Environmental Science and Policy 76 (2017) 12–22

Contents lists available at ScienceDirect

Environmental Science and Policy

journal homepage: www.elsevier.com/locate/envsci

Integrated planning framework for successful river restoration projects: Upscaling lessons learnt from European case studies

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ARTICLE INFO

Keywords:
River restoration
Project planning
Adaptive management
Success
Evaluation
Monitoring

ABSTRACT

Despite considerable investment in river restoration projects, there is still limited information on the efficacy and success of river restoration activities. One of the main reasons is poor or improper project design, resulting in common problems such as: not addressing the root cause of habitat degradation; not establishing reference conditions, benchmarks and not defining endpoints against which to measure success; inappropriate uses of common restoration techniques because of lack of pre-planning; and inadequate monitoring or appraisal of restoration projects. In this paper peer-reviewed and grey literature and a large database of existing case studies were reviewed to identify the prevailing challenges river managers face when planning and developing river restoration projects. To overcome these current challenges an integrated project planning framework has been developed that incorporates adaptive management and project management techniques. It encapsulates key concepts and decision support tools to advance the existing sequence of project identification, project formulation, project implementation and post-project monitoring to incorporate multidisciplinary decision making to meet specific environmental and socio-economic objectives. The proposed river restoration project planning framework is adaptable and can therefore be applied to any project development scenario locally, regionally or internationally.

1. Introduction

Since the late 1980s, there has been a rapid expansion in river restoration projects in industrialised countries in an effort to improve degraded habitats and improve their ecological well-being. Despite considerable investment in these projects, there is limited information on the efficacy and success of river restoration activities (Bernhardt et al., 2005; Roni et al., 2008; Roni and Beechie, 2013). The success or failure, and underlying reasons for either, are rarely evaluated in most river restoration projects (Kail et al., 2015). Consequently, little is known about their effectiveness resulting in many restoration projects failing or falling short of their objectives (Bernhardt and Palmer, 2007); if such objectives have been established prior to the project implementation.

Planning is key to project management success, but, despite there being numerous guidelines available for river restoration project planning (e.g. Cowx and Welcomme, 1998; Hammond et al., 2011; Roni and Beechie, 2013; Gurnell et al., 2015), they are not readily applied by river managers and practitioners (Roni and Beechie, 2013). Globally, it is reported that there are limitations, or even disregard, within the planning stages of river restoration that subsequently restrict or prevent project evaluation (Montgomery and Buffington, 1997; Doyle et al., 1999; Boon and Raven, 2012; Jansson et al., 2007; Roni and Beechie, 2013). These limitations need to be understood and resolved to improve guidance that will further benefit existing and future restoration efforts at a local and catchment scale.

The primary goal of this paper is to present an integrated project planning framework for river restoration that will help practitioners and river manager address the common challenges when designing and implementing the most appropriate river restoration project successfully. The objectives of the paper were to critically review peer-reviewed and grey literature to identify the prevailing processes and challenges river managers face when planning and developing river restoration projects. Further, the objectives of global river restoration projects of European-funded LIFE & INTERREG projects in addition to a large database of existing European river restoration case studies collated for the European Union (EU) REFORM project – Restoring rivers FOR effective catchment Management (http://reformrivers.eu/) were evaluated against outputs/outcomes. The conclusions from the literature review and the analysis of existing case studies created a

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http://dx.doi.org/10.1016/j.envsci.2017.06.005
Received 19 February 2017; Received in revised form 9 June 2017; Accepted 10 June 2017

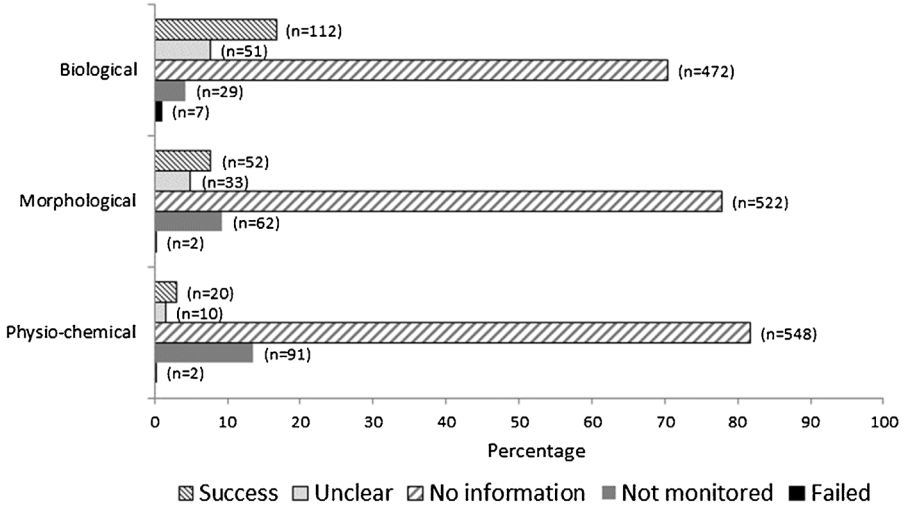

Fig. 1. Biological, morphological and physio-chemical success rates for 671 European case studies from the EU REFORM meta-database.

comprehensive baseline of characteristics and challenges in determining river restoration success or failure and were used to develop the proposed framework.

2. Analysis of existing restoration projects

2.1. Literature review

When planning and implementing river restoration projects, managers are met with perpetual challenges that often lead to unexpected or unsuccessful outcomes or simply do not have sufficient information on existing projects on which to base the project design (Bernhardt et al., 2005; Roni and Beechie, 2013). To identify these fundamental challenges, relevant literature published between 1971 and 2013 was located through a targeted ISI Web of Knowledge search. The following key terms and Boolean links were used: (Topic = (river* OR floodplain OR stream OR riparian) AND Topic = (restor* OR rehab* OR mitig* OR conserv*) AND Topic = (goal* OR objective* OR endpoint* OR benchmark* OR success*)). A total of 663 publications were identified and reviewed to identify the most common challenges or reasons for failure of river restoration projects. Poor or improper restoration project planning due to inadequate guidance (Bernhardt and Palmer, 2007) was found to be the foremost constraint that sequentially led to a number of issues:

- Absence of multidisciplinary approaches to restoration planning (environmental, socio-economic and engineering) (Doyle et al., 1999);
- Not addressing or lack of understanding of the root cause of habitat degradation (Boon and Raven, 2012; Roni and Beechie, 2013);
- Focus on single rivers and small scale restoration actions (failure to plan at a catchment scale and include upstream and downstream processes and connectivity issues) (Jansson et al., 2007);
- Not establishing reference condition benchmarks and success evaluation endpoints against which to measure success (Roni et al., 2002, 2008; Bernhardt et al., 2005; Bernhardt and Palmer, 2007);
- Lack of, or an inconsistent, approaches to sequence or prioritise projects (Roni and Beechie, 2013);
- Inappropriate use of common river restoration techniques because of lack of pre-planning (one size fits all) (Montgomery and Buffington, 1997);
- Failure to get adequate financial and technical support from public and private organizations;
- Cost/benefit analyses overlooked or poor documentation of project costings (costs generally grouped at 'total' cost for whole project) (Brouwer et al., 2009; Shamier et al., 2013);
- Inadequate monitoring or appraisal of outcomes of river restoration projects to determine project effectiveness (Cowx, 1994; Downs and Kondolf, 2002; Wohl et al., 2005; Rumps et al., 2007);
- Paucity of restoration projects that measure success in terms of hydrogeomorphological and ecological outcomes (Hobbs and Harris, 2001);

Advancing from the literature review, 952 European case studies were reviewed to ascertain the key challenges when determining river restoration project success or reasons for success or failure. Two sources of information were used to compile this information: 1) the EU REFORM case study *meta*-database; and 2) European-funded LIFE & INTERREG programmes.

2.2. EU REFORM database

The EU REFORM project compiled a meta-database from peer-review and grey literature to create a resource base of existing knowledge. From this database, 671 European case studies were reviewed to determine ecological outcomes (successful, unclear, no information, not monitored or failed) based on measured improvements to biological (e.g. fish, invertebrates and instream vegetation), morphological (river process and function, e.g. sediment deposition and remeandering) and physio-chemical (water quality including parameters such as dissolved oxygen, pH, nitrate and total dissolved solid) features. Only a small number of case studies reported ecological success (9%) or failure (1%): many studies were either unclear (5%) in their findings, the restoration works were not monitored (9%) or no information (77%) on the outcome was provided. The same pattern was found when subdividing ecological success rate into biological, morphological and physio-chemical success (17%, 8%, 3%), failure (1%, 0%, 0%), unclear (8%, 5%, 1%), not monitored (4%, 9%, 14%) or no information (70%, 78%, 82%), respectively (Fig. 1). This interrogation of the EU *meta*-database supports the conclusions expressed elsewhere (Downs and Kondolf, 2002; Bernhardt et al., 2005; Roni et al., 2008; Cowx et al., 2013; Roni and Beechie, 2013) that success or failure of habitat restoration projects is often not evaluated and therefore little is known about their effectiveness. Whilst the underlying reasons for the absence of project outcomes are complex, they are often attributed to limited guidance for river restoration planning and subsequent methods of evaluation of project success.

2.3. EU LIFE & INTERREG projects

To interrogate further the underlying causes for the failure to assess the outcomes of restoration activities, an online search of 281 EU