Don't Raise The Titanic: How To Set Priorities For Stream Rehabilitation

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SUMMARY: Are you interested in rehabilitating streams? If you are spending your scarce money working on highly degraded streams, then your priorities may be wrong. For rehabilitation it is usually more effective to protect remaining remnants of natural stream, than to salvage badly degraded streams. For effective stream rehabilitation we need a new way to set priorities that takes into account the following features: **rarity** (rare before common), **condition** (good before bad), **trajectory** (deteriorating before improving), and **ease to fix** (easy before hard). Using these criteria we define nine categories of stream reach, from highest priority to lowest, so that you can decide where to work first. You also need to set priorities for the problems that you treat in each reach. We believe that the procedure described here provides a foundation for a successful stream rehabilitation plan.

THE MAIN POINTS OF THIS PAPER

- Priorities for stream rehabilitation should be set in terms of how much natural bio-diversity (or some other measure of stream health) you can get for your money or effort.
- Do not automatically start rehabilitation at the most damaged reaches. In terms of stream health it is usually more effective to protect (preserve) reaches of stream that remain in good condition, than to spend huge amounts of money trying to rehabilitate reaches that are already damaged.
- Similarly, it is usually more efficient to stop a stream deteriorating than to try to fix it later.
- When the good quality assets of the stream have been protected, then you can begin to improve the degraded assets.
- Priorities should be defined hierarchically from national down to the local scale, from large catchments down to reaches of sub-catchments.
- When protecting or improving a reach, you should be careful to identify any fatal or limiting problems, and fix these first.

1. INTRODUCTION

Every year, at least $50 million is being spent on stream management in Australia (White et al, this volume). Where is this money being spent? Without doubt, most of it is being spent on controlling erosion in the streams that are in the worst condition. Making such degraded streams a priority for management is perfectly logical when the manager is protecting assets, such as roads, bridges and valuable land, from the ravages of stream erosion. However, pouring money into degraded streams is not always the best way to allocate resources if your goal is ecological rehabilitation. In this paper we argue that ecological rehabilitation of streams demands a new set of priorities.

What is ecological rehabilitation? It aims to return some of the natural environmental values of the stream that existed before European arrival. This condition can usually be measured by the range of native organisms (plants and animals) that the stream sustains. In order for the stream to sustain these organisms it has to have acceptable water quality, rates of erosion and sedimentation, and appropriate physical structure (such as large woody debris, pools and bed materials). There are, of course, many other reasons why you would manage your streams. These usually involve threats to human use of the stream and floodplain (eg. erosion and flood control). At some point your priorities for stream rehabilitation have to be meshed with your priorities for these utilitarian activities. This 'meshing' is usually a political process reflecting the values of the people involved. We will not go into this process here, instead we assume that your primary goal is ecological rehabilitation.

There are hundreds of thousands of kilometres of streams in Australia, with myriad different problems. There are hundreds of different groups, with minimal resources, trying to address those problems. New procedures are becoming available for those groups to describe and assess the condition of their streams (eg. Anderson method (Anderson 1993), Index of Stream Condition (DNRE 1997)), but these methods do not really consider the next vital step – in what order should you start to tackle the overwhelming range of problems that they identify? In this paper we will discuss some principles for setting priorities for stream rehabilitation projects. What reaches of a stream system should you concentrate on, and what problems should you tackle first. This process of setting priorities is more fully described as part of a full stream rehabilitation procedure in the 'Australian stream rehabilitation manual' available soon on the LWRRDC web site.

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2. ON WHAT BASIS DO YOU SET PRIORITIES?

Let us consider an analogy that will help us to set priorities for stream rehabilitation.

2.1 Saving the Titanic

Imagine that you are in a small rescue boat on the sea. You are watching the Titanic sink. The ship is doomed, but you can save a pitiful number of passengers in your little boat. Who do you save? This is a tough problem because some of the passengers are cute and attractive, others are rich, most are normal people. Which ones most deserve rescue? Women and children traditionally have priority (Figure 1).

Figure 1: The Spirit of heroism defining priorities on the sinking Titanic. (Marshall Everett, Wreck and Sinking of the Titanic)

But you look around and suddenly notice that the Titanic is not alone on the sea. In fact, as far as the eye can see there are ships of all sizes in different kinds of trouble. Some have only their funnels above water, some are burned to the water-line, but are still limping along with survivors on board. There is a damaged ship that is full of school children, and another that is full of used car salesmen. But look! There is a large ocean liner in good condition, with thousands of people on board, heading towards an iceberg! You are faced with the deadly dilemma. Do you stay and save a few passengers on the Titanic (including the particularly cute one that you have seen in the water), or do you save many thousands more lives by rushing to warn the other ocean liner of its danger? There isn't time to do both.

The situation for stream rehabilitation is similar, if you imagine that the ships are stream catchments and reaches, and the passengers are the biological communities that they support. There are many more streams that are damaged, and at risk of deteriorating further, than we can hope to save with the resources available. How do you decide where to start? It is possible to identify similar priorities for managing catchments for bio-diversity, as for saving passengers.

At sea, you base your priorities on how you can **save the most lives**, just as in streams, you should base your priorities on how you can **save the most biodiversity**. It is more efficient to keep the ships afloat, rather than trying to rescue some important passengers from them. Similarly, it is most efficient to save entire reaches, rather than attempt to rescue individual species or communities and leave the reaches to be destroyed. Just

Table 1: Priorities for saving passengers and for rehabilitating streams – in order of priority

Priority	Rescuing the Titanic	Rehabilitating Australia's streams
1	Save ships with more valuable passengers (the children) before those with less valuable passengers (perhaps the used car salesmen?).	Save reaches that support valuable organisms or communities (rare or endangered) before you turn to less valuable reaches that support common organisms..
2	Make sure that the ships that are in the best condition stay in that condition, before you try to fix the ones that are already sinking.	Protect the streams that are in the best general condition, before trying to improve the ones that are in poor condition.
3	Stabilise the ships that are beginning to get damaged, but are not yet sinking, and so do not yet need many repairs.	Stop streams deteriorating, rather than waiting for then to stabilise and then trying to accelerate recovery.
4	Accelerate the rate of repair of ships that have been damaged, starting with those that need the least repairs, and so are easy to save.	Improve the condition of reaches that are damaged, beginning with those that are easy to fix.
5	So long as there are still ships that need protecting or repairing, don't bother raising the Titanic once it has sunk!.	While there are still reaches that need protecting or improving, don't bother trying to fix reaches that are already extremely degraded.
Note!	Identify the most important problem! A big hole in the side of the ship might be the obvious problem, when a smaller hole hidden below the water line is causing the ship to sink.	Identify the most important problems. Raw banks and erosion may seem obvious problems, when the real problem could be water pollution in storm runoff.

as it may be tempting to save the attractive, cute person in the water, it may be just as 'unfair' to expend all of your resources on a cute family of platypus in a degraded stream, when you could be saving whole communities of organisms for the same cost

Table 1 shows six principles, in order of priority, for deciding what actions to take to save the most people at sea, or the most natural biodiversity in our streams.

2.2 Protecting and improving natural assets

In the past, stream management has concentrated on identifying 'problems' such as erosion, pollution sources and the like. By contrast, stream rehabilitation should concentrate on identifying natural assets. These are desirable 'natural' features of a stream that you which to protect and enhance. You protect and preserve an asset by controlling or removing any processes that pose a threat to an asset, or are already causing the asset to deteriorate. Such threats can come from within the reach, (such as weed infestations, or erosion), but could just as easily come from up or downstream, (for example, bad water quality from upstream, or erosion heads from downstream). Threats may not come from the stream at all, but from other activities in the catchment.

Some examples of assets protection would be:

- Declaring a high conservation value area to be a 'special conservation zone'.
- Stabilising headcuts that are migrating upstream into the reach.
- Specifying strict design guidelines for culverts built within high priority areas.

We are not, of course, suggesting that you be overly pedantic about protecting small details in one reach, while major damage is occurring elsewhere. You would not waste time haggling over a tiny increase in turbidity in a good reach, while a downstream reach in moderate condition has 200 cattle drinking directly from the stream.

So this is the order that you do things in: protect the rare and important assets, then turn to protecting and improving the condition of any reasonable quality reaches that are deteriorating, and finally improve the remaining more degraded reaches of the stream.

3. INFORMATION REQUIRED FOR SETTING PRIORITIES

What information do you need to set priorities for action in your catchment? The following assumes that you have divided the stream into reasonably homogenous reaches, usually of several kilometres in length. These are the basic planning unit that we use. Condition of a reach is assessed against a template, that is usually built up from an amalgam of historical and empirical information. The template represents the 'target' condition for the reach, which is as close as possible to the original stream condition.

Assets are characteristics of a reach, that are in good enough condition to be similar to your target for the stream. Thus, a near-natural riparian zone, or macroinvertebrate community, would represent assets. A reach in generally good condition (relative to the template) would be considered an asset in its own right. You would also identify degraded assets, which are reaches that have suffered damage.

It is not enough simply to look at the stream condition and identify assets, you must also consider: (1) the **rarity** of the asset in the region and in the catchment; (2) the **trajectory** in the condition of the reach (is it getting better or worse); (3) the **ease** with which you could improve the asset; and (4) the processes that are **degrading** or threatening the assets, and how these could be treated.

4. SETTING PRIORITIES

Of the reaches that you have assessed, how do you decide which deserve immediate attention, and which can be left for another day? Using the principles described above, you can rank reaches according to **rarity** (rare before common), **condition** (good before bad), **trajectory** (deteriorating before improving), and **ease** (easy to fix before hard). This gives you the nine categories that are listed in order of priority below. Once you know which reach to work on, you move onto identifying the problems that threaten the assets in that reach.

"Always preserve rare reaches, or reaches in good condition, first!"
"Work *down* from reaches in good condition when rehabilitating streams"
"When you have reaches of equal condition, rank according to trajectory, and how easy the problems will be to fix"

4.1 Reach Priority Categories

Category Zero: ***Reaches in good condition throughout, that are already protected.*** Reaches in this category need nothing done to them. There are no active threats, and they have been protected against potential threats. All the assets in these reaches are in good condition. All this reach needs is a watchful eye, to check for the development of new threats in the future. The aim of rehabilitation is to move all reaches into this category.

Category One: ***Protecting Regional Conservation Value reaches***. The highest priority is to preserve those reaches with assets that are important nationally or regionally. These could contain endangered species or communities, or be a good quality remnant of a once common stream. For example, the riparian vegetation on the lower LaTrobe River in eastern Victoria is mostly cleared, like almost all rivers in the area. However, one 10 km reach on the LaTrobe has escaped clearing, and retains fairly natural riparian vegetation, providing

natural densities of large woody debris to the stream. Because so few lowland rivers in Gippsland retain a healthy riparian zone, this reach has Regional Conservation Value.

Often you may have no reaches in this category. Alternatively, you may have more than one reach (a rare fish species could be found through half a river system). Protecting these reaches, and preventing any decline in condition, is the highest rehabilitation priority. **Protection must include identifying and fixing threatening problems that come from *other* reaches** (how to identify such problems is described below). These **threatening reaches** may themselves have little value, but it is important to prevent them from causing deterioration elsewhere.

Category Two: ***Protecting Local Conservation Value reaches***. These are reaches in such good condition that they can be considered to be surviving remnants of the original stream (a possible template reach). Unlike the remnant reaches in category one however, local conservation value reaches will be common in the region, though they may be rare within the catchment. For example, the headwaters of the LaTrobe River are forested, impacted only by logging and road construction. These tributaries have Local Conservation Value, because many of the headwater streams in surrounding catchments are also forested. Such remnants should be the second priority for protection. Once again, **preventing these reaches from deteriorating involves treating all threatening problems, including those from *outside* the reach.**

Category Three: ***Protecting and improving deteriorating reaches***. Some reaches will already be damaged, but their condition is continuing to *deteriorate*. As with Categories one and two, it is usually more efficient to stop further deterioration than to wait for the damage to plateau-out, and then try to fix it. Consider, for example, a river with a large weir that forms a barrier to fish passage. Upstream of the weir, the fish populations are declining, and will eventually disappear altogether. It is better to provide fish passage now, while some fish remain, than wait till later and have to re-establish the population from nothing. **Note that this category does not include any reaches already in extremely bad condition. These basket case reaches have low priority (categories seven and eight).**

Category Four: ***Improve close reaches.*** At this stage you should have *protected* all of your important assets, and you are now free to begin to *improve* the condition of the stream. It is easiest to do this by expanding an area in good condition, rather than trying to create a new island of improved stream amongst the degraded reaches. There are two reasons for this. First, although quality assets can be isolated within an otherwise degraded setting (a healthy riparian zone beside a stream with a sand slug, for example), their value is greatest when combined with other assets to form a complete stream community. Secondly, the recovery of plant and animal communities is generally fastest when there is a healthy community close by. This is because colonising individuals will find the new habitat faster if there is no barrier of inhospitable degraded stream. So, in order of priority, you should:

- Work on improving the degraded assets in a reach that already has some high quality assets;
- Work on a poor quality reach that link two asset rich reaches;
- Work on a poor quality reach connected by one end to an asset rich reach.

The lower Hopkins River in western Victoria has various reaches that are in quite good condition because they run through basalt gorges. The intervening reaches between the gorges are on sedimentary geology and are in poor condition, being cleared and heavily grazed. Normally these generally degraded sedimentary reaches would not receive high priority, but because they will link two good reaches, they should receive higher priority.

Category Five: ***Improve impeded recovery reaches (easily fixed reaches)***. These are reaches in poor, but stable condition (ie. although degraded, their condition is not deteriorating). A natural recovery process ought to be occurring, but some stream problem prevents this. If you identify and fix that problem, you can allow the natural recovery to do the hard work of improving the stream condition. An example would be a reach degraded by nutrient enrichment from a point source such as the outfall from a trout farm. Improving the water quality will pave the way for a rapid recolonisation of the reach by stream animals.

Category Six: ***Improve moderately damaged reaches (more difficult to fix)***. These are reaches that are damaged by human impact, but have good potential to recover at reasonable cost. They differ from Category Five streams, because instead of requiring only a single intervention to improve their condition, Category Six streams require several changes. This is typical of many lowland and floodplain streams. For example, they may be cleared of riparian and inchannel vegetation, with marginal water quality and some fine sediment deposition in the channel. Simply revegetating these streams will not rehabilitate them.

Category Seven: ***Improve basket-case reaches*** These are reaches that are in very poor condition, that do not threaten other reaches, but have little chance of recovering by themselves over time. An example would be a channelised stream that has such a low-slope, and low energy, that it cannot cut a new course (Brookes 1987). These reaches have serious instream problems and need intervention to recover.

Category Eight: ***Improve basket-case reaches with hope*** These are the reaches that are in very poor condition, that do not threaten other reaches, but that have some chance of recovering themselves with time. An example would be the high-energy reaches, close to the mountain front, that tend to get damaged by large

floods. Such streams are very expensive and difficult to artificially rehabilitate, and have a pretty good chance of recovering themselves over time. Many lowland streams in coastal NSW could fall into this category. Note that these streams may get bumped up the priority list if their instability threatens downstream reaches.

It is interesting to note that it is 'Category Seven and Eight' streams that have received most of the stream management attention, and most of the stream management resources in Australia over the last thirty or forty years.

4.2 How to use the reach priority categories.

How would this ranking procedure work in the common situation where one reach has both high and low quality assets? The upper reaches of Seven Creeks. for example, in Victoria, are of Regional Conservation Value, because they contain one of the few remaining populations of the endangered trout cod. However, the reaches where the trout cod live are only in moderate condition. How do mixed asset reaches like Seven Creek fit into the reach categories? This dilemma is best handled by allowing each reach to be in more than one category.

1. In each reach that falls under categories 1-3, just do the work that is implied by the title of each category. The trout cod reaches in Seven Creeks are in Category 1: *Protect Regional Conservation Value* reaches. The asset with regional conservation value is the trout cod, so, as priority one, you should protect those cod.
2. Now that you have protected the trout cod, reconsider the quality of the reaches. What needs to be done now? Are **all** the assets in good condition? Are they **all** protected against future threats?
    - If you answer yes, then congratulations, the reaches are now upgraded to *Category Zero*!
    - If you answer no, then there is still work to be done in the reaches. You need to consider what priority this work would have, relative to all the other reaches in your stream. This will be the case with the reaches in Seven Creeks that support trout cod.
3. Categorise the reach again. The trout cod reaches would no longer be Category One, because they have now been protected. Other ecological assets in the reaches do not have special conservation significance, and are only in moderate condition. They now fall into Category 4: *Close reaches*, because they have at least one high quality asset (the cod). So, you will treat any other reaches of Seven Creeks that fall in Categories Two and Three, and then return to the trout cod reaches.

4.3 Getting bang for your buck - Exceptions to the reach categories

Here are reasons to work on a reach with low priority before one with high priority. So far, our emphasis has been on extracting the largest ecological gains for the effort invested. In reality, there are other important criteria that may also be used to make sure you get the most bang for your buck, in the long term. You may decide to rearrange your reach priorities if a particular reach will be unusually **influential.** It may be highly visible from the road, contain a charismatic (if not rare) animal eg. platypus, or be owned by an influential landholder. A second reason to alter the rankings is if a reach has **potential to have regional conservation value**, even if it does not have that value now. For example, the western Victorian unconfined basalt plains stream type are now so rare that rehabilitating one example would create a valuable asset. Thus, rehabilitating this degraded stream becomes a higher priority.

5. WHICH PROBLEMS ARE IMPORTANT?

Within your high priority reach, you have to decide which *problems* are important. To preserve an asset, you have to know what threats it needs to be protected from. To improve a reach, you have to know which problems have caused it to degrade, and which are stopping it from recovering. More commonly than not, you may find that each asset is being threatened or damaged by more than one problem. For example, in a typical rural stream, the fish population could be affected by high turbidity; high nutrient loads; habitat simplification caused by erosion, trampling by cattle, desnagging, and large quantities of sediment derived from erosion upstream; the presence of feral fish species such as carp, and possibly changes to the hydrology. This list could easily be longer. You must decide which of these problems demands attention now, and which can be safely ignored, at least for a while.

How do you decide which problem is most important? You need to identify the hierarchy of problems, from **fatal**, that are so bad that they exclude the animal or plant from the reach, to **limiting** problems that stress the species in question, to **nuisance** problems, that have minor effects on the population. For the stream community to fully recover, all of these problems need to be fixed., but in order to see the fastest improvements along the way, the problems should be tackled in that order. Finally, you should keep track of interactions between problems, so that you know when the success of fixing one problem will be **linked** to the condition of another problem.

The key point here is that, if an asset is threatened by both fatal and nuisance problems, then there is no point spending much time treating the nuisance problem. For example, the Mitta Mitta River has a variety of problems along it that could limit the population of native fish in the stream. These include poor riparian vegetation, and barriers to fish passage. However, the fatally limiting variable for fish in the stream is the cold water released

from the Dartmouth Dam. The cold water has dramatically reduced the number and diversity of native fish in the reach below the dam. If your goal is to return native fish populations to their original size and diversity, then there is little point planting riparian vegetation (presently dominated by willows), and improving in-stream habitat, when the water will still be too cold for fish. You either treat the fatal variable, or you go and work elsewhere.

5.1 Getting more bang for your buck: exceptions to the problem priorities

Just as there are reasons to work on a low priority reach, before one with a high priority, there are reasons to take a problem that is not the most fatal, or limiting, and work on it anyway. In the long run, these may give you more bang for your buck. This would be the case if, first, a non-limiting variable affected a **long length** of stream (eg. a barrier to fish passage), whilst a more limiting variable influenced only a short reach (eg. a pollution outfall that was toxic, but only for a few kilometres downstream of the outfall). A second reason to work on a less-limiting problem is **time for recovery.** Some stream assets will take a long time to recover. Although improving such assets may not be a high priority now, it is sometimes wise to start the recovery process now, so that the asset is there when it is needed. Riparian vegetation is a good example of this. It might be worth getting it growing now so that it will be available when the other limiting problems are solved in a few years.

6. SETTING REGIONAL PRIORITIES BY APPLYING THESE PRINCIPLES

We have discussed priorities mostly in terms of stream reaches. However, reaches are probably not the place to start setting your priorities. Instead you should set priorities from large to small scale, from the national scale down to the reach scale. In practice, this means comparing the condition of whole catchments rather than just reaches. The six principles for setting stream rehabilitation priorities for stream reaches (Table 1) work equally well for catchments or reaches. For example, the Thurra River in East Gippsland is one of the few coastal streams in SE Australia that is in close to original condition throughout its length (see Brooks "Lessons for the river manager from the fluvial Tardis …", this volume). However, the Thurra receives little attention when compared to its neighbouring stream, the Cann River, which has suffered from dramatic erosion (Erskine and White 1996). In terms of stream rehabilitation, at a national level, the Thurra River should be a priority stream. Then within the Thurra Catchment, priorities would be set for reaches according to the criteria described above. The Cann River, by contrast, will be managed for flood control, but it is unlikely to be a high priority for rehabilitation.

7. CONCLUSIONS

In the past, stream management priorities have been set in terms of reduced erosion and flooding. By contrast, priorities for stream rehabilitation should be set in terms of how much natural bio-diversity (or some other measure of stream health) you can get for your money or effort. Healthy, near-natural aspects of the stream should be seen as assets, and stream rehabilitation is chiefly about protecting existing assets and enhancing degraded ones.

Remember our sea of sinking ships in the Titanic analogy? All around you ships are in danger and some are sinking. Should you consider expending all of your resources raising the Titanic from the bottom of the ocean to provide accommodation for survivors? For much less effort you can save thousands of people by protecting the ships that are still floating! Unfortunately, 'Raising the Titanic' is exactly what we are doing with much of the stream rehabilitation work that is being done in Australia at present. By attempting to rehabilitate the most degraded streams we will not achieve our goals.

So do not automatically start rehabilitation at the most damaged reaches. Like most things in life, prevention is better than cure. It is usually more efficient to stop a stream deteriorating than to try to fix it after it has been damaged. Once the good quality assets of the stream have been protected, then you can begin to improve the degraded assets. When protecting or improving a reach, you should be careful to identify any fatal or limiting problems, and fix these first.

It is normal to begin setting our priorities at the scale of a reach, or a section of stream. Instead we should be setting priorities hierarchically, first at the national level, then down to regional, catchment, segment and finally, reach scale.

So to conclude, please ask yourself, are you trying to raise the Titanic with the work that you are doing on your stream?

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