The river restoration issue

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A critique of conventional practice

• restoration efforts usually are focused on the channel; this amounts to an attempt to control the symptoms of stream instability, rather than the causes—it is a significant problem that the symptoms are often of more concern to managers and to the public (because more visible) than are the causes

• the cause of stream instability is a mismatch between the current morphology and the governing conditions; the primary conditions of water and sediment supply are the most common source of problems
More critique

• restoration practice is based on a model of alluvial channel processes and morphology

  *most rivers in British Columbia are not fully alluvial; in general, only the distal courses of the larger rivers fit this template*

• restoration efforts focus on forcing a particular morphology rather than finding a stable state for the observed governing conditions

  *this almost always leads to a situation in which one is fighting the tendencies of the river, and usually leads to long-term failure*

Disconcerting fact

For given governing conditions, stream channels may exhibit a wide range of morphologies

(graph from Trainor and Church, 2003)
This condition presumably arises from the wide range of subtle variations in governing conditions and from historical contingencies that condition individual stream reaches.

Does it make sense, then, to design a specific geometry for the stream channel and expect the stream to take it up?

Where the degrees of freedom exist, it makes more sense to consider certain highly deviant, “pathological” states that we wish to avoid, and to plan to tolerate any other state that the stream may take up.

This at least will produce a more ready adjustment of the channel to the actual governing conditions, which we may not know in all details (and which may change over time anyway).
Our proposal . . .

Channel “restoration” concepts should give way to a concept of managing a channel to allow it to come into equilibrium with the imposed governing conditions;
-- these conditions include the imposed water and sediment supplies; bed and bank materials along the channel; riparian condition; topographic gradient; and any essential fixed constraints along the channel.

Some suggested rules for channel “restoration” activities

1. Do no harm
2. Give primacy to water quality considerations
   *Stream biota can adapt to a substantial range of geometries, so long as water quality is adequate*
3. Next consider appropriate streambank treatments
   *Streambank condition is the most sensitive control of lateral stability, and streambank vegetation is of high ecological importance*
More suggested rules for channel “restoration” activities

4. If at all possible, preserve the lateral freedom of the channel
   
   *Remember that the floodplain is a part of the channel, and that streams require lateral room in order to stage bed material downstream. The floodplain is also a diverse ecosystem.*

   *If the channel must be constrained, expect the stream to respond to the constraint by some other adjustment, such as degradation or channel armouring.*

Still more rules for channel “restoration” activities

5. For threshold channels, consider land surface conditions as the paramount means to manage the channel
   
   *Water and sediment yield to the stream are the major governing factors*

6. For labile channels, consider riparian conditions as the paramount means to influence the channel
   
   *Streambank integrity and gradient are key adjustable factors; the drainage basin probably is too large for planned action anyway*
Almost the last rules for channel “restoration” activities

7. Consider specific geometries only as a last resort. Test any proposed geometry by numerical or hardware modeling before implementation

- Do not expect in-channel structures (log, stone placements, cribs) to be durable

People are not as good as nature at stream design; it is better to establish the conditions for the channel to organise itself than to attempt to impose some fixed organisation

Last rules (honest)

9. Recognise that ongoing environmental change may impose continuing changes on the stream

10. Learn from experience: monitor all “restoration” actions

This implies planning from the outset to monitor, and it implies a reporting structure, which requires an ongoing chain of responsibility for the project

[Moses had 10 rules too]
Conclusion (I)

“Restoration” is not really that; it is more like “habilitation” – attempting to establish a pattern-stable and ecologically acceptable condition in a stream channel.

It is best to take advantage of the stream’s natural processes so far as possible to achieve it, since that will achieve the most sustainable result.

Conclusion (II)

The usual basis for “restoration” (or habilitation) of streams is based on an ideal template that resembles some wild, or near-wild state,

. . . but there is little evidence that the public is willing to accept the consequences of that template, which include a degree of lateral instability in labile channels; episodic major instability in threshold channels; and bank-exceeding floods in most channels.

Where does that leave us in “restoration” efforts?
Sediment in Channel design
At the planning & design level:
"can the channel transport the supplied sediment with the available water?"

Don’t sweat the bankfull. Pick something with a reasonable or useful return period.
Don’t sweat the channel width. Pick something within typical range for area.
DO sweat the sediment supply.
1. Is it a big number or a little number?
2. If a big number, then get the supply right, or relax the design expectation.

Contemplating cost and ecological rehabilitation in typical urban restoration
An incised channel, with tall eroding banks, coarse, rarely mobile sediment, little in-channel topographic variability. Low base flow, poor water quality. Few or no desirable benthic and fish species. Infrastructure at risk

Restoration objectives
Protect infrastructure, improve stability, improve appearance: reduce bank erosion
Improve water quality, reduce sediment, nutrient yield from site
interpreted as lower floodplain to improve detention & filtering

Approach
Rebuild channel – generally maintaining slope and channel section – helps ensure against blow-outs
Grade control imposed with BIG rocks placed in-channel
Grade banks and anchor with vegetation/boulders

Result: A green pipe
“Success” interpreted as a channel that does not fall apart: no incision, little bank erosion or migration but also little or no sediment dynamics producing disturbance, cleansing, and rearrangement of in-channel sediment structures

Alternatives:
Does this provide desirable or sufficient ecological improvement? What can be done to enhance ecological rehabilitation? This is expensive! Is there a cheaper approach that achieves all or most of the objectives? Plantings and local grading only? Addition of in-channel wood? Augmentation of desirable sediment sizes?