Aspects of the Ashley River Weed Problem

1. Introduction

It is well established that birds that breed on braided rivers require bare gravel for their nests, and for many years members of the ARRG have understood that weeds pose a major threat to birds nesting on the Ashley. Exactly when weeds became a threat on the river is uncertain, but from the memories of various people, the fairway was essentially weed-free in the 1970s. Historic air photos have recently been obtained and will help in clarifying this. Efforts to clear weeds have been made since at least 2004 – these are documented below:

Season starting	Method	Area	Bird Breeding Noted
2004	Bulldozer		Yes
2005	Bulldozer?, hand		Yes – SIPO, BD, BFT
2006	None		
2007	Hand	Small	Yes
2008	None		
2009	Hand	Small	
2010	None		
2011	Hand	1 ha	
2012 - 2014	None		
2015	Dozer	7 sites	Poor
2016	Digger	3.2 ha	Yes, wrybill, BFT, BD, PS
2017	Dozer, ripper, spray	3.2 ha	
2018	Tractor-mounted ripper, hand	22.5 ha	Good at Railway site – BFT & BBG

Unfortunately, this has met with only mixed success and for some time weed pulling was done as a team building exercise rather than with real hopes of creating significant nesting habitat. Some years little or no weed clearing was done because floods had created plenty of bare gravel.

In early 2017 work was done that appeared to show that areas of past gravel extraction were preferred by nesting birds – however this needs to be revisited in more detail. Also, at this time areas of bare gravel were measured from air photos and satellite imagery for the length of the river, there appeared to be a strong correlation between bird numbers in the annual (November) surveys and bare gravel area. This work has led to further efforts to clear weeds.

Weed growth is known to be a major problem in other rivers like the Ashley which are not flooded from main divide rainfall events. Such rivers include the Orari, Ashburton and Clarence (Bell & McArthur, 2017). Rivers which have dams in their headwaters – Waitaki and Opihi – are also strongly affected by weeds. Weed clearing has taken place on the lower Waitaki for several years (Schesselmann et al., 2018).

It is clear from observation in several other rivers that gravel extraction does benefit birds by weed clearing. In the 2019 – 2020 nesting season an example of this was the Opihi, where the only colonies

(BBG and BFT) present in the entire surveyed section of the river were at active or recent gravel extraction sites.

Given the general poor success of previous weed clearing, a broader understanding of several aspects of the problem, and the river environment, is required –

1. Further evidence of the relationship between weeds and bird numbers, and the reasons for weed infestation are necessary.
2. It is essential to understand the substrates that the birds prefer to nest on to make sure suitable sites for nesting are cleared.
3. Likewise, we need to understand the geomorphological settings that the birds prefer.
4. We need to develop a better understanding of the erosional and depositional processes of the river – which is constantly creating and destroying nesting habitat.
5. The best method for weed clearing needs to be determined.
6. A greater understanding of weed species, their seeding, growth and regrowth is necessary – this is beyond the scope of this report and is currently the subject of a PhD thesis.

Abbreviations: BFT – black-fronted tern, BD – banded dotterel, SIPO – South Island pied oystercatcher, BBG – black-billed gull, PS – pied stilt.

Locations in this report are shown in Appendix 1.

2. Weed-free gravel area, bird numbers and Ashley River flow

There are many historic Google Earth images, dating back to 2004, available for the Ashley River. These, and several sets of air photos (available from Environment Canterbury) were used to measure the areas of weed-free gravel using QGIS. Areas of bare gravel are generally quite easy to determine – based largely on colour and texture. However, there is some subjectivity about this, and the actual areas calculated should be treated with caution. If this exercise were to be done by different people, different numbers could result. A test of repeatability (and of air photos vs Google Earth imagery) was done for half the length of the river by GD. Weed-free gravel was measured from air photos and from a Google Earth image taken at very much the same date – a 1% difference in area was calculated. I am confident that even if different numbers were arrived at by different people, the trends in weed-free gravel would be almost identical. The areas of weed-free gravel, shown on Figure 3, are very much greater than the actual available nesting habitat. Many of the individual areas of bare gravel are too small, too close to water or of inappropriate substrate. At the time of greatest weed infestation, in early 2017, there was little or no suitable habitat for birds such as the BFT.

Figure 1 shows annual survey results from 2001 to 2019 and the weed-free gravel determined at irregular intervals from 2004 to 2019. Gravel area and bird numbers appear well correlated in this graph and it seems clear that weed infestation is a major determinant on bird numbers – and is perhaps the most important factor in them. BBG are not shown on this graph – they do not correlate with the area of weed-free gravel, often there were none counted, and sometimes their numbers would overwhelm those of the other species on the graph.

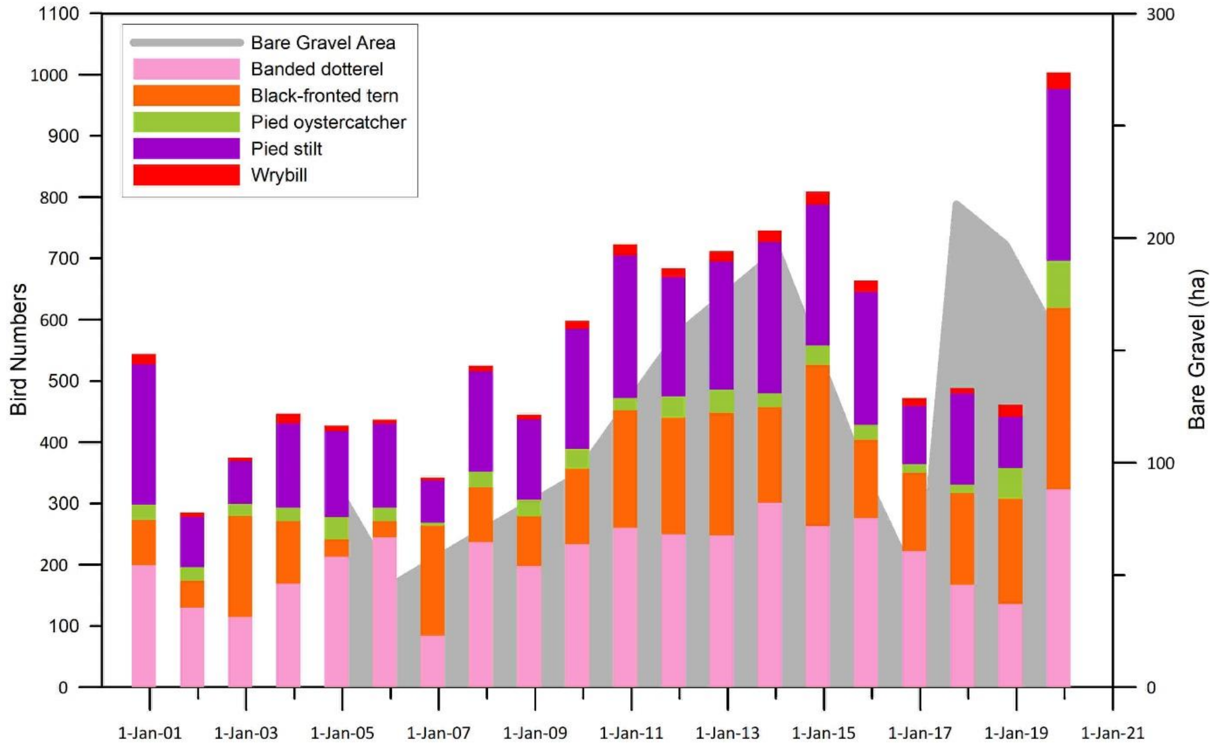


Figure 1. Annual bird survey results and weed-free gravel areas

There is some lag between gravel area and bird numbers apparent – there was a major 1 in 10-year flood in July 2017 but there were two years of low bird numbers until 2019. The very high numbers in 2019 could also be partly due to refugees from the Waimakariri River which was subject to constant flooding. Extremely high BBG numbers in the 2019 – 2020 season were almost certainly due to this factor.

When numbers of individual species are plotted in the same way (Appendix 2), the correspondence with weed-free gravel generally holds true with the poorest correlation being from BD, SIPO, wrybill, and BFT numbers seemed to recover the best from the low in bare gravel area in early 2017.

Figure 2 illustrates the areas of weed-free gravel at maximum and minimum levels during 2017. At periods of maximum weed cover (such as February 2017) bare gravel is restricted to very narrow strips along active channels and to very narrow islands which are not suitable for nesting.

Figure 3 shows flood/fresh events at Ashley Gorge of greater than 50 cumecs (maximum daily flow) and weed-free gravel area. A quite major tributary of the Ashley (the Okuku) enters the river downstream from the gorge, but flow at the gorge is a quite reliable indication of relative flow below the Okuku junction. The increase in bare gravel from 2006 to 2014 was clearly due to frequent floods in excess of 100 cumecs with a number of them greater than the mean annual flood of 291 cumecs. These were negating the natural increase in weed cover. The decrease from 2014 to mid-2017 was due to a paucity of such events – combined with the results of a build-up in weeds and seed through time. Since the major flood of mid 2017 weeds have been rapidly re-growing. Floods of July 2017 and July 2019 are marked on the graph.

Figure 4 depicts maximum daily flow at the gorge, above 30 cumecs, since 1972. It shows that the 3-year period from 2014 to 2017 that is associated with spreading of weeds was not an unusual event. In fact, the first half of the 48-year period from 1972 to 2020 had significantly fewer flood events. There was only one flood above the mean annual flood event threshold in the 14 years from January 1972. If such conditions return, and climate change predictions suggest they might, the amount of weed clearing would have to be stepped up a lot.

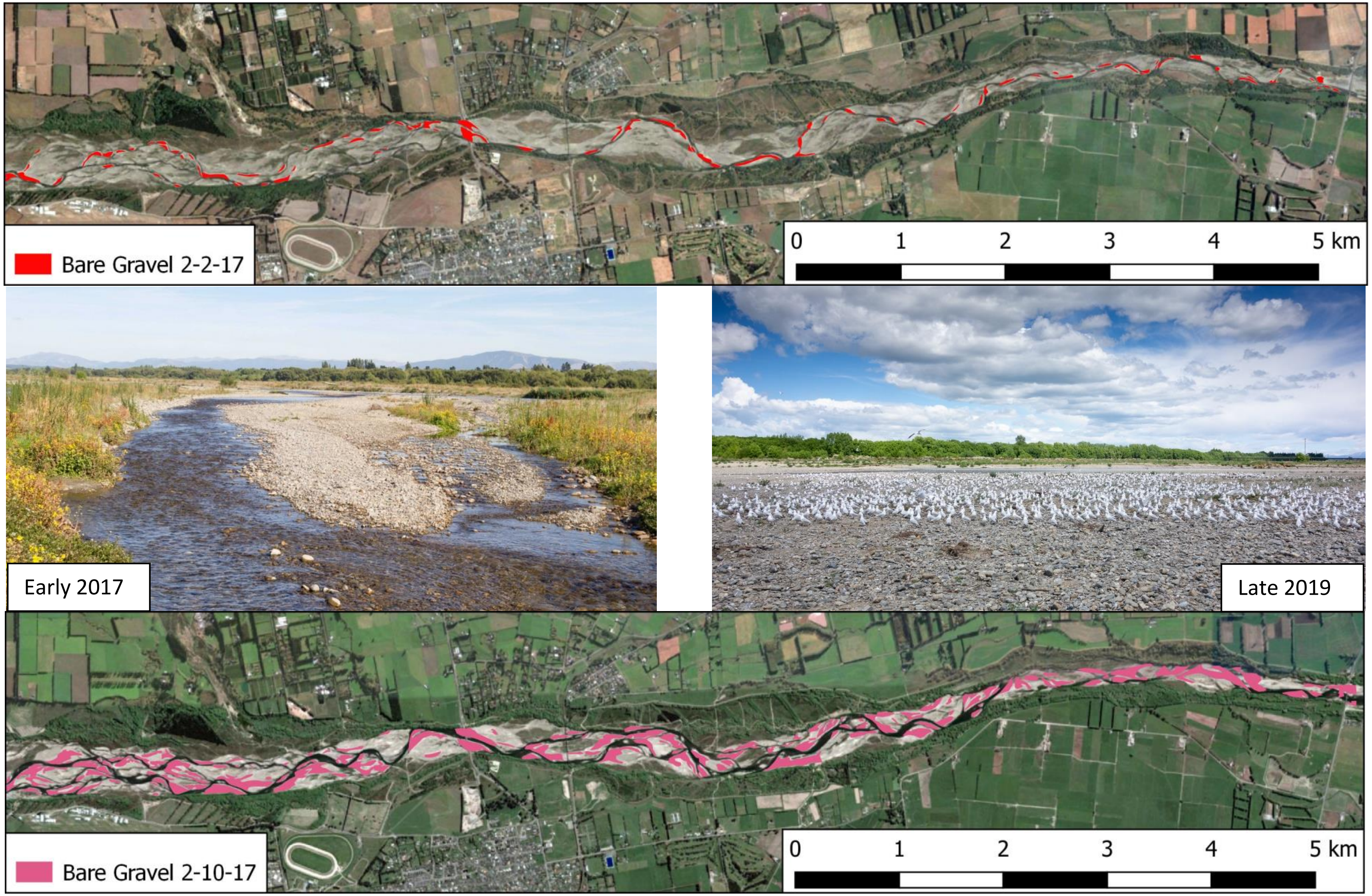


Figure 2. Weedy and weed-free gravel illustrations

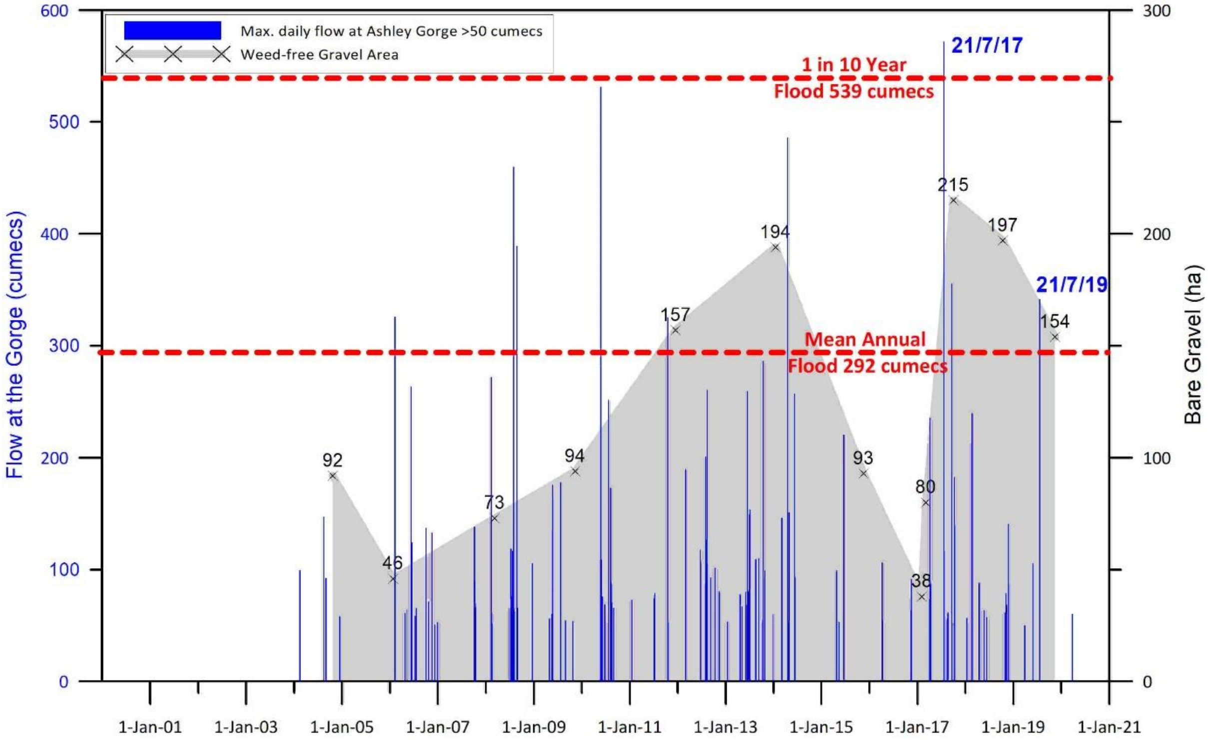


Figure 3. Flow at Ashley Gorge and weed-free gravel area

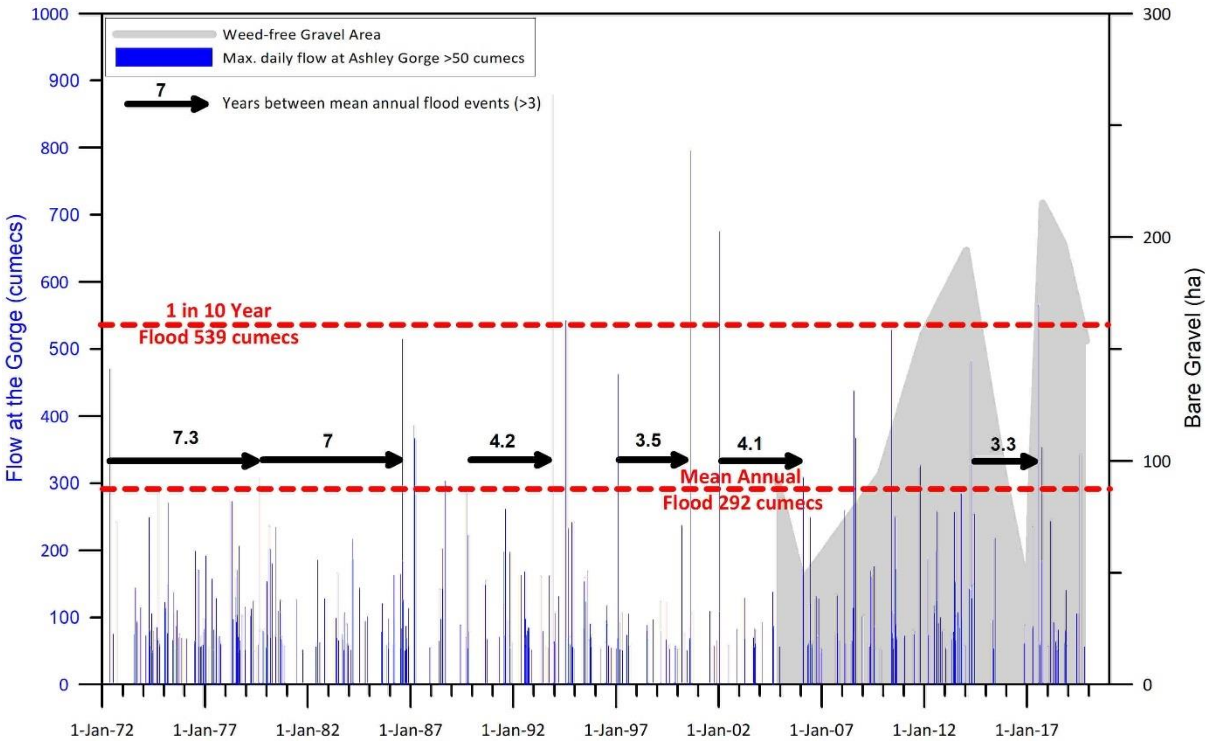


Figure 4. Flow at the Ashley Gorge since 1972

3. Nesting Substrate

During the 2019 – 2020 nesting season all nests found by GD were GPS located and photographed through QField – a version of QGIS for Android. These photographs could then be viewed on a large desktop computer screen with QGIS. Using the BFT eggs for scale (average length 4.1cm – NZ Birds Online) pebble sizes and distances could be measured.

In 2019 – 2020 there were 86 BFT nests found and photographed in colonies stretching from 2 km downstream from the Okuku junction to where the river enters the estuary. Eighty-five percent of nests were similar to Figure 5. These were on an unconsolidated very poorly sorted gravel with pebbles ranging in size from sub-centimetre to just under 30cm in maximum dimension. Fifteen percent of eggs were found to be in locations similar to Figure 6. These consist of poorly sorted coarse gravel with a strong sand component. No nests were found to be present on well sorted fine gravel or on sand. Poorly sorted coarse gravel is the most common substrate along the river, but it will be shown later that is by no means the only one.

All eggs were found to be within 10cm of pebbles that were at least 8cm in length (Figure 7). They had been laid on much finer gravel – pebbles beneath or within 1cm of the eggs were generally approximately egg size (Figure 8). The preference of BFT for such gravel is probably because, when sitting on nests, the large pebbles hide them to some extent from predators (Figure 9). Also, they may provide some protection from wind - eggs laid on a flat surface without protection could possibly even blow away in a northwest gale. The areas of finer gravel between the coarse pebbles allow for comfortable areas to sit – with proper contact between bird and eggs. All nests were in essentially weed-free areas.

Figure 6. BFT nest on poorly sorted coarse gravel

Figure 5. BFT nest on sandy gravel

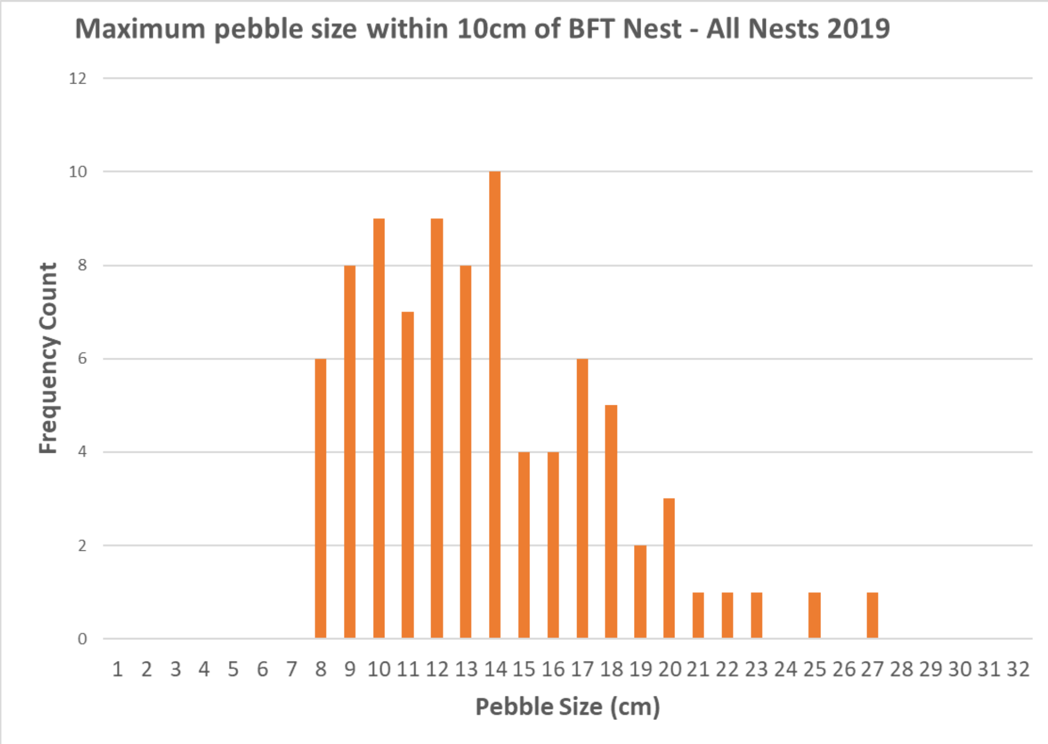


Figure 7. Histogram of maximum pebble size within 10cm of BFT eggs

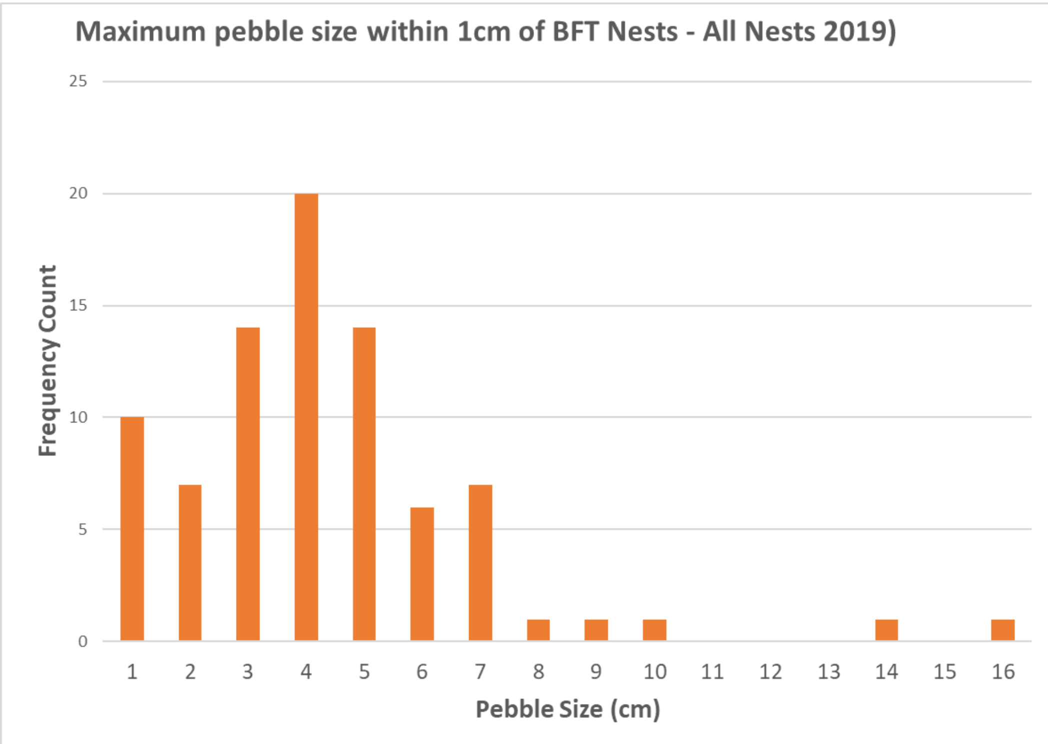


Figure 8. Histogram of maximum pebble size within 1cm of BFT eggs

Figure 9. BFT on nest, Railway colony

Mosaics of drone photos taken from 12m altitude had been made for 3 BBG colonies – two in 2019-2020 and one in 2018-2019. These photographs were taken after the birds had left the nests and the colony area. Two of these mosaics, at Toppings and Smarts, could be used to do a similar exercise to that for the BFT colonies. The third colony, the Railway colony of 2019 – 2020 was not suitable as the chicks were in the colony for too long after hatching and had destroyed too many of the nests.

Figure 10 shows a similar relationship between gravel character and nest position as with BFT and Figure 11 documents the maximum pebble size within 25cm of the nests. The photomosaics were georeferenced, so pebble size could be measured directly within QGIS.

Figure 10. Part of Toppings 2019 - 2020 BBG colony area

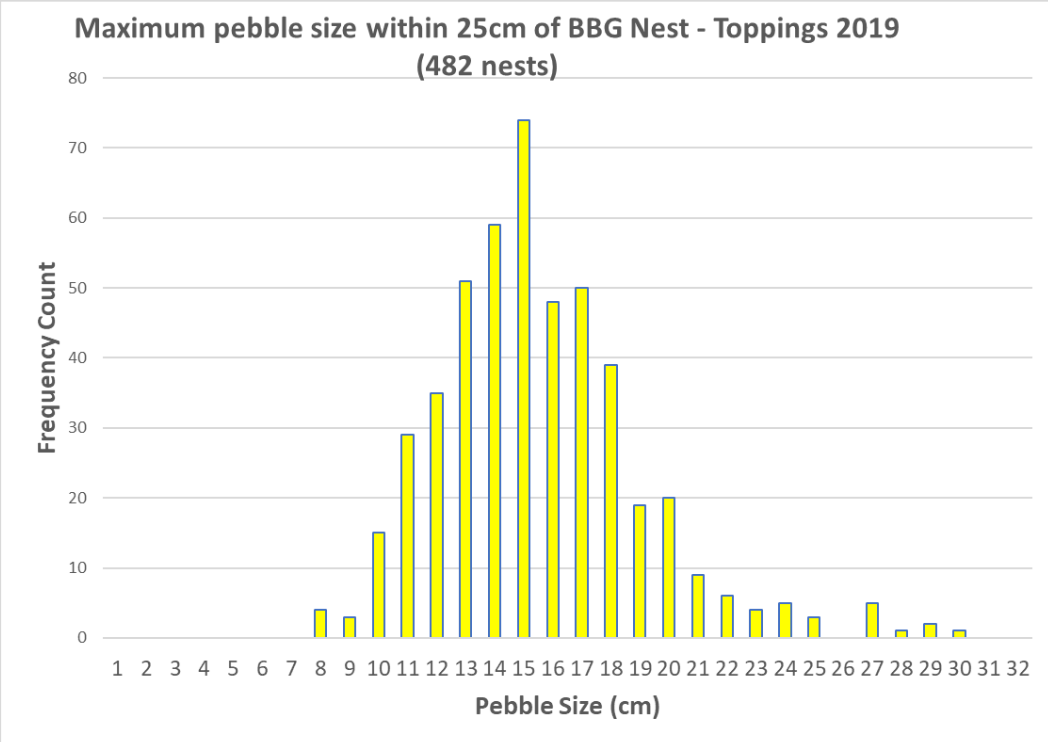


Figure 11. Histogram of maximum pebble size within 25cm of BBG nests - Toppings

Figure 12 shows part of the Smarts 2018 – 2019 colony. The great majority of nests are also in poorly sorted coarse gravel, in spaces between the larger pebbles. But this image makes it clear that BBG are more weed tolerant than BFT – they sometimes nest close to large weed plants, sometimes under them, and often like to nest close to logs and driftwood. When optimal nesting habitat isn't available, e.g. 2016, they can even nest in worked paddocks – before they become vegetated. Figure 13 shows a distribution of maximum pebble size similar to that at Toppings, and to the BFT nests.

Figure 12. Part of Smarts 2018 - 2019 BBG colony area

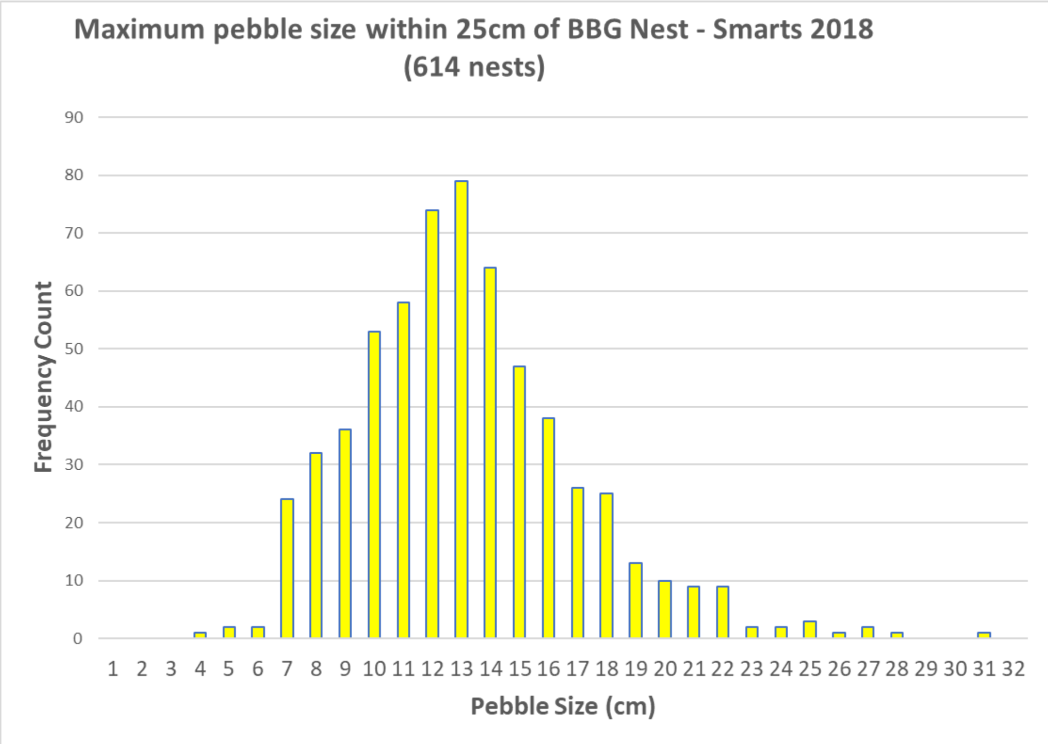


Figure 13. Histogram of maximum pebble size within 25cm of BBG nests – Smarts

From the nests found in 2019 – 2020 wrybill also prefer sites with poorly sorted coarse gravel, Figure 14 is a typical nest. Figure 15 shows a wrybill on a nest partly hidden by large pebbles and in an area with significant weed presence.

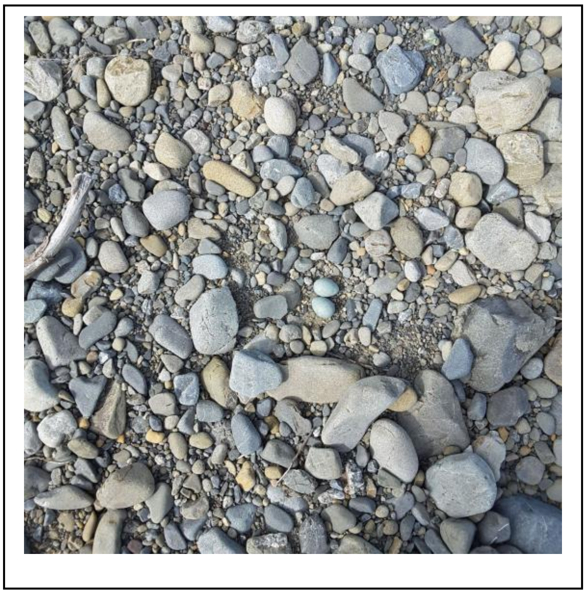


Figure 14. Typical wrybill nest

Figure 15. Wrybill nest in weedy area

Figure 16. Wrybill on nest crouching beneath the level of large pebbles

Banded dotterel often also choose such substrate, but will nest on sand and under weeds - Figure 17, Figure 18, and Figure 19.

Figure 17. BD nest on poorly sorted coarse gravel

Figure 18. BD nest on sand

Figure 19. BD nest under lupin plant

Evidence from far fewer nests shows that pied stilts and pied oystercatchers often also nest in poorly sorted coarse gravel on the riverbed.

In summary, using evidence mainly from one nesting season, BFT, BBG and wrybill prefer to nest in unconsolidated poorly sorted coarse gravel – with pebbles close to the nests of at least 8cm in size. Their nests are on finer gravel – leaving enough room for the bird to sit and properly contact the eggs which can be in stable positions. BFT strongly prefer weed-free settings, wrybill probably a little less so and BBG and BD are more tolerant of weeds. **When clearing weeds, we need to prioritize areas where such poorly sorted coarse gravel is present.**

3. Geomorphological colony setting and river processes

These aspects are addressed by case studies of the major 2019 - 2020 colony areas, two of the previous season sites, and some sites which were not nested on. A summary of this information is given in Appendix 3.

3.1 Railway Black-billed Gull and Black-fronted Tern Colony, 2019 - 2020

This site is 1km downstream from the Railway bridge (Appendix 1). In 2019 – 2020 it hosted what must be by far the greatest concentration of breeding birds ever observed by the ARRG. In late October there were more than 4,300 BBG, this resulted in approximately 1,550 nests (Davey, 2020). Forty-eight BFT nests were made in the same area, with 2 PS nests and 1 SIPO nest also present.

This site was at an island of 4.9 ha in size, at a southern bend in the river (Figure 20). Flow either side of the island was approximately equal, the river only dried up at the very end of the breeding season when all BFT had gone and there were only some fledgling BBG remaining. This island seems like an ideal setting - Pickerell (2015) modelled the probability of mammalian predators being present on islands in the Rangitata River and concluded that islands smaller than 3.5 ha, clear of vegetation, more than 20 m from the mainland or nearest predator source, and separated by a channel with a discharge of more than 6 m^3s^{-1} would provide the best sites for breeding bird species. By far the main land predators caught on the island were Norway rats. One stoat was caught and hedgehogs only began to be caught after the river had dried out.

Two of the BFT nests were on a much smaller island just to the south. The main island had 0.8 ha of moderate weed cover that had been cleared in July 2019 by tractor-mounted ripper – except for on banks where the ripper couldn't reach. These weeds were almost entirely lupin, which was quite tall, to almost a metre, but only of moderate density. Fifteen of the BFT nests were within the ripped area as were approximately 1,300 of the BBG nests. The ripping must be judged as a success, the 15 terns which nested on the ripped area would almost certainly not have been there if the weeds hadn't been cleared. It seems possible that BFT might not have nested there at all without weed clearing – they seem to require quite large areas of bare gravel. The BBG could possibly have chosen this site if the weeds hadn't been cleared, as they weren't very dense.

Figure 20 shows the colony area, bird nests and geology. The base image is from drone photographs taken at 50m altitude. BBG nests were located from drone images taken at 25m altitude while the birds were on nests. Greatest BBG nest density was just north of a narrow but steep bank. Nests of the other birds were GPS located on the ground whilst walking 5m spaced N-S grid lines.

Four distinct lithologies could be mapped on the ground –

- Poorly sorted coarse gravel 70%
- Fine well sorted gravel 22%
- Sand 5%
- Sandy gravel 3%

In most cases contacts between these units were sharp, some of them appearing to be the result of distinct deposition events. Less often the contacts were gradational and somewhat obscure – this sort of situation often has to be dealt with in geological mapping. Birds did have the choice of nesting on a substrate other than poorly sorted coarse gravel, but few chose to do so.

Immediately downstream from the colony area there was a large (1.4ha) gravel bar on the south side of the river made up almost entirely of poorly sorted coarse gravel – which looked ideal nesting substrate. No birds were seen to nest here – perhaps because the area of bare gravel was smaller and it wasn't an island.

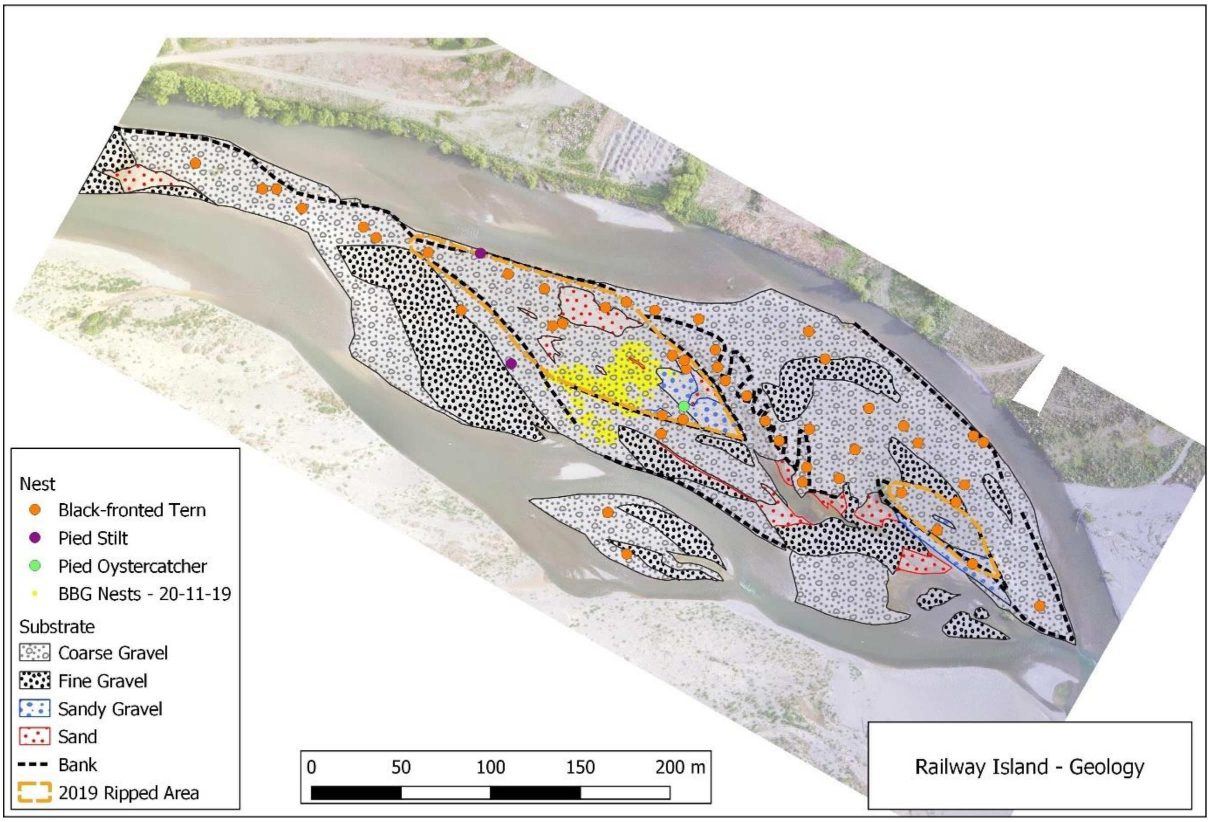


Figure 20. Railway island geology

Google Earth historic images were used to reconstruct the history of the colony area and highlighted the dynamic and ever-changing geomorphology of a braided river surface:

- Between June and September 2012 two large islands, seemingly well-suited to colony nesting, had been created in the river upstream and downstream from the 2019 – 2020 colony area. These had disappeared by August 2014.
- Prior to mid-2014 the great majority of the colony area was within the northern berm (gorse and broom covered) berm of the riverbed.
- It wasn't until after the major 21/7/17 flood (Figure 3) that almost the entire colony area had been eroded out of the berm – but in early October 2017 the sites of many of the 2019 BFT nests were in an active channel and 2 were on berm.
- The first image showing a clear geographical similarity to late 2019 was from 30 November 2017 – but 2 BFT nest sites were still on berm and several were in active channel.
- In January 2019 one of the BFT nest sites was still on berm, one in active channel, and one very close to the river on the north bank.

This was an ideal site for nesting – the substrate was good and the island location gave protection from predators other than Norway rats. The site was very recent with the substrate having been deposited no more than about 2 years before nesting – the flood of July 2017 was instrumental in creating this colony area, but there were modifications to it right up to at least early 2019.

Currently this site hasn't been modified by the river since the 2019 – 2020 season, but lupin is growing back strongly and should be cleared again. However, one more significant flood could result in it being no longer suitable for nesting. A flood could change the whole geometry of the riverbed and make the island disappear (as happened between 2012 and 2014) or cover the island in sand making the substrate unsuitable for nesting.

3.2 Groyne Nine Black-fronted Tern Colony, 2019 - 2020

This site was 2km downstream from the Okuku confluence (Appendix 1). Sixteen BFT nests were found here, but several more no doubt were present – no systematic effort was made to find nests. Whilst checking traps, several nests were found long after the birds had left the area. One wrybill also nested here and there were a number of PS pairs nesting in the general area.

This site was very similar to the Railway colony site – at a south bend in the river with a spring-fed stream along the southern boundary making it nearly an island (Figure 21). Across this stream to the west was a raised gravel bar with quite heavy lupin cover and much driftwood and logs. A number of hedgehogs and 2 stoats were caught in traps here, but the only predators caught in the colony area itself were Norway rats. This seems to indicate that the spring-fed stream, acted as a barrier to predators – this is likely to be especially true of hedgehogs. Also, it seems possible the lack of vegetation in the colony area itself deterred predators.

No weed clearing had been done at this colony area and none was needed as it was almost weed-free. The area of bare gravel on which the birds nested was 3.4 ha.

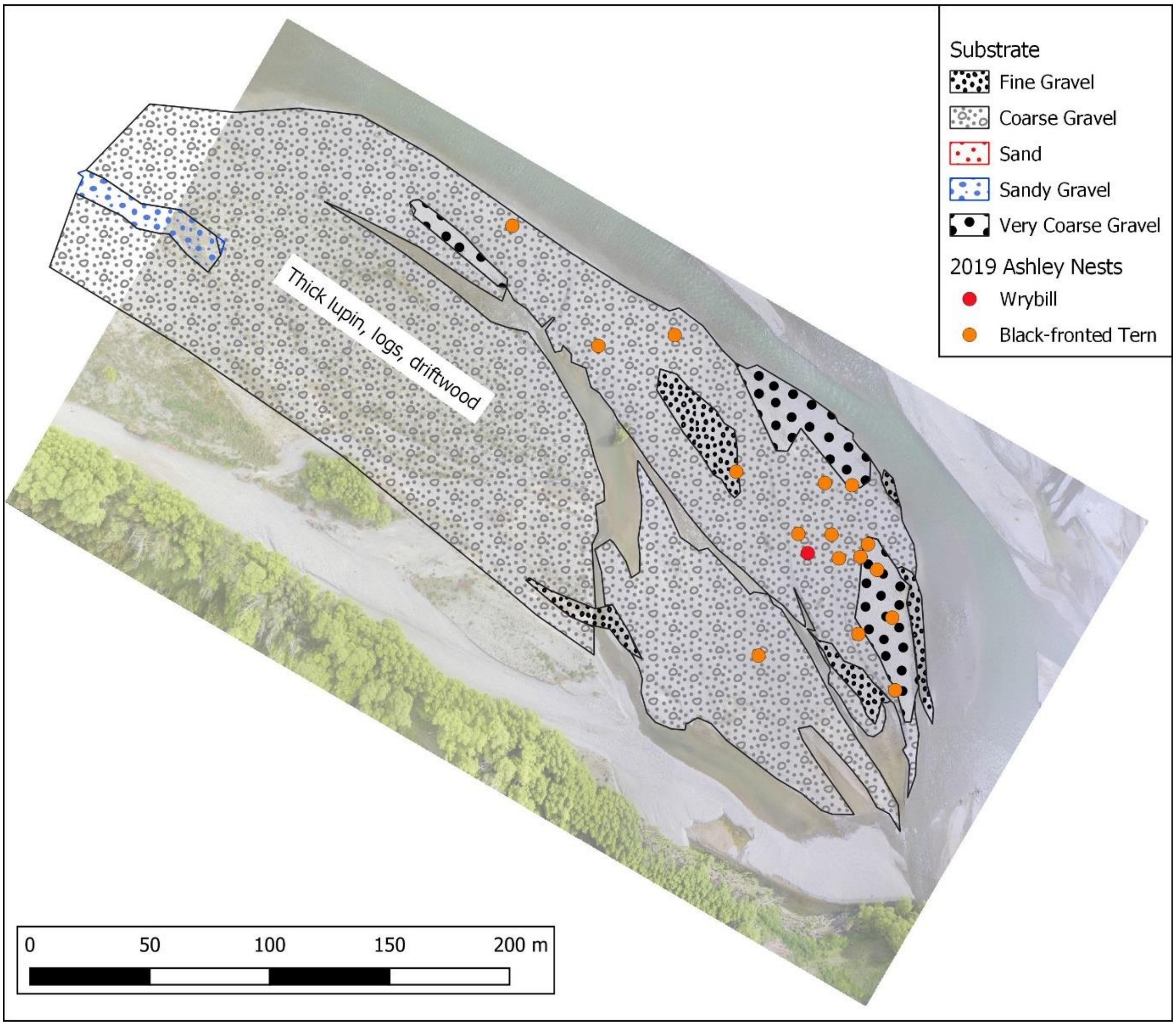


Figure 21. Groyne Nine colony area

Substrate in this area was 90% poorly sorted coarse gravel. Areas of very coarse cobble (>25cm clasts) gravel were also mapped – BFT also nested on this material which is generally a little better sorted than the coarse-grained gravel.

Colony area history, highlighting the rapid changes in geomorphology:

- The geomorphology of this area was quite different in mid-2017 with most 2019 nest sites being on a large mid-river island, in active channels and 1 being on the northern berm.
- The July 2017 flood changed the course of the river and on 30/11/17 the BFT nest sites were mainly on a large clean gravel bar on the south side of the river.
- By August 2018 most 2019 nest sites were on a gravel bar on the north side of the active channel (in 2019 the location of the spring-fed stream), and gravel in the area had obviously been completely reworked.

This site was almost ideal for nesting with very good substrate and some protection from predators due to the spring-fed stream. Reworking of the gravel here meant that the substrate was probably less than a year old when nests were made. In future a single large flood could completely change the geometry of the area, and potentially dump sand on it.

Lupin is re-growing strongly here and the area should be machine ripped before 2020 nesting. If funds allow, consideration should be given to partially diverting the river through the spring-fed stream – this would require 50m of excavation. This could perhaps be shallow – only deep enough to divert some of the river at higher flows through here – with erosion hopefully leading to a permanent flow.

3.3 Toppings Black-billed Gull and Black-fronted Tern Colonies, 2019 - 2020

This was located about a kilometre upstream from the State Highway One bridge (Appendix 1). Four hundred and eighty-five BBG nests were counted from 12m altitude drone photographs after the birds had left the area. Four BFT nests were found 235m west of the gull colony, but several more were no doubt present.

This site was very similar to Groyne Nine, with a spring-fed stream marking the southern boundary (Figure 22). There was also some flow along a channel further southward adjacent to the berm. These two streams seemed to give good protection against predators – nothing was caught in the traps placed around the colonies, and no remains of birds consistent with ground predation were found. Again, there was a raised weedy gravel bar to the west of the colony area. No weed clearing had been done in 2019 and the 2.5 ha area was essentially weed-free. Some lupin was starting to grow in the BBG colony area - Figure 10. The BBG colony was close to an indented steep bank which marked the northern edge of the spring-fed stream.

There was a very large area of longitudinal gravel bar – dominantly poorly sorted coarse-grained gravel – downstream from the Toppings area. There were no colonies on this, but perhaps there could have been some BD and PS nests.

The substrate here was similar to Groyne Nine – dominantly poorly sorted coarse gravel with large sandy areas west of the BBG colony and especially on the weedy higher gravel bar (Figure 22).

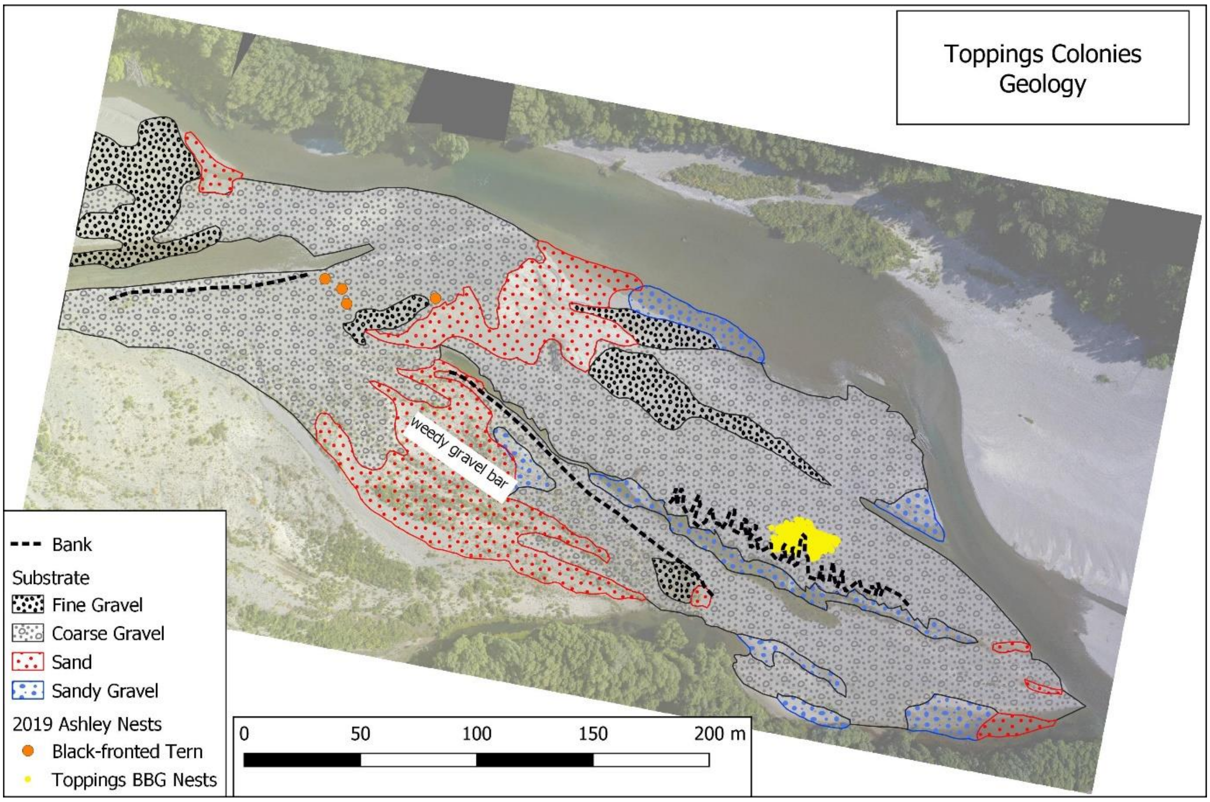


Figure 22. Toppings BBG and BFT colonies

Colony area history:

- On 2/10/17 the 2019 BBG colony area was in the middle of a gravel extraction trench.
- By 29/10/17 most of this trench had been filled with gravel by the river and the colony area was on the edge of the active channel.
- On 16/1/18 the BBG colony area was in the middle of the active channel.
- On 19/1/19 the BBG colony area was on the northern edge of a new gravel bar on the south side of the river and the BFT colony area was in the active channel.
- It seems likely that the flood of 21/7/19 was responsible for creating the gravel bar as it was during the 2019 – 2020 nesting season.

This was a near ideal nesting site with good substrate and good protection from predators. The substrate on which the birds nested seems to have been only about 3 months old.

Once again, this area is developing weed cover – lupin, plantain and Californian poppy - and should probably be cleared before next nesting season. The quite large amount of guano produced by the nesting gulls may be encouraging weed growth. This work should probably have lower priority than the previously mentioned areas as the riverbed here is very narrow and any significant flood would be bank to bank and could completely change the geomorphology and rip out the weeds. Again, it would be quite simple to connect the spring-fed stream to the main channel – but it is perhaps best not to encourage birds to nest on a site from which they would have a high chance of being washed off.

3.4 Groyne Four BFT Colony, 2019 - 2020

Sixteen BFT nests and 2 PS nests were found in this area about 1km upstream from the airport (Appendix 1). Nests were only found when checking traps, more would have been found with a systematic search. At the time of nesting the area, of about 3.9 ha, was essentially weed-free and no clearing had been done. It was on the upstream end of a large 800m long island. No drone photography has been done of this area, as it is close to the airport, and the Google Earth image in Figure 23 dates from August 2018. The position of active channels at the time of nesting is dotted in Figure 25 – the middle southeast-running channel did not exist in late 2019 – it had been filled in by gravel.

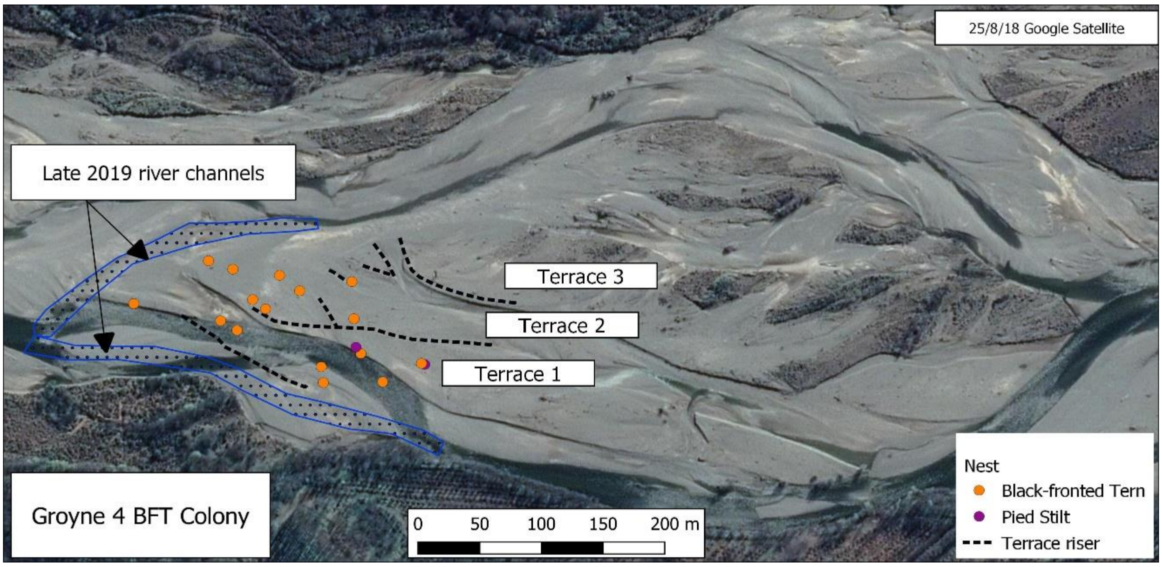


Figure 23. Groyne four BFT colony

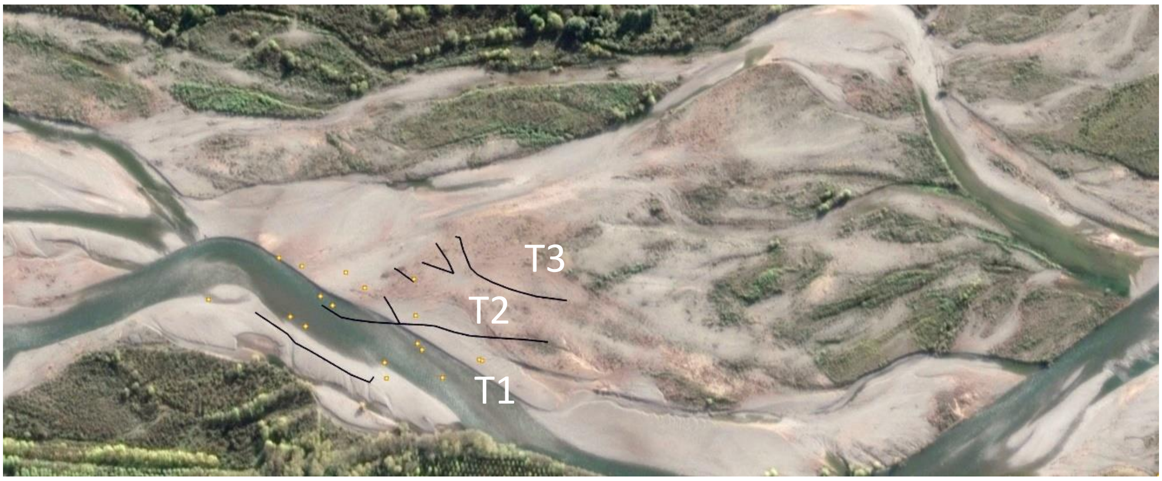


Figure 24. Groyne four area, 3/5/17

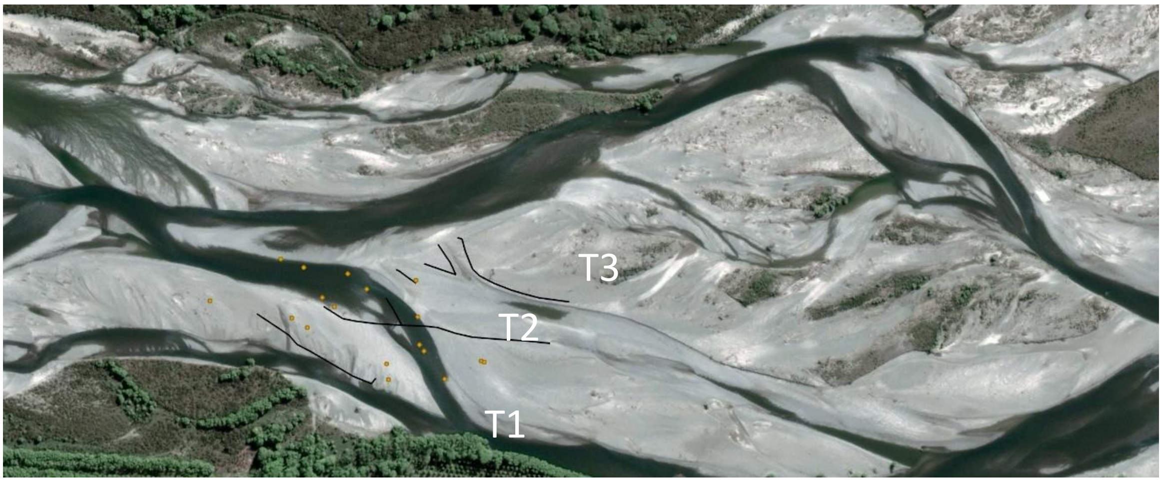


Figure 25. Groyne four area, 2/10/17

Three terraces levels occur here with a noticeable increase in sand content with altitude. Parts of the higher parts of Terrace 3 – east of the colony area – are completely sand covered. From comparison of Figure 24 and Figure 25 most of T1 appears to be an aggradational feature – built up in the July 2017 flood – with probably some contribution from the July 2019 flood. The T2 area is partly aggradational (probably July 2019) and partly the result of the river eroding into the older T3 terrace.

Traps in this area only caught 2 Norway rats and 1 hedgehog – essentially after the nesting season had finished. So it appears that the island may have been of benefit in stopping predators. New lupin is growing over this area and it should be cleared before the next nesting season.

3.5 Swamp Road BFT Colony, 2018 - 2019

This was near the western end of a large island about 2.5km downstream from the Okuku junction (Appendix 1). In an area of about 4.6 ha 10 BFT, 7 BD and 1 PS nested. There were also a few BFT, PS, BBG and probably more BD nests further downstream. Most of these nests were made after Taggarts had started the gravel extraction works which can be seen on Figure 26. Nests were in poorly sorted coarse gravel, there was some scattered weed in this area, especially in hollows.

Figure 26. Swamp Road 2018 BFT colony

This area has a lot in common with the Railway, Groyne 9 and Toppings colony areas in terms of physical situation. There was very poor success from the nests here – Norway rats are suspected to have taken most of the eggs before hatching. Unfortunately, the haulage roads created a connection with the berm – but for Norway rats this would be irrelevant as water is part of their natural habitat.

The excavation method may have been good for river protection reasons, but not for bird nesting during the 2018 season. The deep excavation along the edge of an existing channel cut off the lesser channels to the north which gave the birds some protection against predators. This may not have been a long-lasting effect though. Despite Taggarts increasing the northern channel flow before departure, and the site surface being largely the same as in 2018-19, the site was not used by breeding birds (except a few BD) in the 2019-20 season. It needs to be stated that Taggarts are very responsible gravel extractors and have a genuine concern for the birds.

Comparison of Google Earth images on 3/5/17 and 30/11/17 shows that the geomorphology of the area changed significantly in the July 2017 flood – with new gravel being deposited or at least old gravel being completely reworked where the birds nested in late 2018.

3.6 Smarts BBG Colony, 2018 - 2019

This was approximately in the middle of a large 400m long island (Appendix 1). The nests were largely confined to old channels which had somehow escaped sand deposition and only had sparse weed (Figure 12 and Figure 27). At higher levels, especially to the east, sand and weed cover was quite extensive. No weed clearing had been done in this area, but bulldozer ripping had been done to the northeast and northwest. 768 nests were counted on the ground, 701 from drone photographs. A wrybill had previously nested on a bank immediately adjacent to the colony.

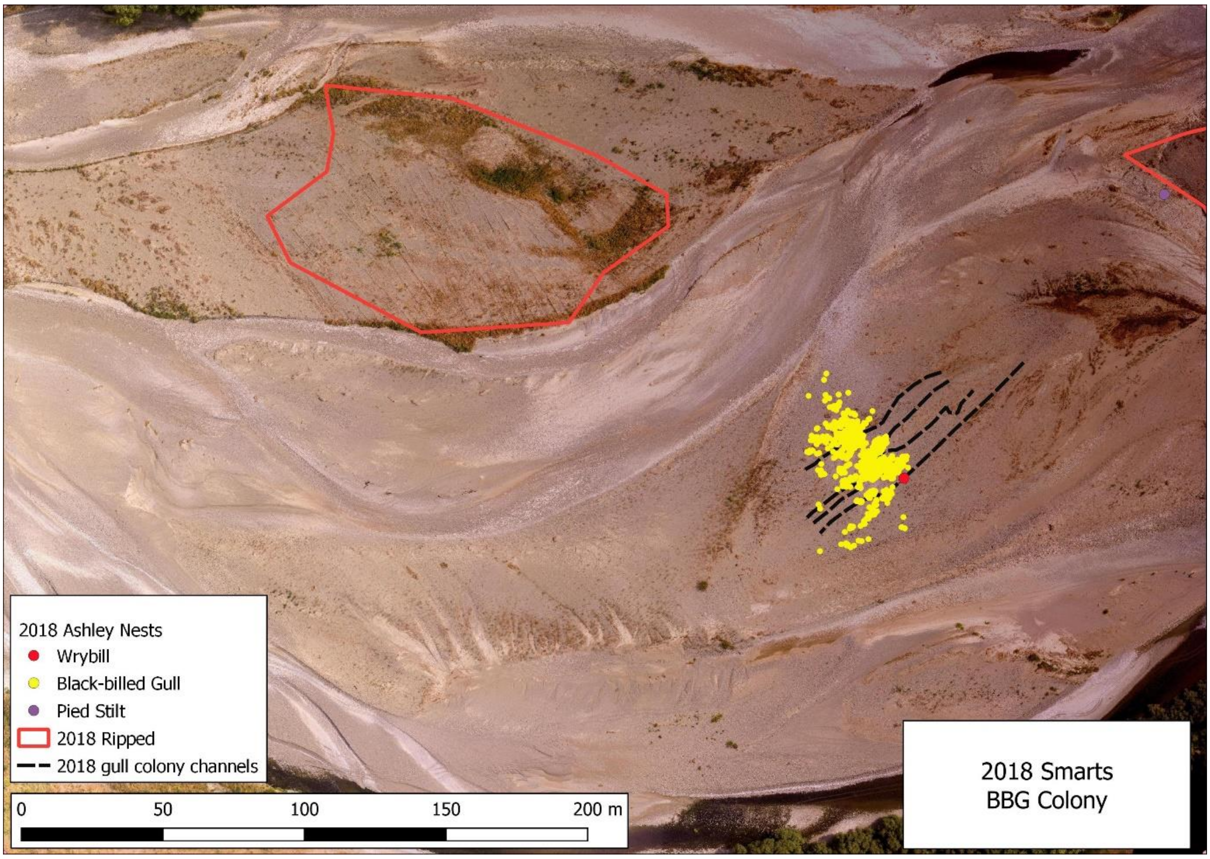


Figure 27. Smarts 2018 BBG colony area

From mid-2014 to prior to the July 2017 flood (which totally reshaped the area) the 2018 colony area would have been in the middle of an active river channel. There seems to have been little modification to the surface of the island between the 2017 flood and December 2018 nesting.

Since the 2018 – 2019 nesting season the area has been cleared of weeds twice – in July 2019 with tractor-mounted ripper and in February – March 2020 by grader (Taggarts). There was little nesting in this area in 2019 – 2020 – see later section.

3.7 Tulls Island

This is about 2.5km upstream from State Highway One and is a large island in a very narrow (<200m wide) section of the river (Appendix 1). It is about 400m long by up to 120m wide (about 2.6 ha) and is at first glance an extremely good nesting environment – it is quite high above the water which in times of normal flow is reasonably deep all around it (Figure 28).

This island tends to have a lot of weeds, which have been cleared twice – in July 2018 and early August 2019. In 2018 part of the area was cleared by bulldozer blade, and the majority was done with the rather widely spaced, but still reasonably effective, dozer rippers. Figure 28 shows that the blade-cleared area, some of the ripped area to the west of it, and patches elsewhere were very sandy – too sandy to expect most species of bird to nest. Figure 29 shows how compacted the blade and dozer tracks made the surface – any large pebbles would have been too flattened down to provide protection for nesting birds. The rippers left large ridges, which would slow down floodwaters and thus enhance sand deposition. Much of the sand in the river tends to be in the fine to medium range (0.125 – 0.5mm) and would probably be mainly transported by saltation – bouncing along the bottom of the river.

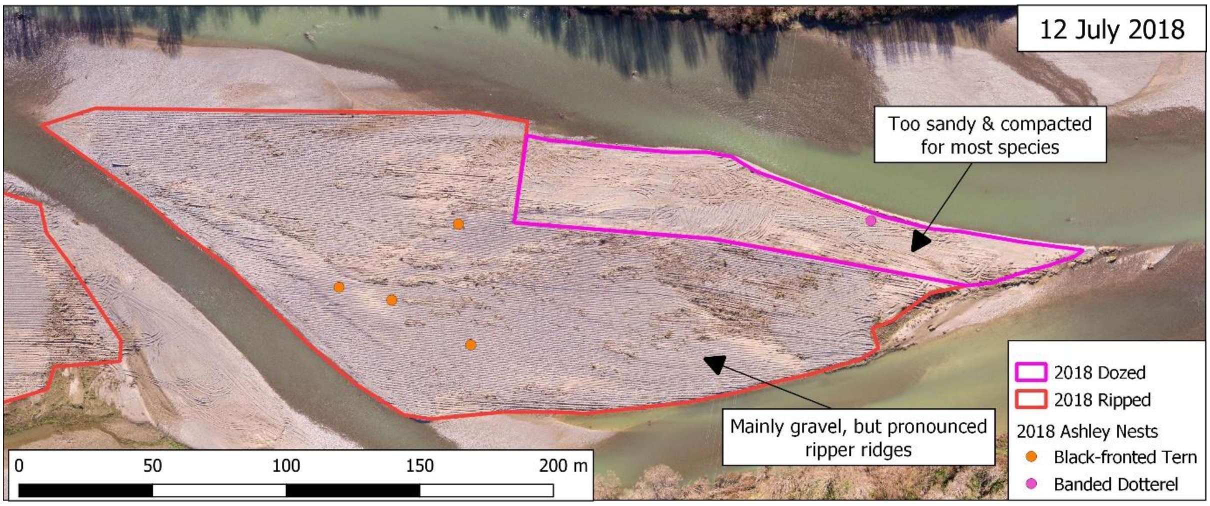


Figure 28. Tulls island July 2018

In the 2018 – 2019 nesting season 1 BD nest was found in the dozer bladed area with 4 BFT nests found in the gravelly part of the ripped area. From the numbers of BFT in the area, these nests probably were less than half of those actually present. By the time the BFT chicks hatched, there had been very significant regrowth of lupin – this was the weediest area that BFT have nested on in the last two seasons. Unfortunately, the BFT chicks were abandoned – perhaps because of nighttime disturbance.

Figure 29. Dozer blade and ripper clearing, July 2018

Just before it was planned to clear weeds again, in July 2019, there was a flood of slightly greater than the mean annual flood size. The island was drone photographed before and after the flood and the effects of the flood are instructive. Only part of the eastern end of the island was emergent and most of it had a quite thick covering of sand. The large area of sand in the western part of the island is within a hollow. Water flow directions could be seen from the sand deposition, these were commonly across the ripper ridges. Only small areas of weed were eroded away or perhaps covered by sand. By this time significant areas of the island had been eroded away – especially the bladed part (Figure 31). Most of this erosion took place before the July 2019 flood.

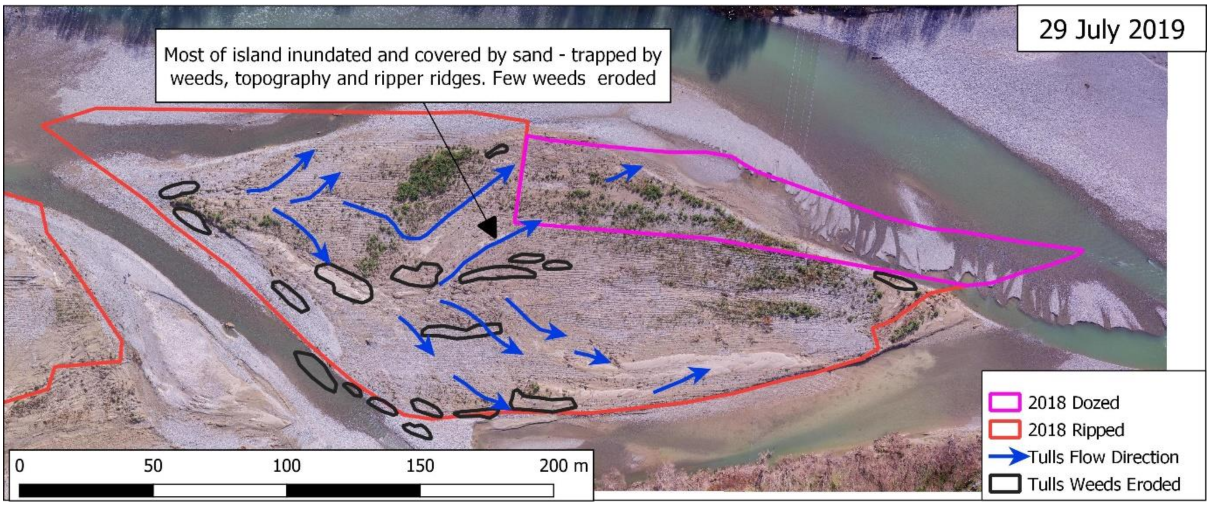


Figure 30. Tulls island after July 2019 flood

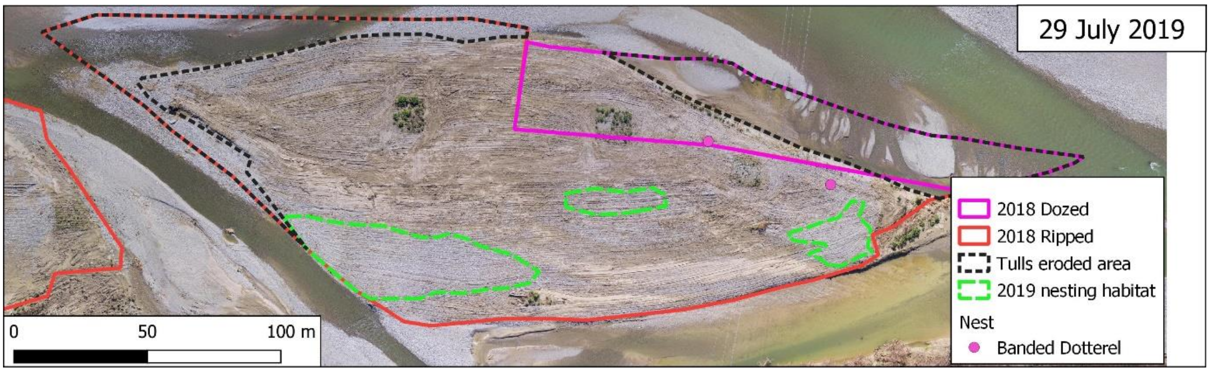


Figure 31. Tulls island after 2019 ripping

Figure 31 also shows the extent to which nesting habitat for most species has been destroyed by sand – interpreted from the drone image. Figure 32 shows ground mapping agrees quite well with drone photo interpretation, but much of the sandy area on Figure 31 was mapped as sandy gravel – BFT etc may possibly nest on this. Thirty-nine percent of the island area was mapped as sandy gravel, 35% as sand and 26% as poorly sorted coarse gravel. In the 2019 – 2020 season only 2 BD nests were found on the island.

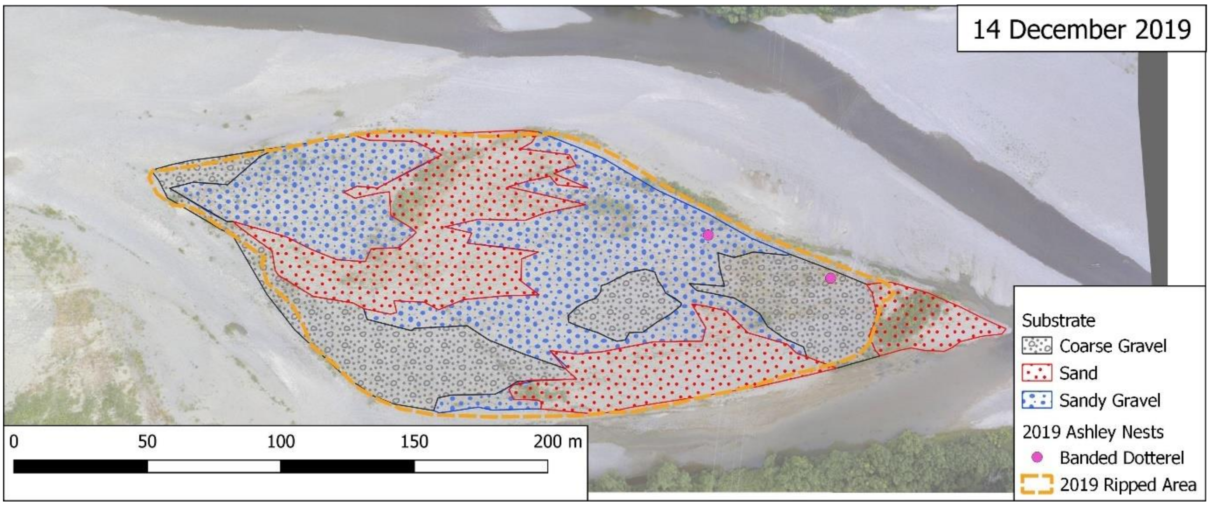


Figure 32. Tulls island geology, December 2019

Figure 33. Tractor mounted ripper in action

From Google Earth images the island area was the site of a major gravel operation in early 2011 and in mid-2012 there was little gravel left here following floods. From 2013 to the present most of this area seems to have been quite stable. The July 2017 flood eroded the island into approximately its current shape, but appears to have done little reworking of gravel on it – just deposited fine sediment and incompletely removed or covered up weeds (Figure 34 and Figure 35).

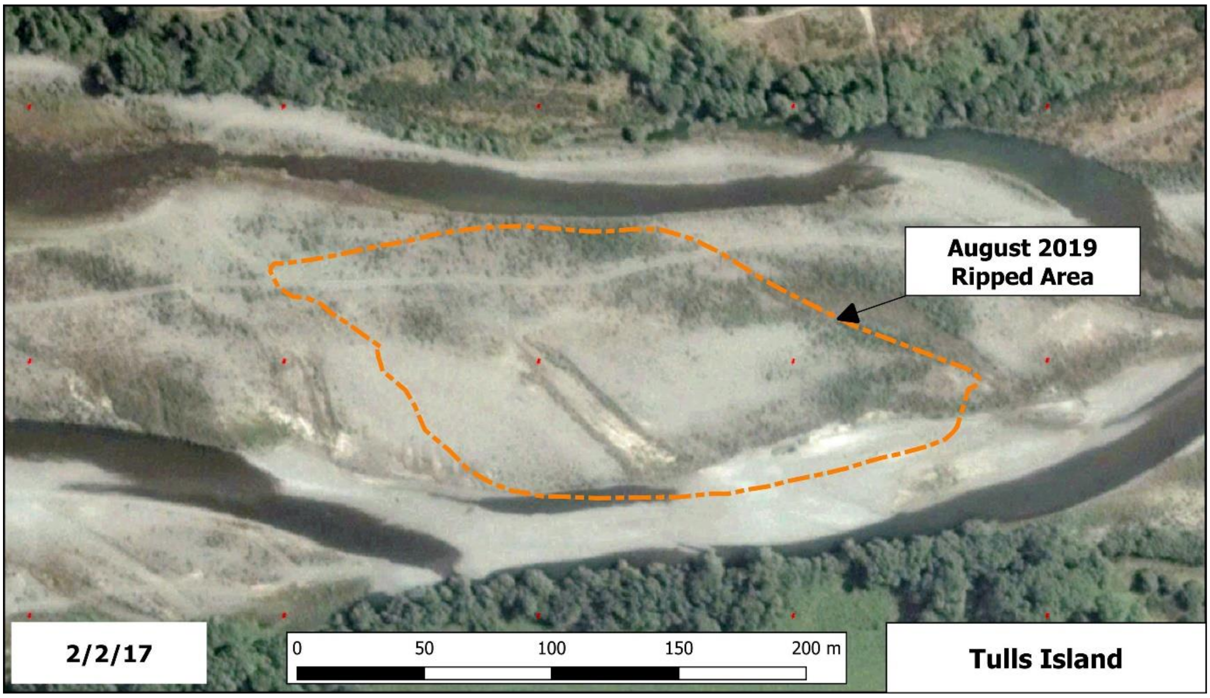


Figure 34. Tulls island, 2/2/17, before July 2017 flood

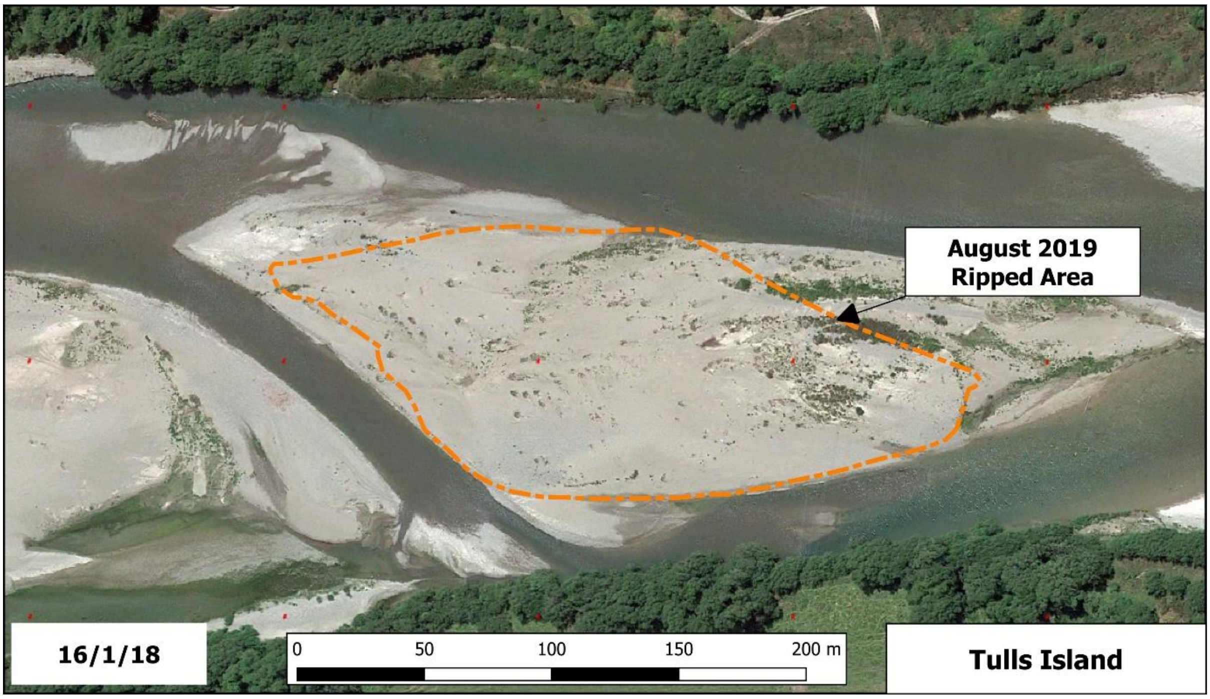


Figure 35. Tulls island, 16/1/18, after July 2017 flood

This island probably should be cleared of weeds for the 2020 – 2021 nesting season, but few nests can be expected. The clearing would be with the aim of continuing the study of weed regeneration in the area. The tractor mounted ripper should be used, as this is highly effective with lupins and other weeds that grow here, and does not compact the surface (Figure 33). However, with the current design of the ripper machine, some ridges are left. It should be easily possible to modify it to leave a flatter surface without compaction.

3.8 Smarts – Marchmont Islands

This area extends upstream from Tulls island for 2.6km (Appendix 1). Several large islands here were ripped, and a smaller area bladed, of weeds in July 2019. Most of this area is shown in Figure 36. These islands were long, high and had good flows of water either side. Despite this only a few birds nested there in 2019 – 2020. Two BD nests and 2 SIPO nests were found, both the latter nests seem to have been by the same pair – with the first one being abandoned probably due to disturbance. There could possibly have been several BD and PS nests that were not found, but there was no BFT or BBG nesting here. One wrybill pair nested off the raised islands closer to the river. Further west, in the Marchmont area, at least 7 BFT and 1 wrybill nested off cleared islands and 1 BD nested on a cleared island. The 2018 BBG colony was centred on the site of the western 2019 – 2020 SIPO nest.

A close look at the August 2019 drone imagery (done after ripping) in Figure 36 shows a considerable amount of sand on the islands. Drone images of this area were also taken prior to ripping but after the July 2019 flood. Figure 36 shows the sand deposited from this flood - which has deteriorated the nesting habitat. Between the Marchmont area and Tulls island (3km) 24% of the fairway of the river, other than the actual channels, had significant sand cover. This was mainly on the mid-channel islands. Unfortunately, no drone photography was done before the flood, but Google Earth images from 19/1/19 and 14/11/19 shows there was little or no erosion of the islands. Large parts of these islands have been in place for many years and there was some heavy weed cover, especially where there was deep sand. Some reworking and gravel extraction has taken place.

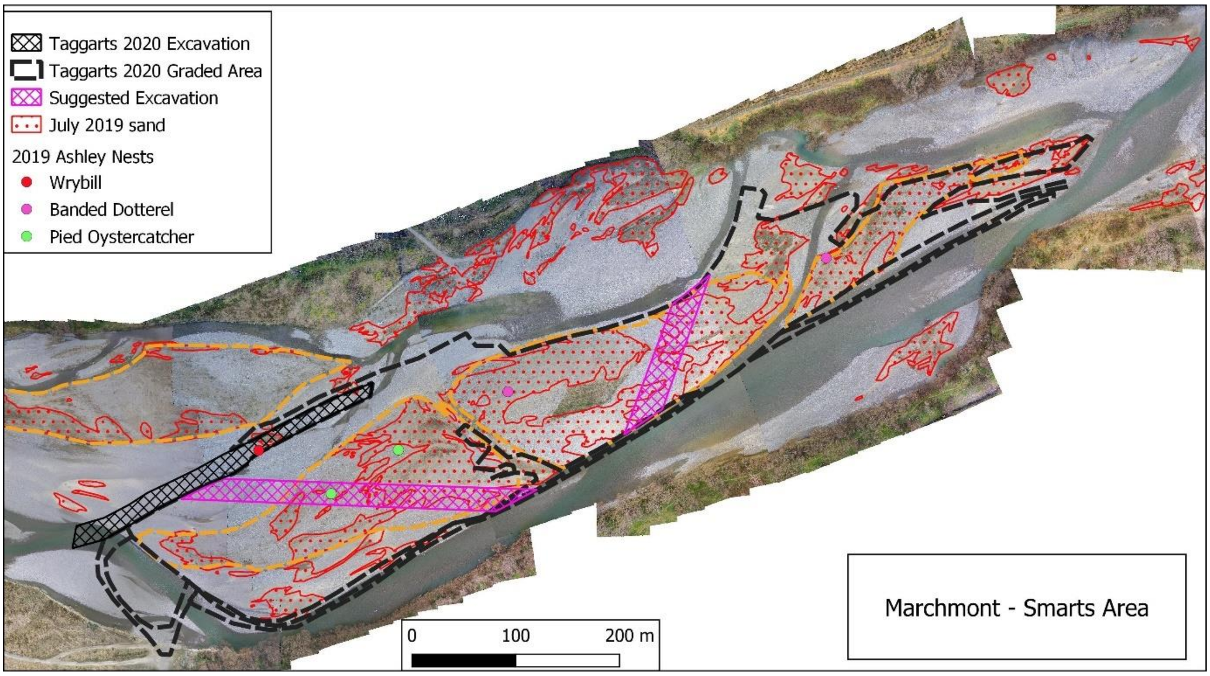


Figure 36. Marchmont - Smarts area

Flume model experiments done by Ashworth et al. (1994) found settings for fine-grained sediment deposition included –

- Bar top hollows – found randomly distributed on the tops of large mid-channel bars. The bar top hollows become sites of dead water which may then become zones of fine-grained deposition in the time between the maximum overbank flows.
- Splay/overbanks – laterally extensive, but often thin, drapes on the tops of mid-channel bars and overbanks on the floodplain.

The main reason for this mid channel bar/island sand deposition is probably simply because the gradients in downstream and lateral directions on these bars are shallower than those in the channels and in the gravel fringing the channels. Water thus moves slower over the islands, which causes finer sediment to be deposited. Hollows, logs, weeds or anything else on the surface which slows down the water (such as ripper ridges) enhance this effect. If an island-topping flood does not erode away the edges of it, the flood will just make the island less attractive for nesting by sand deposition. The sand will enhance weed growth, and weeds will cause more sand to be deposited. Such islands have limited life as attractive nesting sites.

In February – March 2020 Taggarts began gravel extraction in the area. They used a grader to clear a large part of it, but excavation was initially from a narrow deep trench along an old channel between islands. This type of excavation increases channelization and will lead to less chance of the islands being eroded and more chance of sand continuing to be deposited on them. It would have been better for nesting birds, and the natural environment of the river, if gravel had been taken from the islands – but it is understood that Taggarts intend to eventually take gravel from almost the entire area that was graded. If deep trenches are the optimal gravel extraction method, then something like what is shown in Figure 36 in pink cross-hatch may perhaps lead to increased erosion and reworking of the islands – and less sandy conditions.

After the area had been graded field mapping showed less than 2% of the area consisted of uncompacted coarse poorly sorted gravel (Figure 38, Figure 37). Only a very small part of the area had that basic lithology, and compaction by the grader blade, the grader and truck etc. wheels led to the large pebbles being flattened down. Loosening the gravel by some sort of ripper would probably not be worth the expense as the basic lithology is not optimal for nesting. However, a trial of this will be done in the 2020 season.

Hydrographs of floods with similar maximum flow to the July 2019 have been plotted – their durations were a little shorter than that of July 2019, and they could perhaps have deposited a little less sand.

Figure 37. Compacted fine sandy gravel

Figure 38. Compacted coarse poorly sorted sandy gravel

Semi-permanently Vegetated Islands

There are a number of islands on the river which have been there for many years and have a thick cover of weeds the same as on the berm. These weeds include grass, broom, blackberry, gorse, willow and poplar. Braided river bird nesting on these is impossible. The substrate on these islands is almost exclusively sand, so even if the weeds were cleared away, nesting of most species would not happen. The sandy tops of the islands could potentially be dozed off, but sand is likely to occur to some depth – having been carried down amongst the pebbles by water.

From flume experiments by Gran and Paola (2001): *…we were able to show that riparian vegetation can substantially alter channel geometry and flow characteristics. Our results indicate that as vegetation density increases, lateral mobility decreases, braiding intensity decreases, width to depth ratios decrease, maximum channel depths increase, and channel relief increase.*

From NIWA, 2017 - *Floods are usually potent enough to keep woody vegetation in check, but when floods are regulated by dams or irrigation diversions (or even by natural lakes upstream), and/or when an aggressive exotic plant species appears, the vegetation can gain ascendency and reduce braiding, even forcing the river into a single meandering channel. An example is provided by the South Island's Lower Waitaki River, which, by the combined effects of hydro-power-related flow regulation and the arrival in the 20th century of willow, gorse, and broom, has trended historically towards diminished braiding.*

Foothills-fed rivers, such as the Ashley, are particularly vulnerable to weed growth as they don't have as many large flood events as the alpine-fed ones. The heavily weeded islands are changing the natural character of the river leading to less nesting and feeding habitat for the birds. They are also a source of weed seed for all points downstream and provide cover for predators.

Figure 39 shows such an island, 500m down from the Railway colony area (Appendix 1). This island has been there for more than 10 years and could remain for another 10. Traps on the island have caught 7 hedgehogs in recent months. The dashed red line shows part of the island that was eroded away by the 1 in 10-year flood event of July 2017. Vegetation on these islands strongly armours against erosion, floods running over the top of them will erode very little but will deposit more sand - the only significant erosion will be from the sides. Figure 40 shows typical sand cover on an island (often 30cm thick or more) with gorse roots extending deeply into the gravel below. Without action, it seems possible that this island could become part of the berm in a few years – with the single channel to the south becoming permanent. Removing the weed from the island and taking gravel from the almost unused channel to the north of it would be highly beneficial.

Figure 41 shows islands that have not been eroded in at least 5 years and generally have heavy weed cover, this is from inspection of historic Google Earth images. Such islands make up more than 8% of the fairway area from between the Okuku junction and the top of the estuary. The large islands just down from the Okuku junction are of particular concern as they narrow and channelize the river markedly.

From Hicks et al., 2003 - *recent research has shown that the lower Waimakariri River turns over two-thirds of its available floodplain annually (> 0.2 m vertical erosion or deposition) and would probably re-work its entire floodplain within 5 years*

A similar process seems to be happening on the Ashley - except where vegetation prevents it (Figure 39). This process is necessary for the river to create nesting habitat by getting rid of sand and weeds and creating new gravel bars.

Figure 39. Heavily vegetated island, Google Earth 19/1/19

Figure 40. Island-top sand

Figure 41. Islands that haven't been eroded in at least 5 years

4. Conclusions

1. There appears to be a clear correlation between weed-free gravel area and total bird numbers – this holds true to some extent for all species other than BBG.
2. Floods determine the amount of bare gravel available for nesting – the natural increase in weeds has to be offset by them. It appears to be necessary to have regular flood events of close to mean annual flood size, and more widely spaced floods in excess of this. These cannot be relied upon and may become less frequent with global warming – flow records back to 1972 show that there can be long periods with very few floods. A big drop in available nesting area from 2014 to mid-2017 caused a steep decline in bird numbers, a major flood in July 2017 led to only a gradual climb in numbers.
3. The preferred nesting substrate for most of the birds, from 2019 – 2020 observations, is weed-free poorly sorted coarse gravel. This seems particularly true for BFT which, on the basis of lack of breeding success, are the most threatened species on the Ashley river. From much less data, but from past experience, wrybill favour a very similar substrate – but they perhaps nest higher on the gravel bars. They appear to tolerate more weed and their nest positions seem strongly controlled by habit – they return to nearly the same position every year. Black-billed gulls, whilst seeming to prefer the same substrate can, when necessary, nest on more weedy and driftwood covered substrate, and even in worked paddocks.
4. BFT make their nests within 10cm of pebbles that are at least 8cm in maximum dimension. This presumably makes them less visible on the nest and perhaps shields against wind. BBG generally make their nests within 25cm of pebbles that are more often around 12 – 15cm in size – but they also nest close to driftwood, logs and weeds.
5. In the last 2 years the colonies that the ARRG has monitored in detail, the larger ones, have all been on islands or gravel bars which, due to spring-fed streams, were almost islands.
6. All of the colony areas were on substrate which had been created or at least reworked by the major flood of July 2017 or by subsequent floods. This adds to the evidence of the importance of floods in creating nesting habitat.
7. However, floods also destroy nesting habitat in other parts of the river, especially flat-topped islands, by depositing sand on top of the gravel. Sand may be almost as large a deterrent to nesting as weeds - the islands in the Marchmont to Tulls area were cleared of weeds in 2019 and appeared to be geomorphologically good sites, but sand cover was probably the reason for lack of nesting.
8. Due to the dynamic nature of the river, islands may be viable nesting sites for very few years. This is due to natural and unnatural causes – the former are erosion and sand cover, the latter – weed growth. Weeds also attract more sand - further ruining the nesting environment.
9. About 8% of the fairway area of the river (including active channels) consists of islands with mature weed cover such as grass, gorse, broom, blackberry, and willow. These islands have existed for at least 5 years, and some of them for significantly longer. Braided river bird nesting is impossible on them, the weeds strongly resist erosion, cause more sand to be deposited and they cause the river to narrow down to often only one braid reducing feeding habitat and increasing bank erosion.
10. The best method of weed clearing, when the weeds are at an early stage of development, will involve some form of ripper. The tractor-mounted ripper used in 2019 did a very good job, but cost and durability need addressing. Grading and dozing compacts the gravel too much – but dozer blading would be the only way to handle the areas with more mature weed.

5. Recommendations

Weed clearing can be subdivided into three distinct tasks and priorities:

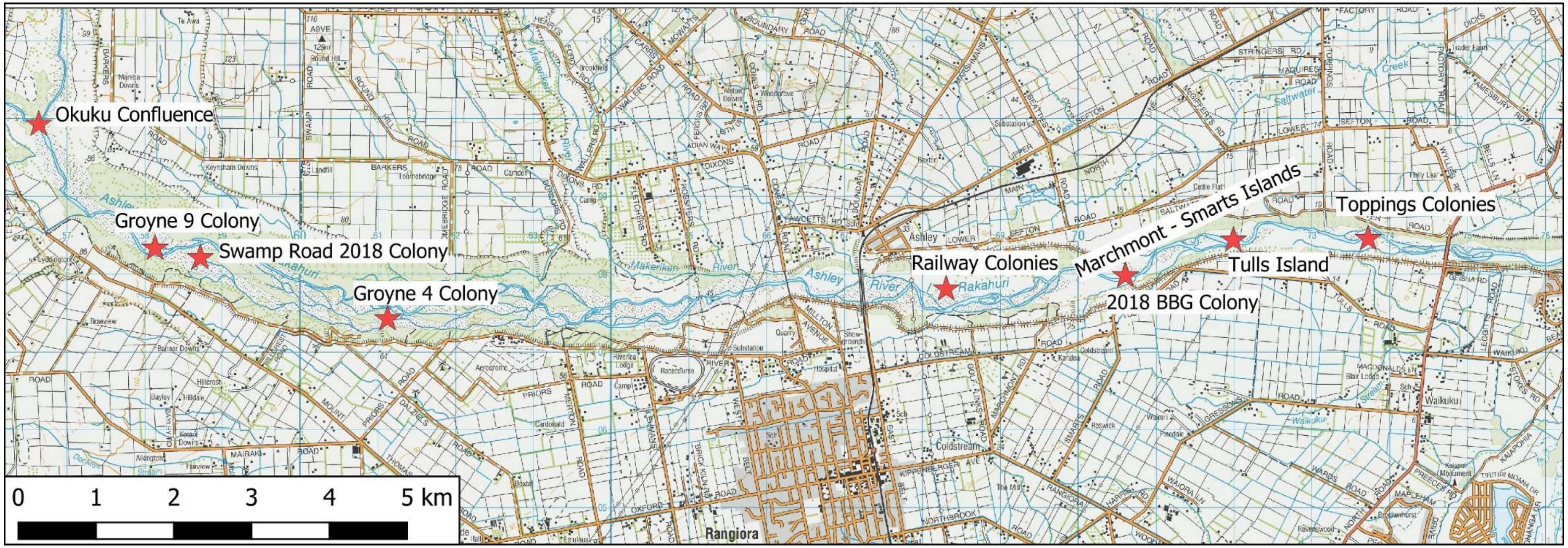
1. Creating or improving nesting areas on an annual basis. These sites should be mainly on islands of approximately 2 – 5 ha in size that have a preponderance of poorly sorted coarse gravel substrate. This can be managed by the ARRG, and the tractor-mounted ripper seems to be the best method. Some hand pulling of weeds can also be done – especially useful would be clearing around the edges of ripped areas. All 2019 – 2020 colony areas still seem viable as nesting sites for 2020 – 2021 but will require clearing. Without such weed clearance, the likelihood is that bird number gains achieved over the last 20 years will be lost. This is particularly important where lupins are re-emerging, as they generally do not seed in their first year. If left for longer, then a new seed bank will be created. Areas with lower priority for clearing would be those where the river is narrow and there is more danger of submergence by floods, and those close to powerlines where birds can be killed by collision with the lines. Suggested areas for 2020 – 2021 weed clearance are shown in Appendix 4.
2. Clearing the islands that have semi-permanent vegetation. ECan (with ARRG participation) should develop a programme to progressively clear these – perhaps in conjunction with gravel extraction. Some construction of channels which will direct the flow to erode the islands and remove sand would be preferable. Also contouring to avoid shallow sand-collecting slopes should be done – perhaps by burying the weeds in the middle of the island.
3. Clearing weedy areas which although may not be optimal nesting sites, will stop them from getting a cover of mature erosion-resistant and sand attracting weed and help decrease the amount of weed seed downstream from them. This could also be done in conjunction with gravel extraction – as has been done by Taggarts in the Smarts area in early 2020.

In addition:

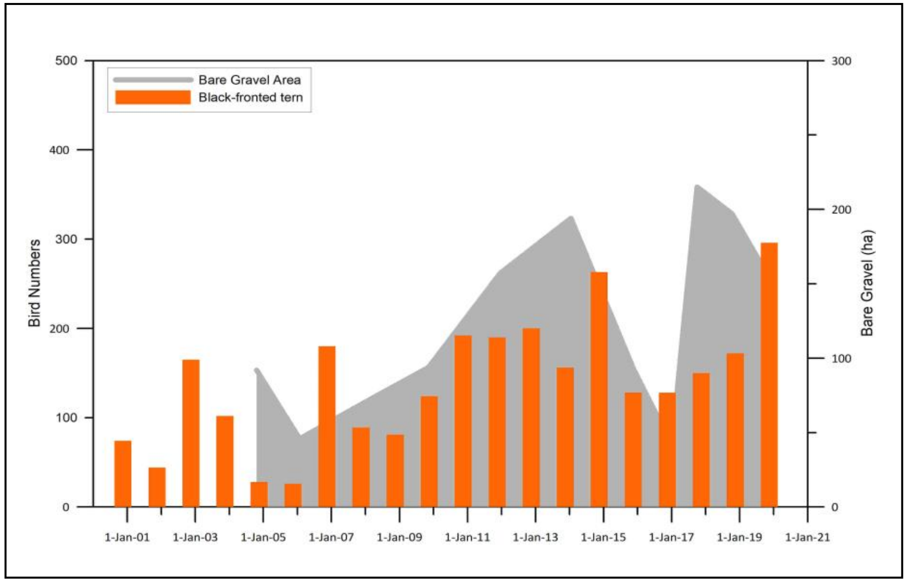
1. We should continue to GPS-locate, photograph, and describe as many nests as possible and drone photograph colony sites to add to the work described in this report.
2. Further tracking of the weed problem through study of historic air photos is underway
3. ECan should review gravel extraction methodology so that it better addresses the environment for nesting and feeding birds as well as flood protection.

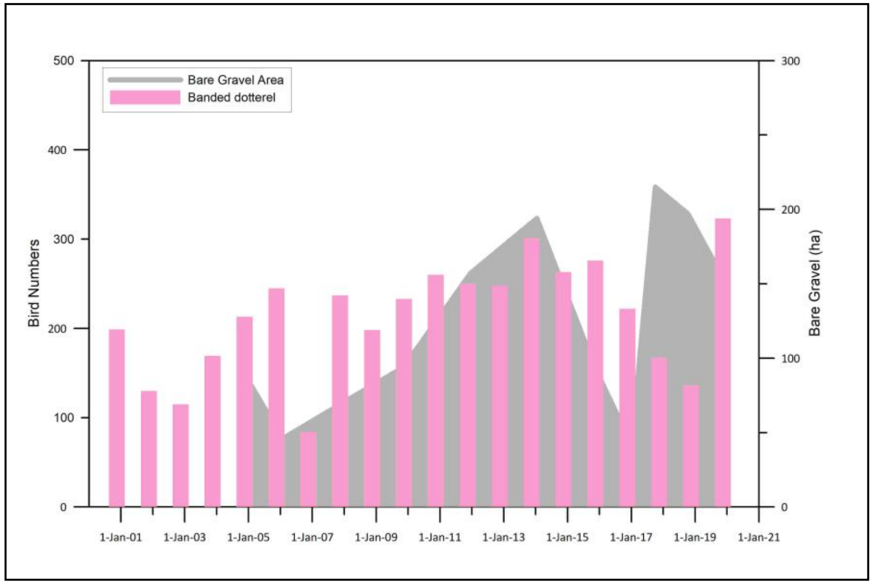
Grant Davey, 4/5/20

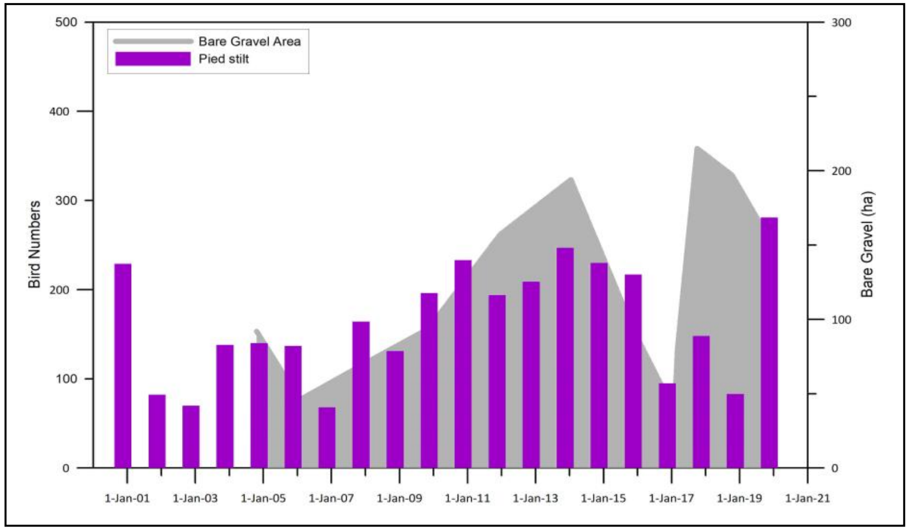
Appendix 1 – Location Map

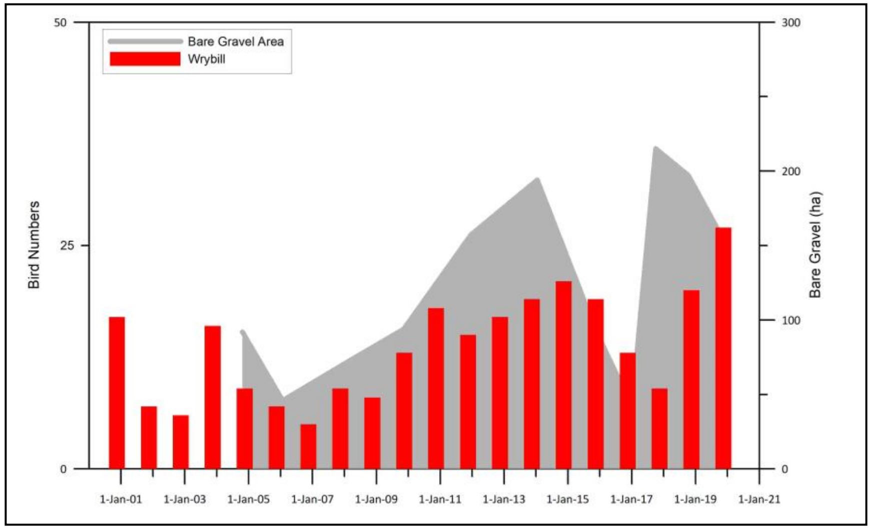


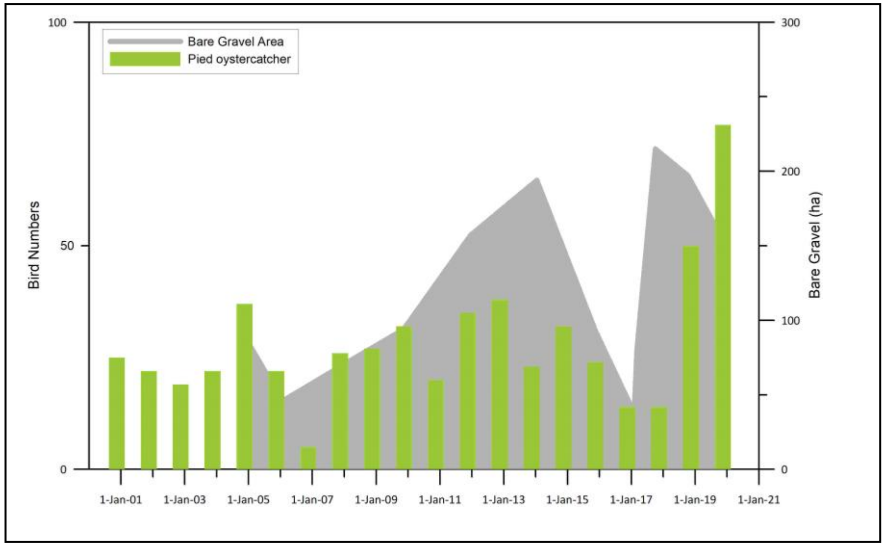
Appendix 2 – Individual bird species with weed-free gravel area

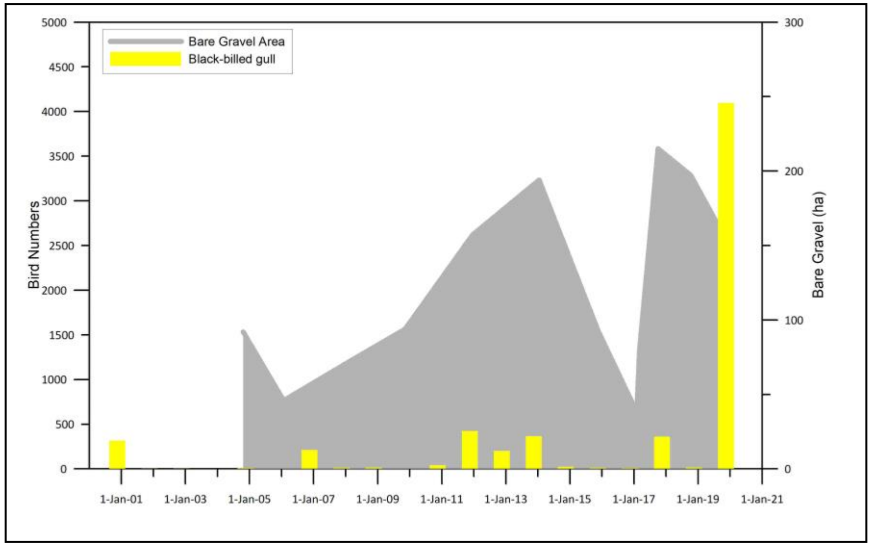









Bare Gravel Area
Pied oystercatcher
Bird Numbers
Bare Gravel (ha)
100
50
0
300
200
100
0
1-Jan-01
1-Jan-03
1-Jan-05
1-Jan-07
1-Jan-09
1-Jan-11
1-Jan-13
1-Jan-15
1-Jan-17
1-Jan-19
1-Jan-21


Bare Gravel Area
Black-billed gull
Bird Numbers
Bare Gravel (ha)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
300
200
100
0
1-Jan-01
1-Jan-03
1-Jan-05
1-Jan-07
1-Jan-09
1-Jan-11
1-Jan-13
1-Jan-15
1-Jan-17
1-Jan-19
1-Jan-21

Appendix 3 – Summary of colony sites

Location	Geomorph.	Area (ha)	Substrate	Weeds	Weeds Cleared	Success	Surface age, years
Railway 2019	Island at bend, adj. to berm	4.9	70% psg 22% fg 5% s 3% sg	Few – around edges of banks	Part area ripped	1,550 BBG nests 48 BFT nests 2 PS nests 1 SIPO nest	0.75 - 2
Toppings 2019	Island at bend, adj. to berm	2.5	69% psg 9% sg 9% fg 12% s	Near nil	No	485 BBG 4+ BFT	0.3 – 0.75
Groyne 9 2019	Island at bend, adj. to berm	3.4	84% psg 7% fg 9% vcg	nil	no	16+ BFT 1 wrybill	<1.2
Groyne 4 2019	Upstream end of large island	2.5	>90% psg	Near nil	No	16+ BFT 2+ PS	0.3 – 2
Swamp Road 2018	Island adj. to berm	4.6+	90%? Psg	Sparse	No	10 BFT 7 BD 1Ps	1.3
Smarts 2018	Old channels in middle of large island	<0.1	>90% psg	Sparse in colony area – moderate surrounding	No	768 BBG 1 wrybill	1.4

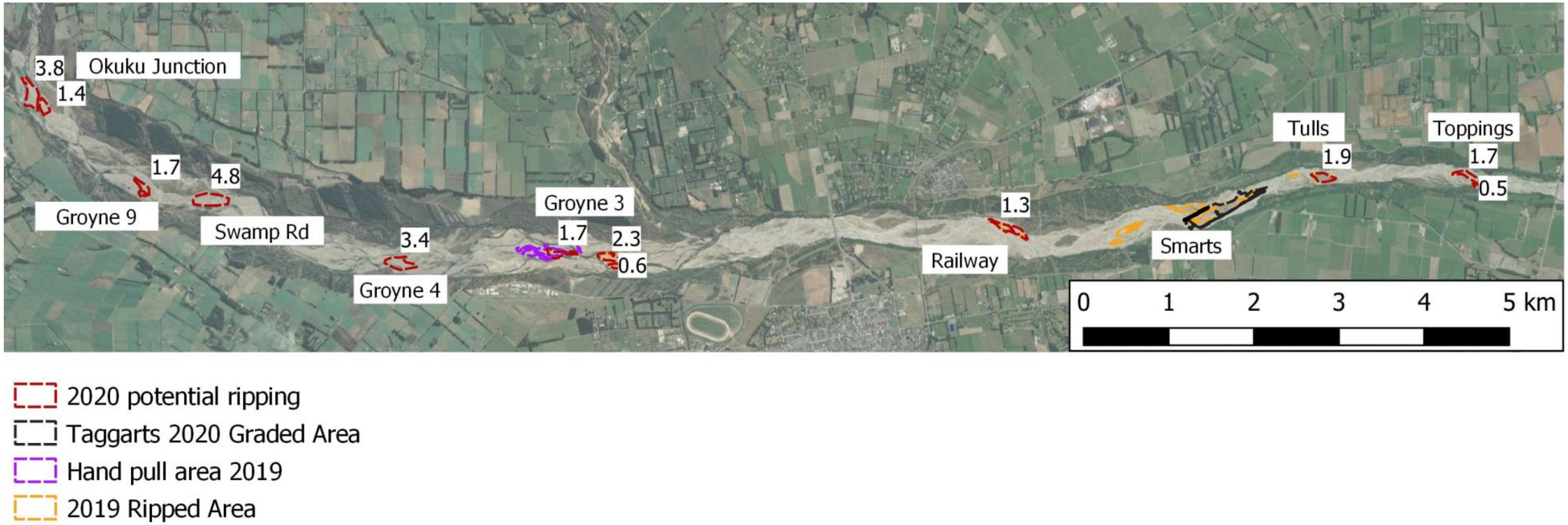
Table 1. Successful nesting areas

Psg – poorly sorted coarse gravel, fg – fine gravel, s – sand – sg – sandy gravel, vcg – very coarse gravel with cobbles
Age of surface – time between start of colony and building or complete reworking of substrate
Area - of the generally bare substrate on which the colony was made

Location	Geomorph.	Area (ha)	Substrate	Weeds	Weeds Cleared	Success	Surface age, years
Tulls island 2018 & 2019	Island at bend, adj. to berm	2.6	2019 39% sg 35% s 26% psg	Some regrowth late in season & around edges	Complete – 2018 & 2019	2018 – 1 BD, 4+ BFT 2019 – 2 BD	>5
Smarts & Marchmont islands	Islands along straight sections of river	Individual islands from approx. 0.35 – 2.8	Probably subequal psg, sg and s	Some regrowth late in season & around edges	Partial 2018, complete 2019	2019 – 3+ BD1 SIPO	Variable – 2.3 – 10 years

Table 2. Unsuccessful nesting areas

Appendix 4 – Planned weed clearing for 2020 – 2021 season



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