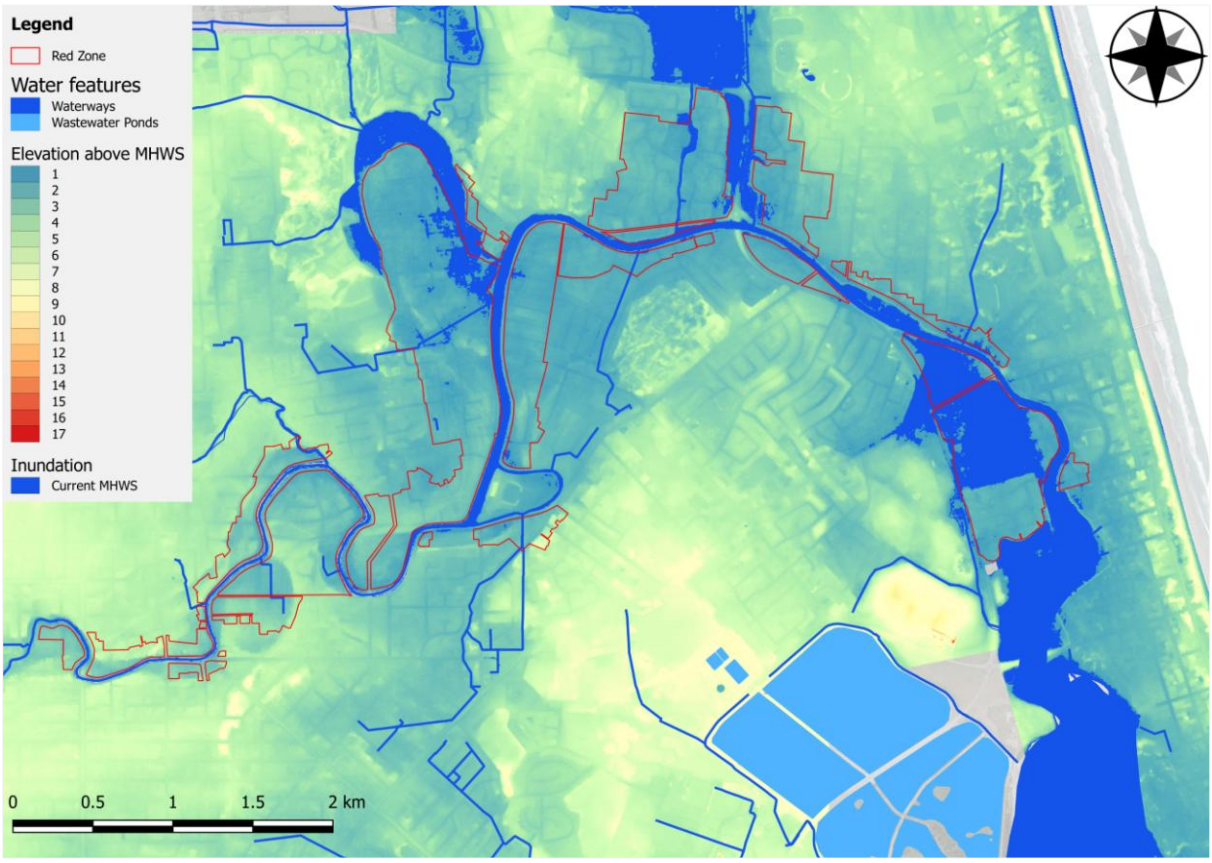

Figure 3-3. Inundation extent at MHWS as simulated by a 1.15 m LVD event on ground surface elevations derived from 2012 LiDAR. The underlying DEM has been re-scaled to show elevation above 1.15 m LVD in the adjacent areas.

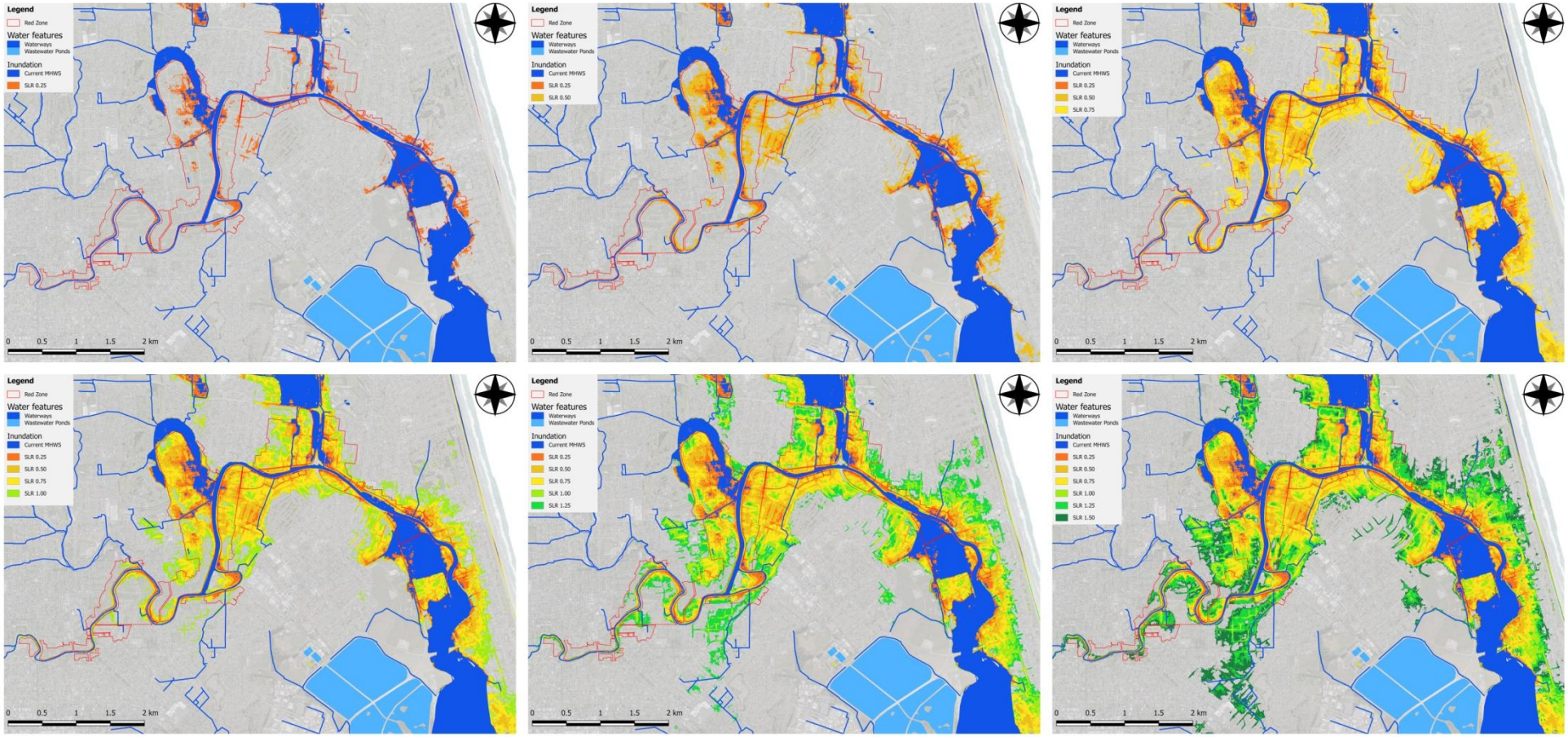

Figure 3-4. Sea level rise scenarios simulated in 0.25 m increments relative to an elevation of 1.15 m LVD as used in Figure 2-3. Available from http://bit.ly/2oe0d7R

Implications for ecological restoration and regeneration planning

In general, the earthquake impacts were more severe in the vicinity of the estuary and waterways and included changes to ground levels and bathymetry (Allen et al., 2014; Measures et al., 2011). Post-quake studies have shown further more subtle changes in a variety of drivers important to ecological structure and function. These include substrates (Cochrane et al., 2014; Zeldis et al., 2011), river bank and channel profiles (Allen et al., 2014, Orchard & Hickford, 2016) and alterations to the salinity regimes of the lower rivers (Orchard, 2016a; Orchard & Measures, 2016). The magnitude of these effects has been sufficient to drive long-term ecological changes in the distribution of species and habitats. Examples include rapid responses in the distribution of glasswort (*Sarcocornia quinqueflora*) and other saltmarsh species (Cochrane et al., 2014), and spawning sites for īnanga (*Galaxias maculatus*) (Orchard, 2016b; Orchard & Hickford, 2016). The full extent of these effects remains poorly understood yet is fundamentally important to the current ecology and ongoing successional processes in the AORZ.

Plate 1. A recent view of the lower Ōtākaro / Avon River near Anzac Bridge. Photo: Shane Orchard.

4. The bigger picture – creating room for rivers

A central theme of floodplain restoration concerns release from, or reversal of, the effects of human land use encroachment on riparian ecosystems and waterways. Many of these have been completed in the context of river regulation (Nilsson et al., 2000), often accompanied by various forms of drainage schemes on floodplain land to assist the development of settlements and intensive human land uses.

Examining the historical pattern of human land use encroachment with regards to the naturally occurring ecosystems of the AORZ is an essential starting point for restoration planning. The combination of earthquake impacts and land acquisition via Red Zoning creates a unique opportunity to reverse undesirable aspects of previous land use decisions. However, the literature contains many examples of human land-use encroachments similar to those that have historically affected the waterways and floodplains of the lower Ōtākaro / Avon River, and there are examples of restoration initiatives in some of these contexts. One of the best examples is found in the lower Danube where floodplain restoration initiatives have been in place for several years and include studies that have reported on the ecological outcomes of attempts to reverse land use encroachment.

Case Study 1

Ecological restoration of the lower Danube floodplain

Overview

Floodplain restoration in the Danube River Basin (DRB) recognises the cumulative loss of natural river features and associated habitat degradation and loss of indigenous species. In many parts of the DRB the goal of floodplain restoration is to reverse these long term degradation trends to achieve restoration outcomes that include the recovery of river dynamics, natural ecosystems, and ecological functions (ICPDR, 2009). However, the river system and floodplain remains characterised by a high degree of interest in intensive land uses. Many of the restoration initiatives have involved re-imagining the concept of sustainable floodplain management by identifying alternatives to the historical development pattern, thereby addressing the many competing demands. The DRB is the world's most international river basin, spanning 19 countries (Figure 4-1). In most reaches, river dynamics have become heavily impacted by human land use encroachments and direct engineering of the waterways and their margins (Figure 4-2). A recent assessment of floodplain extent and condition found that the morphological floodplain area (delineated by post-glacial lower terraces) was 26,524 km^2, or 3.3% of the total DRB. Active floodplains, being those currently located within flood protection dikes, cover 8452 km^2 equating to a 68% loss after accounting for the in-stream water surface area of 1724 km^2. Including the main tributaries in the assessment raises the total loss to around 80% of the original floodplain areas (Schwarz, 2010). Other impacts include the modification of 1,100 km of natural river banks (Schwarz, 2010, 2013)

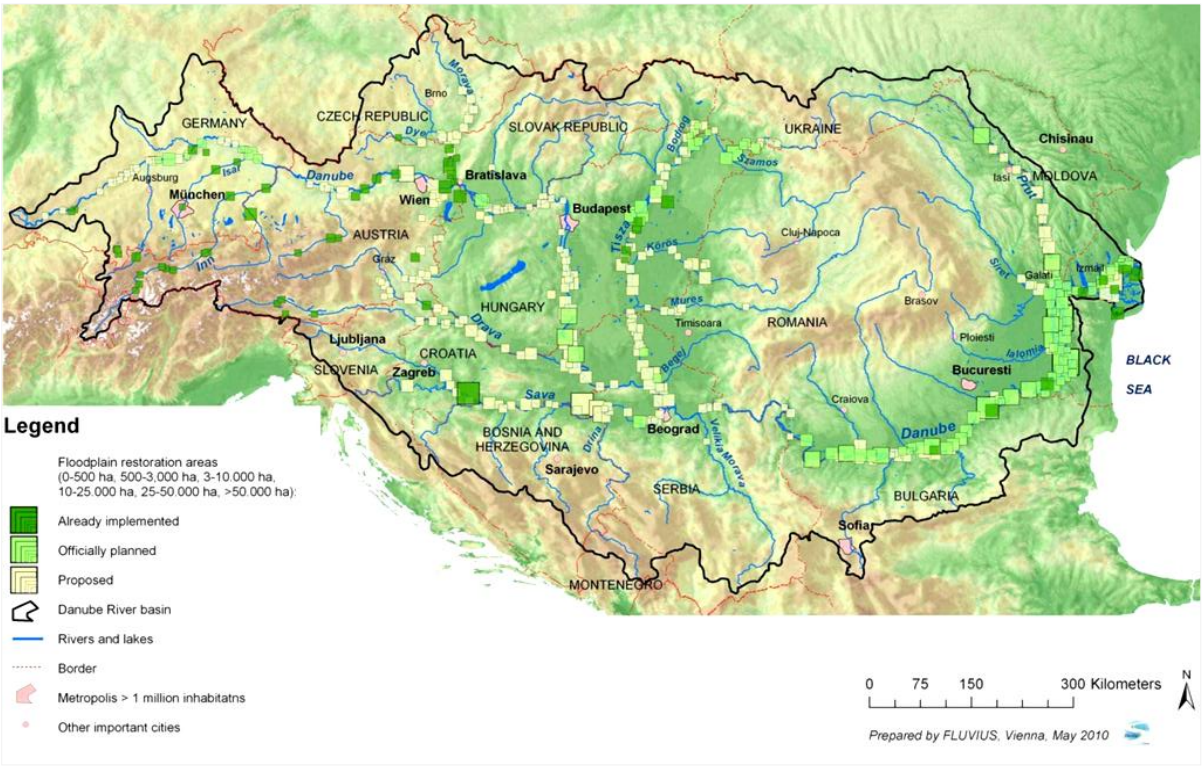

Figure 4-1. Floodplain restoration areas in the Danube River Basin (Schwarz, 2010),

Figure 4-2. Example of the status of river banks in a section of the Danube River Basin (adapted from Schwarz, 2013).

Key activities that have contributed to ecological degradation include the channelization of waterways for navigation, building of flood defences, hydropower developments, and extractions of gravel and sand (ICPDR, 2008). As is common across Europe, flood protection works have been a major contributor to the loss of floodplain areas due to the traditional approach of building defences to confine water within the river channel (Hohensinner & Drescher, 2008). This has resulted in a progression of engineering works that have disconnected floodplain areas from river systems, accompanied in many areas by agricultural expansion and in others by urbanisation (Habersack et al., 2014). Signing of the Danube River Protection Convention in 1994 marked a step-change for river management. This established the International Commission for the Protection of the Danube River (ICPDR) for the purposes of facilitating a more sustainable approach to river management that addresses the competing water uses (ICPDR, 2009). In addition, a series of severe floods across Europe around the turn of the century forced a re-think in approaches to flood risk that resulted in heightened awareness of the role of floodplains in flood management (Barredo, 2007; European Commission, 2013). Together with increased attention to biodiversity targets these developments have set the scene for a concerted focus on floodplain restoration across the basin that has grown steadily over the years.

Early initiatives began in the 1990s (Schiemer et al., 1999; WWF 2000; 2002) and were assisted by low economic returns from agricultural polders (low-lying land enclosed by dikes) together with improved recognition of restored floodplains as a cost effective land-use alternative (Staras, 2001). Since then, studies in the DRB have reported a range of benefits associated with floodplain restoration, including reduced flood risks in the immediate catchments of restoration projects and downstream (e.g. Schober et al., 2015). The contemporary policy framework has also become more supportive of an integrated approach to river management in which ecological objectives are recognised. The three primary influences are the EU Habitats Directive, Water Framework Directive, and Floods Directive (Council of the European Communities, 1992; 2000; 2007). Considerable policy progress was made in the context of the current EU Floods Directive (Council of the European Communities, 2007) that includes attention to the avoidance of further ecological degradation. This demonstrates better alignment with integrated river basin management principles in comparison to the earlier philosophy (Habersack et al., 2015). In addition to these governance aspects, increased public awareness of the degradation of floodplains has been, and remains, an important factor driving the development of new approaches to river management in the DRB (Sommerwerk et al., 2010).

Floodplain restoration in the lower Danube

The remainder of this case study focuses on the lower Danube where land use patterns and restoration initiatives include many aspects relevant to regeneration activities in the lower Ōtākaro / Avon River corridor. In particular, this part of the DRB is characterised by extensive channelization and river-bank engineering (Buijse et al., 2002). Many disconnected floodplains have been converted into agricultural areas and ponds for aquaculture, and systems of man-made channels are a commonly found for drainage (Staras, 2001). From a societal standpoint, conversion of the Lower Danube floodplains can be observed to have favoured a select few river uses at the expense of other user groups (Nichersu, 2006). Activities that have historically sought to restrict the natural flooding dynamics of floodplains include navigation, agriculture, and residential development (Moss, 2008).

The consequences of these alterations have been the subject of many studies. Commercial fisheries reliant on the floodplain habitat have collapsed (Staras, 2001) providing an example similar to the loss of resources contributing to mahinga kai in the Ōtākaro / Avon River and wider Ihutai catchment (Pauling et al., 2007; Lang et al., 2012). Despite this, some areas experience increased water levels on flood peaks versus historical river states illustrating that flood risk management remains an issue (Schober et al., 2015). Human impacts have had a drastic effect on many aspects of floodplain ecology. Many of the effects on biota can be traced back to the curtailment of riverine dynamics, in most places associated with land use conversion. As a result, habitats characteristic of floodplain ecosystems are no longer regenerated by fluvial processes, leading to a cascade of effects on habitat

structure that may occur even when other aspects of the competing land uses do not pose a direct threat to biodiversity (Naiman, 1988).

A key step in facilitating a new river management approach in the lower Danube was establishment of an innovative project, the Ecological and Economical Resizing of Lower Danube Floodplain (REELD) (Covasnianu et al., 2010). REELD activities have included prioritising the restoration of selected areas to enhance habitat values, and evaluating opportunities for mixed-use polder concepts elsewhere that combine cultivation and water retention functions (Covasnianu et al. 2010). In general, REELD has been successful in resolving conflicting socio-economic demands for the use of the river and floodplains, as evidenced by a growing number of restored areas (Figure 4-3). Key restoration measures have included reconnecting areas cut off by embankments and the reinstatement of meanders that had been bypassed by engineered channels (Staras, 2001). Practical actions have including the blocking of man-made channels for drainage as well as the reconnection of polders through planned breaches of dikes (Figure 4-4).

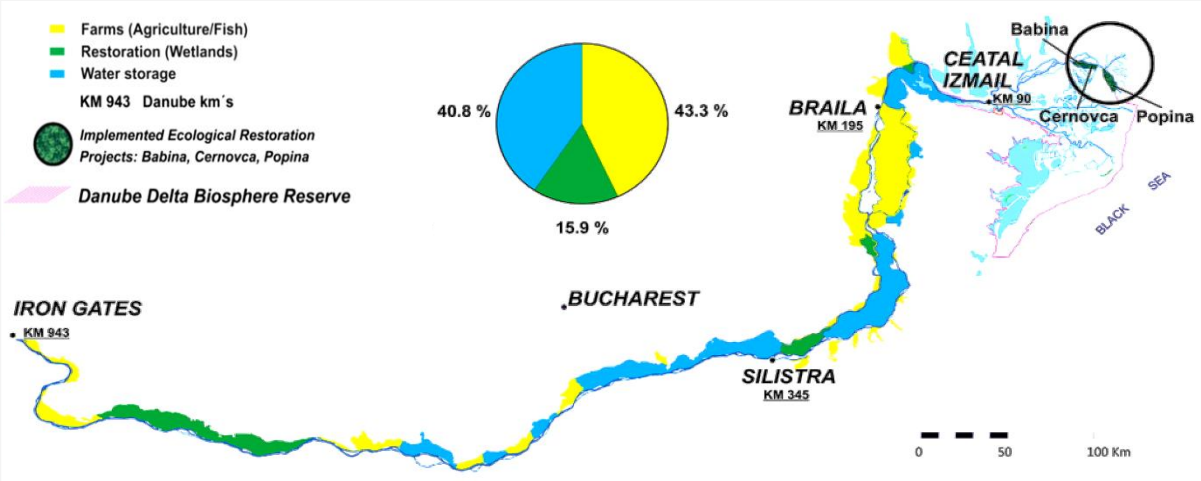

Figure 4-3. Farmed floodplain areas and sites undergoing restoration in the Lower Danube including floodplains reverted to wetlands (green), and floodplains with restored water storage function (blue) (Hein et al., 2016).

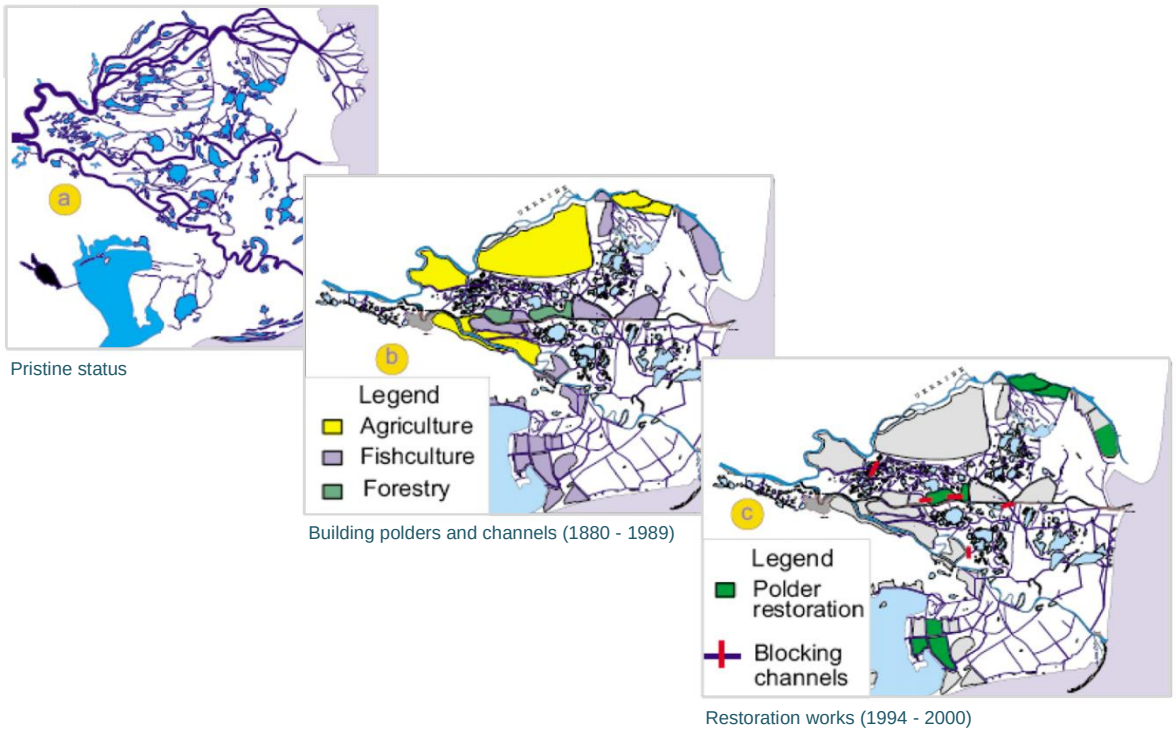

Figure 4-4. Key phases in the history of ecological restoration in the Danube Delta (Adapted from Staras, 2001).

The results of these measures have typically been rapid recovery of floodplain structure and function (Zöckler, 2000). For example reconnected polders have increased spawning habitat availability for several fish species (Navodaru et al., 2005) and other benefits have included improved retention of nutrients and suspended solids (Schneider, 2002; Suciu et al., 2002).

Challenges

Some of the challenges for the achievement and maintenance of restoration objectives in the lower Danube include invasive species and climate change (Hulea et al., 2009). Invasive species are a particular consideration in floodplain re-connection works since these may introduce undesirable exotic species into areas that were formerly protected by the absence of connectivity (Havel et al., 2015). The significance of these effects relates to the specific biodiversity and circumstances of the floodplain areas in question (Flanagan et al., 2015). Particular concerns in the AORZ could include improved access for predatory species or creation of invasion pathways for plant pests.

Climate change creates another set of considerations that interacts with species distribution and connectivity aspects, both unwanted and desirable (Mauser et al., 2012; ICPDR, 2013). As is the case in the Danube, lower Ōtākaro / Avon River corridor is exposed to sea level rise. This has the potential to exert widespread impacts due to the low-lying topography of considerable area within the AORZ. Many of the potential effects are interdependent leading to a complex set of considerations for attempts to engineer the system towards a targeted end state, or indeed, define which state is the most desirable (Flanagan et al., 2015). For example, Hein et al. (2016) considered that disconnected floodplain remnants of the lower Danube could exhibit amplified warming effects under climate change placing their biota at greater relative risk. Re-connection of water bodies could moderate warming effects though carries with it invasive species considerations as discussed above.

The many different combinations of stressors indicate that floodplain conservation and restoration will need ongoing attention and an adaptive approach. In the lower Danube, this is being addressed by a package of measures that include the recognition of impacts, and strategies designed to enhance the adaptive capacity of ecosystems under likely climate change scenarios (ICPDR, 2013). In general, floodplain re-connection offers several benefits that include buffering the effects of hydrological and thermal extremes and improved habitat connectivity for mobile species (Schiemer et al., 2007). However, incremental alterations to hydrological and thermal regimes remain likely effects of climatic change and are certain to influence the outcomes of floodplain restoration measures (Vaughan et al., 2009). The early detection of these changes is a key activity for restoration planning and longer term adaptation to climate change (ICPDR, 2013). Additional considerations include the need to address potential interactions between discrete restoration projects and sites as these evolve over time (Sommerwerk et al., 2010). This can be achieved through evaluation approaches that capture the outcomes of restoration at different spatio-temporal scales relevant to the system as a whole.

Conclusions

The lower Danube case shows strong similarities in the land use patterns that have contributed to historical degradation of riverine wetlands in Ōtautahi Christchurch. Regeneration activities in the AORZ include opportunities to reverse legacies of previous land use development and reinstate more natural floodplain dynamics as well as improving resilience to new threats such as sea level rise. Restoration efforts in the lower Danube have tackled similar legacy issues albeit without the impetus provided by a large scale disturbance and government land acquisition response. However, the need to address the economic implications of alternative future land uses and the cost effectiveness of re-development strategies are aspects in common.

The long history of restoration projects in the Danube provide examples to learn from, and numerous principles that may be useful in the design of restoration strategies for the AORZ.

Key aspects to highlight include:

- Establishment of a strategic oversight organisation (in this case REELD) was useful to achieve the finer-scale planning needed and achieve stakeholder buy-in as necessary steps prior to the implementation of restoration treatments.

- Evaluation and prioritisation assessments have been used extensively to progressively identify opportunities and consider their impacts and alternatives. Cost-effectiveness was a consideration for restoration options assessment. This accounted for the cost to implement any particular change from the status quo versus its benefits and alternatives. Benefits have been assessed primarily against the policy objectives found in three high level directives addressing water, habitats, and flood risk.

- Enlargement of the active floodplain area has contributed to reduced flood risk in terms of lowering peak water heights in the immediate catchment and also downstream during flood events.

- Restored floodplain areas were found to retain suspended matter and nutrients thus improving eutrophic conditions in downstream water bodies. Thereby the floodplain acted as a filter in comparison to a previous drainage configuration characterised by constructed drains that discharged high nutrient and sediment loads into the natural waterways effectively bypassing any filtration or other interception function. An analogous situation exists in the AORZ and in other nearby catchments (e.g. the Ashley and Waimakariri) was observed to be exacerbated by earthquake induced ground level subsidence leading to increased run-off of polluted water into existing drains, accompanied in some cases by the construction of new drains creating further point source discharges.

- The creation of high value habitat to address conservation priorities, and mixed-use concepts elsewhere were features of the broad-scale restoration strategy applied to the former floodplain areas.

- A re-engineered hydrological regime was found to be a strong driver of change mostly associated with improved ecological outcomes. Natural habitats typically recovering quickly in response to floodplain reconnection. Increased hydrological connectivity improved habitat availability for many aquatic species such as fish. Moreoever, this presented a highly cost effective technique for ecological restoration in many cases requiring only the alteration or removal of former defences.

- Reconnection of meanders and lentic water bodies was used extensively to improve habitat and ecological connectivity. This caused some negative effects on species adapted to conditions on floodplain remnants. Invasive species benefitting from improved connectivity are another consideration.

- Reinstatement of natural erosion dynamics and lateral (bank) erosion in particular, are critical aspects of natural floodplain function being essential for the self-maintenance of the full range of dynamic riparian habitats.

5. Adaptive management

Overcoming the challenges posed by the complexities of eco-hydrological relationships and the societal demands on rivers are core issues for successful approaches to floodplain restoration and management (Schiemer et al., 2007). One of the best frameworks for overcoming these challenges in a practical manner is through the implementation of an adaptive approach (Ball, 2008; Folke et al., 2005; Norton, 2005). The core concept involves an iterative process whereby complexities may be addressed sequentially in both the societal and ecological dimensions of the system. This approach provides opportunities to resolve the many difficult decisions regarding priorities, reference states, techniques, and trade-offs that are typical of river restoration (Nilsson et al., 2007). Key benefits include the opportunity to incorporate successive cycles of learning and application to refine the overall trajectory of a project towards optimal outcomes as these become more obvious over time (Pahl-Wostl, 2006). These learning opportunities may be applied within a programme of scientific investigations designed to explore the likely responses to alternative strategies at various scales, or as an aspect of social learning and motivational work with the wider community, and many combinations thereof.

One of the prominent international examples of this approach to river restoration is the Kissimmee River Restoration Project in central Florida. The project aims to restore the ecological integrity of a degraded river corridor that resulted from channelization for flood control purposes in the 1960s. The project area includes 70 km of river channel and approximately 11,000 ha of floodplain wetland. Although this is some 20 times the size of the AORZ regeneration project there are many similarities. A particular feature is the adaptive management approach taken, supported by a series of outcome evaluations. After several years of implementation these provide useful information on the success of the restoration strategies used.

Case Study 2

Kissimmee River Restoration Project

Overview

The Kissimmee River runs between Lake Kissimmee and Lake Okeechobee in central Florida. The historic river ecosystem was characterised by a meandering somewhat braided channel situated within an extensive riparian floodplain (Toth et al., 1995). Under a flood control programme, the river channel was dewatered and replaced with a 9 m deep, 100 m wide excavated canal (U.S. Army Corps of Engineers, 1956). Accompanying this, a series of embankments were created and the floodplain water table lowered by drainage channels over a large area of the river corridor. This work was completed in 1971 and caused the loss of a large area of the former floodplain ecosystem (Figure 5-1).

Over time, the negative impacts of the channelization project began to attract political attention (Loftin et al., 1990) with a particular focus on the degradation of waterfowl habitat in addition to other historic aquatic and wetland values of the area (Bousquin et al., 2005). This led to calls for restoration of the former ecological structure and function resulting in federal authorisation for the Kissimmee River restoration project in 1992 (Dahm et al., 1995; Toth et al., 1995). Re-engineering of the river channel commenced in 1999 and has progressed through several stages. Key aspects of the wider restoration strategy include acquiring land in the catchment adjoining the river, re-establishing historic discharge

patterns, and reinstatement of more natural river channels (Bousquin et al., 2005; Toth, 2015). All of these restoration treatments are applicable at various scales within the AORZ.

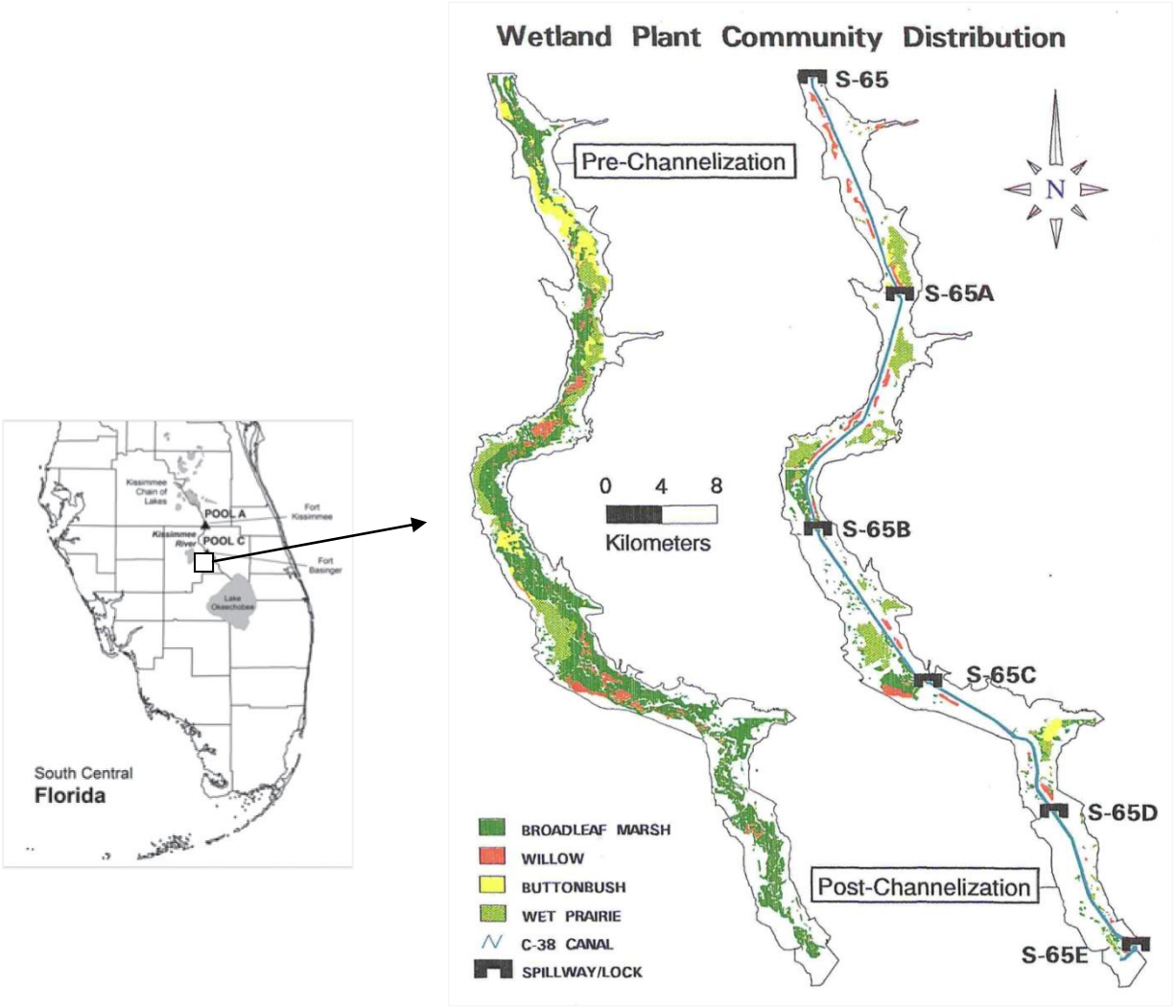

Figure 5-1. Location of the Kissimmee River restoration project in central Florida showing the pre-channelisation (natural) and post-channelisation (degraded) distributions of dominant wetland plant communities (Toth et al., 1995).

Prior to channelization and floodplain drainage, the hydrology of the Kissimmee River was characterised by prolonged overbank flooding (Toth et al., 1998). This was likely a major driver of ecosystem structure and function a mosaic of aquatic, riparian and ephemeral habitats that supported a rich biota of wetland plant species, fish, and water birds (Warne et al., 2000). This example is especially relevant to the current opportunity presented by the AORZ due to similarities in the historical ecosystem types that were found in the area prior to modification (Tau et al., 1990). The restoration of these ecosystems and the cultural values they support remains of high importance to Ngāi Tahu (Jolly et al., 2013; Lang et al., 2012). An additional activity at Kissimmee was back-filling of sections of the drainage canal which has no direct comparison in the AORZ. However, remediation of these filled surfaces, and others formed by spoil deposits from the original canal excavation, bear similarities to the filled and compacted ground conditions that are present across a large proportion of the AORZ as a result of previous residential land uses and land clearance following the earthquakes.

Implementation of the Kissimmee project has involved four major phases of re-engineering to remove water control structures, backfill old canals and reconnect natural waterways channel and floodplains

(Bousquin et al., 2005). Other important steps have included land acquisition, a new headwaters regulation regime, and a restoration evaluation programme providing a feedback loop guiding implementation of the other steps (Figure 5-2).

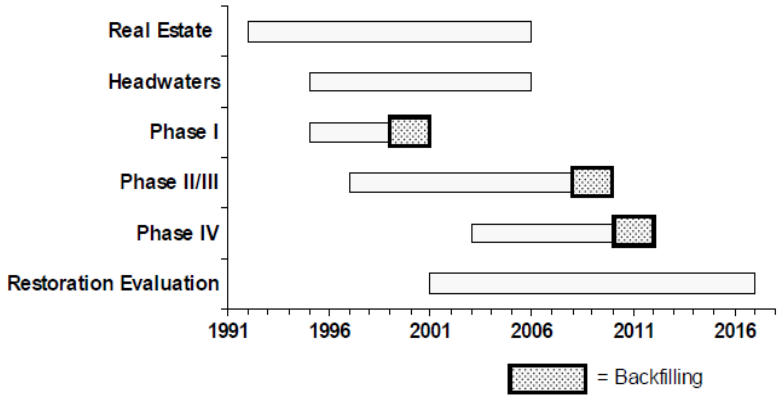

Figure 5-2. Major steps and timelines of the Kissimmee River Restoration Project (Bousquin et al., 2005).

Key aspects of the Kissimmee project

Ecological integrity objective

From the outset, the Kissimmee River restoration identified the concept of "ecological integrity" as the overarching goal for restoration planning. This created an opportunity to shift away from more commonplace restoration examples that single out particular species or desired functions for attention, in favour of a more ecosystem-based approach (Dahm et al., 1995). In practice this was reflected in restoration objectives for a self-sustaining system and a focus on resilience to future events. The inclusion of resilience as a goal has similarly been recognised by Regenerate Christchurch in the Outline for the Ōtākaro/Avon River Corridor Regeneration Plan (Regenerate Christchurch, 2017). As with the Kissimmee case, inclusion of the concepts of resilience and sustainability in high level planning documents is important to guide and enable the possibility of managing for resilience in the more detailed design and implementation phases.

Opportunistic socio-ecological context

In the Kissimmee River case, the development of a restoration project and accompanying social buy-in for implementation was achieved in a context where the negative effects of past modifications were reversible. For example, over much of the project area land development patterns had not advanced to the stage where land acquisition for restoration was difficult or prohibitive. The socio-ecological context also assisted the development of an adaptive approach, due to the lack of competing interests that may have introduced uncertainty over whether a large scale and long term restoration project would eventuate. The AORZ may offer a similar socio-ecological context albeit generated by a different set of historical events. The acquisition of a large tract of contiguous land offers similar opportunities to consider ecosystem-level restoration objectives consistent with an integrated whole-of-system approach to river corridor restoration. This creates a unique opportunity since antecedent societal conditions often present challenges in the restoration of channelized river systems. Factors such as complex resource allocation arrangements and land tenures are commonplace and often prohibitive (Arthington et al., 2010).

Adaptive management philosophy

The approach developed for the Kissimmee identified adaptive management as a core process that would direct restoration planning activities (U.S. Army Corps of Engineers, 1991). Although commitment to large scale re-engineering components was secured early on, the exact implementation of these was the subject of considerable experimentation. This approach was the

cornerstone of a strategy to maximise the eventual benefits despite that their accurate quantification was initially unknown. Given the unprecedented scale and cost (approx. USD$620 million) of the restoration initiative (Bousquin, 2008) this philosophy is highlighted as a critical component that eventually contributed to the level of success.

Information acquisition using pilot projects

Demonstration and pilot projects were used to overcome technical questions and produce information on the expectation restoration trajectories of key components of the ecosystem (Figure 5-3). Examples included backfilling demonstration areas monitored for five years to identify technical issues regarding soil stability (Anderson, 2014). Social elements were also included to identify the changing public perceptions for the project and its potential future benefits (Koebel & Bousquin, 2014). The results of the demonstration projects were documented in a symposium volume (Loftin et al., 1990), technical bulletin (Toth, 1991), and several peer-reviewed papers.

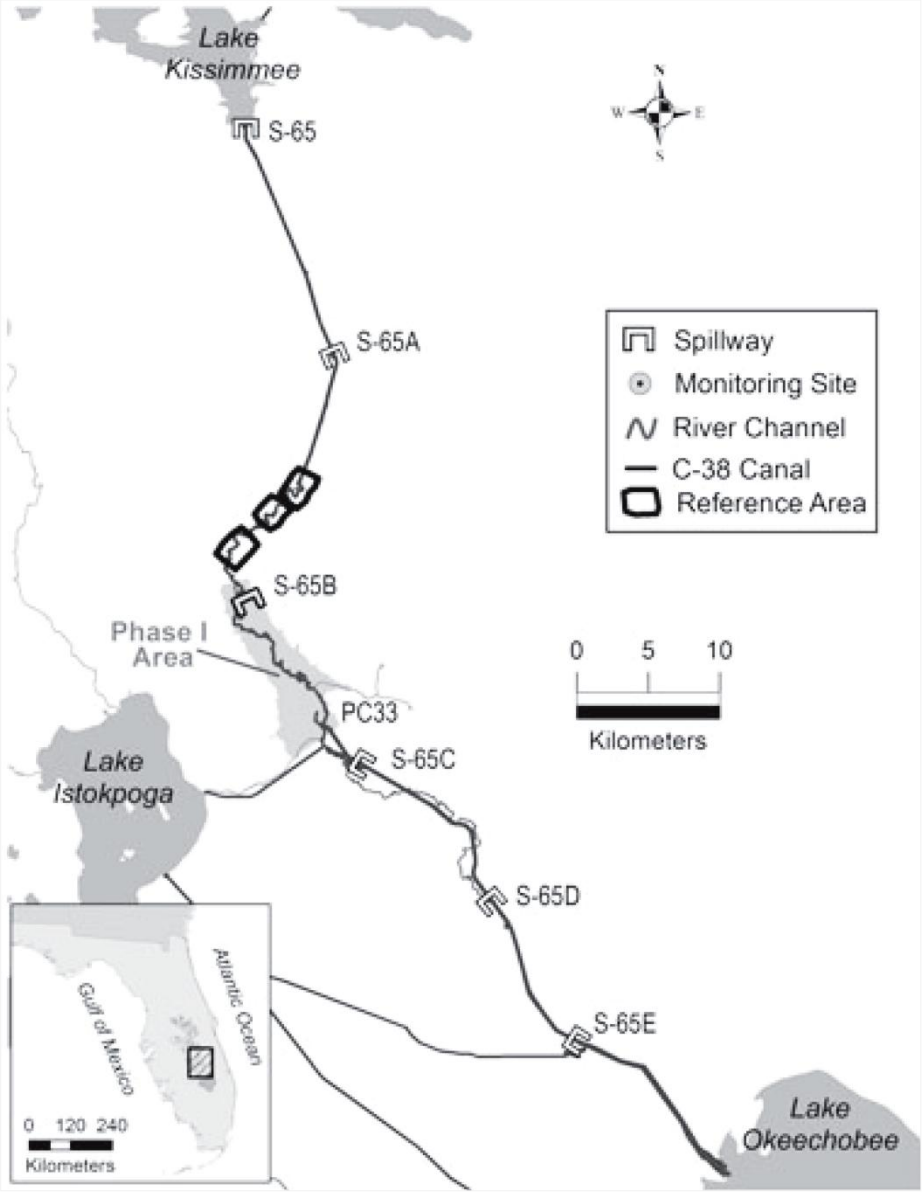

Figure 5-3. Map of the Kissimmee River from Anderson (2014) showing the locations of the reconnected river channel in the Phase I of the restoration project water control structures, and reference areas where the demonstration study was conducted. Note that the control structure S-65B was removed as part of the restoration project.

A similar approach could be useful in the AORZ to evaluate impacts of embankment reconfiguration at smaller scales to inform the prediction of restoration trajectories at larger scales, for example as part of a staged approach. Several studies have shown highly dynamic effects including rapid channel widening and downstream sedimentation associated with the release and recovery of previously retained river channels (e.g. Thomas et al., 2015) and incised river channels more generally (e.g. Beechie et al., 2008). Pilot studies could be a useful approach to assess and manage these effects.

Other studies at Kissimmee sought to relate small scale river dynamic manipulations to the overarching project objective of ecologic integrity (Toth et al, 1998). The findings are likely transferable with regard to this objective. The key conclusion that emerged was the reinstatement of natural hydrologic regimes as a central strategy for restoring floodplain ecological integrity (Anderson, 2005). Consequently, this became the central restoration objective. Remaining practical considerations included the definition of appropriate reference conditions and acquisition baseline measurements against which restoration predictions could be made to support more detailed planning, and outcomes assessed to gauge progress (Bousquin et al., 2005).

Re-establishing dynamic components of the environment

Acceptance of a shifting and highly dynamic biodiversity pattern in time and space is a central issue for wetland restoration (Zedler, 1988) and a necessary aspect for ecological integrity and self-maintenance as restoration objectives. At Kissimmee ecological integrity has been promoted primarily through restoration of floodplain structure and function. Although predictions of expected responses have also received consideration (e.g. as summarised in Anderson et al., 2005) and they have generally not driven the restoration strategy (Toth et al., 1995). Core restoration activities have included re-establishing spatial and temporal diversity in river corridor habitats through attention to aspects such as channel morphology, deposition dynamics, and discharge variability, many of which have inter-related effects. At larger scales the expected biotic outcomes include reinstatement of a mosaic of habitat conditions. At the finer scale the resultant species assemblages have not always met *a priori* species dominance predictions (e.g. Toth, 2016).

The identification of hydrologic components including variability is an innovative aspect of the restoration approach differing markedly from criteria based on a deterministic optimum. Implications include the need for continual re-evaluation to inform a restoration strategy that is designed for adaptive re-adjustment (Suding, 2011). Although expert and local knowledge has been employed extensively in the development of expectations for restoration trajectories, assembly rules have been found to be of limited use past the initial phases of restoration (Toth & van der Valk, 2012). Vegetation studies (e.g. Toth, 2015; 2016) have shown that continuing dynamics are often the source of confounding factors for the attainment of long term goals. Examples include both new and legacy effects and their interaction over the successional timeframe important to key ecosystem components.

Monitoring & evaluation process

Throughout the Kissimmee project, feedback from the ecosystem and the human users has driven adaptation of the process. The core evaluation model made use of a GIS-based hierarchical habitat classification scheme and accompanying bio-physical data. This accommodates a multidisciplinary approach that includes monitoring of many aspects (e.g. hydrology, substrates, chemistry, flora and fauna). The need for comprehensive monitoring to evaluate the success of the restoration project was identified early in project development and documented within the final Integrated Feasibility Report (IFR) for the project (U. S. Army Corps of Engineers, 1991).

Development of the evaluation programme has itself produced an exemplar for other projects in the USA and further afield (Bernhardt et al., 2005). As is the case in the AORZ, opportunities for benefits spanned both land and water environments. Conceptual models of restoration benefits linked to monitoring programmes designed to detect them were developed for many components of the project site and adjacent area (e.g. nearby communities). These included aspects of the vegetation, avifauna,

fish, and invertebrates, as well as the health of the overall ecosystem (Dahm et al. 1995). The initial evaluation framework was documented (Anderson & Dugger, 1998) as were the processes used to develop expectations for specific restoration actions (Toth & Anderson, 1998) supporting opportunities for re-evaluation and learning in both the societal and biophysical aspects of the project.

Biophysical aspects of the monitoring and evaluation effort was organised around four major topics: ecological, hydraulic, sedimentation, and stability (U. S. Army Corps of Engineers, 1991). The ecological components included specific attention to water quality, habitat, threatened and endangered species, birds, fish and fisheries as part of comprehensive approach to support the restoration objectives (Table 5-1). Before-after-control-impact (BACI) analyses (Stewart-Oaten et al., 1992; Underwood, 1992) have been used to assess many of the evaluation questions (Bousquin et al., 2005). This approach considers the restoration treatment as the impact and evaluates the response against a similar area that has not been treated (the control). The experimental and staged approach to the restoration has specifically set aside control areas to enable this type of study and the results used to inform future stages.

Table 5-1. Components of the baselines studies and ongoing monitoring programme for the Kissimmee River Restoration Project (from Bousquin et al., 2005).

	Ecology/Fish and Wildlife						Hydraulics	Sediment	Stability
Baseline Study	Birds	Fish/ Fisheries	Habitat	Water Quality	Threatened/ Endangered Species	Ecosystem Function			
Hydrology			X				X		
Geomorphology			X					X	X
Water Quality			X	X					
Dissolved Oxygen			X	X					
River Channel Vegetation			X						
Vegetation Classification			X						
Vegetation Mapping			X						
Floodplain Vegetation			X			X			
Algae			X			X			
Invertebrates						X			
Fish		X				X			
Reptiles and Amphibians						X			
Birds	X				X				

Vegetation responses

In 1998, a network of sampling locations was established to evaluate restoration responses of wetland plant communities compared to reference sites outside of the restoration area (Toth, 2005). Another study used daily stage data to calculate hydroperiods and inundation depths at the study sites for comparison to historic floodplain dynamics (Toth & van der Valk, 2012). The results showed that the dechannelisation programme had re-established a flood-pulse regime that was comparable to historical patterns. Results from vegetation monitoring showed that rapid vegetation change had occurred following reinstatement of a more natural flooding regime, as expected. The major changes included the elimination of pasture grasses and facultative shrubs that were intolerant of the inundation regimes. However the predicted dominance of historically occurring (indigenous) wetland vegetation did not eventuate due to the spread of relatively new exotic species in the area (Toth, 2010; Toth & van der Valk, 2012).

A study based on species turnover rates (Toth, 2015) related these changes to invasibility aspects of the restored system versus the modified pre-restoration state. This highlighted that increased opportunities for invasion are fundamentally important to the restoration process following a ‘working

with nature' type approach that depends on the extant seed bank for recolonisation of the hydrologically restored areas (Arnold et al., 2009). Since the same invasibility may offer opportunities to exotic species (Lonsdale, 1999), trials to quantify the likely effects are useful to inform the best strategies and investments that may be needed to ensure success. Potential issues include the availability of local seed sources (Markwith et al., 2014) and opportunities for exotic species to establish an alternative stable state (Holling, 1973) or long-term transient state (Fukami & Nakajima, 2011) that are counterproductive to restoration objectives (Toth 2016a; 2016b).

In other instances exotic species have been shown to assist the attainment of conservation objectives (Ewel & Putz, 2004; Schlaepfer et al., 2011). Risk assessment that addresses the specific restoration context provides a practical basis to address these important decisions. On sites that are already highly modified the human element is a key consideration in developing a philosophy on exotics and is strongly influenced by the objectives for indigenous species that are identified as being important.

Conclusions

Many aspects of the Kissimmee Restoration Project are relevant to the regeneration potential of the AORZ. Of particular note is the substantial opportunity to apply the 'working with nature' approach. In the context of New Zealand's largest floodplain regeneration project to date this approach could improve cost-effectiveness if successful strategies can be identified in comparison to intensive treatments such as planting. In addition, the adaptive approach exemplified at Kissimmee provides a practical means to address knowledge gaps. These are likely to arise due to ecological succession processes whilst it is also important to manage for resilience to climate change. In combination, these are important aspects for managing risks to the expected benefits and to enable readjustment of objectives and investments as required.

Perhaps to a greater degree than any comparable project Kissimmee exemplifies the benefits of implementing action through experimentation and learning. A feature of the project has been the use of small scale studies to optimise the design of specific restoration treatments within an overall strategy. As in the Danube example, these treatments explored the potential gains offered by hydrologic restoration alongside other investments. However, additional innovative components include the use of whole-system conceptual models to guide the project, including the development of its experimental aspects, from the very beginning. This same opportunity is available to the AORZ.

Tangible results of this conceptual focus have included widespread buy-in for a focus on whole-system outcomes that accommodate multiple desirable objectives and are self-maintaining over time. This foundation is important since it enables a focus on integration across the many sources of potential benefits. In turn, the implementation of this strategy has required attention to trade-offs where they occur despite that the theoretical basis centres on the assumption that a more natural floodplain structure and function will support the greatest range of resources and values (Toth et al., 1995). To address this, the project has invested heavily in an ecosystem-based monitoring and evaluation programme to support restoration planning and adaptive decision making with a specific focus on establishing the outcomes that have, and could be achieved. This represents a comprehensive approach to dealing with uncertainty and decision making, whilst also providing evidence to confirm successes or otherwise at each step of the way.

The inclusion of local knowledge, for example in the recognition of historical patterns and considerations around reference states, is an additional strength of the project. Alongside this, the recruitment and retainment of a core multi-disciplinary team of people invested in the project is a defining feature that has helped facilitate the adaptive management approach. Governance and leadership have also been important aspects. Interagency coordination was a key focus from the outset and has helped to gain consensus on priorities and objectives, together with the measurement criteria to be used to gauge success and the approach required for implementation.

6. Environmental water allocation for floodplain restoration

Learning from the Kissimmee River project and elsewhere suggests that an experimental, adaptive approach to large scale river restoration can be successful. In that example, water control structures were progressively removed and channel configurations re-engineered in phases to create a staged approach coupled to an extensive monitoring and evaluation programme. A different though complementary approach involves planned watering of the floodplain whilst the existing water control infrastructure remains in place. All of these approaches can be related to the wider topic of environmental water allocation (EWA).

Within the AORZ the planned watering approach could be used to kick-start restoration of selected sites as pilot projects or as part of a wider adaptive programme. In particular, there are practical opportunities for diversion of flood flows to selected sites using existing stormwater network infrastructure. Such projects could be combined with the daylighting of sections of the current network, the creation of constructed wetlands to receive flows as part of a treatment train prior to discharge, and combinations of these integrated within a staged approach to reconnecting and restoring the hydrology of former floodplain areas. Examples of environmental water allocation elsewhere in Ōtautahi Christchurch include a recent Christchurch City Council proposal to create an urban forest in Woolston. The 2.75 hectare project will involve lowering ground levels at the site by up to a metre and diversion of stormwater from a nearby drain to create suitable hydrological conditions for the establishment of floodplain forest species.

In more heavily regulated river and estuarine systems, decisions on allocation of water to the environment require strategic planning to address competing resource demands, which may include flood protection demands, thereby ensuring the best range of outcomes. Worldwide, there has been increasing interest in EWA approaches to sustain floodplain and wetland values (Arthrington et al., 2010). A prerequisite for this planning is comprehensive information on the flood-dependency of natural values. Although, floodplain plant communities are known to be structured by characteristics of the inundation regime predicting the ecological effects of hydrologic alterations is difficult (Olden & Naiman, 2010; Zelder & Callaway, 1999). There remain few examples where the specific flood pulse requirements of natural occurring vegetation have been established (Paillex et al., 2009; Toth & van der Valk, 2012). This topic will only become more important for lowland floodplain restoration strategies in New Zealand, and elsewhere, due to increasing human pressures on these systems coupled with the challenges posed by climate change. The following case study illustrates recent progress in this under-researched topic. The example comes from a Victorian government initiative that recognised the need for improved information on effects of flood pulse regimes on the natural values of the Murray River catchment (Ballinger & Mac Nally, 2006).

Case Study 3

Murray River floodplain restoration

The Living Murray project

The Living Murray is a large scale river restoration programme established in 2004 with a focus on addressing negative effects of historic river regulation. In the lower Murray-Darling Basin (MDB) overbank flooding can only occur in extremely large flood events due to extensive river engineering. Much of this is designed to harvest flows for agriculture with water being diverted to irrigation storage

schemes. Overbank flooding occurs only when these are full (VEAC, 2006). This regulates peak water levels in downstream reaches with the effect of reducing the frequency and size of flood events experienced by most of the floodplain (DSE, 2008).

VEAC (2006) highlighted the long-term environmental impact that insufficient flooding is having on the survival of riverine forests and wetlands. Riverine flood events are critical for conservation of the region's biodiversity due to aspects that include maintaining ecological connectivity between otherwise fragmented habitat patches (Ballinger & Mac Nally, 2006). This connectivity is an important determinant on the geographic range of many plants and animals (VEAC, 2008b). Recently, the reduction in flooding has been exacerbated by continuing drought, and it is likely that the situation may worsen under climate change due to reduced rainfall and increased evapo-transpiration resulting in reduced runoff (DSE, 2008). Several studies have indicated that floodplain dewatering is having adverse effects on biodiversity including riparian forest habitats characterised by River Red Gum *(Eucalyptus camaldulensis*) and Black Box (*E. largiflorens*) (Cunningham et al. 2007; MDBC, 2003; VEAC, 2008a). It has also contributed to the development of acid sulphate soils (McCarthy et al., 2006) and has reduced opportunities for water-based recreation (VEAC, 2008b). Despite this, water allocations for environmental purposes were, until recently, restricted to a very limited number of floodplain sites, generally being 'icon sites' identified for particular conservation objectives (Leslie & Ward, 2002).

Barmah-Millewa EWA initiative

In 2005 a Victorian government initiative began investigations into River Red Gum forests and associated ecosystems in the lower Murray-Darling Basin (MDB) with a focus on the impact of insufficient flooding on riverine forests and wetlands (VEAC, 2006). At the time, EWA initiatives were already being explored at the Ramsar-listed River Redgum (*Eucalyptus camaldulensis*) forests at Barmah-Millewa (Figure 6-1), one of the six icon sites for conservation (King et al., 2010). Historically, this floodplain area supported a diverse range of fish and other aquatic species that provided a major food source for the local aboriginal community (King, 2005) as did the lower Ōtākaro / Avon River for local Māori communities (Tau et al., 1990).

A series of EWA initiatives have been conducted at Barmah-Millewa following an experimental approach. This sought to generate information on ecosystem responses to inform the potential use of EWA at other sites under the Living Murray initiative, as well as achieve specific objectives at Barmah-Millewa. These target objectives included improving vegetation health, enhancing spawning and recruitment of native fish and frogs, and improving habitat for water birds (King et al., 2010). A large floodplain watering event was completed in the 2005-2006 summer, resulting in Australia's largest EWA initiative to date with the allocation of 513GL to the Barmah-Millewa floodplain. The bulk of the release made between October and December 2005 providing medium level flooding across over half of the floodplain area (King et al., 2010). Hypothesis driven studies were designed to test responses in relation to key ecological objectives and also to guide design of the inundation regime for the release. Significant results included evidence in support of several of the hypothesised ecological outcomes. These included enhanced vegetation growth, and stimulation of a major water bird breeding event (King et al., 2007; 2010).

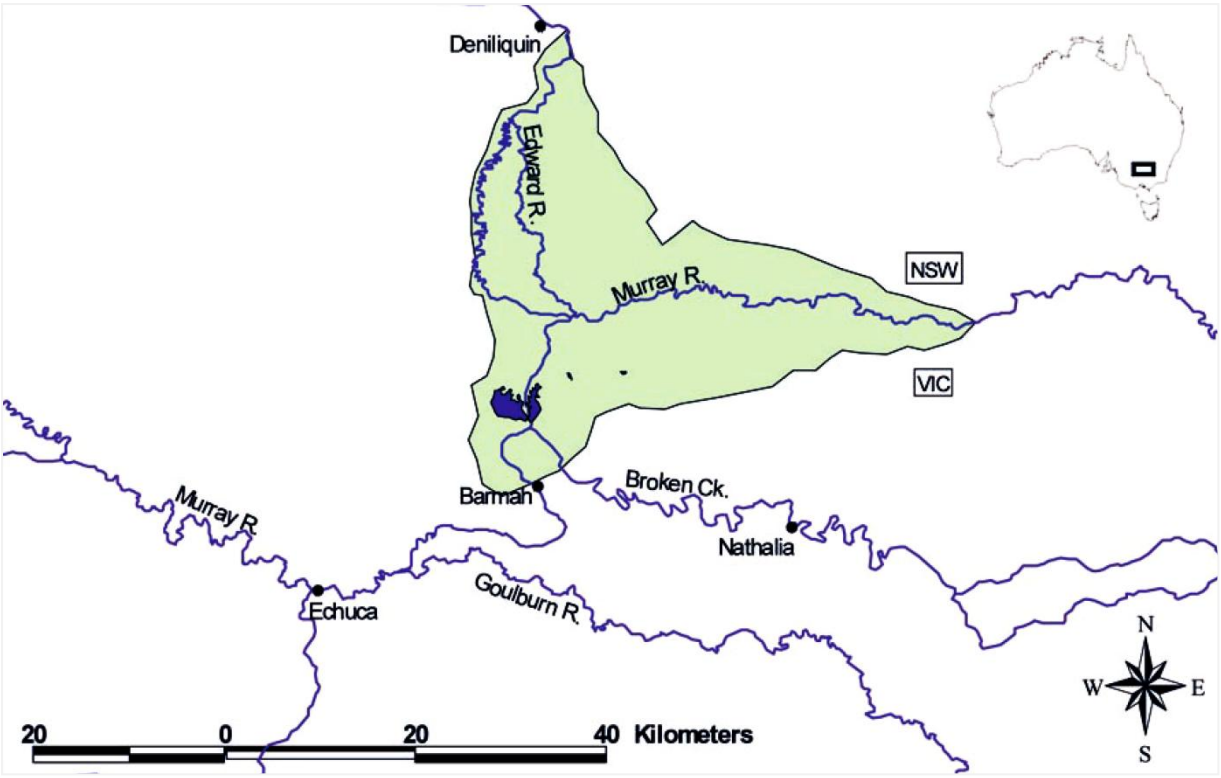

Figure 6-1. Location of the Barmah-Millewa forest in the Murray River catchment (King et al., 2007).

One of the knowledge gaps addressed was the effects of various water management arrangements on the spawning and recruitment of native fish species. To investigate these effects, the 2005 initiative was designed to support a three year study of effects on four key species (King et al., 2007; 2009). Two years of pre-EWA data were collected during which hydrological conditions were similar, and the third year of the experiment coincided with the period of floodplain inundation. The study showed increases in spawning activity occurred for two of the four species in response to the EWA, and despite some variability, evidence of enhanced recruitment for all species (King et al., 2009; 2010). Although knowledge gaps remain, these results demonstrate the potential for EWA to enhance fish spawning and recruitment. Less successful outcomes were also recorded including a large numbers of native fish being trapped in drying pools following the inundation period (Jones & Stuart, 2008). Other undesirable effects included increased spawning, recruitment and dispersal of exotic fish (Macdonald & Crook, 2006; Stuart & Jones, 2006) and increased spread of an exotic waterweed (King et al., 2010). As with the initiatives at Kissimmee, the learning gained from the experimental approach taken has helped raise awareness of the information gaps and complexities to be addressed in planning for future river restoration projects using hydrologic techniques.

Establishing the flooding requirements of natural floodplain values

Globally, the habitat requirements of fish and birds have been commonly used as a guide for establishing inundation objectives in river and floodplain restoration projects (Miller et al., 2004; Welcomme, 2008; Turnhout et al., 2012; Twedt, & Best, 2004). Similarly, indicators based on fish and fisheries responses are often used as indicators for evaluation (Jungwirth et al., 2000; Lasne et al., 2007; Schiemer, 2000). There has been much less attention to establishing the inundation requirements of a wide range of species and habitats as is required to support more integrated approaches to floodplain management through simultaneously considering a range of natural values. An example is a study conducted by the Victorian Environmental Assessment Council (VEAC) in connection with restoration of the Murray River (VEAC, 2006, 2008a; 2008b). Its objectives were to support management decisions, particularly involving EWA, beyond a focus on the 'icon sites' to include the full extent of river's floodplain ecosystems.

The analysis was applied to a large proportion of the Murray River and major tributary floodplain areas in Victoria (Figure 6-2). The study considered a broad range of natural values relevant to conservation planning and river management by using habitat units based on ecological vegetation classes (EVCs). These were identified and mapped using a classification system that considered a combination of floristic, life form and ecological characteristics (Peake et al., 2011; VEAC, 2008b).

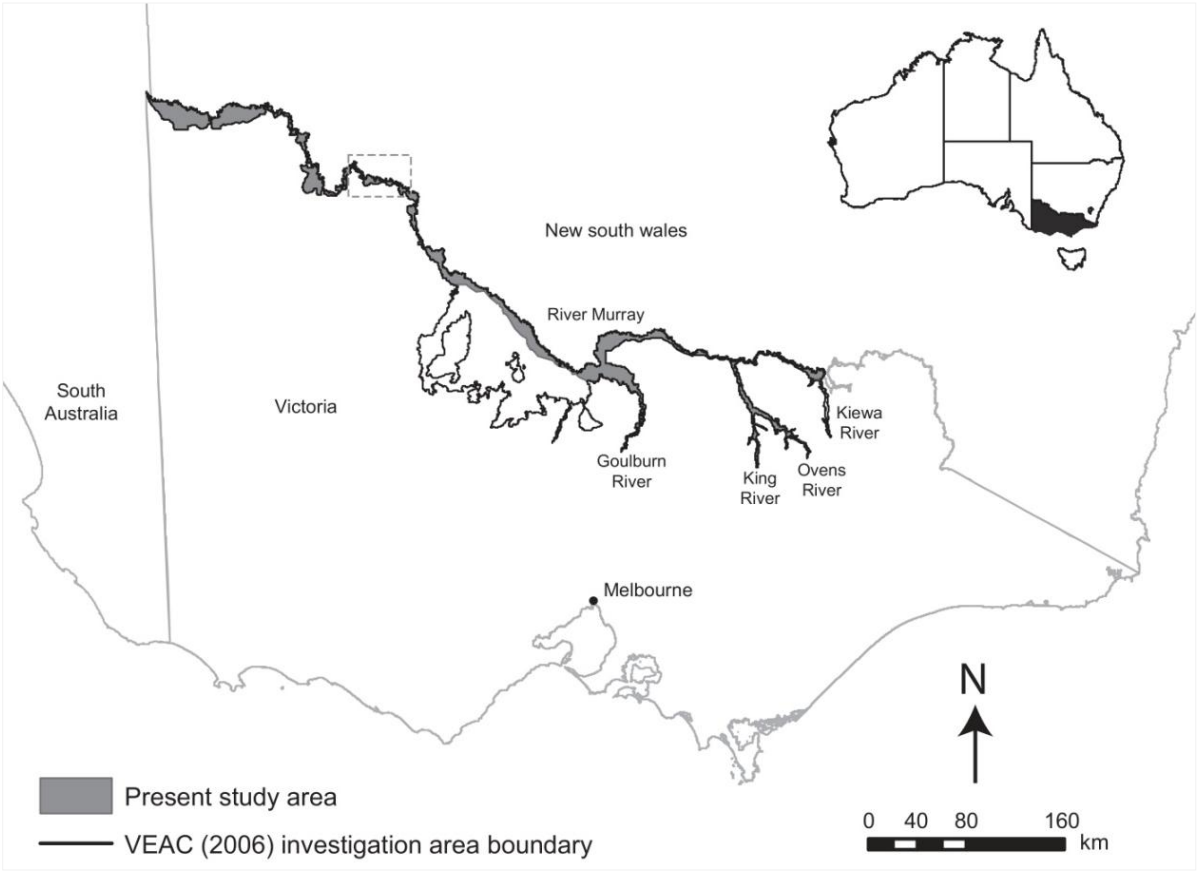

Figure 6-2. Location of the study area for the VEAC flood-dependent natural values study. The area covered represents a contiguous length of the floodplain ecosystem on the Victorian side of the Murray River. The inset is the Robinvale area case study areas shown in Figure 6-3 (Peake et al., 2011).

Outputs included identifying the location and extent of vegetation communities that are at least partly dependent on flooding and therefore require attention in water management arrangements particularly in connection with river regulation (Figure 6-3). A range of scenarios were produced for these areas to illustrate options for management across multiple values.To support impact assessments, restoration planning and other decision making contexts the study provided estimates of inundation requirements for each natural value for components such as flooding frequency, maximum period without flooding and minimum duration of each flooding event before significant deterioration occurred (Peake et al., 2011).

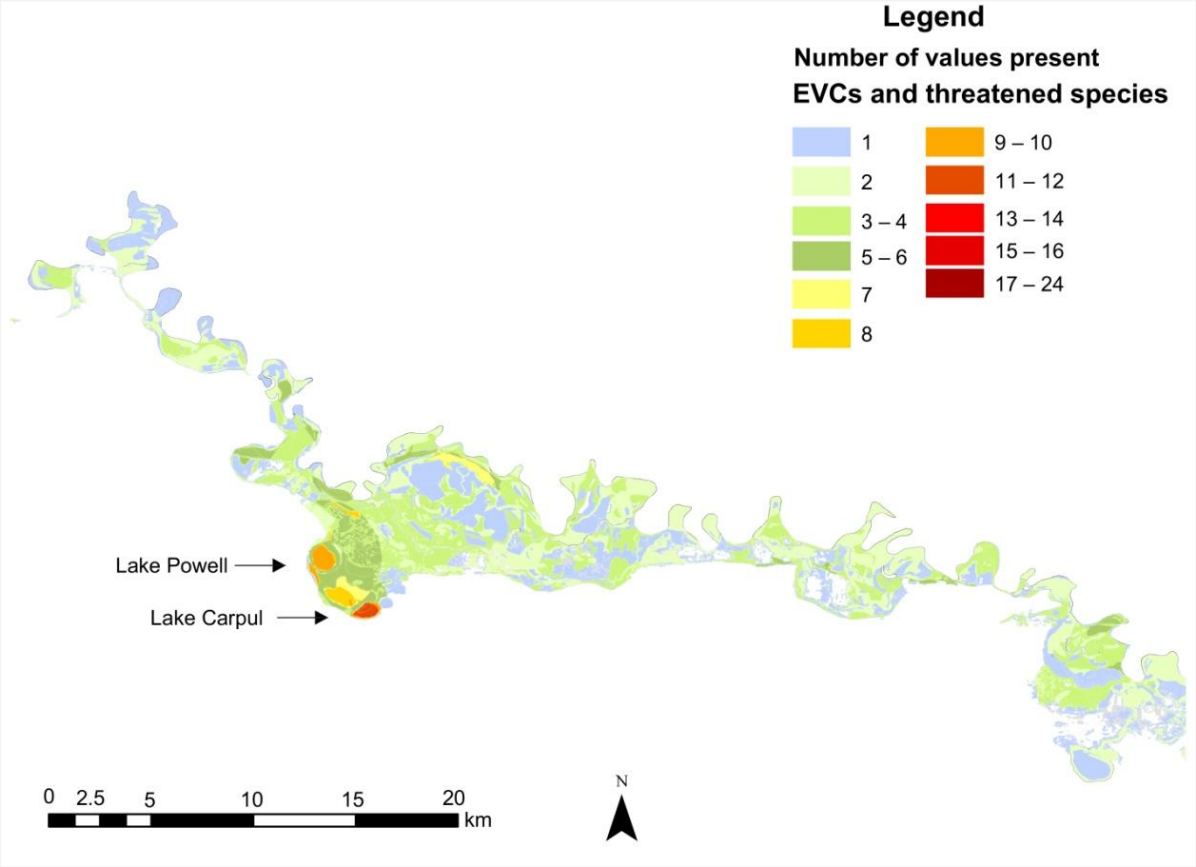

Figure 6-3. An example of flood-dependent natural values mapped on the Victorian side of the River Murray in the Robinvale area (VEAC, 2008b).

Overall this study represents a practical approach to bringing together information on multiple values to support the development of an integrated management approach. Although it was applied to a much larger area than required for regeneration planning in the AORZ the underlying philosophy and range of natural values considered are highly relevant. The use of GIS-based data visualisation techniques are a strength of the approach used in the Victorian study. The spatial data can be used for scenario modelling to compare the outcomes of different EWA opportunities and potentially other restoration techniques across the entire project area, producing a useful tool for identifying trade-offs and optimising promising strategies. Spatially explicit scenarios may also be readily visualised for the public providing a platform to support community engagement and public input to the scenario generation and evaluation process. A similar approach offers a potentially useful decision support tool to support conservation planning and adaptive management in the Ōtautahi Christchurch context.

Conclusions

The allocation of water to and across the riparian margins of waterway channels is a fundamental issue for floodplain management, particularly where these areas are subject to human impacts. In this context, allocation is defined in a whole-system sense with particular focus on the distribution of water across the catchment and deviations from the natural pattern. Such deviations can exert differential effects in different parts of the catchment and may include altered hydrological gradients and flood pulse characteristics of riparian and floodplain areas. Human modification may originate by many means including via abstraction of in-stream flows, impoundment of water in dams, floodplain dewatering through the use of embankments, or lowering of groundwater levels using incised drainage channels (Tockner et al, 2008).

In the AORZ context, in-stream abstraction is not generally an issue (with the exception of the potential effects of alpine river abstraction on spring flows) and impoundment is restricted to

stormwater detention facilities designed to lower flood risk, primarily in upstream reaches. However, floodplain dewatering through embankments and artificial drainage are prominent features of the AORZ. For conservation and restoration activities the significance of water allocation does not so much revolve around a single preferred hydrologic configuration given that regeneration of the AORZ may include a variety of land-uses. Continued use of hard defences and/or engineered drainage patterns may be desired for some AORZ land-uses together with the need to address flood risk in adjacent residential areas. However it is a useful concept to explore in the context of hydrologic restoration. As shown in the Kissimmee case, restoration of a more natural hydrologic regime can be adopted as a core objective. The Murray River case shows how the same concept may be adapted and applied within a highly regulated allocation context.

A potential approach to environmental water allocation within the AORZ involves commitment to a staged progression of hydrologic changes once decisions on the range of land uses and role of existing defences have been made. Re-engineering of drainage and flood defence arrangements can then be planned to drive desirable changes in riverine and floodplain ecology through effects on both water level and salinity regimes.

There are at least two major knowledge gaps that will require attention. These are:

(a) Impacts of drainage and flood defence decisions on hydrodynamics within the AORZ, together with evaluation of the ecological effects on restoration opportunities and objectives. Key topics include establishing the likely eco-physiological effects on desirable habitats, possible alternatives, spatial patterns, and successional trends.
(b) Re-evaluation of the longer term sustainability of potential restoration strategies. In keeping with current climate change adaptation policy this assessment requires consideration of at least a 100 year planning horizon with sea level rise being an obvious physical driver that will exert widespread effects. In practice this is amenable to an iterative process whereby various hydrologic scenarios could be evaluated for resilience over time following the recommended guidelines for the assessment of climate risk.

7. Floodplain restoration principles

Several strong themes can be identified from the literature reviewed and cross-case comparisons presented in this study. Many of these are relevant to regeneration planning in the AORZ and could usefully inform the development of an innovative, integrated, and forward thinking approach.

Key transferable principles that could be applied are:

- The regeneration of more natural hydrological regimes is a core potential strategy that may underpin the attainment of other benefits through influences on ecological structure and function. A re-engineered hydrological regime is a strong driver of change often associated with improved ecological outcomes.

- The attainment of a self-maintaining system is promoted by restoring natural hydrodynamic regimes, together with associated disturbance, erosion, and deposition processes. Reinstatement of natural erosion dynamics and lateral (bank) erosion in particular, are critical aspects of natural floodplain function being essential for the self-maintenance of the full range of dynamic riparian habitats. This requires a degree of tolerance of channel migration.

- A fundamental step for restoration planning is an assessment of floodplain reconnection potential with regards to existing channel configurations and former floodplain remnants (such as ox-bows). Reconnection of meanders and lentic water bodies has been used extensively to improve habitat and ecological connectivity. This has caused some negative effects on

species adapted to conditions on floodplain remnants and invasive species benefitting from improved connectivity are an additional consideration. However, natural habitats typically recover quickly in response to floodplain reconnection. Increased hydrological connectivity offers improved habitat availability for many aquatic species such as fish. Moreoever, this presents a highly cost effective technique for ecological restoration in many cases requiring only the alteration or removal of former flood defences.

- Environmental water allocation is a useful concept to explore in the context of hydrologic restoration. The concept may be applied in the sense of periodic restoration of lost hydrological connections or as a component of a staged approach to floodplain reconnection associated with the progressive retreat of flood defences and other forms of drainage. In each case, optimisation of the environmental allocation is assisted by establishing the likely ecological responses to hydrological manipulation in target areas, together with associated effects on natural values and key habitats.

- A focus on high value habitat to address conservation priorities, and on mixed-use concepts elsewhere provides a potential framework for restoration planning. A systematic and spatially explicit assessment of the flood-dependency of natural values is a useful decision tool that supports trade-off assessment when allocating or restricting natural flows.

- An adaptive management approach provides a practical means to address knowledge gaps and predictive challenges such as those arising from complex relationships, ecological succession and the future effects of climate change. Assessment of restoration potential also requires attention to societal aspects such as competing uses. These aspects may be supported by an iterative and adaptive approach with a focus on identifying opportunities and issues as they arise using the best available information.

- Evaluation and prioritisation assessments are beneficial throughout the adaptive management cycle to progressively identify opportunities and consider their impacts and alternatives across multiple values. Whole-system conceptual models can be useful to guide project development and identify information requirements and implementation options.

- Investment in a comprehensive monitoring and evaluation programme supports restoration planning, innovation, and adaptive decision making with a specific focus on establishing the outcomes that have, and could be achieved. This also helps reduce risks associated with uncertainty and change.

- Small scale pilot studies and demonstrations offer opportunities for innovation and experimentation. These may help inform the design of larger scale initiatives and provide opportunities for community engagement, participation, and learning.

- Recruitment and retainment of a multi-disciplinary science team provides practical support for an adaptive management approach centred on iterative cycles of design, implementation and learning. The inclusion of local and traditional knowledge and practical know-how are important elements. Science outreach, communication, and participatory opportunities are additional aspects that support the cross-sector and cross-disciplinary integration needed.

- Governance and leadership are important aspects. Attention to interagency coordination and strategic oversight functions help to achieve stakeholder buy-in, gain agreement on priorities and objectives, establish suitable measurement and reporting criteria, and identify opportunities for implementation.

8. Key conclusions

There are internationally proven strategies available for hydrological and ecological restoration in the AORZ. These approaches are consistent with a city-to-sea philosophy for river corridor regeneration that accommodates ongoing dynamics including ecological succession, climate change, and resilience to sea level rise.

Due to the difficulty of producing accurate *a priori* predictions of complex eco-hydrological relationships and expectations for restoration and successional change, an adaptive management approach is recommended.

A feature of prominent and successful river corridor restoration projects has been the assembly of a core science and information management team able to support and guide the development and implementation of an adaptive management approach. Local and traditional knowledge, practitioner know-how, and technical expertise in ecosystem-based management and the restoration ecology of key taxa are some of the recommended knowledge and skill sets for inclusion. Attention to governance, outreach, science communication, and citizen science activities are additional dimensions that can support the successful implementation of adaptive management in practice.

Comparative evaluation of restoration options can occur at many different points within an adaptive management cycle to facilitate decision-making. These assessments may help refine or select a short list of options at strategic decision points before committing resources to greater levels of detail. These aspects may be readily included in the proposed Integrated Assessment activities and Better Business Case evaluations being developed to support the regeneration planning process for the AORZ.

An adaptive approach can accommodate experimental trials, pilots and innovative demonstrations at small scales to inform the design and planning of larger scale initiatives.

Close proximity to the central city provides many opportunities for community engagement, education, and experiential activities to feature prominently in the development, design, and implementation of restoration strategies. These have been shown to be the source of beneficial outcomes in other successful projects, including through the socialisation of restoration objectives, and by encouraging participation, buy-in, and ownership of the new management paradigms that may be implemented.

The *process* of developing and implementing an adaptive management strategy could be a significant source of benefits in relation to overall project objectives. Attention to, and development of this process is an important component of identifying specifications for ecological restoration in the AORZ, consistent with a socio-ecological systems approach to managing common-pool natural resources. The objective of developing and implementing optimum restoration and regeneration activities lies at the centre of this process and is a dependent on it. To address this further, information on the potential opportunities and benefits offered by innovative restoration processes were among the topics addressed at the ERO workshop (Orchard et al., 2017).

Ecological restoration activities in the AORZ offer an unprecedented opportunity to address national priorities including the remediation of legacy effects on lowland biodiversity and associated cultural values. Through attention to design and integration between compatible activities and co-uses ecological restoration can be achieved alongside, or incorporated within other beneficial land use options.

9. Acknowledgements

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To Christchurch City Council

Please find attached our submission on the Enhancing Lake Sheppard and Bower Park Project

For any further inquiries, please contact:
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Introducing Disabled Persons Assembly NZ

We work on systemic change for the equity of disabled people

Disabled Persons Assembly NZ (DPA) is a not-for-profit pan-impairment Disabled People's Organisation run by and for disabled people.

We recognise:

- Māori as Tangata Whenua and Te Tiriti o Waitangi as the founding document of Aotearoa New Zealand;
- disabled people as experts on their own lives;
- the Social Model of Disability as the guiding principle for interpreting disability and impairment;
- the United Nations Convention on the Rights of Persons with Disabilities as the basis for disabled people's relationship with the State;
- the New Zealand Disability Strategy as Government agencies' guide on disability issues; and
- the Enabling Good Lives Principles, Whāia Te Ao Mārama: Māori Disability Action Plan, and Faiva Ora: National Pasifika Disability Disability Plan as avenues to disabled people gaining greater choice and control over their lives and supports.

We drive systemic change through:

Rangatiratanga / Leadership: reflecting the collective voice of disabled people, locally, nationally and internationally.

Pārongo me te tohutohu / Information and advice: informing and advising on policies impacting on the lives of disabled people.

Kōkiri / Advocacy: supporting disabled people to have a voice, including a collective voice, in society.

Aroturuki / Monitoring: monitoring and giving feedback on existing laws, policies and practices about and relevant to disabled people.

The Submission

DPA welcomes the opportunity to give feedback to the Christchurch City Council on the Enhancing Lake Kate Sheppard and Bower Park project.

We support the proposals outlined for upgrading the area.

In this brief submission, we make recommendations on how to improve the project's accessibility from a disability perspective.

Playground

We have several recommendations to make about the playground area.

DPA recommends that all pathways have compacted gravel surfacing – this will avoid people slipping when it's wet.

DPA asks that some play equipment is made accessible for everyone, including disabled tamariki/children.

DPA recommends making at least one of the tables underneath the canopy an accessible table designed to accommodate wheelchair and mobility aid users.

DPA recommends that park benches are at various heights to accommodate the needs of people of varying heights, including disabled people. This will assist with people being able to get on and off benches easily.

DPA recommends that car parks are located near the dunes and swales to ensure that they are accessible to everyone.

DPA asks that there is at least one mobility parking place created in the parking area.

Sports fields

DPA supports the proposals made in relation to the sports fields.

We have some recommendations around how things can be further improved in this space:

DPA asks that an accessible pathway is created around the perimeter to accommodate the needs of all pedestrians and spectators, including disabled people.

DPA recommends that seating of various heights is placed around the sports fields.

DPA recommends that significant shading is placed in the spectator areas to provide cover in all types of weather – wind, rain and sun.

DPA asks that at least one picnic table is made accessible to accommodate wheelchair and mobility aid users.

DPA recommends that a wheelchair user height friendly drinking fountain is installed in the sports fields area.

DPA asks that the fitness circuit is made accessible for everyone, including disabled people. This will require the installation of accessible equipment throughout the circuit which can be used by all people, including disabled people, older people and tamariki/children.

DPA asks that the toilet block is upgraded to include an accessible railed toilet and wet floor shower facilities, built to universal design standards.

This will enable all sports fields users/spectators to use fully accessible showering and toileting facilities, including disabled people.
DPA recommends that if new trees are planted that species are chosen which provide good shade and that roots are also well managed to prevent their protruding onto footpaths.

Lake Kate Sheppard

Lake Kate Sheppard is an area being visited by an increasing number of people.

We have some recommendations around how this area could be improved in terms of its accessibility.

DPA recommends that all roadways are replaced with accessible pathways, usable by everyone including disabled people and which contain compacted gravel surfacing.

DPA recommends that the proposed look out is made fully accessible for everyone, including disabled people.

DPA asks that all play areas in this section need to have some accessible play equipment available that all children can use, including disabled tamariki/children.