LIVING FENCES AND IMPROVED FORESTRY PRACTICES FOR WOODY DEBRIS MANAGEMENT

Context and Challenges

Severe storm events mobilise large volumes of woody debris from multiple sources, including eroded riverbanks, windfallen trees on saturated soils, cut timber piles, and trees displaced by landslides. In extreme cases, debris flows, largely of sediment, but also woody debris, result from slope failures during intense storm events. Once in waterways, this material is transported through streams and rivers, often causing significant damage. Woody debris can compromise bridges, destroy fences, damage crops, impact buildings, and scatter across floodplains before ultimately reaching beaches and the ocean.

The movement of woody debris is a natural process, but human land-use practices, coupled with the growing frequency and severity of climate change-induced storms, are intensifying its effects. To reduce the risk of slash movement during severe weather events, Nelson's forestry sector has adopted a range of proactive measures. These include removing a greater volume of timber from cutover sites for secure storage, and maintaining strong post-harvest infrastructure, such as sediment traps, culverts, and effective skid site drainage. Operators are also fast-tracking the stabilisation of exposed soils through oversowing and additional planting to encourage rapid revegetation. Where possible, slash is processed or mulched and relocated to low-risk areas, significantly reducing the chance of debris being mobilised during storm events.

The effectiveness of these efforts was evident during the recent Nelson/Tasman double flood events, where less than one percent of woody material found on beaches was attributed to forestry slash. However, some newer practices, such as increased stream setbacks and natural regeneration, may temporarily increase the risk of wood movement within forestry areas. Additionally, during extreme events, such as 1 in 100-year floods, woody debris (including whole trees and slash) from forestry, streams and river banks (usually >50% of woody material) and many other sources, such as native bush, can be mobilised.

The adoption of a series of living fences by landowners with treed steep gullies could greatly reduce the downstream movement of woody debris, offering a practical and nature-based solution to this ongoing challenge.

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Potential Solutions, Living Fences

Living fence barriers are specifically designed to capture and retain woody debris, preventing it from entering and impacting waterways.

Methods for Constructing Living-Fence Debris Barriers

There are four main techniques for establishing living-fence barriers, each aimed at effectively intercepting and managing woody debris within steep catchments and stream systems.

1. Block Living Fence

A block living fence consists of a permanent stand of fast-growing trees planted in multiple rows on either side of the stream, typically near the base of the catchment. These trees form a solid, vegetated barrier capable of capturing large quantities of woody debris during high-flow events.

2. Hold Living Fence

A “hold living fence” is established during harvest by strategically retaining pine trees along high-risk stream margins. Spaced approximately 5 to 8 metres apart, these trees are left standing to intercept and hold woody debris during the post-harvest period, when the risk of debris mobilisation is at its highest. As material accumulates, fallen logs often lodge at right angles against the retained stems, forming a complex tangle that acts as a natural barrier, or “leaky weir”. While highly effective in the short term, purpose-built block living fences typically follow these organic structures as part of a longer-term stabilisation approach.

3. Arrow Living Fence

An arrow living fence is a strategic arrangement of "arrow-shaped" plantings established along rivers or gullies in areas prone to significant wood movement. These formations are typically positioned at the first viable downstream location, where the channel levels out and a meander allow woody debris to be diverted toward the riverbank. The arrow configuration functions as a natural interceptor, guiding debris away from the main current and into accessible zones for easier removal when necessary.

4. Continuous Living Fence

A continuous living fence is a row of plants established along a stream or river. Its purpose is to prevent woody debris and sediment from entering the waterway, or to stop material from escaping the channel and spreading onto the floodplain.
While this method offers thorough protection, it is often expensive and impractical to implement on a large scale. More cost-effective strategies include:

- Planting poles at wider intervals. Once mature, these can be cut at ground level or at a height of approximately 4 metres. The harvested material can then be laid down to form a barrier, while the remaining poles can be used for propagation.
- Using suckering species like Aspen. When planted at wider spacings (e.g., 20 metres), their natural suckering will fill the gaps over time.

As logs and other debris accumulate against the living fence, it becomes an increasingly effective barrier, capturing both coarse and fine sediment.

Unlike large, engineered slash barriers designed to hold back mass flows, living fences utilise fast-growing coppicing species such as poplar and willow. These are chosen for their rapid growth and ability to regenerate after being cut. However, a potential disadvantage is that the annual leaf fall from willows and poplars can negatively affect water quality as the leaves decompose.

Poplars and willows are commonly planted in multiple rows along streams, with spacing of 3.0 to 5.0 metres between trees. Wider spacing is generally preferred, as it allows long, intact trees to become trapped and interwoven, increasing the strength and stability of the structure. In contrast, closer spacing tends to capture a greater volume of smaller debris, which adds weight and increases the risk of structural failure. Planting along forest margins also helps retain open areas for vegetation growth and improves light penetration. While denser planting can improve debris capture, it also increases the load on the structure and increases the likelihood of collapse.

The design of a living fence, including planting density, species selection, and final height, must be tailored to the specific site. Key factors to consider include setback width, catchment size, slope, harvesting methods, soil moisture levels, tree availability, and budget constraints. In forestry settings, it is important to account for harvest rotations and select species that grow quickly enough to reach sufficient size before the next harvest cycle.

Benefits of Living Fences

Woody material is a vital component of waterways, providing both ecological and physical benefits. It enhances habitat diversity by creating features such as dammed pools, plunge pools, and backwaters, which support fish and macroinvertebrates. Woody debris also plays an important role in aquatic food webs by trapping organic material such as leaves and twigs. This material provides a food source for invertebrates and supports nutrient cycling within the stream ecosystem.

Woody material also offers a natural and sustainable approach to managing the impacts of increasingly frequent and intense storm events. When debris accumulates, it can form structures such as leaky weirs that slow water flow, reduce the erosive force of floodwaters, and capture sediment. These structures help stabilise stream banks, limit sediment loss, and retain sediment within the catchment.

In New Zealand, however, the risk of woody debris being mobilised during and after forestry harvesting has led to costly mitigation measures. Approaches such as multiple cutover passes, full debris removal, mulching, or slash processing are designed to prevent debris movement, but they come with significant financial and environmental costs. These practices often remove organic matter and nutrients from the site, slowing forest regeneration and reducing soil health. The loss of organic material can also limit fungal activity, which is essential for healthy soils, and increase long term erosion risk.
By integrating ecological benefits with practical flood mitigation, woody material can be recognised as a valuable natural asset. It plays an important role in building climate resilience and supporting sustainable catchment management across Aotearoa.

Risk and Design Considerations for Arrow-Shaped Living Fences

While arrow shaped living fences can be effective at intercepting woody debris during high flow events, their use requires a strong understanding of potential risks during extreme storm scenarios.

In severe events involving widespread landslides, these structures can increase hazards for downstream properties. If an upstream debris flow overwhelms a living fence, or if the structure itself fails, the sudden release of accumulated material can significantly increase the volume of woody debris being transported. This surge can greatly increase the erosive force and destructive potential of the event.

To reduce these risks, arrow shaped designs should be constructed to guide debris towards the riverbank, rather than act as a complete barrier across the stream channel. This approach helps prevent full blockages, maintains channel capacity, and redirects hazardous material away from vulnerable downstream areas.

Careful species selection is also critical. Tree species that sucker or self seed readily should generally be avoided in arrow shaped configurations, as uncontrolled spread can compromise the structure and its intended function over time. These species are better suited to continuous living fences along stream margins, where spreading growth provides additional protection.

Risk management can be further improved by installing multiple arrow shaped fences along a stream reach. Using several interception points, rather than relying on a single structure, provides redundancy and reduces the load and failure risk on any part of the system.

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Species Selection

To ensure that living fences are effective and safe during extreme weather events, careful planning is essential. This includes appropriate species selection, correct spacing, and site specific design. As the gentler slopes needed to reduce these risks are often located on downstream properties, managing woody debris and storm driven flows requires collaboration between neighbours and across property boundaries. These efforts should apply to all steep, tree covered land, not just forestry areas.

Willows and poplars form the foundation of most living fence systems, valued for their rapid growth and strong ability to regenerate after cutting. For best results, fastigiate varieties should be used, as they grow tall and narrow with branches held close to the main stem. For long-term success, modern cultivars with good disease resistance should be selected and carefully matched to local climate and soil conditions.

Integrating species, such as oaks, redwoods, and selected native trees, can significantly improve forest longevity, biodiversity, and long-term timber value. In Golden Downs Forest, Eric Appleton is trialling suckering species including Populus tremula and European aspen. These species can be successfully propagated from root cuttings after only one year. On suitable sites, European aspen develops an extensive root system that produces upright shoots, forming an expanding network of living stems. This growth habit is particularly effective for creating continuous living barriers along river margins. These natural fences help prevent woody debris from entering waterways and trap material already present during flood events.

Mixed species plantings provide clear benefits over monocultures. Alongside improved long-term timber returns, greater species diversity reduces the risk of water quality issues associated with heavy, simultaneous leaf fall from a single species. By promoting species variety, forest systems can improve ecological resilience, stabilise vulnerable land, and more effectively intercept woody debris.

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Planting and Maintenance

Most living fences do not qualify under the current Emissions Trading Scheme (ETS) due to the minimum area requirement of 1 hectare and the average width criterion of greater than 30 metres. However, living fences established as blocks within gullies or along rivers may meet these criteria. This potential should be considered during planning and design.

Poplars and willows are commonly available as 2–3 metre poles or 1-metre rooted cuttings. In some regions, councils may supply poles free of charge or at cost.

- Poles with sleeves (approximately $32) are recommended where livestock or pest animals are present, as they provide greater protection and resilience.
- Poles are heavy, require ramming for installation, and may need re-ramming if they loosen over time.
- In areas without grazing pressure, rooted cuttings (approximately $7) provide a lighter, lower-cost alternative and can be planted using a crowbar to form the planting hole.

Planting should generally occur after autumn rains in early winter. Poles or cuttings should be spaced approximately 2–3 metres apart, close enough to form an effective barrier without causing excessive competition between trees.

Deciduous species typically fall under the exotic hardwoods ETS category, with indicative sequestration rates of approximately 20 tonnes of carbon per hectare per year. At a carbon price of $50 per tonne, this equates to around $1,000 per hectare per year, where eligibility criteria are met.

Effective weed control is critical for establishment success. A weed-free zone should be maintained around each planting for at least two years. Herbicides such as glyphosate (Roundup) or glufosinate-ammonium (Buster) may be used. Metsulfuron should be avoided, as it can translocate and kill poplar and willow poles.

After two to three years, young trees should be pruned to a single leader. Where future timber harvest is planned, lower branches should be pruned annually to a height of approximately six metres.

Most poplars and willows have an average lifespan of around 50 years. Long-term management plans should therefore include strategies for self-replacement to ensure the ongoing effectiveness of living fence systems.

Pruned Douglas fir within the living fence, Motupiko, Upper Motueka Catchment

Appleton, Motupiko Upper Motueka Catchment

Background

In the 1970s, a block of land was acquired in Motupiko, within the Upper Motueka catchment. At the time, the property comprised abandoned farmland with scattered remnants of native vegetation and heavy infestations of gorse and broom. Repeated burning had been used unsuccessfully for weed control, and the land included steep hillsides dissected by a 40–60-metre-deep gully. The lower gully was actively mined for gravel, resulting in severe erosion and sediment loss.

Establishment and Management

Initial stabilisation involved planting pine, which improved soil stability but proved vulnerable to windthrow due to soil conditions. In subsequent rotations, planting was diversified to include Douglas fir and redwoods, selected for their interlocking root systems and superior wind resistance.

To reduce downstream movement of woody debris and gravel, the entire gully was planted with poplars, forming a continuous living fence. The upper gully, already supporting approximately 20 hectares of native vegetation, was retained and protected. At the time, goat and possum numbers were high but have since been successfully controlled.

An adjacent block with lower erosion risk was later purchased. A stream on this property flowed toward a downstream dairy farm. To protect riparian margins, plantings of poplar, red alder, and Douglas fir were established along stream edges. Trenches were created using a ripper, and planting occurred at a density of approximately 1,100 stems per hectare, generating sufficient shade to suppress weeds. Over time, Douglas fir and red alder have become self-replacing, with native species regenerating naturally beneath them. Selected trees have been pruned to improve form and allow for potential future timber harvest.

During recent dual flood events in the Nelson Tasman region, the properties experienced approximately 32 hectares of windthrow. Despite the severity of the storms, woody debris was successfully contained within wet gullies due to established living fence plantings, which prevented material from moving downstream.

A regional shortage of logging equipment, resulting from an estimated 10,000 hectares of windthrow across the district, required a tailored recovery approach. Timber was salvaged using a small crew and a bulldozer. The presence of living fences provided a strategic advantage by allowing the skid site to be located among alder trees just outside the riparian margin. This placement reduced slash movement and improved the efficiency of the harvest operation. The effectiveness of sediment control measures was confirmed by downstream silt capture ponds, which showed no visible discolouration.

To manage a significant slip at the head of the gully, where gravel was eroding from the native vegetation zone, a sump was constructed. This structure now captures an estimated 40 to 50 truckloads of gravel each year, preventing sediment from filling the protected gully while also providing a sustainable source of aggregate for ongoing maintenance.
While much of the wider Motupiko Valley experienced severe land loss and major changes to river channels, the planted gullies showed strong resilience. Douglas fir and redwood species displayed significantly greater windthrow resistance than pine. These outcomes highlight the importance of careful species selection and demonstrate the effectiveness of living fence design in protecting erosion prone landscapes.

Red alder and regenerating native species in the gully, Motupiko, Upper Motueka Catchment

Skid site surrounded by living fence plantings, Motupiko, Upper Motueka Catchment

Rooted poplar cuttings seven months after planting, Moutere- Blackbird Valley

Moutere Catchment – Blackbird Valley OneFortyOne Forestry

Background

In October 2020, a living fence and downstream filtering wetland were established along a stream in Blackbird Valley, within the Moutere Catchment. This project drains a 60-hectare catchment located inside a recently harvested forestry block. While October is an unconventional season for planting, and the site's gentle slope presents a minimal risk of woody debris movement, the location was specifically chosen as a demonstration area due to its high visibility from a nearby public road.

Site Description

- Soils: Moutere clay soils, comprising shallow, moderately low-fertility loams over deep, gravelly clay subsoils derived from moderately weathered greywacke
- Topography: Rolling country with slopes from 0–25% (average ~15%)
- Rainfall: 1,300–1,400 mm annually

The site lies above private farmland, with a 0.26-hectare sediment pond located immediately downstream. This pond connects to the Moutere River, approximately 5.7 km downstream of the planting site.

Design and Establishment

In collaboration with OneFortyOne Forestry and the Moutere Catchment Group, weed control was completed prior to planting. The design included:

- Three arrow-shaped living fences, each approximately 75 metres long, established using 1-metre rooted cuttings of Crowsfoot poplar (supplied by Appletons Nursery)
- Plant spacing of 1.5–2 metres
- A naturally flat engaged flood plain area approximately 30 metres downstream, enhanced with 1,000 wetland plants (including Carex secta, Carex virgata, swamp flax, giant rush, bullrush, jointed baumea, and vetiver grass) to capture fine sediment

Early Observations

Post-planting maintenance was minimal. By the end of summer 2020:

- Poplar cuttings showed strong growth and high survival rates.
- Wetland species showed poor establishment, likely influenced by seasonal timing and site conditions


Layout of demonstration site


Wetland area prior to planting


January 2026 drone footage of Arrow Living fence, Moutere Catchment

CASE STUDY

Arrow living fence shortly after planting, Riwaka Valley

Arrow living fence in January 2026 in Riwaka catchment

Riwaka Valley – Gibbons Forest – Forest Management Group

Background

In July 2024, Craig McMiken undertook a collaborative project (Forest Management Group) in partnership with the Motueka Catchment Collective and Tasman District Council. Living fences were established along a stream within the recently harvested Gibbons Forest, located in the Riwaka Valley near Motueka.

Design and Establishment

The project included:

- Three arrow-style living fences
- A downstream block planting (see site layout diagram)

A range of 2-metre poplar poles supplied by Tasman District Council were planted, including the cultivars: Gus, Otahoa, Veronese, Kawa, Crowsnest, Henley, Dudley, Mapiu, and Weraiti.

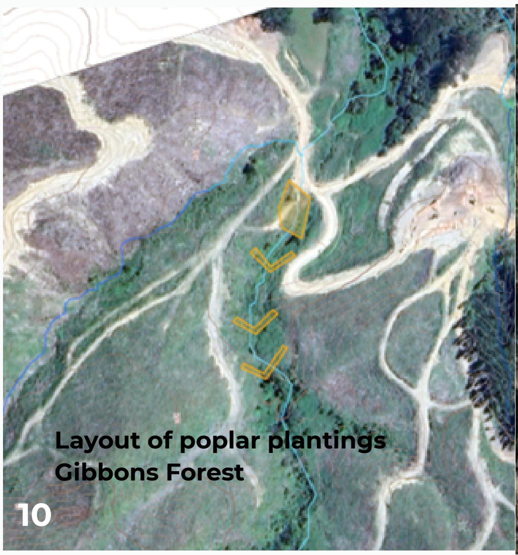
These cultivars will be monitored over time to assess growth, stability, and suitability for living fence applications.

Monitoring and Long-Term Intent

This site has been established as a long-term demonstration project to compare:

- Arrow-shaped living fence formations, and
- Block plantings downstream

Performance will be assessed at the next harvest cycle (approximately 25 years) and, where possible, during any significant flood events occurring before and after harvest.



Layout of poplar plantings Gibbons Forest

Arrow living fence in July 2024

CASE STUDY

Gisborne examples

Picture to the right, a living fence of unharvested pine trees in Gisborne has captured significant woody debris. This debris was later mulched using an adapted head on existing forestry harvesting equipment. In the green area, poplar poles have been planted to contain debris in future events.

Dan Fraser, a former co-owner of Forest Enterprises, delivered a compelling presentation at the Environmental Forestry Conference in June 2023, in the aftermath of Cyclone Gabrielle. He shared insights into forestry practices that proved effective during the extreme weather event. One standout strategy he highlighted was the use of live trees as natural woody debris catchers. Positioned at the base of steep catchments where streams level out, these trees are planted along the edges of waterways. Fraser emphasised that large, living trees serve as a critical tool in mitigating debris flow, and confirmed his commitment to continuing this approach. He explores these techniques further in "Good Practice Guidelines for Eastern Wood Council," with some photos below sourced from this document.

Interestingly, setbacks from waterways and the slow regeneration of native vegetation can unintentionally leave these areas more vulnerable. To address this, Fraser has implemented an innovative practice known as "hold living fences." This involves leaving unharvested pine trees standing along sensitive waterways during harvest. These trees remain in place until the entire catchment has been replanted, and the new trees have grown to a size that reduces the risk of mass movement. This method has already demonstrated its effectiveness, capturing approximately 20,000 tonnes of woody debris during a single storm event (see photo below). By consolidating debris in accessible areas, this practice also enables further solutions, such as mulching.

Pine left as a "hold" or living hold fence in Gisborne showing how effective it can been in capturing large woody material.

Living block fence of mature mixed poplars and willows along water ways offering full protectionin lower part of the catchment in Gisborne.

Hold trees that retained approximately 20,000 tons of large woody debris in Gisborne.

An example of a living block fence in Gisborne

Conclusion

Landowners managing steep, forested gullies are well placed to reduce flood risk by installing carefully designed living fences to intercept woody debris. With appropriate technical guidance, these natural structures can be located to capture hazardous material before it reaches vulnerable areas. However, the most effective locations for living fences are often found in lower gradient, meandering sections of streams, which frequently lie on neighbouring or downstream properties. This highlights the importance of collective stewardship across catchments. When landowners and catchment groups work together to establish and maintain living fences, the shared effort can significantly reduce the risk of damage to property, infrastructure, and productive land across the wider floodplain.

Additional reading

Debris flows. New Zealand planted forests environmental facts. Scion
Good Practise Guideline for Catchment Management.For the plantation forestry members of Eastland Wood Council December 2022.
Slash Risk Management Handbook. Te Ura Rakau. New Zealand Forest Service.
Design of Debris Slash Traps: Considerations for NZ Plantation Forestry Operating.April 2020