



# Quantitative assessment of the relationships among ecological, morphological and aesthetic values in a river rehabilitation initiative



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## ABSTRACT

Promoting community support in rehabilitation efforts through incorporation of aesthetic considerations is an important component of environmental management. This research utilised a small-scale survey methodology to explore relationships among the ecological and morphological goals of scientists and the aesthetic goals of the public using the Twin Streams Catchment, Auckland, New Zealand, as a case study. Analyses using a linear model and a generalised linear mixed model showed statistically significant relationships between perceived naturalness of landscapes and their aesthetic ratings, and among ratings of perceived naturalness and ecological integrity and morphological condition. Expert measures of health and the aesthetic evaluations of the public were well aligned, indicating public preferences for landscapes of high ecological integrity with good morphological condition. Further analysis revealed participants used 'cues to care' to rate naturalness. This suggests that environmental education endeavours could further align values with these cues in efforts to enhance approaches to landscape sustainability.

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## 1. Introduction

It has been asserted that the process of river rehabilitation has not truly begun until efforts strive to ensure that the river not only functions effectively in morphological, ecological and hydraulic terms, but also in socio-cultural terms (Chen et al., 2009; Higgs, 2003; Hull and Robertson, 2000; Nijnik and Mather, 2008; Spink et al., 2009). Landscape aesthetics are a critical component of these determinations, as they help to frame cultural visions of 'what is expected' for any given system (Hull and Robertson, 2000; Nassauer et al., 2001; Purcell and Lamb, 1998). Nassauer (1997:69) argues for a cultural sustainability built on the premise that 'landscapes that are ecologically sound, and that evoke enjoyment and approval, are more likely to be sustained by appropriate human care over the long term'. Cultural sustainability recognises 'the powerful effect of human perceptions, values, attitudes, and habits on the viability of restored [landscapes] ... (and) ... the potential for the public to become watchful caretakers of restored [landscapes] – if they recognize value in the landscape they see' (Nassauer, 2004:757). However, the fact that good ecological function and

notions of naturalness are not always synonymous with aesthetic appeal is problematic to this concept (Daniel, 2001; Ford et al., 2009; Tanago and Jalon, 2004). To date, limited research has appraised notions of culturally desirability in terms of aesthetics. The perceived naturalness of a landscape has been shown to be the most significant factor determining aesthetic appeal (Purcell and Lamb, 1998; Williams and Cary, 2002). At the same time, notions of 'naturalness' as management goals are highly contested (Fryirs and Brierley, 2009; Montgomery, 2008; Wohl, 2013; Wohl and Merritts, 2007). Prospectively, relating biophysical values to aesthetic values will provide a coherent platform to support movers towards an era of river repair (Brierley and Fryirs, 2008).

Hull and Robertson (2000) acknowledge the contestability of 'nature' as a subjective term or condition whereby decisions over which 'nature' to recreate in rehabilitation projects can be seen as negotiations over human values and preferences among different sets of actors. They note how seemingly scientific concepts such as naturalness, ecological health and integrity are value-laden and socially constructed. Consequently, contentions about what nature to recreate expose the disjuncture between aesthetics and science and gives rise to management questions such as where is the appropriate 'middle-ground' whereby all stakeholders are somewhat satisfied, or whose claims (or values) are strongest and,

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therefore, ought to be prioritised most highly (Hillman, 2004, 2006).

It could be argued that rehabilitation projects are destined to fail unless the ecological goals of scientists and environmental managers are viewed alongside the aesthetic considerations of the public, as these projects are unlikely to engender public involvement and support (Gobster et al., 2007; Nassauer, 1997; Zaugg, 2002). Alternatively, instances where aesthetic objectives override scientific considerations are also prone to failure (e.g. Nassauer et al., 2001). For example, historical and cultural preferences for the aesthetics of meandering channels may be an appropriate goal in only a small proportion of the circumstances to which they are applied (see Kondolf (2006)). Similarly, aesthetic preferences for exotic trees may be highly contested (Herzog et al., 2000) and recent research has highlighted differing societal preferences in relation to the presence/absence of wood in streams (Chin et al., 2008; Mutz et al., 2006; Piégay et al., 2005). Although evidence suggests that projects with higher aesthetic appeal are valued by the public and ultimately are more likely to achieve public support (Junker and Buchecker, 2008; Tunstall et al., 2000), efforts to incorporate these values have, to date, seldom been appropriately framed alongside scientific objectives.

In a landmark study, Junker and Buchecker (2008) show that aesthetic preferences and perceptions of what is 'natural' do not necessarily align with expert assessments of eco-morphological quality. Nassauer (1995) explains how evidence of human intention to care for landscapes can influence how people interpret and comprehend a landscape. Understandings of these interrelationships can help to designate cues to care serve as indicators of ecological quality and aesthetic appeal (Nassauer, 1995). However, what cultural values do these cues to care represent? In many instances, concerns for intentional care and neatness reflect the intent to 'control'. For example, flood control and safety improvement measures may be developed in conjunction with actions like pruning, mowing, removing unfamiliar plants, straightening and other actions associated with standard 'yard care' procedures. In New Zealand, the 'clean and green' slogan embeds the assumption of a clean landscape representing naturalness with the connotations of tidiness (Egoz, 2000). The stronger the implicit assumption of human presence, but with a lack of explicit cues, like concrete, within a landscape, the stronger the social claim over the landscape's ecological integrity. In this light, evaluations of naturalness are a function of the degree that people perceive the landscape to be 'cared for' or, in scientific terms, the extent of explicit management.

In arguing the significance of socio-cultural context to the cultural sustainability of river rehabilitation, this paper reports on quantitative results of a small-scale survey methodology (Punch, 2003) administered to the general public to critically examine the relationship between the ecological and morphological goals of scientists and the aesthetic goals of the public in a New Zealand setting. Firstly, this study quantifies the relationships between: ecological integrity and perceived naturalness, morphological condition and perceived naturalness, ecological integrity and aesthetic preference, morphological condition and aesthetic preference, and perceived naturalness and aesthetic preference. Secondly, the landscape elements that increase and decrease both the perceived naturalness and aesthetic preference of a riverscape are assessed.

## 2. Methodology

### 2.1. Site selection

The Project Twin Streams Catchment in Waitakere City,

Auckland, New Zealand (Fig. 1) covers some 10,000 ha. Rapid population growth in the area in the past decade has caused urban sprawl and precipitated a shift in land use activities from agriculture, horticulture and some manufacturing toward retail and construction industries. The population of approximately 103,000 people in Waitakere is ethnically diverse, young, and reasonably affluent, with more than half of the residents working in Central Auckland (Gregory and Brierley, 2010).

Public participation and engagement have been critical components of Project Twin Streams, a prize-winning urban river rehabilitation initiative fashioned by the local city council and the local community. Originally designed as a stormwater project to address residential flooding, Project Twin Streams evolved from community-based river rehabilitation activities targeting native species revegetation of 56 km of streambanks, into a project which has also sought to promote local community development (Gregory and Brierley, 2010).

The alignment of biophysical goals and socio-cultural objectives deems Project Twin Streams an appropriate location to explore aesthetic preferences of the public in relation to ecological and morphological condition. 'Real' sites were chosen for this investigation (cf., Junker and Buchecker (2008) used computer generated images). Thirty sites were chosen to represent a continuum of ecological integrity and morphological condition. Emphasis was placed upon biophysical attributes of the streams rather than water quality concerns such as their visual clarity (cf., Davies-Colley et al., 1993; Smith and Davies-Colley, 1992). Ecological integrity and morphological condition were treated as separate variables, both representing scientific evaluations of health and naturalness. Use of the term 'ecological integrity' follows the definition of Schulze (1996:101) where ecological integrity is considered to be 'the capacity to support and maintain a balanced, integrated, adaptive biological system having the full range of elements ... and processes ... expected in the natural habitat of a region'.

Ecological monitoring and morphological condition assessments have generated a large database in this catchment. The Macro-invertebrate Community Index (MCI) provides a standardized measure of ecological integrity in analyses of freshwater aquatic biodiversity in New Zealand (Harding et al., 2009). MCI scores were obtained from a report prepared by Kingett Mitchell, Enviro Ventures and Diffuse Solutions (2006) (see Table 1). For the purposes of this research, MCI scores were re-classified, as shown in Table 2, so that ecological integrity and morphological condition both had two classes.

Morphological condition was defined as 'a measure of the capacity of a river to perform functions that are expected for that river within the valley setting that it occupies' (Reid et al., 2008:7). Building upon the River Styles framework (Brierley and Fryirs, 2005) this includes considerations of river type, river behaviour, river evolution and aspects of human disturbance (Brierley and Fryirs, 2005:298). The appropriateness of geomorphic diversity is framed in the context of human modification (Fryirs, 2003). Morphological condition assessments for the Twin Streams Catchment were obtained from Reid et al. (2008) and (2009). Assessment criteria are presented in Table 3.

Poor morphological condition was defined as having a rounded morphological condition assessment score of 62.5% (5/8) or below, while good morphological condition were rounded scores of above 62.5% (6/8). This discriminating function separates half the sites as 'good' and the other half as 'poor'. Half the sites had gravel-bed (hard-bottomed) streams, while the other half had fine-grained (silt/sand; soft-bottomed) beds (Table 4). It was not possible to ensure an even split between morphological condition, ecological integrity and bed material size among the 30 sites, as fine-grained beds are characteristic of downstream sites which are generally

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