Discussions on science support of riparian setbacks September to November 2011 emails Claire Graeme (DoC) and Bridget Robson (BOPRC)

Hi Claire
My reading of Roddy's research is that does not show that stream banks in a plantation forest are a significant source of sediment. Nor does the paper address the role of riparian vegetation controlling stream bank stability by comparing the performance of native forest to plantation forest.

Before expanding on why I reached this conclusion, I think we need to clarify what is going to be effective at achieving the outcome that addresses your concern.

If the concern is large amounts of sediment entering streams; with sometimes very significant consequences for in-stream biota **then** the primary target by a large margin (>90%) is forest infrastructure management, for good soil mass control and good water control on exposed surfaces.

Riparian margins have a great "feel good" factor, but robust responses that will survive a section 32 analysis demands that there is good science support for the choices that we make on the NES. That means we should primarily tackle the biggest problems or sources. Those that have a low benefit or low effect on the outcome would be tackled much later than those with a high and obvious link.

So, going back to the outcome being to **reduce sediment inputs into water ways**, where the biggest source is from earthworks/infrastructure, then the wide riparian margins can create more problems than they might fix.

The primary risk is in creating forest harvest infrastructure – roads and landings. If the size of the riparian margins is such that it is no longer possible to pull across a whole valley to one landing, then the increase in roads and landing required for harvest leads to increases in exposed ground, which leads to increased risk of that exposed ground moving. This increased risk on an increased area will more than outweigh the value of a wider riparian setback.

You note that the Roddy's research identifies stream-bank erosion in production forestry as a source, and have highlighted parts of the research. Put in a table though, on his first analysis this is how significant a source it is:

	Native forest	Exotic forest	pasture
Total sediment sources	40%	33%	27%
Surface sources 10%			
Sub surface sources 62%	25%		
Stream bank sources 28%	11%	9%	

On his second analysis:

	Native forest	Exotic forest	pasture
Total sediment sources	62% +/- 17%	23% +/- 12%	15% +/- 1%
Surface sources 8%+/- 6%			
Sub surface sources 79% +/- 6%	49%		
Stream bank sources 13% +/- 5%	8%	3%	

I can't tell whether his paper identifies total area of each land type feeding into the estuary, to see what he proportional representation is (i.e. is native forest 62% of the catchment with a proportional sediment input? – or is it more area, thus has a comparative lower input?)

All we can glean from his second analysis is that of the input types, the input from exotic forest due to stream bank sources is about 3%, and the input from native forest stream bank sources is about 8%. From what you sent through of Roddy's work there is no evident distinction in rate of sediment loss from stream bank between native forest and plantation forest, so changing from plantation to native vegetation is not a question he has analysed. He has observed that logging disturbance appears to increase stream bank erosion, but he has also observed that vegetation quickly colonised the banks and that stream-bank erosion was hard to find in closed canopy exotic forests.

Chris Philips and Mike Marden's work would not necessarily correlate with Roddy's view, that low magnitude/high frequency events would keep stream bank erosion active in the exotic forest and agricultural landscape units. This is because for much of the plantation forest cycle the hydrological regime is more like that of native forest. There are only a few years where a pasture and a plantation forest catchment would have similar runoff and thus flow and erosion characteristics. i.e. just as for macro-invertebrate and fish species/presence, in the main the plantation forest system will look and operate more like a native forest than it will a pasture system.

I also ran into Ian Boothroyd on a recent field trip and he is happy to help out with any interpretation issues we may have with his work, so I'll have a go at interpreting what his research is saying for our context, flick it past him and get back to you on that as well. I presume you mean the paper "Riparian buffers mitigate effects of pine plantation logging on New Zealand streams 2. Invertebrate communities John M. Quinn,*, Ian K.G. Boothroyd, Brian J. Smith?

Regards

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From: Claire Graeme [mailto:cgraeme@doc.govt.nz]
Sent: Thursday, 29 September 2011 3:15 p.m.
To: Bridget Robson
Subject: RE: riparian setback research

Thanks Bridget

Yes, I agree that riparians aren't going to stop large scale sediment movement across a slope into streams. I've walked past recently harvested areas with good riparian buffers in the rain and seen streams of mud going into the water. But the stream banks and near stream area under the riparian vegetation was intact. What the Roddy paper did show (from my interpretation) was that stream banks are a significant source of sediment (thought certainly not the biggest source), therefore reinforcing the idea that riparians can stop some part of the forestry area from losing its soil and entering the system. I think this shows that riparian areas are important and do have a function in retaining soil, alongside their other roles.

Also the Boothroyd Quinn papers and several others show how the stream system where a wider (18m average width) riparian protected stream can stay relatively intact and healthy compared to clear cut examples. The benefits, cooler temps, lower periphyton growth etc. are clearly evident. In the Boothroyd paper the clear-cut examples had distance to stumps ranging from 6m to 0m which I think indicates that 5m setbacks aren't going to generally provide you much riparian protection. The problem is that the riparian vegetation isn't going to be retained necessarily over the harvest period so some of the benefits won't occur. This paper didn't show where the soil came from, but it did show that a particular width of riparian's result in healthier stream systems, surely that is the result we are after?

So riparian areas are important to:
- help keep streams healthy and lower the 'shock' period over harvesting.
- Retain and reduce soil erosion from the stream bank area
- Studies and scientific advice is to have a riparian that is: permanent, continuous and over 10 wide.

I still see riparian margins as a practical and sensible way to protect receiving environments.

But I agree that limiting sediment movement on the rest of the forestry area isn't going to be addressed by riparians much and that we need to look beyond riparian margins to solve this problem. How do you see erosion and soil movement being best addressed? Has the NES managed to address this? The Roddy paper talked about the need to have forestry on mid-slopes and not have the high risk erosion period during harvesting occur on the very high risk areas (keep them permanently forested). That is about <u>where</u> the forestry is located. I'm not sure that councils are actually turning down forestry or replanting in the steepest areas?

Forestry is still going to occur on orange areas (and probably some red too) which have a pretty high risk of erosion occurring still. Shouldn't we therefore also control the amount of earthworks and harvest area on high risk sites? I see your plan contains a number of provisions for limiting the size of earthworks exposed in steep areas, but doesn't look at the size of harvested areas exposed.

Here are some more extracts from Roddy thesis below.

A pilot study was conducted as the sediment fingerprinting technique had not been applied before in New Zealand. The pilot study tested the null hypotheses that the sediment fingerprinting technique could not distinguish between the three landscape units (native forest, exotic forest, and agriculture) in the Whangapoua Harbour catchment, nor that it could distinguish between the three erosion positions (surface, subsurface, and streambank erosion) that had been identified as potential sediment sources in the catchment (Chapter 2). The pilot study showed that sediment fingerprinting could distinguish between the landuses and the sediment positions, thus the null hypotheses were rejected. The relative contribution of sediment to the estuary by landscape unit determined in the pilot study was 40% from native forest, 33% from exotic forests, and 27% from agriculture. The relative contribution by erosion position was 10% from surface sources, 62% from subsurface sources, and 28% from streambank sources (Table 5-4). It was observed that the sediment fingerprinting statistical verification method did not optimise the number of geochemical elements identified by the Kruskall-Wallis H-test by discriminant function analysis (DFA). A resampling method (Jackbooting) identified that there was a hierarchy of importance of geochemical elements and that the default *F-to-enter* score of one in the DFA process was too low. An *F-to-enter* score of three provided a better optimisation of elements in the DFA process and meant that only geochemical elements that were statistically were used in the mixing model.

A full sediment fingerprinting programme was conducted in the Whangapoua catchment (Chapter 6) and showed that the native forest landscape unit was the main sediment contributor to the estuary (62% ± 17%) followed by exotic forests (23% ± 12%) and then agriculture (15% ± 1%) (Table 6-7). The results for 'process' was that the majority of sediment was derived from subsurface sources (79% ± 6%) followed by streambanks (13% ± 5%) and then surface sources (8% ± 6%) (Table 6-7).

Streambank erosion was also observed in the exotic forest areas. There appears to be no buffering of riparian zones in harvested areas where higher order streams occur. The logging disturbance appears to increase streambank erosion by stripping away the protective vegetation (Figure 2.18-A). It was also observed that vegetation (mainly exotic weeds) quickly colonised the banks (Figure 2.18-B) and that streambank erosion was hard to find in closed canopy exotic forests (Figure 2.18-C) due to the large variety of shade tolerant understory species (Ogden *et al.* 1997).

The low magnitude/high frequency events would be more important for the mid-slope exotic forest and lowland agricultural areas as the absence of steep slopes means that large amounts of sediment are not delivered to streams via landslides. Low magnitude/high frequency storm events would keep streambank erosion active in the exotic forest and agricultural landscape units as streambank erosion is an efficient deliverer of sediment to streams in the moderate and lowly coupled mid and low slope areas. Low magnitude/high frequency events would also remobilise sediment from surface erosion and smaller landslides in the exotic forest landscape unit.

11.6.2 Objective 2

The second objective was to:

> *identify the dominant processes generating the sediment within the native forest, exotic forest, and pastoral landscape units.*

This objective has been met with the identification that the main sediment source was from subsurface (i.e., landslide), followed by streambank erosion, and then surface erosion. The dominance of subsurface sources was confirmed by radionuclide tracing techniques. To be consistent with the first objective results, it appears that low frequency/high magnitude rainfall events in the native forest/headwater areas trigger landslides that efficiently deliver sediment to streams. High frequency/low magnitude events are more important in the harvested exotic forest/mid-catchment area and agricultural/lowland plains area where streambank and surface erosion are more important, but decoupling buffers some of the impacts.

From: Bridget Robson [mailto:Bridget.Robson@envbop.govt.nz]
Sent: Wednesday, 28 September 2011 9:46 a.m.
To: Claire Graeme
Subject: RE: riparian setback research

Hi Claire

I have loads of papers on:

- Contrasting sediment loads in various catchments (pumice, greywacke, mudstone) with various vegetative cover (pasture, native, Plantation)
- The impact of harvesting on macroinvertebrates (with control catchments in pasture and native)
- The impact of harvesting on fish (with control catchments in pasture and native)
- Sediment transport mechanisms in-stream and to estuaries
- Sediment effects of various forest earthworks (comparing 1970's style to present practice, good and bad practice)
- Differential sediment loads at different phases of the forest production cycle (higher just after harvest, but when averaged over a whole forest cycle = about 1/3 the sediment load provided by pasture)
- effects of various treatments of slash in streams n fish and macroinvertebrates

What I don't have is any studies showing the influence of riparian margins (at various widths) on sediment transfer into streams in a clear-fell plantation forest context. That is what I was hoping you might have.

The ones you have sent through are about sediment that has already reached stream systems. Those papers are discussing sediment transport (and proportions by land use) into the harbour. The papers compare quantities and rates of transport, but not how sediment sources reach the streams in the first place. Thus they provide no guidance on what would be an effective treatment to reduce sediment inputs to streams.

My observations are that due to the "leggy" nature of riparian vegetation in a forest (compared to the dense sward created in a high light environment of a pasture riparian margin) the sieving capability of a permanent riparian buffer is very limited. I am also aware that most sediment transfer comes in huge dollops; from slope failure or earthworks failure. The volume and speed with which this arrives at a stream overwhelms any riparian vegetation. You are then faced with often tens of years of sediment transport through the stream system.

In the Coromandel (which has been extensively studied) this in-stream sediment mobilisation occurs at different storm frequencies depending on the nature of the catchment cover, with smaller events mobilising sediment in pasture catchments and larger ones mobilising sediment stored in forest streams. By only mobilising in the larger events, the amount transferred in these events is proportionally larger too. Another feature about the Coromandel streams is the history of land interference. There are legacy sediment issues from all of these: Kauri logging and the associated log flumes, gold mining and the massive amount of soil moved to get at those deposits, pasture farming on areas too unstable to support it long term, with extensive soil slip, then hydrological changes as a result of changing from a pasture to a forest regime. All these mean that there are a large number of streams with significant sediment loads already in the stream, that the sediment is working its way down the stream system. Some of them the sediment is perched or parked most of the time and only mobilised in large events. But this legacy load does muddy the waters (so to speak) of research into the impacts of various land uses now. Chris Phillips (Lincoln office) or Mike Marden (Gisborne office I think) at Landcare Research are both useful people to talk to if you want to find out more about those dynamics.

I just don't see the research or evidence base to support conclusions that a non-crop riparian buffer stops sediment and a wider one will stop more. It doesn't tie in with the observations or experience of those extensively involved in RMA forest management in the Bay of Plenty. While we definitely want to minimise sediment inputs, we believe that there are much more effective treatments to do that than what [uniformly wide] riparian buffers can provide.

Regards

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From: Claire Graeme [mailto:cgraeme@doc.govt.nz]
Sent: Tuesday, 27 September 2011 3:42 p.m.
To: Bridget Robson
Subject: RE: riparian setback research

Seems to be lots of info coming from coro area based around impacts on estuarine ecosystems. Some of these papers findings differ, but some common themes coming through and some useful questions.
Jone (2008) attached.

Also will send Gibbs paper.
Also Roddy's thesis. Not sure if I can send you Roddy though as is huge. Will send ref. and some key points if I can't.

You will probably have most of the other papers already I imagine. Boothroyd and Quinn etc.?

From: Bridget Robson [mailto:Bridget.Robson@envbop.govt.nz]
Sent: Tuesday, 27 September 2011 8:55 a.m.

To: Claire Graeme
Subject: riparian setback research

Hi Claire
I've had a trawl back through the various research papers people have sent round through the NES process, and other ones I am aware of. But have yet to come across one that focusses on the effect of forest riparian distances on sediment transport. Do you still have the reference of the one you were talking about last week? I'd be really interested to see it.

Regards

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