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# Response of a stream ecosystem to debris flows

A case study following the recovery of a recently harvested headwater riparian and stream ecosystems after extreme rain, flooding and debris flows.

Many regions in New Zealand are susceptible to storms that generate debris flows and flooding. These events are a natural occurrence in steepland forests; however in planted forests, the impacts can be amplified in recently harvested catchments.

The recovery of a riparian and stream ecosystem after harvesting and extreme rainfall gives an insight into how forest waterways recover in a worst case scenario.

The debris flows and flooding scoured out the stream channel and riparian vegetation. Hardy weeds were first to colonise the riparian areas. Five years later a few native shrubs are starting to emerge through the canopy.

After an initial decline, both aquatic invertebrate and native fish densities increased markedly over the five years. After five years, invertebrate community composition was similar to that prior to harvest. Some fish species thrived post-event but others were rare or absent showing that recovery is a dynamic process.

Management practices that enhance and protect riparian vegetation recovery and reintroduction of large stable pieces of wood into the stream can assist the stream recovery process.

## Extreme rain, flooding and debris flows

Floods and debris flows are natural disturbance events in forested stream ecosystems.

Steepland planted forests on erodible geologies and soils are particularly vulnerable to these events during harvest and in the immediate post-harvest phase. This is due to the larger quantities of more mobile logging slash, loss of roots to hold the soil and lack of protective standing vegetation on the hillslopes. Intense rainfall events can initiate landslides containing large quantities of sediment, water and wood that transform into debris flows when they reach the stream channel.

*Debris flows scour out headwater stream channels (top) and depositing the material downstream (bottom).*

A study of an extreme rainfall event in the eastern Bay of Plenty, New Zealand in April 2011 (estimated 1-in-100 year event) has provided some insights into its impact on recently harvested headwater riparian and stream ecosystems and their subsequent recovery.

## What happened in the riparian area?

The debris flows and flooding scoured the stream channels removing the soil, seed sources and the predominantly indigenous riparian vegetation. After the debris flows, a range of hardy, light-demanding pioneering exotic species (e.g. broad-leaved fleabane and pampas) gradually established in the riparian areas, dominating riparian vegetation composition. Indigenous species comprised a smaller proportion of the riparian vegetation community. Five years later, indigenous shrubs such as karamu and tutu were starting to emerge through the canopy and out-compete the pampas. Recovery to an indigenous shrub composition is likely to be within a decade.

Pool habitat before harvesting and the extreme weather event.

Pool habitat immediately after the event and five years later.

## What happened in the stream?

The debris flows removed any shade provided by the riparian vegetation remaining after harvest and woody debris exposing the stream channels to increased levels of sunlight. Water temperatures warmed initially, then gradually declined as the height and density of the recovering riparian vegetation increased, shading the stream channel. Algae was prevalent in the streams in the first few years.

The scouring effect of debris flows also reduced the number of pools, including nearly all the pools formed by stable wood in the streams. The number of pools recovered to varying degrees in the first five years. Although pools formed by wood were scarce, some in-stream and overhead cover was provided by the reestablishing riparian vegetation.

## Aquatic invertebrates

Aquatic invertebrate densities initially declined immediately after the debris flows, then rapidly increased, reaching densities up to four times higher than those recorded when the catchments were in mature radiata forest. The community composition also changed, influenced by an increase in caddisfly taxa adapted to the post-event in-stream conditions. After five years, the invertebrate community composition was similar to that found in mature planted forests.

## Indigenous fish

Within two years, post-event fish densities were around three times that of densities prior to harvesting and the debris flows. Those fish species that were both resilient and thrived in these conditions included; redfin and bluegill bullies, smaller longfin and shortfin eels and inanga. Species that were more sensitive to the loss of shaded habitat, wood covered pools and warmer water temperatures, such as banded kokopu, common bullies and common smelt, declined or were not caught. Overall, the fish communities are taking longer to recover than aquatic invertebrate communities and the recovery timeframes are unknown.

Before harvest | 1 year after harvest | After the debris flow | 3 years later | 5 years later

*The overhead cover and shade provided by the recovering riparian vegetation was a key factor influencing in-stream recovery.*

*Retention of an intact riparian margin during and after harvesting.*

## Management options to aid recovery following debris flows

- Minimise the amount of logging slash entering streams during harvest (Forest Practice Guide).
- Facilitate riparian recovery as the shade it provides has a strong impact on stream recovery rates.
- Maintain current practices for herbicide application that include a 'no herbicide' zone along stream margins to protect recovering riparian vegetation.
- In sites with available wood supply and machine access, there is the potential for the re-introduction and strategic placement of large stable pieces of wood (see Wood in Streams).
- Retain intact riparian forested margins to provide shade, habitat and a long-term source of wood and leaf litter to streams.

*Management of wood in streams must meet statutory and regulatory requirements. Council approval will be needed if the slash management practices deviate from Council rules and the National Environmental Standards for Plantation Forestry.*

## Conclusion

Flood events and debris flows have been occurring in steep forested waterways for millions of years. These events will continue to occur and may increase in intensity and frequency with climate change. When these events occur in harvested catchments the impacts may be amplified.

New Zealand's indigenous freshwater organisms have developed adaptive strategies and varying degrees of resilience to cope with flood events. Some species have adaptive strategies that enable them to colonise, survive and thrive in the post-event stream conditions. Other species and taxa are less resilient and their recovery time is unknown. Invertebrate and fish density and composition is likely to change with time, as the species adjust in response to changing physical conditions.

## Reference


Baillie, Brenda R.; Evanson, Anthony W.; Kimberley, Mark; Bergin, David. (In preparation) Effects of an extreme rainfall event and debris flows on recently harvested headwater streams in New Zealand.

Environmental Forests Debris Flow fact sheet
www.scionresearch.com/?a=60576

Environmental Forests Wood in Streams fact sheet
www.scionresearch.com/?a=66038


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Scion is a New Zealand Crown research institute that specialises in research, science and technology development for forestry, wood and wood-derived materials, and other bio-material sectors.

Scion's purpose is to create economic value across the entire forestry value chain, and contribute to beneficial environmental and social outcomes for New Zealand.

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