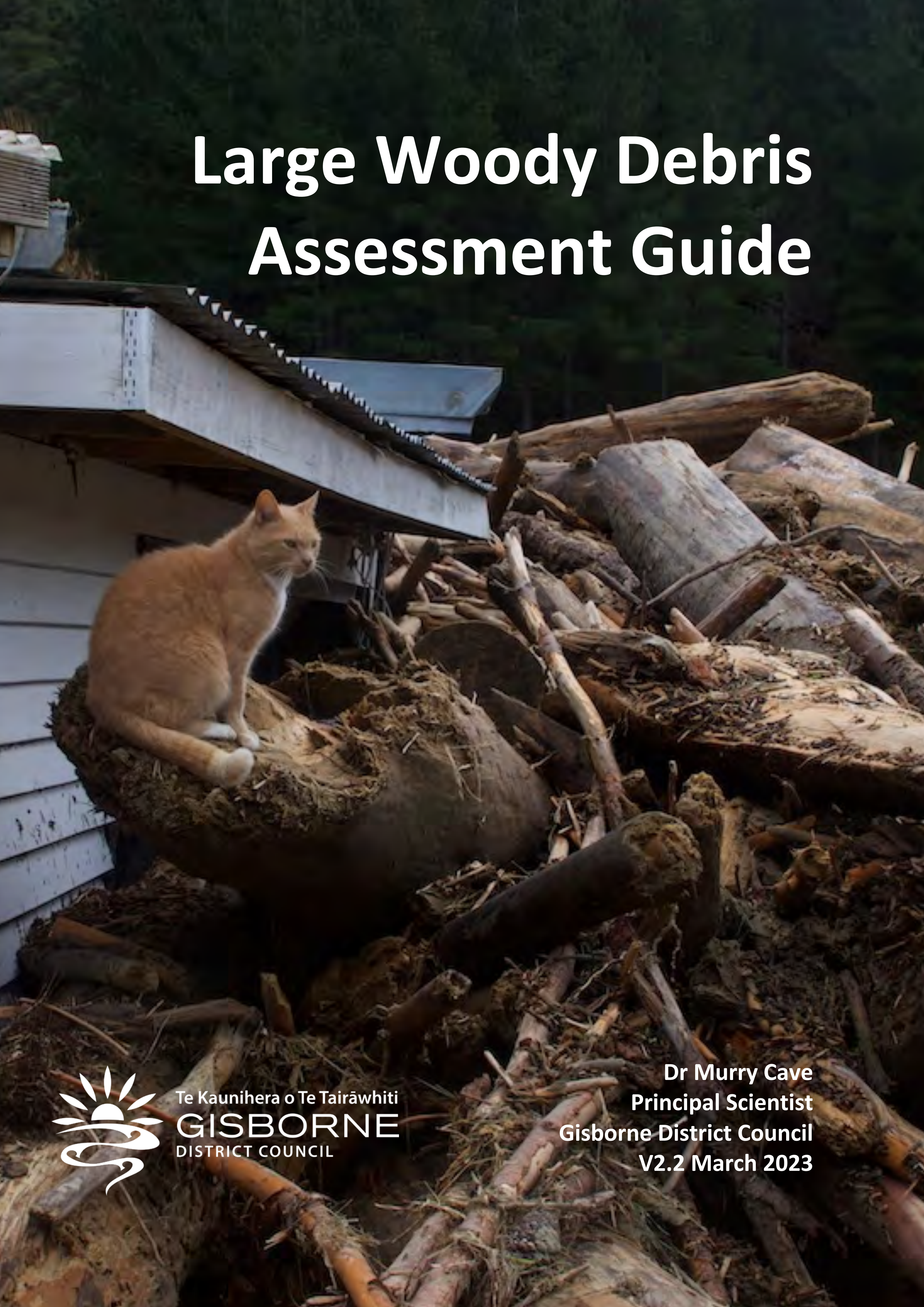
Large Woody Debris Assessment Guide



Te Kaunihera o Te Tairāwhiti
GISBORNE
DISTRICT COUNCIL

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V2.2 March 2023

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Summary

The mobilisation of large woody debris (**LWD**) from the forests of Gisborne/Tairawhiti has been an issue for a considerable time. Migration of woody debris during significant rain events has been a largely annual occurrence since 2012. No systematic effort to document the problem was undertaken until 2017 when a report into the impacts of wood mobilisation following Cyclone Cook was prepared (Cave, *et. al* 2017). Prior to that, the evidence was only anecdotal, and it was common to see statements such as *"Our early investigations have indicated much of the debris that has washed into the waterways and beaches is mixed rubbish debris from poplar and willow riparian plantings, and includes a lot of land and sediment, and also rural debris."*

A literature search undertaken in 2017 did not identify any studies that outlined methodologies for quantifying LWD in either the catchments below forests or in the ultimate receiving environment. Accordingly it was necessary to develop a methodology that was robust, while remaining flexible to changing circumstances, and also capable of being used by non-subject matter experts. It was not possible to have a one shoe fits all method as there were morphological differences between the various receiving environments assessed. In addition, there is always a time consideration as the composition of large woody debris at a site can change, typically as a result of subsequent storms, post event remedial works, and well-meaning interventions such as the local community burning the LWD before an assessment could be undertaken.

Furthermore, there is little point attempting a quantification process unless a few ground rules are established and followed. The main elements of the quantification process were thus important to establish and have three main components;

- What is it (**definitions**),
- Where is it (**assessment locations**),
- Types of assessment and
- How best to establish representativeness of the sample (**robust and reproducible methodologies, elimination of bias**).

The main types of LWD identified in the receiving environment are fresh cut pine logs, long resident pine logs, pine logs with root balls, either with cuts or without, pine cut to waste, slovens, modified pine or other logs, slash (thinning's and other material under 15cm diameter), dross, willow, poplar or acacia (and other erosion control species), Indigenous semi-hardwoods or softwoods, and fence posts/battens and large items of rubbish.

There are multiple ways of quantifying such LWD and Gisborne District council has used 10m square plots, traverses and wood pile counts to assess the proportions of LWD present in the receiving environment. Drone mapping has been used to undertake larger catchment assessments along with high resolution satellite imagery for regional assessments.

Users of this guide should be familiar with the identification of the key LWD species and it is recommended that users spend time looking at standing willow and poplar trees in the field before undertaking any assessments.

This guide only covers on the ground assessments undertaken on riparian margins and in coastal environments. It doesn't cover the more comprehensive regional investigations. A number of references are provided at the end of this guide.

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Introduction

The mobilisation of large woody debris (**LWD**) from the forests of Gisborne/Tairawhiti has been an issue for a considerable time. Migration of woody debris during significant rain events has been a largely annual occurrence since 2012. No systematic effort to document the problem was undertaken until 2017 when a report into the impacts of wood mobilisation following Cyclone Cook was prepared (Cave, *et. al* 2017). Prior to that, the evidence was only anecdotal, and it was common to see statements such as *"Our early investigations have indicated much of the debris that has washed into the waterways and beaches is mixed rubbish debris from poplar and willow riparian plantings, and includes a lot of land and sediment, and also rural debris."*

But the empirical basis for such claims was unclear. A literature search undertaken in 2017 did not identify any studies that outlined methodologies for quantifying LWD in either the catchments below forests or in the ultimate receiving environment. Accordingly it was necessary to develop a methodology that was robust, while remaining flexible to accommodate changing circumstances, and capable of standing the test of time. It was not possible to have an one shoe fits all method as there were morphological differences between the various receiving environments assessed. In addition, there is always a time consideration as the composition of large woody debris at a site can change, typically as a result of subsequent storms, post event remedial works, and well-meaning interventions such as the local community burning the LWD before an assessment could be undertaken.

Furthermore, there is little point attempting a quantification process unless a few ground rules are established and followed. The main elements of the quantification process were thus important to establish and have three main components:

- What is it (**definitions**),
- Where is it (**assessment locations**),
- Types of assessment and
- How best to establish representativeness of the sample (**robust and reproducible methodologies, elimination of bias**).

Further, it was considered desirable to have a methodology that was simple enough that it could be used by community groups and non-subject matter experts. Indeed in 2017 it was not clear that there were any subject matter experts.

This guide only covers on the ground assessments undertaken on riparian margins and in coastal environments. It doesn't cover the more comprehensive regional investigations. A number of references are provided at the end of this guide.

Definitions

The material discharged from such events is commonly referred to as slash as was the case in Cave *et. al* (2017) but this is a misnomer. Cave (2021) referred merely to woody debris. The following definitions have been used in this note and generally since 2018. A count sheet is attached as an appendix. It is best that these are printed onto card as beach assessment sites are often windy.

Large Woody Debris (LWD)

Woody material over 15cm in <u>diameter</u> irrespective of species. This term LWD is that used internationally to describe logs from various sources mobilised within a catchment. In earlier council reports this material was often referred to as harvest residues and the Cyclone Cook report kept with *the commonly used term slash but **LWD** is a more appropriate term as it doesn't differentiate between pine and other large wood species. LWD is generally not counted itself as its normally possible to categorise LWD by species and processing in the case of pine.*

Fresh cut pine (FCP)

*A pine log larger than 15cm in diameter that has sharp cut at the ends and typically shows the gouge marks characteristic of debarking (Waratah marks) and will occasionally show generic or company specific stencilling on the butt ends. There will be no or minimal weathering evident on the cut ends. Bark will be absent (**Figure One a&b**).*

Figure One. *A minor amount of weathering is evident on the log in Figure One a (top) indicating that it was likely harvested earlier than the log in Figure One b (bottom) which shows no weathering rim. The probable harvest time ranges from about a year or less for (a) to c.4 months for (b).*

Long Resident Logs (LRL)

*Pine that has been harvested but not recently. They may still have sharp cut ends, but a weathering rind will be present, or the ends will be uniformly weathered. In other instances, the cut ends will have been rounded off and can form cone shapes (**Figure Two**). Waratah marks may still be present. The trunk may look relatively fresh or may be grey (**Figure three**).*

Figure Two. *Long resident logs on the beach. One with relatively sharp cut ends the other rounded.*

Figure Two. *Long resident logs on a riparian margin. Note grey colouration and the obvious waratah marks.*

Slovens

*A short pine log cut into rounds (**Figure Four**). Where a short length of older pine only has a cut at one end it should be classed as a Long Resident Log.*

Figure Four. *Typical weathered pine short length slovens.*

Short cut pine root balls

*The root mass of a pine tree cut within 1m or so of the root ball (**Figure Five**). Root balls from harvested areas are sometimes used to buttress the base of side-cast material.*

Figure Five. *Pine root ball with a cut immediately above the base.*

Long cut pine root balls

*The root mass of a pine tree with a cut several metres from the root ball (**Figure Six**).*

Figure Six. *Cut pine trunk with the root ball still attached.*

Cut to waste pine (CTW)

*Medium to large but out-of-spec cut logs that may or may not have been debarked (**Figure Seven**). They include trees that were cut on the slope but not picked up by the hauler. Will sometimes have painted markers on the trunk. They are sometimes difficult to identify, but where pine logs over 15cm diameter have been cut they have been classed as cut to waste for convenience of counting (**Figure Eight**).*

Figure Seven. *Large cut log that hasn't been processed through a Waratah.*

Figure Eight. *Harvested but unprocessed logs with paint marks. The logs may be either without bark still, or generally smaller than a typical harvest log. There will normally be no indications of waratah marks.*

Slash

*This is largely pine harvest residues that are generally under 15cm diameter (**Figure Nine**) which may include thinning's, branches, and small cut to waste material (under 15cm).*

Figure Nine. *Small diameter material often makes up a significant area of woody debris on the beach but is difficult to individually count and estimating the percentage of the assessment plot covered by slash is the best option. The smaller material is classed as dross (see below).*

Dross

*Very small, disseminated pine or other wood debris which may include bark, waratah waste and a mix of fine woody "mash". This material will not be all pine and will likely include willow, poplar or other introduced species or indigenous wood material (**Figure Ten**).*

Figure Ten. *Dross-sized material can make up a big area of debris on the beach.*

Post event modified logs

*This may include material on a beach which is the burnt remnant of prior clean-up operations. Or long resident logs which have been subsequently cut in the receiving environment (**Figure Eleven**).*

Figure Eleven. *Long resident pine log that has been subsequently cut after it was deposited, in this case, on a beach. Not the unweathered rim indicating low immersion time in water.*

Root ball Pine with full or partial trunks with no cuts or signs of processing

*Often referred to as windthrow and without signs of cut ends. but the provenance of such material is not confined to the action of wind-induced downbursts and can be derived from riparian erosion, landslides, or potentially other processes as well as dislodgement during the harvesting of adjacent trees. May have partial or significant loss of bark (**Figure Twelve**).*

***Figure Twelve**. Long pine logs with root balls still attached but no indication of cut ends.*

Willow, Poplar and Acacia (WPA)

*Willows Poplar and Acacia are the most common erosion and riparian margin control species within the region. They can generally be readily distinguished from pine by their different bark textures and markings, although willow, poplar and acacia bark can be quite variable in texture (**Figure Thirteen**). Poplar can have a slim relatively straight truck and normally finer bark. Debarked poplar will often have a dimpled texture and a spiral crack system (**Figure Fourteen**). Willow generally has an irregular trunk and if it's a whole tree will show a long root system (**Figure Fifteen**).*

***Figure Thirteen**. Willow bark textures can be variable (left and middle) but can be readily differentiated from Pine (right).*

***Figure Fourteen**. A common poplar bark pattern.*

***Figure Fifteen**. A long stringy root system differentiates willow from pine.*

Indigenous

*Many different species of indigenous vegetation can be incorporated within the LWD and these can include softwoods, semi-hardwoods, and Manuka/Kanuka. These are generally readily distinguished from either pine or the willow/poplar/acacia suite (**Figures Sixteen and Seventeen**).*

***Figure Sixteen**. Indigenous hardwood.*

***Figure Seventeen**. Indigenous hardwood. The paint is a dazzle mark added during the log count process to ensure that it is not counted twice. See page 12.*

Fence posts and battens and rubbish

*As LWD migrates downstream during a flood it will often "take out" any fences standing it its way (**Figure Eighteen**). Similarly, some waste transfer stations are presently in flood zones and* *consequently, a wide mix of rubbish can be incorporated to the woody debris in the receiving zone (**Figure Nineteen**).*

***Figure Eighteen**. Fence posts and other processed woody debris.*

***Figure Nineteen**. A severe flood will bring down a variety of debris with parts of jetty's, decks, deck chairs, fruit, fridges and in this instance, a beehive.*

Assessment Types

In an ideal world every piece of LWD will be counted but the volumes involved means that this will be impracticable in most instances. Instead subsets of the woody debris field are counted and provided that enough assessments are undertaken, they should be representative.

There are three main assessment types for on-the-ground rapid assessments.

- 10 metre square plots
- Transect, and
- Wood pile counts.

These are complimented by drone mapping which gives a broader perspective of the quantities involved at final and intermediate receiving zones whereas the on-the-ground plots give relative proportions of different species classes. An AI tool was trialled in 2018 and while it proved successful in delineating landslides and sediment deposition, it did not successfully contribute to an understanding of woody debris sources or migration.

Satellite and aerial photography assessments proved more successful and give a good overview of sources and migration paths but any tree species assessment may be indirect. For example, it may be assumed that wood discharged from a sub-catchment which is predominantly in exotic forestry will be discharging exotic forest LWD. As the LWD migrates downstream, however, other material may be incorporated in the flood, thus the catchment assessments do not differentiate types of woody debris unless it is 100% certain.

Square Plot

The square plot is a classic sampling methodology. For the LWD assessment, a 10m square plot has been adopted and ideally multiple plots should be undertaken to ensure that the results are representative and to eliminate observer bias. The method works well on a beach at low to mid tide (**Figure Twenty**) but at high tide LWD mobilisation can occur and thus a transect is a better option. The person counting should identify up to three (relatively) equally spaced sites along the beach where a 10m square area is dominated by LWD. Every piece of LWD over c.25cm within the plot is counted and the counted wood is dazzle-painted to ensure that it is not counted twice. Logs are photographed with a GPS enabled camera (or phone) for later exporting to a GIS software application.

Not all of any plot will be woody debris and it is likely that areas of bare sand or finer <25cm slash or dross material will be present (**Figure Twenty One**) and a visual estimate of the percentage area slash or dross should be made and noted but excluded from the calculation. Some LWD will extend beyond the plot area and the following has been adopted to address this issue. The rule adopted has been that any log where 25% or less of the log sits outside the plot is counted while logs which are only 25% within the plot area are not counted.

Handy Hints

Use two people, one as a counter and the other as a recorder. Both should have a copy of the identification sheet and it is useful if they discuss any LWD where the origin of that LWD is uncertain. It is also valuable to use the local community to undertake the assessments (**Figure Twenty Two**). Use a 50m tape to measure out the plot with wooden stakes to mark the corners. A small mallet is handy to make sure the stakes are secure.

Figure Twenty. *A typical beach environment where a 10m square plot is suitable (South Tolaga Bay).*

Figure Twenty One*. Drone image of a 10m square plot, North Tolaga Beach after the March 2022 storm. Note the yellow dazzle marks and the white tape marking the plot area. The plot includes a small area of sand and a significant area of slash and dross.*

***Figure Twenty Two**. Having a counter and a recorder do the work is helpful and it means that if they are uncertain, the provenance of a particular log can be debated. In the above photograph a team from Ruatoria is doing a count of logs on Tikapa Beach.*

Transect

The transect method works well on river banks or on beaches/river mouths when storm action has put the LWD into narrow rows. The person counting should traverse the river bank for at least 1km counting every piece of LWD over c.25cm over a corridor which is at least 1m and preferably 2m wide. Logs are photographed with a GPS enabled camera (or phone) for later exporting to a GIS (**Figure Twenty Three**). Wood is dazzle painted to ensure that it is not counted twice. Piles of smaller <25cm wood or scattered small wood need not be counted but such piles should be photographed for later description in any report. Sometimes the area of LWD in a riparian margin is such that and a 10m square plot can also be assessed (**Figure Twenty Four and Twenty Five**).

Wood Piles

Wood piles may occur naturally for example when LWD gets lodged against standing trees on a flood plain. Generally, however, wood piles result from urgent works undertaken to clear log jams against bridges that could otherwise fail. They can also occur on beaches where clean ups have been initiated prior to the assessment. This can easily happen during a state of emergency where urgent log clearance is necessary and local resources are tied up in the response and are unable to carry out an LWD assessment.

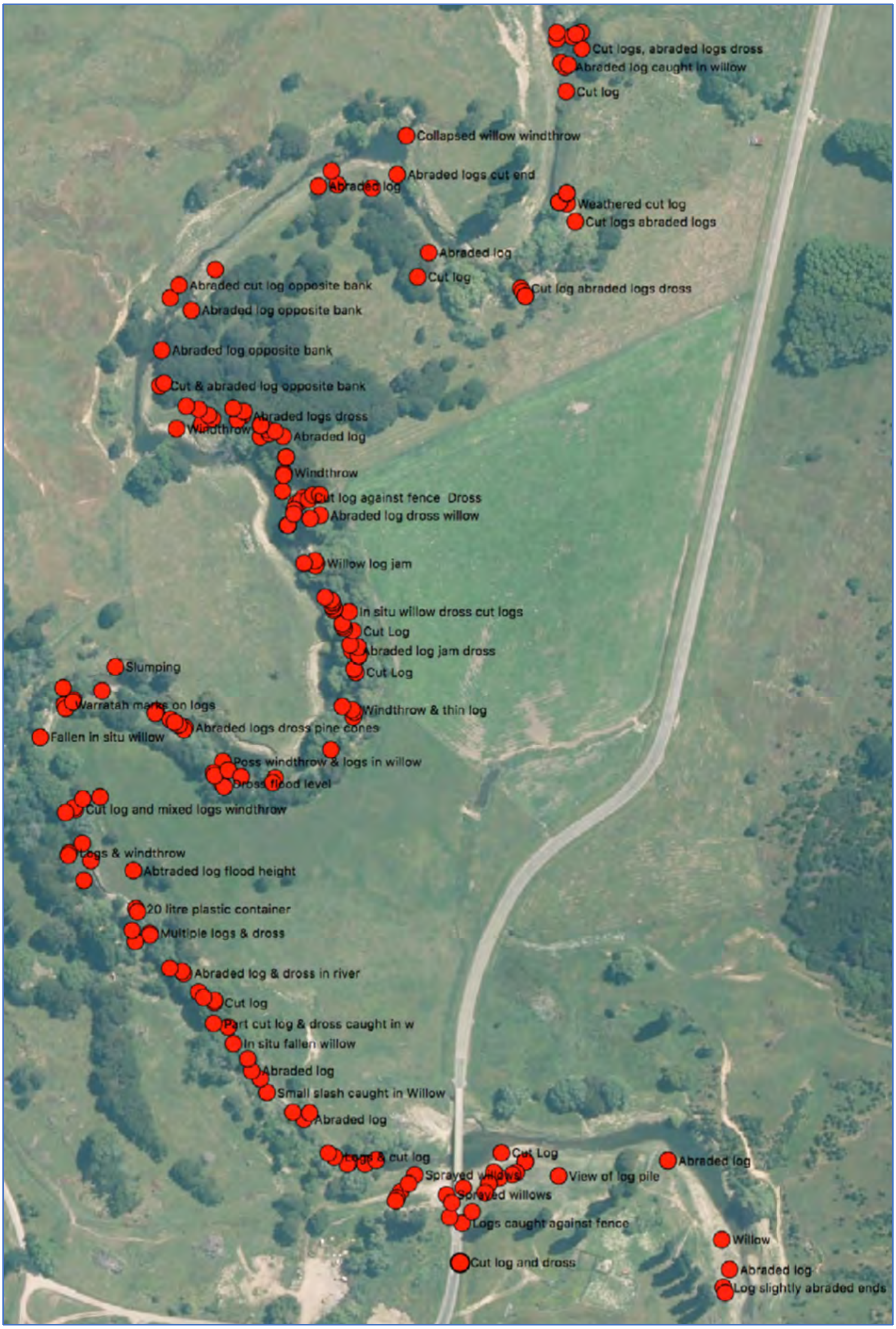

Figure Twenty Three. *GIS plot of woody debris count on the Mangaheia River (2017).*

Figure Twenty Four. *Satellite image of the Mangatoitoi July 2018 showing a large area of LWD (Middle Right) that would be suitable for a 10m square plot. As this is within the forest harvest area the LWD would be primarily pine harvest residues.*

Figure Twenty Five. *An expansive area of LWD below Wakaroa Forest in the Waimata Valley. It would be possible to do at least two 10m square plots in this mass of wood.*

Two options for counting wood piles are available. The best option is to use a digger to pull apart the piles and place them in separate sub-piles based on species class (**Figure Twenty Six**). A good digger operator will get the idea pretty quickly but good communication between the counter and the operator is essential. It is helpful if the counter gets some familiarisation training about the hand signals digger operators use. Having a radio on the same channel is also useful. Once in each species class, the piles can be readily counted using the identification sheet.

If the budget does not stretch to use of a digger or if the wood pile is inaccessible to machinery, hand counting is necessary. In the case of hand counting, it may not be possible to count all logs as they may be obscured or it is too hazardous to count. For safety reasons clambering over wood piles is to be avoided. Large enough wood piles to ensure a minimum of 100 pieces of LWD are counted and it is preferable to undertake multiple counts of piles to avoid observer bias. As is the case with other methods it is desirable that there is a counter and a recorder and in this instance the recorder is an essential health and safety observer.

Figure Twenty Six. *A digger being used to deconstruct a wood pile at Wigan Bridge (2017) to facilitate the counting of the LWD.*

Assessment Locations

Four obvious assessment locations present themselves and each have their own complexities.

Riparian Margins. Quantifying LWD which typically spreads along riverbanks as a narrow but widely spread linear woody debris field where a transect is generally a suitable option but sometimes expansive woody debris fields can develop (cf. **Figure Twenty Three** above and **Figure Twenty Seven below**).

Flood plains. Woody debris will frequently break out beyond the riparian margins and cover the adjacent pasture or croplands (**Figure Twenty Eight**).

Beach Margins. Expansive LWD fields typically but not always having a significant width as well as length (**Figure Twenty Nine**). Where the woody debris has already been put into piles as part of a clean-up then a wood pile assessment is possible **(Figure Thirty)**. In other instances the debris may not be 10m wide and thus a transect is more appropriate (**Figure Thirty One**).

Road (& rail) Bridges. Road and rail bridges are especially vulnerable to the forces exerted by LWD and a failure to remove this debris may result in a bridging catastrophically failing (**Figure Thirty Two**). Consequently, contractors will often mobilise to extract the LWD before an assessment can be undertaken. Typically this material will be stored in large piles and this material can then be quantified through counting individual logs (**Figure Twenty Six** above).

Figure Twenty Seven. *Drone mapping of the Upper Tauwhareparae Road after Cyclone Cook to identify areas for a riparian margin transect.*

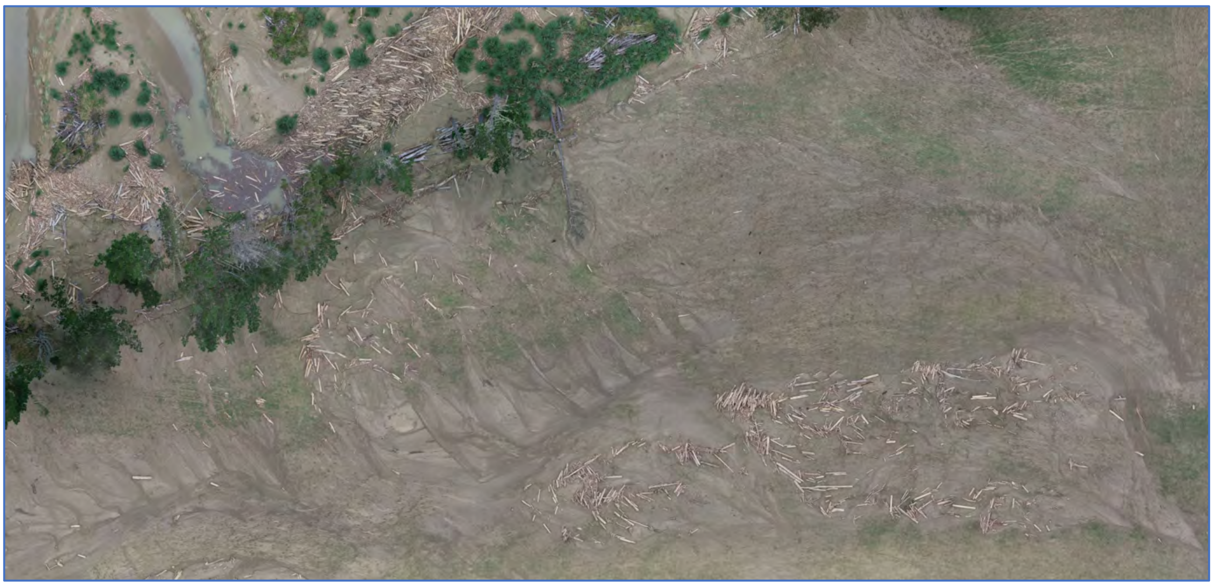

Figure Twenty Eight. *LWD distributed over the flood plain adjacent to Tapuae Stream on Paroa Road after Cyclone Hale. The woody debris in the stream may be too hazardous to count but that on the flood plain can be safely accessed and counted.*

Figure Twenty Nine. *South Tolaga Bay. This is an ideal site for a 10m square plot.*

Figure Thirty. *North Tolaga Bay. Here the debris has been pushed into piles which provide convenient counting locations but in some instances these piles may be too large or too high to safely count each log within the pile.*

Figure Thirty One. *South Tolaga Bay. Here the debris has been pushed into a narrow strip and a traverse may be a better option than an 10M square plot.*

Figure Thirty Two. *Woody Debris jammed against Wigan Bridge on the Mangaheia River, Upper Tauwhareparae Road. This material will typically be pushed into piles before they can be assessed. The most desirable counting tool is to use a bigger to sort the lWD into piles based on species.*

Other suggestions

Using local community groups or a school to undertake the assessment is a good option as it is an opportunity for a "citizen science" exercise (see **Figure Twenty Two**). This option was employed following Cyclone Cook in 2017 (Cave *et. al* 2017). Another suitable method is to invite local forestry company or land owner representatives to attend when the the assessment is undertaken. This has been successfully used in the Cyclone Cook assessment. In addition, having the assessments undertaken by more than one person, where one or more people do the counts and there is a separate recorder.

It is a good idea to ensure that multiple assessments are undertaken at a particular site. For example, in Gisborne/Tairawhiti the adopted best practice has been to undertake at least 3 separate assessments at each site but 4 or more assessments at each site is desirable. The results can be averaged across the assessments. In addition, having good documentation is important with many photographs taken of each site and each recording sheet scanned and filed for later reference and/or verification. Users of this guide should be familiar with the identification of the key LWD species and it is recommended that users spend time looking at standing willow and poplar trees in the field before undertaking any assessments.

The results are usefully plotted as pie charts and columns.

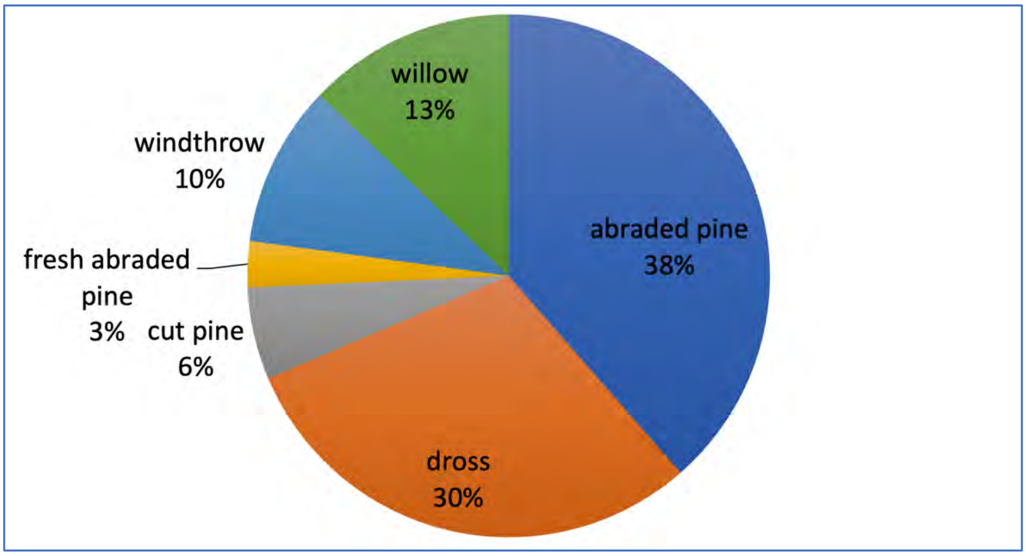

Figure Thirty Three. *Pie chart showing the results of the LWD count at Wigan Bridge (cf. Figure Twenty Six)*

In the Gisborne/Tairawhiti region, drone mapping using Drone Deploy has also been routinely adopted for all sites excluding the city beaches where proximity to the airport makes drone flights impracticable (c.f., **Figure Twenty Nine**).

Conclusions

Since 2017, Gisborne District Council has developed and used a large woody debris (LWD) assessment methodology as set out in this guide. It has proved to be;

- Robust.
- Reproducible.
- Able to be adopted by community groups and schools.
- Have suitable checks and balances to offset any potential observer bias.

References

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Cave, M.P., (2020) Inspection of Tolaga Bay beaches 27th June 2020. Gisborne District Council. 11p

Cave, M. P., (2021) An assessment of Woody Material on Tikapa Beach after the July 2020 storm and potential sources. Gisborne District Council, January 2021. 71p.

Location

Date

Observer

Use the crossed 5 recording system with 1 set of 5 per cell ; ie ~~||||~~

Pine Fresh cut																				
Pine LRL																				
Pine RB short cut																				
Pine RB Long cut																				
Pine RB no cut																				
Pine CTW																				
Slovens																				
WPA																				
Indigenous																				
Post-event modified																				
Fence posts etc																				

Rubbish																				
Sand																				
Slash																				
Dross																				