Assessment of Large Woody Debris at Waikanae-Midway Beach, Uawa River Mouth, Tolaga Beach, Waiapu River Mouth and Tikapa Beach 25-26th November 2023 Storm

Dr M. P. Cave
Principal Scientist

10 December 2023 v.2 draft

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Summary and Conclusions

1. The highest daily and event rainfall occurred at the road bridge at Monowai Station which had 108.8mm of rain on the 25th and 154mm for the two days. No sites reached the normal rainfall duration/intensity landslide triggering threshold of 120mm/d, however, antecedent conditions were wet and landslides still occurred but were not regionally significant. The LWD mobilisation that did occur was largely the result of debris already resident within the waterways being remobilised.

2. The river level data shows that while the Hale and Gabrielle events were the largest events, the 25-26th November event in the Waimata was bigger than either the 24th February (son of Gabrielle) or June events while in the Uawa catchment, the November event was significantly smaller than the 24th February (son of Gabrielle) or June events. Peak flood heights in the Waimata on the 26th of November were 62% of the peak flood heights in Gabrielle whereas in the Uawa, the peak flood heights were between 44 and 60% of the Gabrielle flood heights.

3. An overflight indicated that there had been limited or no new LWD deposited on some beaches (Whangara, Anaura, Karaka, Kaiaua, Waipiro, Loisels, Tokomaru). Other beaches such as Reporua, Pakarae river mouth, Pouawa to Turihau, Makorori, and Okitu/Wainui had minor to moderate volumes of LWD but much of this could be pre-existing. The most significant impacts occurred in the Waimata with significant volumes deposited on the city beaches and to a lesser extent at Tolaga Bay.

4. A total of 9 LWD counts have been undertaken since the November 25-26th event, 4 at Waikanae to Centennial Marine parade, 1 at the Uawa River mouth, 1 at south Tolaga Bay beach, 2 at Tikapa Beach and 1 at the Waiapu River mouth. The analysis indicates that the LWD was predominately pine ranging from a low of 53% at the middle Tikapa Beach to a high of 86% at the Uawa River mouth (average 73%). Excluding Tikapa and the Waiapu, pine LWD averaged 79.45%. Small amounts of fresh cut pine were present on the city beaches and Tikapa/Waiapu but rare at Tolaga.

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Introduction

The mobilisation of large woody debris (LWD) from multiple catchments have become a significant issue in recent years and has been assessed comprehensively since 2017. It is an issue that has regularly impacted on the environment and on amenity values of our rivers and beaches in that time. 2018 and 2023 have been watershed years; 2018 because it led to the successful prosecution of multiple forestry companies and 2023 because of the death of Oliver Shone after Cyclone Hale.

Following the two cyclonic events in January and February and to a lesser extent the June 2023 storm, there has been a concerted effort to clean up the worst affected beaches and to remove mobilised LWD from affected catchments. Over the weekend of 25-26th November, however, a severe storm impacted the region and this resulted in the remobilisation of LWD from several catchments. The Waimata was particularly affected and to a lesser extent the Uawa catchment. Rainfall duration and intensities were not high enough to result in a widespread landslide event, although some did occur. Instead the mobilisation of LWD resulted from floodwaters gathering already mobilised LWD from point sources and riverbanks within the catchments. At Tolaga Bay, some of the LWD was the result of the exhumation of LWD from the dune system which has been undergoing storm wave and surge erosion since 2022. Tikapa Beach at the mouth of the Waiapu has also experienced severe LWD influxes recently but the volumes attributed to the November storm are low.

The Weather Event

An in-depth analysis of the November 25-26th storm is waiting on receipt of full data from our Environmental Monitoring team. On an interim basis, individual rain gauge and river level data for both days for selected catchments have been extracted from our online data and form the basis for this initial assessment (**Table One**, **Figure One**).

Rainfall

The highest daily and event rainfall occurred at the road bridge at Monowai Station which had 108.8mm of rain on the 25th and 154mm for the two days. The remaining sites had rainfalls in the range 90 to 94mm for the 25th and 109 to 118.6 mm in total.

None of these sites reached the normal rainfall duration/intensity landslide triggering threshold of 120mm/d, however, it needs to be noted that antecedent conditions were wet and so landslides may and did still occur. Landslide activity was not regionally significant, however, and thus the LWD mobilisation that did occur was not the result of new material mobilised from forests but debris already resident within the waterways.

Table One. *Rainfall data for selected sites 25-26th November 2023*

	25th	26th	Total
Wakaroa	90	28.6	118.6
Monowai	108.8	45.2	154
Willowbank	91	23	114
Hikuwai #4	94	15	109

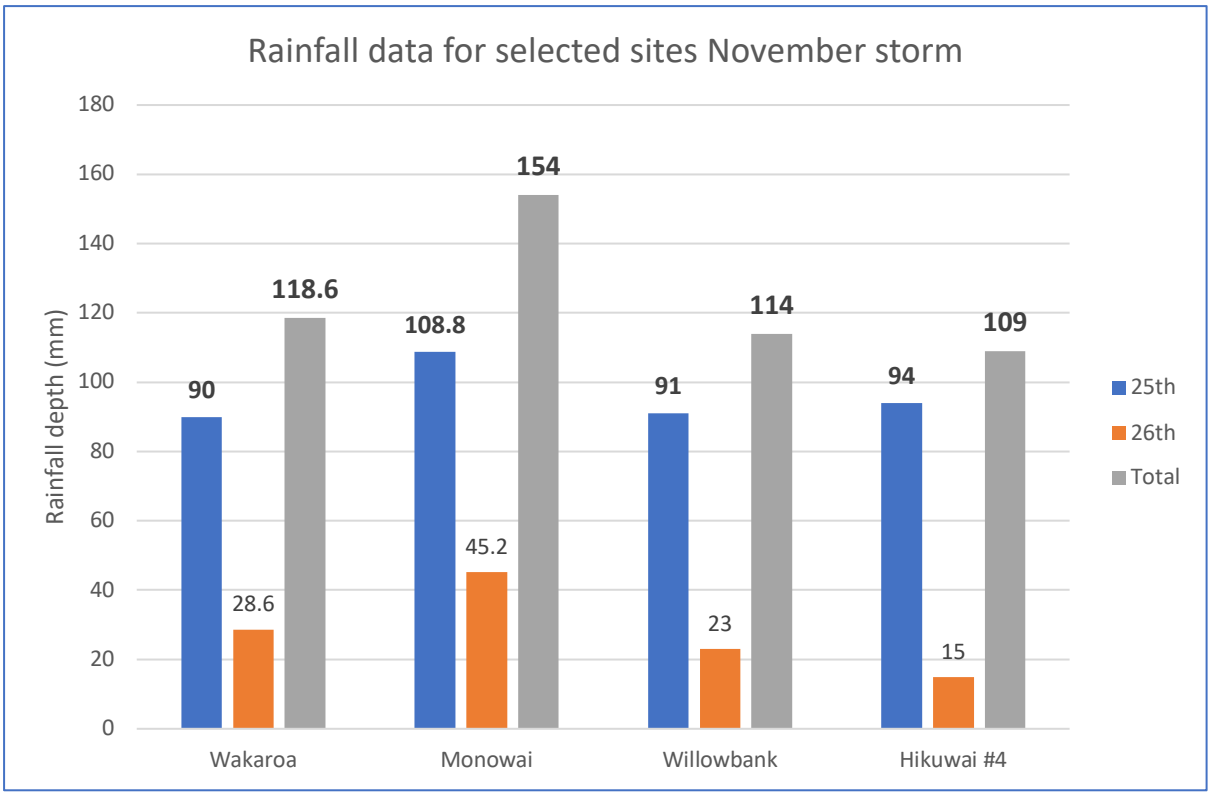

***Figure One**. Rainfall data for selected rain gauges for the key sites for the 25-26th November severe storm.*

River levels

The river level data has been assessed for both the Waimata and Uawa catchments. While this shows that the Hale and Gabrielle events were the largest events, it also shows that in the Waimata catchment the 25-26th November event was bigger than either the 24th February (son of Gabrielle) or June events (**Figure Two**) while in the Uawa catchment, the November event was significantly smaller than the 24th February (son of Gabrielle) or June events (**Table Two**).

In the case of the Waimata, peak flood heights on the 26th of November were 62% of the peak flood heights in Gabrielle whereas in the Uawa, the peak flood heights were between 44 and 60% of the Gabrielle flood heights. In the Uawa, the Mangaheia had the lowest flows and assessments at both Wigan and Mangaheia on Paroa Roads showed that no new LWD had been mobilised.

***Table Two**. Peak flood heights for storms in 2023.*

	Monowai	William Petti	Hikuwai #4	Willowflat	Willowbank
10-Jan	8.449	4.237	12.514	13.386	4.842
14-Feb	**8.564**	**5.578**	**13.38**	**14.01**	**5.296**
25-Feb	4.979	3.795	8.772	12.003	3.004
24-26-Jun	4.716	3.44	7.104	9.609	3.181
25-Nov	**5.357**	**4.314**	5.917	8.463	2.899

***Figure Two**. River levels for the Waimata in 2023.*

Impact on Bridges

On the 25th November LWD could be observed migrating down the Waimata on the Goodwin Road rivercam and to a lesser extent the Hikuwai rivercam, and the woody debris build up at the William Petti Bridge was monitored throughout the day (**Figure Three**). By the morning of

the 26th November the build-up was significant (**Figure Four**) and the decision was made to close the William Petti bridge to clear the material (**Figure Five**) after which the Gladstone Road bridge was cleared. This left a raft of material above the disused railway bridge (**Figure Six**) which was subsequently partially cleared using grapples.

***Figure Three**. Screenshot from video showing LWD mobilised in the Waimata River at William Petti Bridge.*

***Figure Four**. LWD against the William Petti Bridge, 6:30AM Sunday 26th November.*

***Figure Five**. LWD against the William Petti Bridge being cleared, 12:43PM Sunday 26th November.*

***Figure Six**. Approximately 2000 m^3 of LWD against the railway bridge below the Gladstone Road bridge, Monday 27th November.*

Post Event Rapid Assessment

A rapid assessment on the volume of LWD mobilised within the Uawa catchment was undertaken on the afternoon of 26th November which indicated that LWD debris had been deposited at the mouth of the Uawa river (**Figure Seven**). This area had been cleared of woody debris related to the Hale and Gabrielle storms following the June 2023 weather event.

***Figure Seven**. Newly deposited and remobilised LWD at the Uawa river mouth 26th November 2023.*

On the 27th of November a helicopter flight was undertaken to assess potential sources of the LWD as well as general storm damage. The prime areas covered included the Waimata, Waiomoko, Pakerae, Uawa headwaters, Mangahauini gorge, Mata, and the beaches between Reporua and Gisborne City (**Figure Eight**).

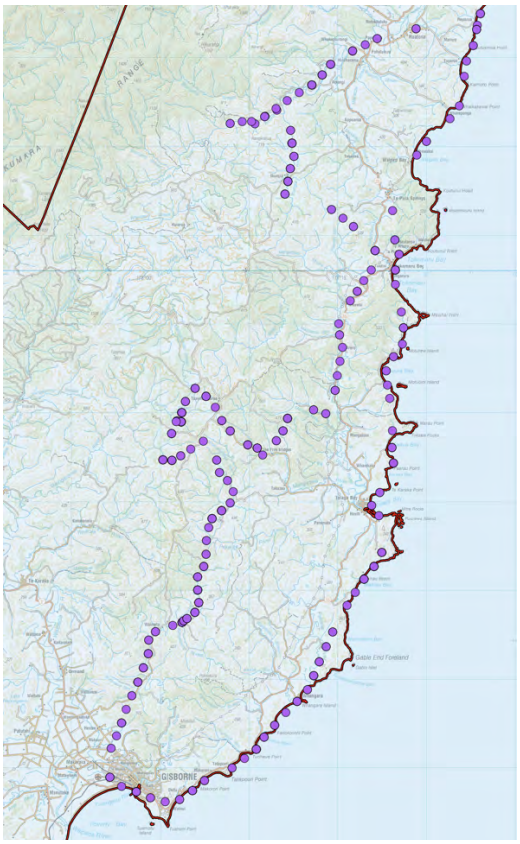

***Figure Eight**. Map showing flight path, 27th November.*

Imagery obtained during the flight indicated that in the Waimata the weather event had resulted in the remobilisation of LWD debris concentrations (**Figure Nine**), and localised landslide in closed canopy pine forest causing downstream lateral erosion and loss of riverbank vegetation (**Figure Ten**).

The flight also indicated that there had been limited or no new LWD deposited on some beaches (Whangara, Anaura, Karaka, Kaiaua, Waipiro, Loisels, Tokomaru). Other beaches such as Reporua, Pakarae river mouth, Pouawa to Turihau, Makorori, and Okitu/Wainui had minor to moderate volumes of LWD but much of this could be attributed to the Hale and Gabrielle storms. The flight confirmed that the most significant impacts occurred in the Waimata with significant volumes deposited on the city beaches (**Figure Eleven**) and to a lesser extent at Tolaga Bay (**Figure Twelve**).

***Figure Nine**. Large volumes of LWD at the mouth of a tributary to the Waimata River. Large volumes of LWD from pine forestry which had been deposited on the riverbanks after the earlier severe storms has been remobilised.*

***Figure Ten**. A landslide in a pine woodlot has discharged LWD into the Waimata. Immediately downstream lateral erosion has resulted in the collapse of mature poplars. Scattered LWD are present and LWD piles have been caught against standing trees.*

***Figure Eleven**. LWD deposited at the Uawa river mouth. This area had been recently cleaned of debris.*

***Figure Twelve**. LWD and finer woody debris deposited on Waikanae Beach.*

Drone mapping has been undertaken for the Waikanae beach from the Cut to the edge of the airport yellow restricted zone and at the Uawa River mouth and south Tolaga beach. These help give insights as to the quantities and size of material that has been deposited and also support the LWD assessments also undertaken. The drone mapping at Waikanae was undertaken with three flights using a Phantom 4Pro flying a grid at 60m elevation with 500 images then combined into an aerial photo mosaic (**Figures Thirteen, Fourteen** and **Fifteen**).

***Figure Thirteen**. LWD and associated finer grained woody debris at the Cut carpark site.*

***Figure Fourteen**. LWD at the Roberts Road car park site.*

***Figure Fifteen**. LWD at the Centennial Marine Parade (Beacon) site.*

A flight was undertaken on south Tolaga beach and incorporated 336 images at an altitude of 60m (**Figure Sixteen**). The Uawa River mouth involved 2 flights, the first including the river mouth itself and the first part of the north Tolaga beach as well as the LWD stored in the League Field and incorporated 500 images acquired at an elevation of 70m (**Figure Seventeen**). The second flight targeted the area where a LWD assessment was undertaken and incorporated 168 images taken at an altitude of 20m for a higher resolution map (**Figure Eighteen**).

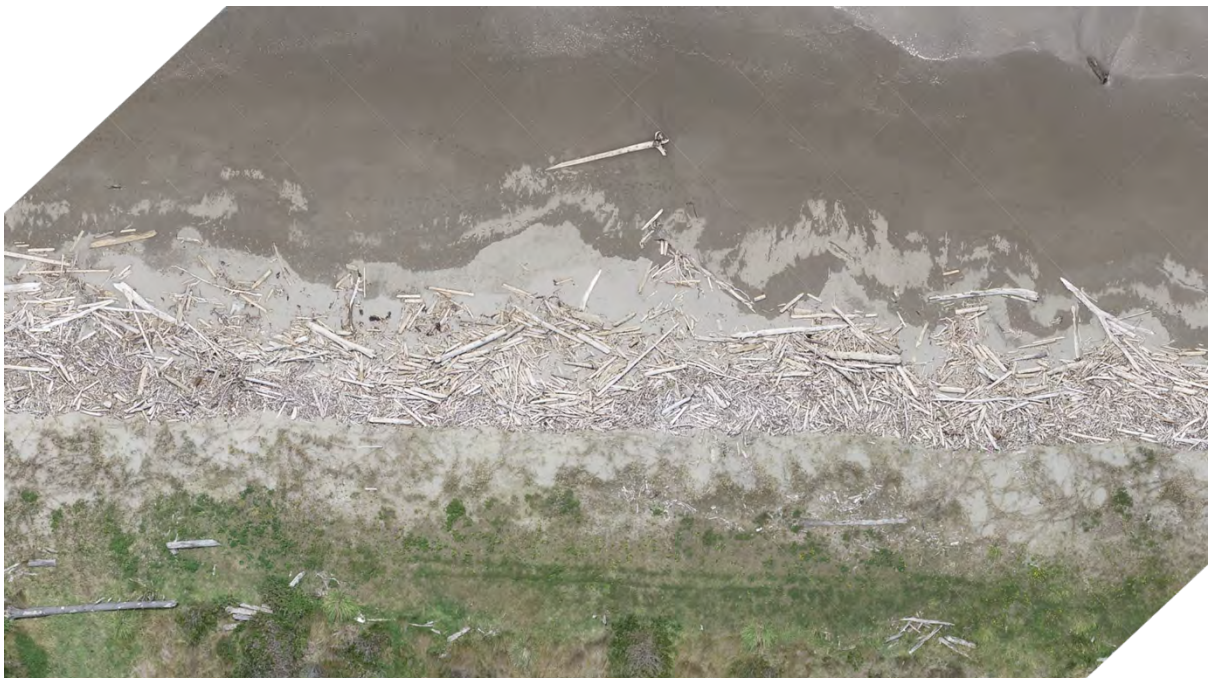

***Figure Sixteen**. LWD around halfway along the South Tolaga Bay beach.*

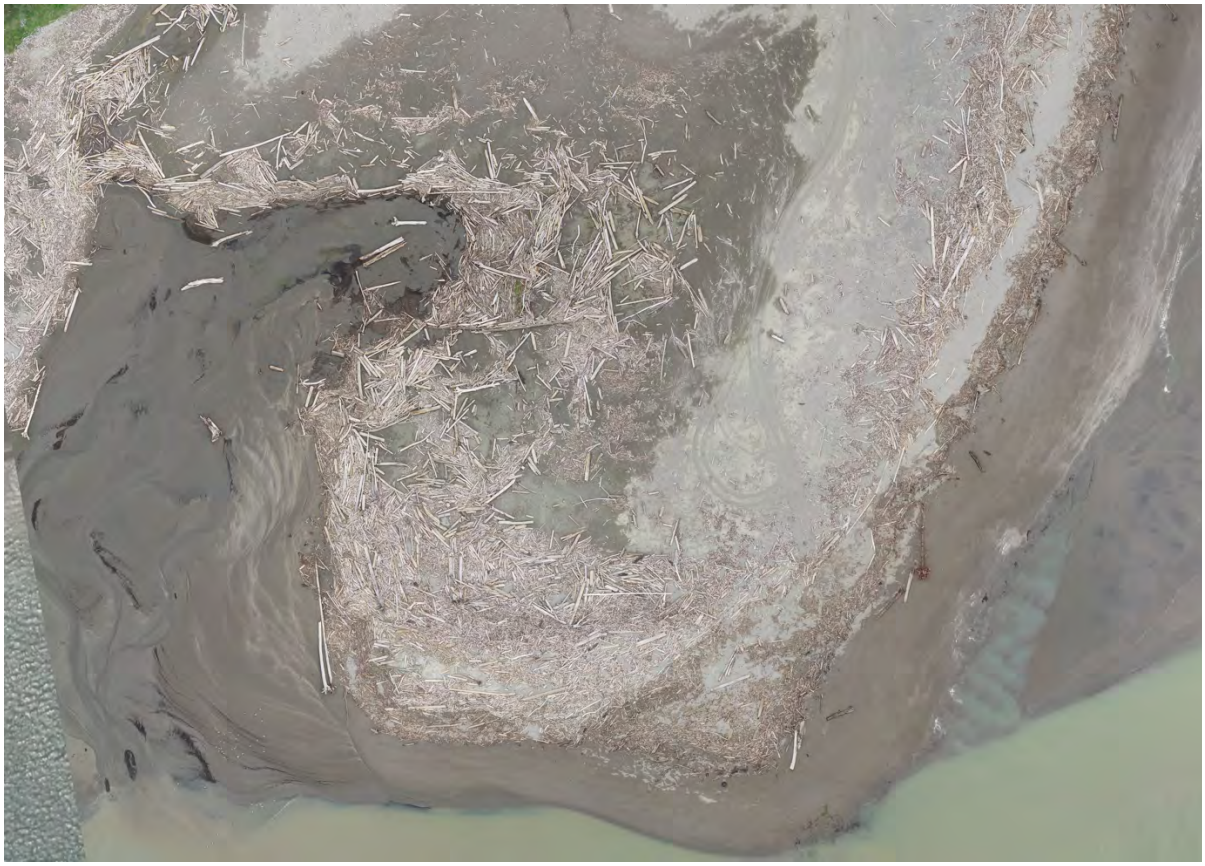

***Figure Seventeen**. LWD on the true left bank of the Uawa River at the river mouth. This area was recently cleared of LWD.*

***Figure Eighteen**. High resolution drone image at the LWD assessment site at the Uawa river mouth site.*

LWD Assessment

A total of 9 LWD counts have been undertaken since the November 25-26th event, 4 at Waikanae to Centennial Marine parade, 2 at Tikapa Beach, 1 at the Waiapu river mouth, 1 at the Uawa River mouth and 1 at south Tolaga Bay beach. These assessments have been undertaken using the methodology applied by Council since 2017 and subsequently refined to allow it to be used by community groups (Cave, et al, 2017, Cave 2021, Cave 2023). The full result of this assessment is appended to the report and is summarised here[1].

City Beaches

The location of the 4 plots undertaken on the city beaches are shown in **Figure Nineteen** below. The sites at the Cut, Captain Morgans and Roberts Road were counted using the $10m^2$ method while the Beacon site was counted using a 100m traverse. In addition, 212 georeferenced photographs were taken of logs and groups of logs over the 4 sites (see **Figure Nineteen**). The results of the LWD assessment are shown graphically in a Pine> WPA[2]> Indigenous ternary plot diagram (**Figure Twenty**).

[1] LWD is defined as material greater than 10cm diameter.

[2] WPA stands for Willow Poplar Acacia but can include other non-pine non-indigenous species if identified such as fruit trees.

***Figure Nineteen**. The location of the 4 city beach sites where LWD assessments were undertaken. Each red dot represents a photograph taken during the assessment.*

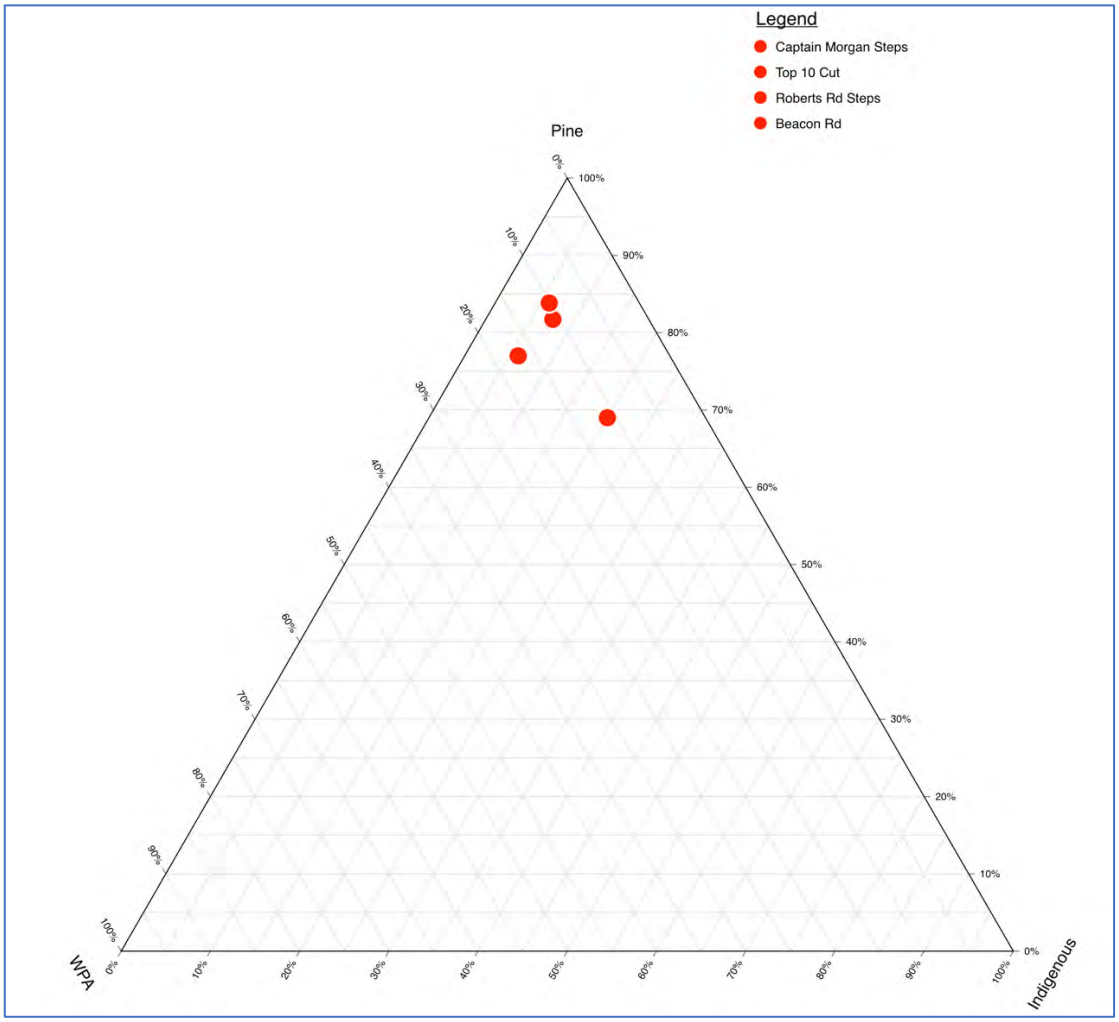

***Figure Twenty**. Ternary plot of the assessment for the city beaches showing that the LWD is dominated by pine woody debris.*

Long resident pine logs, that is, weathered logs that have cut or rounded cut ends, and sometimes stencil marks or waratah marks were most obvious of pine woody material observed averaging over 50% of all pine LWD (range 42% to 64%). Smaller diameter pine wood with cut marks or rounded ends were the second most common pine type observed averaging 24% of all pine LWD (range 17 to 28%). Other types of pine were subordinate (stumps, slovens or rootball pine logs) but of note were fresh cut logs which is defined as logs that were likely harvested or mobilised over the 2022-2023 summer. While the total numbers were not high ranging from 1 to 4% of total pine, their presence is significant as it indicates that harvested logs are being mobilised from active forest sites, despite the significant number of prosecutions of forestry companies after 2018.

Tolaga Bay

The location of the 2 plots undertaken at Tolaga Bay are shown in **Figure Twenty One** below. The Uawa river mouth site was counted using the $10m^2$ method while the south Tolaga beach site was counted using a 100m traverse. In addition, 113 georeferenced photographs were taken of logs and groups of logs over the 2 sites (see **Figure Twenty One**). The results of the LWD assessment are shown graphically in a Pine> WPA> Indigenous ternary plot diagram (**Figure Twenty Two**).

***Figure Twenty One**. The location of the 2 Tolaga Bay sites where LWD assessments were undertaken. Each red dot represents a photograph taken during the assessment.*

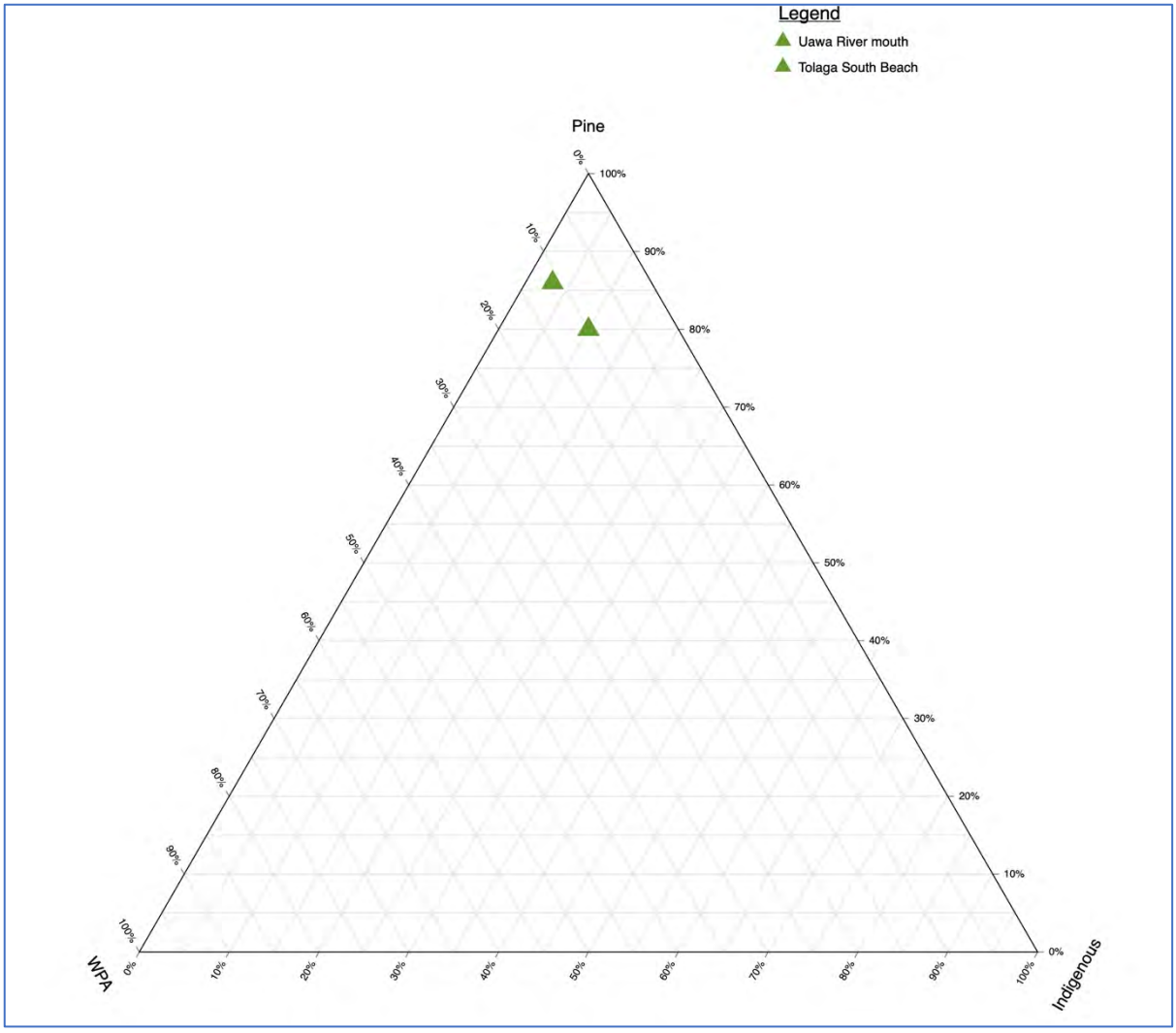

***Figure Twenty Two**. Ternary plot of the assessment for the Tolaga Bay sites showing that the LWD is dominated by pine woody debris as was the case for the city beaches.*

As was the case for the Gisborne city beaches, long resident pine logs, that is, weathered logs that have cut or rounded cut ends, and sometimes stencil marks or waratah marks were most obvious of pine woody material observed averaging 61% of all pine LWD (range 58% to 64%). Smaller diameter pine wood with cut marks or rounded ends were the second most common pine type observed averaging 21.5% of all pine LWD (range 17 to 26%). Other types of pine were subordinate (stumps, slovens or rootball pine logs). In contrast with the city beaches fresh cut logs were rare with only 2 observed.

Tikapa Beach and Waiapu River Mouth

An assessment of Tikapa Beach and the mouth of the Waiapu River was undertaken on the 7th December and the location of the survey sites are shown in **Figure Twenty Three**. The Waiapu River mouth site was assessed using the 10m2 plot method (**Figure Twenty Four**) while the middle and south Tikapa beach sites were assessed using a 100m traverse. In addition, 132 georeferenced photographs were undertaken of logs across the 3 sites. The Waiapu River mouth site is likely to be material from Cyclone Gabrielle.

The results of the LWD assessment are shown graphically in a Pine> WPA> Indigenous ternary plot diagram (**Figure Twenty Five**).

***Figure Twenty Three**. Aerial image with drone mapping overlay of the mouth of the Waiapu and Tikapa Beach showing the location of the 3 LWD assessment sites including the location of photographs taken on the 7th of December 2023.*

***Figure Twenty Four**. Drone map of the Waiapu River mouth LWD assessment site.*

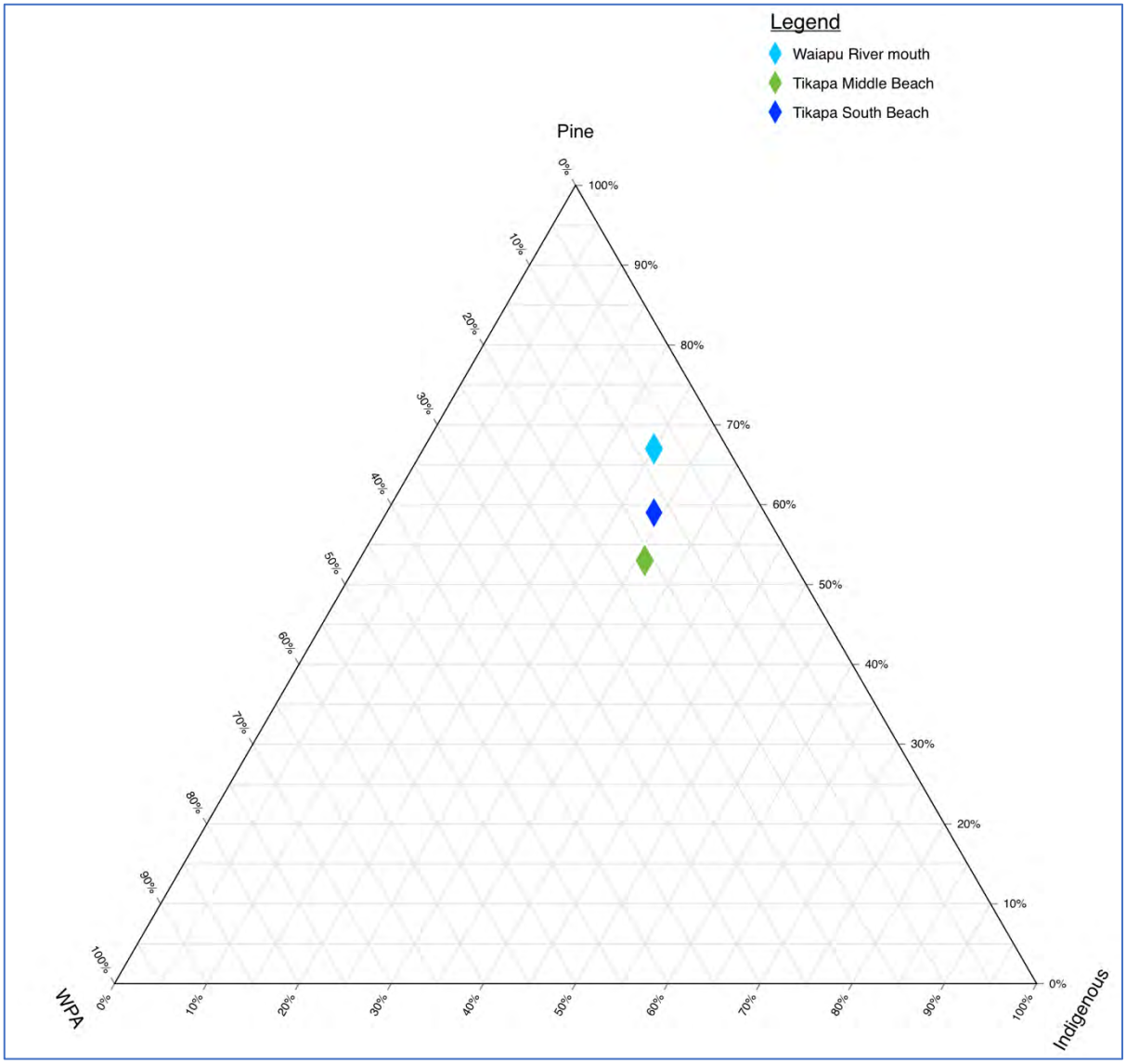

***Figure Twenty Five**. Ternary plot of the assessment for the Waiapu River mouth and Tikapa Beach sites showing that while pine LWD was still the largest contributor the percentage of indigenous LWD was larger than is the case at the City or Tolaga beaches.*

Comparison of the city beaches with Tolaga Bay and Tikapa Beach

The data in **Figures Twenty**, **Twenty Two and twenty Five** have been combined in **Figure Twenty Six**. This shows that most of the city and Tolaga sites are tightly clustered with the Cut site standing out has having less pine LWD, but this site still has significant pine at 69%. The Waiapu and Tikapa sites have less pine LWD but event here pine ranges from a low of 53% to a high of 67%. The notable difference between the City and Tolaga sites and the Waiapu/Tikapa sites is the higher percentage of indigenous LWD (25-31%). It would be speculative to suggest what the cause of this difference is and that has not been attempted here. It is enough to say that the data is strongly skewed to pine LWD overall but less so at the Waiapu/Tikapa sites. This difference was also noted for previous assessments at Tikapa (Cave 2021).

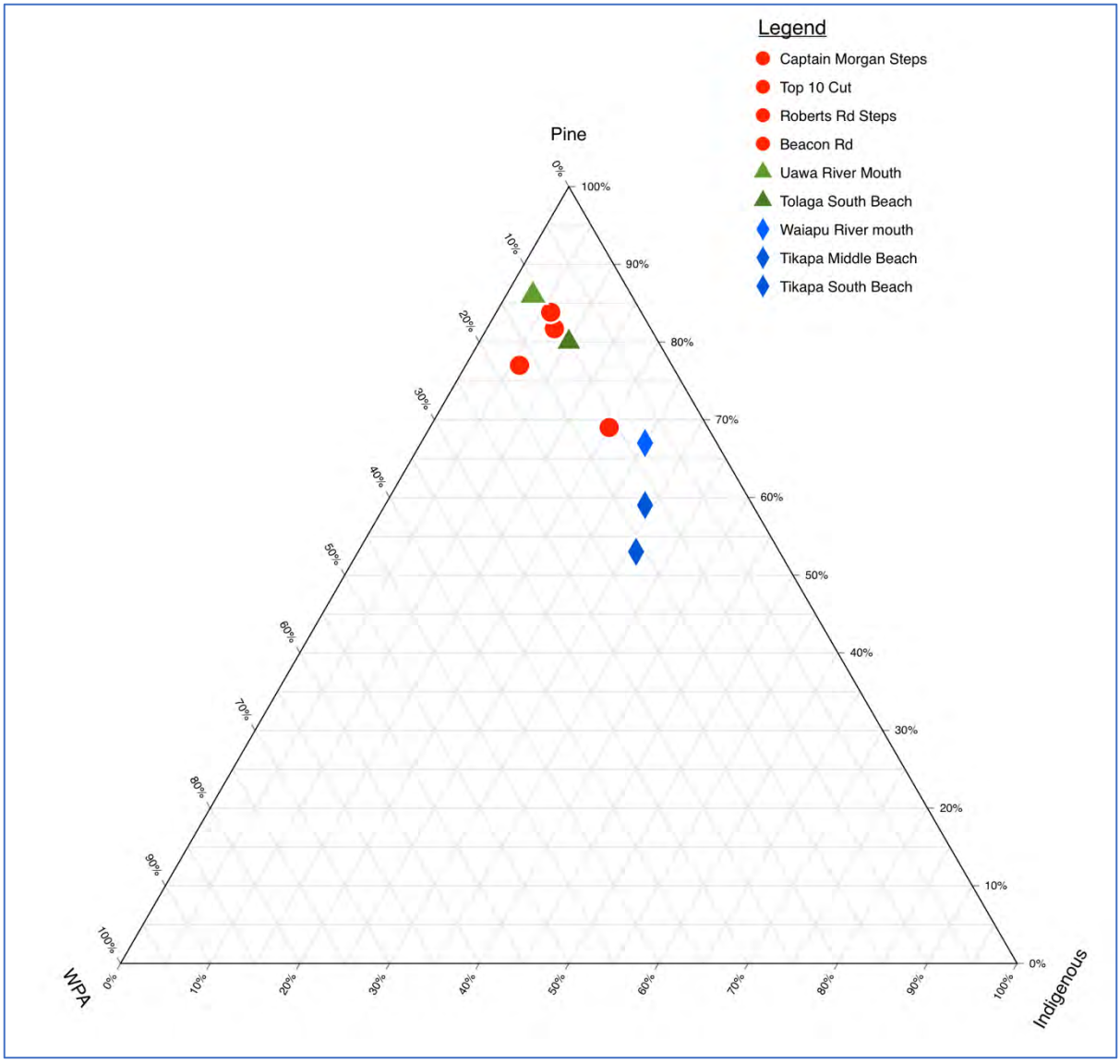

***Figure Twenty Six**. Ternary plot of the assessment for the city beaches, Tolaga Bay and Waiapu River mouth and Tikapa sites showing that the LWD is dominated by pine woody debris as was the case for the city beaches.*

Summary and Conclusions

1. The highest daily and event rainfall occurred at the road bridge at Monowai Station which had 108.8mm of rain on the 25th and 154mm for the two days. No sites reached the normal rainfall duration/intensity landslide triggering threshold of 120mm/d, however, antecedent conditions were wet and landslides still occurred but were not regionally significant. The LWD mobilisation that did occur was largely the result of debris already resident within the waterways being remobilised.

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flood heights in Gabrielle whereas in the Uawa, the peak flood heights were between 44 and 60% of the Gabrielle flood heights.

3. An overflight indicated that there had been limited or no new LWD deposited on some beaches (Whangara, Anaura, Karaka, Kaiaua, Waipiro, Loisels, Tokomaru). Other beaches such as Reporua, Pakarae river mouth, Pouawa to Turihau, Makorori, and Okitu/Wainui had minor to moderate volumes of LWD but much of this could be pre-existing. The most significant impacts occurred in the Waimata with significant volumes deposited on the city beaches and to a lesser extent at Tolaga Bay.

4. A total of 9 LWD counts have been undertaken since the November 25-26th event, 4 at Waikanae to Centennial Marine parade, 1 at the Uawa River mouth, 1 at south Tolaga Bay beach, 2 at Tikapa Beach and 1 at the Waiapu River mouth. The analysis indicates that the LWD was predominately pine ranging from a low of 53% at the middle Tikapa Beach to a high of 86% at the Uawa River mouth (average 73%). Excluding Tikapa and the Waiapu, pine LWD averaged 79.45%. Small amounts of fresh cut pine were present on the city beaches and Tikapa/Waiapu but rare at Tolaga.

References

Cave, M. P., Davies, N., Langford, J., (2017) Cyclone Cook Slash Investigation. 106 pages plus appendices.

Cave, M. P., (2021) An assessment of Woody Material on Tikapa Beach after the July 2020 storm and potential sources. 70 pages plus appendices.

Cave, M. P., (2023) Large Woody Debris Assessment Guide v2.2. 31p

Appendix One

Summary of site data

Waikanae Beach LWD assessment Captain Morgan steps
Murry Cave 10m plot 1:30PM 28112023

FCP	1	1.3%
LRL	32	42.1%
Rootball log	12	15.8%
Stump	6	7.9%
Slovens	5	6.6%
CTW	20	26.3%
	76	100%

Includes 2 FCP shorts

WPA	10
Indigenous	7
	17

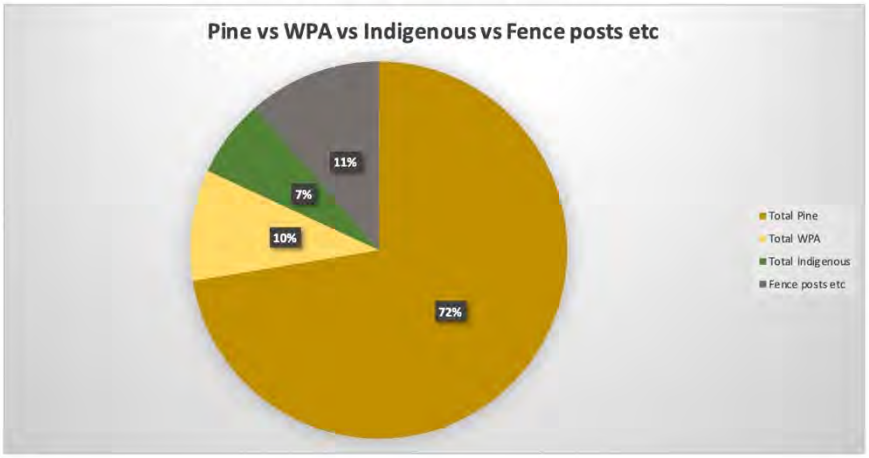
Fence posts etc	**12**
Plastic bottles	4
Tire	1

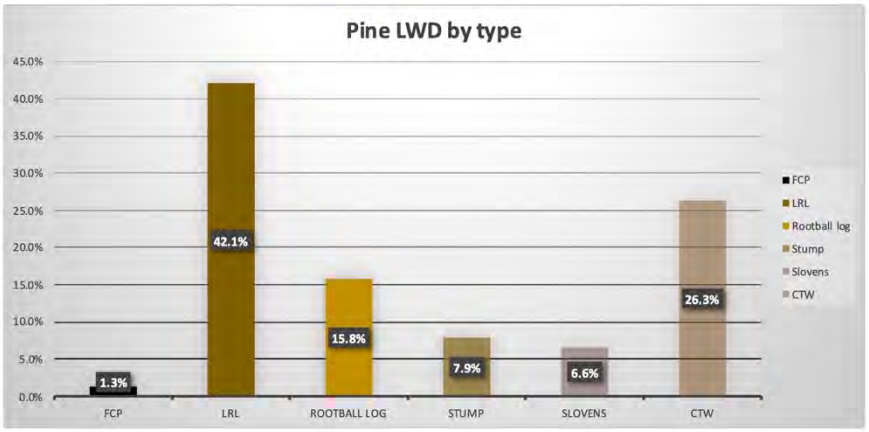
Total Pine	76	81.72%
Total WPA	10	10.75%
Total Indigenous	7	7.53%
N1	**93**	100%

Total Pine	76	72.38%
Total WPA	10	9.52%
Total Indigenous	7	6.67%
Fence posts etc	12	11.43%
N2	**105**	100%

Percent LWD (N2)	60%
Percent sand	10%
Percent dross/slash	30%
N3	100%

(Slash <10cm, dross <5cm)





Waikanae Beach LWD assessment Roberts Road steps
Murry Cave 10m plot 03122023 7AM

FCP	4	4%
LRL	60	57%
Rootball log	8	8%
Stump	2	2%
Slovens	2	2%
CTW	30	28%
	106	100%

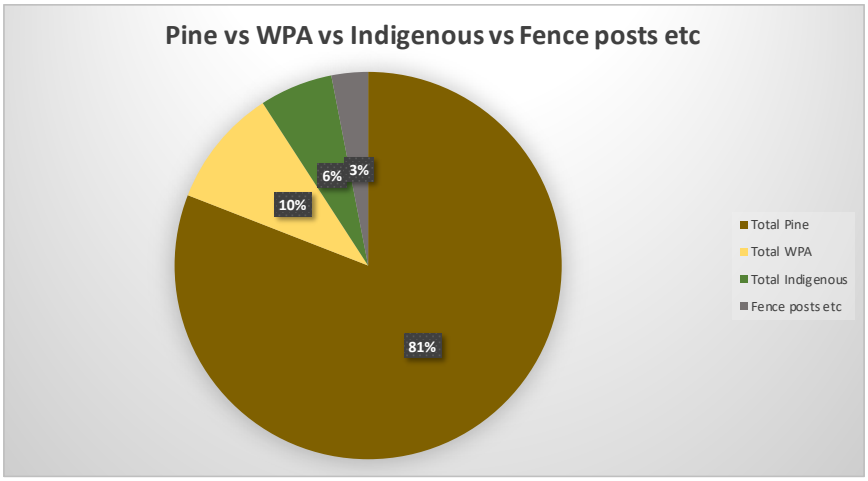
WPA	13
Indigenous	8

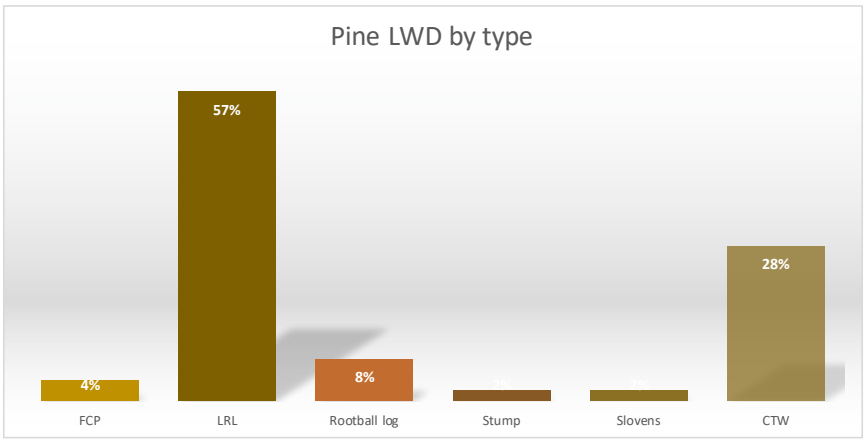
Fence posts etc	4
Plastic bottles	1
	5

Total Pine	106	83%
Total WPA	13	10%
Total Indigenous	8	6%
N1	**127**	**100%**

Total Pine	106	81%
Total WPA	13	10%
Total Indigenous	8	6%
Fence posts etc	4	3%
N2	**131**	**100%**

Percent LWD (N2)	70%
Percent sand	20%
Percent dross/slash	10%
N3	**100%**





Waikanae Beach LWD assessment Top 10 Cut
Murry Cave 10m plot 02122023 7AM

FCP	2	3%
LRL	26	43%
Rootball log	13	21%
Stump	3	5%
Slovens	1	2%
CTW	16	26%
	61	100%

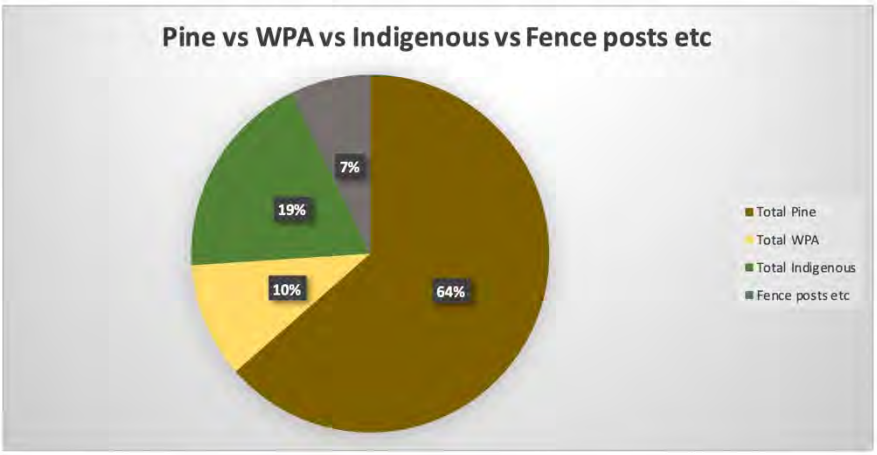
WPA	10
Indigenous	18

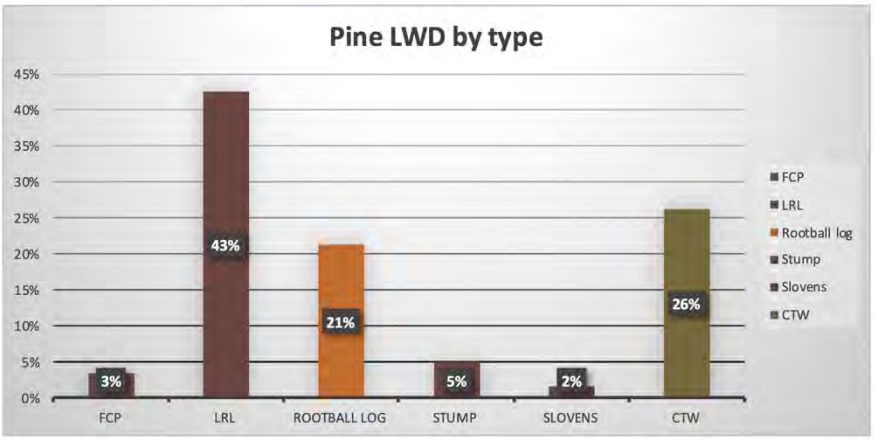
Fence posts etc	15
Plastic bottles	6
	21

Total Pine	61	69%
Total WPA	10	11%
Total Indigenous	18	20%
N1	**89**	**100%**

Total Pine	61	64%
Total WPA	10	10%
Total Indigenous	18	19%
Fence posts etc	7	7%
N2	**96**	**100%**

Percent LWD (N2)	50%
Percent sand	0%
Percent dross/slash	50%
N3	**100%**





Waikanae Beach LWD assessment Beacon
Murry Cave 100m Traverse 03122023 10AM

FCP	1	1%
LRL	89	64%
Rootball log	13	9%
Stump	7	5%
Slovens	5	4%
CTW	23	17%
	138	100%

WPA	31
Indigenous	11

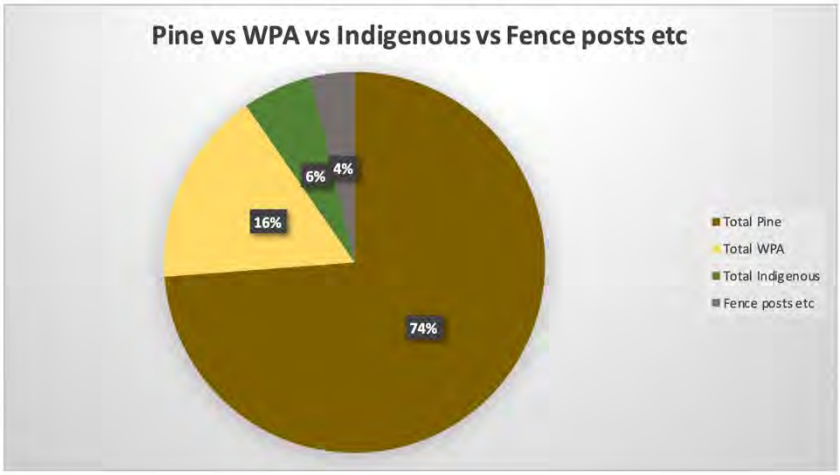
Fence posts etc	11
Plastic bottles	0
	11

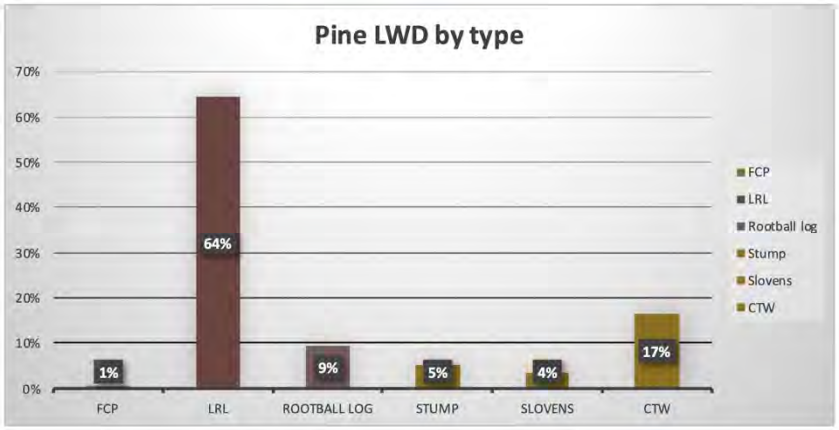
Total Pine	138	77%
Total WPA	31	17%
Total Indigenous	11	6%
N1	**180**	**100%**

Total Pine	138	74%
Total WPA	31	17%
Total Indigenous	11	6%
Fence posts etc	7	4%
N2	**187**	**100%**

Percent LWD (N2)	100%
Percent sand	0%
Percent dross/slash	0%
N3	**100%**

Note 2x pieces of redwood





Tolaga South Beach
Murry Cave 100m traverse 02122023 11:30AM

FCP	2	1%
LRL	158	64%
Rootball log	14	9%
Stump	9	5%
Slovens	13	4%
CTW	55	17%
	251	**100%**

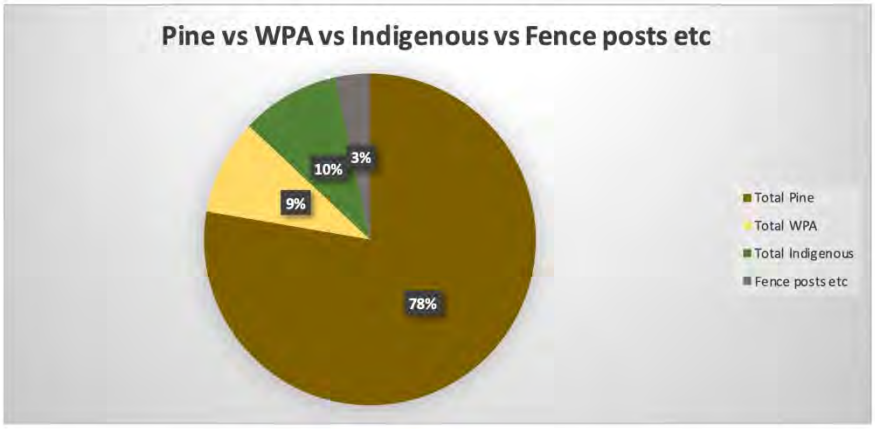
WPA	30
Indigenous	31

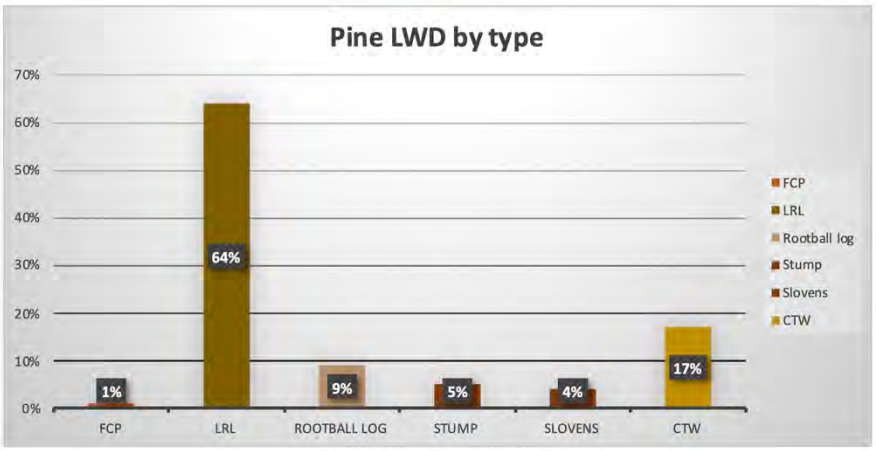
Fence posts etc	11
Plastic bottles	0
	11

Total Pine	251	80%
Total WPA	30	10%
Total Indigenous	31	10%
N1	**312**	**100%**

Total Pine	251	78%
Total WPA	30	9%
Total Indigenous	31	10%
Fence posts etc	11	3%
N2	**323**	**100%**

Percent LWD (N2)	100%
Percent sand	0%
Percent dross/slash	0%
N3	**100%**





Uawa River mouth

Murry Cave 10m plot 04122023 1:30PM

FCP	0	0%
LRL	86	58%
Rootball log	6	4%
Stump	11	7%
Slovens	8	5%
CTW	38	26%
	149	100%

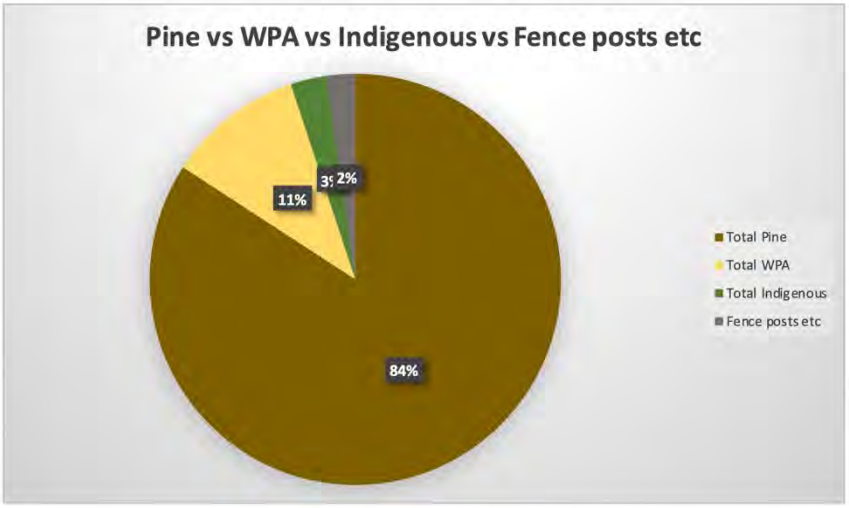
WPA	19
Indigenous	5

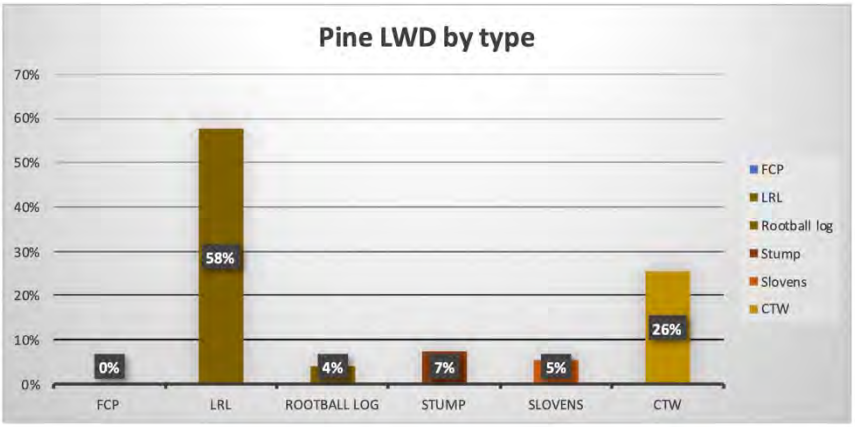
Fence posts etc	4
Plastic bottles	0
	4

Total Pine	149	86%
Total WPA	19	11%
Total Indigenous	5	3%
N1	**173**	**100%**

Total Pine	149	84%
Total WPA	19	11%
Total Indigenous	5	3%
Fence posts etc	4	2%
N2	**177**	**100%**

Percent LWD (N2)	100%
Percent sand	0%
Percent dross/slash	0%
N3	**100%**





Waiapu River Mouth True right bank
Murry Cave 10m plot 07122023

FCP	0	0%
LRL	62	69%
Rootball log	8	9%
Stump	1	1%
Slovens	2	2%
CTW	17	19%
	90	100%

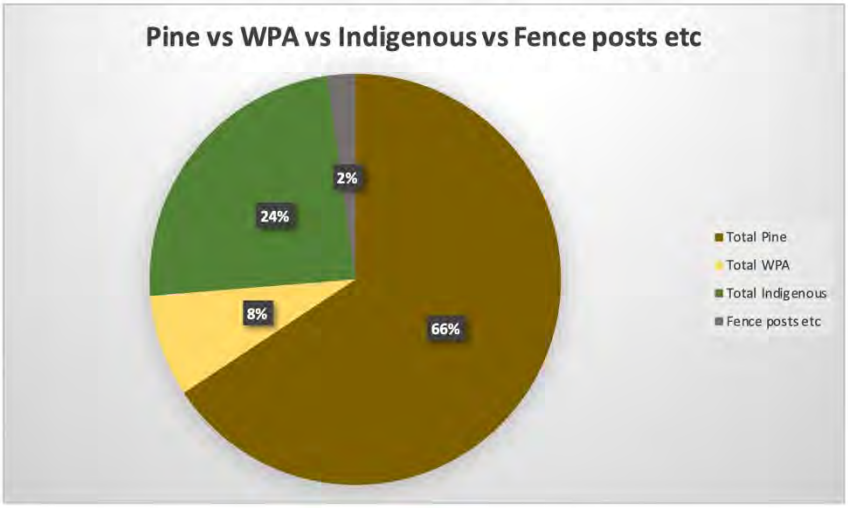
WPA	11
Indigenous	33

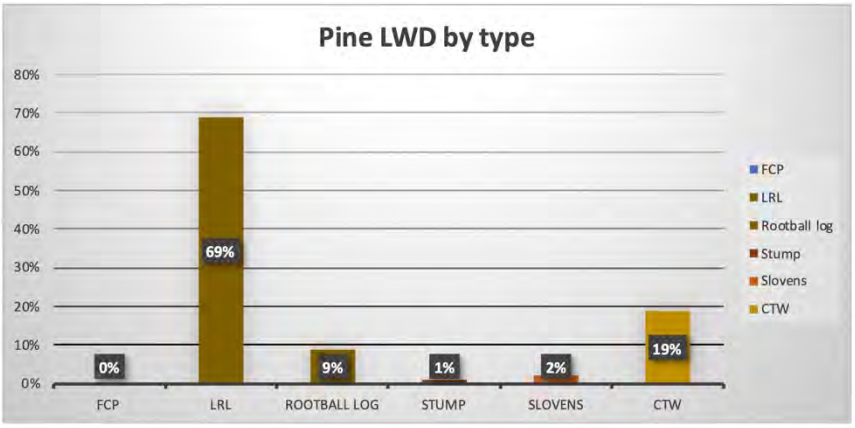
Fence posts etc	3
Plastic bottles	1
	4

Total Pine	90	67%
Total WPA	11	8%
Total Indigenous	33	25%
N1	**134**	**100%**

Total Pine	90	66%
Total WPA	11	8%
Total Indigenous	33	24%
Fence posts etc	3	2%
N2	**137**	**100%**

Percent LWD (N2)	100%
Percent sand	0%
Percent dross/slash	0%
N3	**100%**





Tikapa Middle Beach
Murry Cave 100m traverse 07122023

FCP	2	1%
LRL	61	64%
Rootball log	5	9%
Stump	0	5%
Slovens	0	4%
CTW	14	17%
	82	**100%**

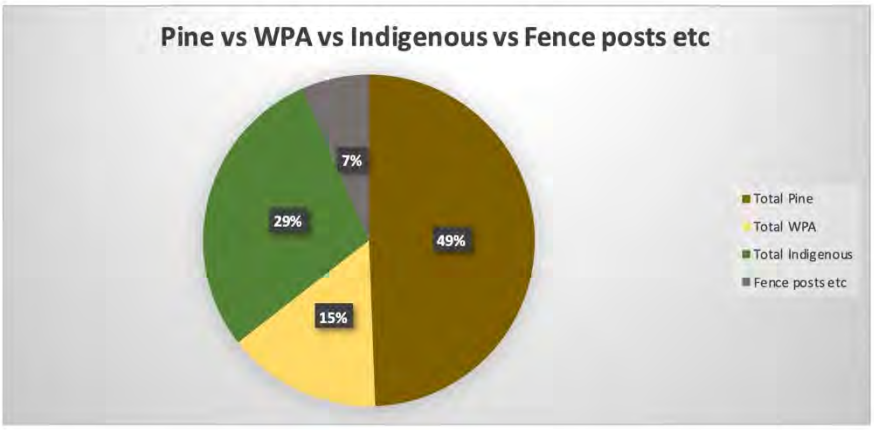
WPA	25
Indigenous	48

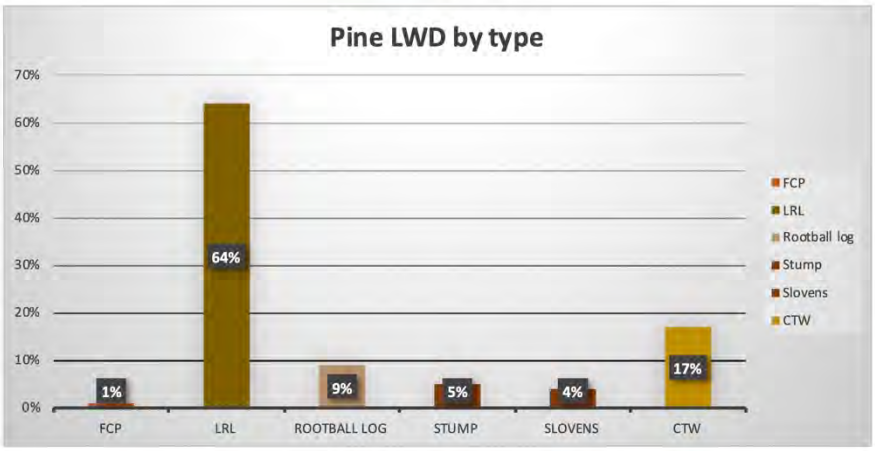
Fence posts etc	11
Plastic bottles	0
	11

Total Pine	82	53%
Total WPA	25	16%
Total Indigenous	48	31%
N1	**155**	**100%**

Total Pine	82	49%
Total WPA	25	15%
Total Indigenous	48	29%
Fence posts etc	11	7%
N2	**166**	**100%**

Percent LWD (N2)	100%
Percent sand	0%
Percent dross/slash	0%
N3	**100%**





Tikapa South Beach
Murry Cave 100m traverse 07122023

FCP	2	1%
LRL	84	64%
Rootball log	14	9%
Stump	5	5%
Slovens	2	4%
CTW	16	17%
	123	**100%**

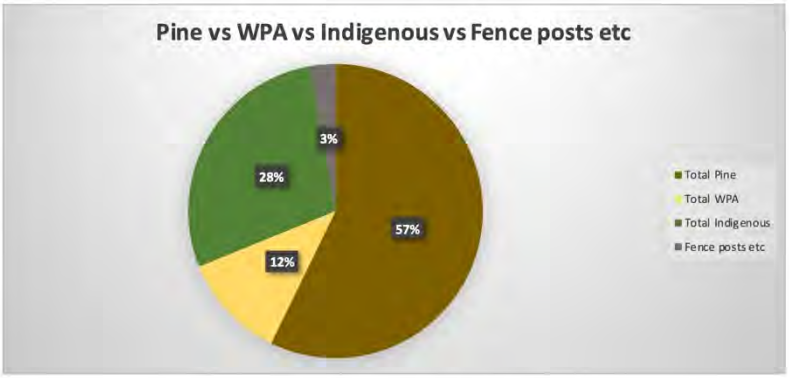
WPA	25
Indigenous	61

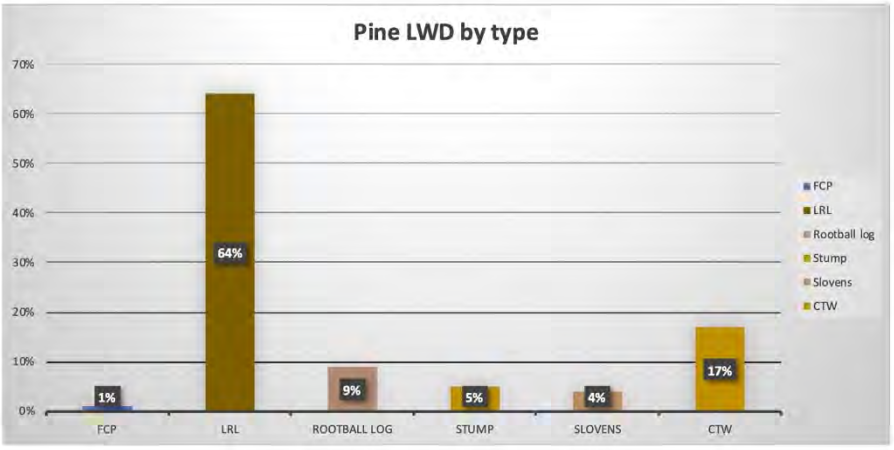
Fence posts	6
Plastic bottle	0
	11

Total Pine	123	59%
Total WPA	25	12%
Total Indigenous	61	29%
N1	**209**	**100%**

Total Pine	123	57%
Total WPA	25	12%
Total Indigenous	61	28%
Fence posts etc	6	3%
N2	**215**	**100%**

Percent LWD (N2)	100%
Percent sand	0%
Percent dross/slash	0%
N3	**100%**





Appendix Two

Site photographs

The Cut

View of the LWD assessment area. Note tape and corner stakes. This area was characterised by a significant volume of smaller material mixed in with the LWD.

Cut log with a long resident log (right) small poplar branch at base and top left.

Two long resident logs, cut poplar branch far right, willow branch on left, fresh rootball pine middle right.

Fence post and cut to waste sized pine material. Indigenous branches at bottom right.

Slovens (bottom) and processed post (middle)

Captain Morgans

View of Captain Morgans site showing LWD in a less of slash and dross.

Poplar log and indigenous short.

Long resident pine log and fence battens

Fresh cut pine log with long resident log and cut to waste sized material.

Highly weathered pine (middle), poplar on right. Long resident log top right, pine cone (middle left) with indigenous branch above.

Fence post (base) with long resident pine logs.

Long resident pine log at base, fence batten at top in a drossy mix.

Pine logs and cut to waste pine.

Weathered long resident pine logs

Weathered long resident pine logs with one relatively fresh cut pine log and cut to waste sized material. Poplar log at top.

Roberts Road Carpark

View of Roberts Road assessment site.

Predominately pine.

Pine long resident logs with cut to waste sized material, willow branch (middle right) and highly weathered poplar (top)

Long resident pine log and cut pine above.

Cut pine logs and indigenous root ball. Poplar branch top right.

Cut pine log with indigenous branch sized material and weathered pine log remnants.

Beacon Road Car Park

View of Beacn Road site showing LWD among a mix of fine slash-sized material

Pine slovens and long resident log

Poplar

Poplar and pine

Pine slovens

LWD including log resident logs, rootball pine and some willow.

Fence post (bottom left), and mix of smaller pine and CUT ENDS.

Mix of material including highly weathered and relatively fresh logs. Indigenous branch top right.

Long resident log with waratah marks.

Predominantly pine logs with finer woody debris. Rootball pine at top.

Fence post (at base) with pine logs including cut to waste top right. Typical slash and drossy material on left. Batten on right.

Typical pine based LWD. Note burnt log at top. Some smaller indigenous branches.

Pine logs with fence batten and post (middle and top left), Poplar branch above.

Poplar log (bottom) with pine logs surrounding.

Fence batten and cut pine log

Uawa River Mouth

View of Uawa River mouth site showing predominately long resident pine.

Drone vertical of 10m^2 plot.

Long resident logs.

View of Uawa River mouth site showing predominately long resident pine with cut to waste sized material and two slovens.

Weathered pine slovens and pine logs. Cut to waste pine top left.

Mix of smaller, largely pine material, poplar branch in middle.

Predominantly long resident pine with poplar log in middle and poplar branch top right.

Predominantly long resident pine with fence post in middle, slovens bottom.

Tolaga South

Tolaga South traverse line looking south.

Predominately pine, not waratah mark on large log. Log in background by tape is poplar.

Rootball pine. Commonly referred to as windthrow, however, failure genesis cannot be determined and its origin could be from lateral erosion, landslide or windthrow.

Tolaga South traverse line showing mix of material, mainly pine with one obvious poplar in middle.

Pine slovens and pine log

Poplar log with highly weathered pine material.

Relatively fresh cut pine.

Relatively fresh cut pine short.

Tikapa and Waiapu River mouth

South Tikapa Beach showing a succession of LWD deposition. November 2023 debris on the shore face with brown colouration. Hale and Gabrielle material higher on the beach.

Middle Tikapa Beach looking towards the Waiapu River mouth showing a succession of LWD deposition. November 2023 debris on the shore face with brown colouration. Hale and Gabrielle material higher on the beach.

Tikapa South

Long resident pine log (middle), broken pine LRL remnant (base). Fresh (c.1 year) pine with broken stems either end (probable full tree where rootball has broken off during transport).

Small pine log and cut to waste sized pine. Indigenous log piece at base.

Weathered pine logs and broken pine pieces. Indigenous branch top left.

Indigenous log (left) and log resident log (middle) with smaller indigenous material (middle bottom)

Fence post (bottom) with pine logs above. Poplar log at right with weathered pine logs either side.

Indigenous log remnant (base), Poplar at top and pine logs (middle).

Middle Tikapa

Pine log (middle) with remnant square post between that and an indigenous log remnant. Short highly weathered pine log at right.

Mixed pine and indigenous.

Branched poplar log (left) with fence post and cut to waste sized pine below. Pine log bottom right with an indigenous log remnant adjacent.

Pine log at base and cut to waste size pine top right. Obvious ponga and other indigenous material.

Mix of pine with long resident log at base and middle. Indigenous log with rootball and poplar top right.

Relatively fresh looking pine logs

Waiapu River mouth

Mix of LWD types including pine logs and large branches, indigenous log remnant at base. Cut willow in middle.

Mainly long resident pine logs, and rubber matting on right with poplar branch beneath.

Long resident pine logs with two obvious poplar pieces in middle. Small branched indigenous (middle).

Pine slovens (middle), with weathered pine logs at left and top. Smaller indigenous material base and right.