Pages 1-5 in Collier, K.J. (Ed), 1994. Restoration of Aquatic Habitats. Selected papers from the second day of the New Zealand Limnological Society 1993 Annual Conference. Department of Conservation.

RESTORATION OF FRESHWATER HABITATS: INTRODUCTION AND SYNTHESIS

Kevin Collier

NIWA, P.O. Box 11-115, Hamilton

ABSTRACT

Issues leading to the initiation of a special symposium on aquatic habitat restoration held at the 1993 Limnological Society conference are described. The ten papers presented in this proceedings are briefly introduced and their implications for future restoration works are discussed. Good communication at the community and professional levels should be maintained at all stages of restoration. The desired outcomes must be clearly defined and the goals should be presented in a way that maintains public interest and creates realistic expectations of the timeframes involved. The planning and implementation phases of restoration require a multidisciplinary approach that recognises the complexity of the systems that are being managed. Scientifically-based monitoring of the ecological outcomes is necessary for the continuing development of successful techniques.

INTRODUCTION

"He looked lovingly into the flowing water, into the transparent green, into the crystal lines of its wonderful design. He saw bright pearls rise from the depths, bubbles swimming on the mirror, sky-blue reflected in them. The river looked at him with a thousand eyes – green, white, crystal, sky-blue. How he loved this river, how it enchanted him, how grateful he was to it! In his heart he heard the newly awakened voice speak, and it said to him: "love this river, stay by it, learn from it". Yes, he wanted to learn from it, he wanted to listen to it. It seemed to him that whoever understood this river and its secrets would understand much more, many secrets, all secrets."
Siddhartha, Herman Hesse

In New Zealand (Aoteaora), aquatic habitats occupy around 3% of land area (Molloy and Forde 1980). This includes 776 lakes, most (69%) of which cover less than 0.5 km^2 (Lowe and Green 1987). In addition, there are approximately 186,347 km of rivers evident on 1:250,000 maps of the North and South Islands (Collier 1993). Assuming that mapping at that scale distinguishes only rivers of third order and above, and that 95% of river system length is represented by first and second order streams (as is the case in the U.S.A.; Leopold *et al.* (1964)), then there is probably a total of around 4 million kilometers of stream and river channel on mainland New Zealand.

The mauri (life force) of many of our freshwater ecosystems has been degraded by increasing demands for land, water, power, waste disposal etc imposed by a growing human population. In addition, land clearance has reduced native forest cover from 75% to about 23% of land area, and consequently almost half the length of rivers (at 1:250,000) in the North Island now flow through catchments with modified vegetation cover (Collier

1993). Increased light inputs, erosion and runoff associated with forest clearance can be expected to have altered the natural structure and functioning of many aquatic ecosystems. Other human-induced changes to aquatic habitats include the introduction of more than 228 species of alien aquatic plants and animals, and the draining of 90% of our wetlands.

The recently passed Resource Management Act 1991 (RMA) has heralded a new era of environmental management for New Zealand in which all natural resources are to be managed in an integrated and sustainable fashion. The RMA places statutory importance on "safeguarding the life supporting capacity of air, water, soil and ecosystems" and on "avoiding, remedying or mitigating any adverse effects of activities on the environment". The emphasis on remedial action or mitigation provides considerable scope for habitat restoration works, particularly in lowland areas where there has been widespread degradation of aquatic habitats.

It was with this background that the steering committee for the 1993 New Zealand Limnological Society conference decided on the theme of "Restoration of Aquatic Habitats" and organised a special symposium on the topic. International perspectives to the symposium were provided by Russell Shiel of the Murray-Darling Freshwater Research Centre, Australia, and by Jim Gore and Dina Crawford of Troy State University, Alabama, U.S.A., who presented a workshop on stream and river restoration following the symposium. The conference committee recognised that some restoration work had already been carried out in New Zealand, and that there was a need to draw this information together and to learn from overseas experiences and philosophies.

The term "restoration" has been defined by the National Research Council (1992) as the return of an ecosystem to a close approximation of its condition prior to disturbance. This may entail reconstruction of antecedent hydrological and morphological conditions, chemical clean-up or adjustment, and biological manipulation including revegetation and the reintroduction of absent or currently non-viable native species. For the purposes of the symposium we adopted a broader view of restoration to include studies that focus on rehabilitating or recreating specific aspects of ecosystem structure and function.

The papers presented in this proceedings have been divided into four broad groups: Wetlands, Lakes, Streams and rivers, and Social considerations. It is clear from the majority of papers that, to proceed successfully, restoration work needs the involvement of people from a broad range of disciplines. In recognition of their varied backgrounds, the authors were not asked to adhere to a strictly scientific format when writing their papers. However, all authors were asked to include a section on "Future Directions" to provide the proceedings with a visionary perspective that will, hopefully, guide future workers in the field. All of the papers that follow were peer-reviewed.

CONTENTS OF THIS PROCEEDINGS

The proceedings begin with the results of a study by Sanders and Muloney aimed at enhancing invertebrate food supplies for the endangered wader, the black stilt. This study is part of a large-scale habitat restoration project currently underway in the Waitaki River Basin where flow regulation and the invasion of alien plants, particularly willows and lupins, have degraded riverbed habitats (Rawlings 1993). This paper serves to remind us

that restoration work can be focussed not only at the habitat but also at the species level, depending on the specific goals of management.

Shiel provides an Australian perspective by describing the degradation of billabongs in the Murray-Darling basin. The complexity of these wetlands, the incredible diversity and density of life colonising them, and their intimate biological association with the adjacent floodplains leads the author to question whether restoration is a viable management option given the enormous costs and conflicting needs of a growing human population. The author highlights the need for education and an integrated approach to restoration, themes that arise in many other papers in this proceedings.

The viability of restoration is also discussed by Clayton and de Winton who document recent ecological changes to Lake Rotoroa, an urban lake in Hamilton. They use historical information to assist in identifying which management options are achievable and sustainable in terms of user interests and public expectations, and conclude that restoration to a **pre-urban** condition is not feasible due to the irreversible nature of catchment development and the associated impacts.

Rowe and Champion report on successful restoration work in Lake Parkinson, southwest of Auckland, where biomanipulations of plants and fish were used to eradicate alien weeds, restore native macrophyte communities, and establish a trophy trout fishery. The discovery of viable native seed banks in the lake bed sediments and the successful use of grass carp to remove problem weeds provide hope for other lakes suffering similar problems, such as some Northland dune lakes. The importance of public education programmes to prevent the recurrence of problems resolved by restoration is highlighted in this paper.

Hicks and Reeves review the use of instream structures to restore fish habitat in northwest America, and discuss the utility of similar structures in New Zealand waterways. They conclude that our understanding of the habitat requirements of many native freshwater fish is not sufficient to guarantee the success of instream habitat restoration. In their view, the best options appear to be the re-establishment of natural processes that provide instream structure, such as the planting of woody vegetation alongside streams.

It is regrettable that this proceedings does not contain a paper on the important issue of restoration of fish passage. Seventeen of our 27 native species move to and from the sea to complete their natural life-cycles, and trout and salmon also require access up rivers and streams to spawn. Considerable progress has been made in New Zealand in developing techniques to restore passage for native fish. Recently, success has been achieved for native eels and some galaxiids using wetted PVC pipes with large "bottle-brush" or gravel linings (J. Boubee pers. comm., Mitchell *et al.* 1984). For example, 15,000 elvers passed over the 63 m high Matahina Dam in the eastern North Island between January and March 1992 using one of these passes (Boubee and Mora 1993).

Howard-Williams and Pickmere provide valuable insights into the timescales of change associated with the restoration of water quality and aquatic habitats through riparian protection of a pasture stream near Lake Taupo. Their longterm dataset shows that successional changes in vegetation following protection may take 30 years to reach an equilibrium. In the intervening period, there were changes in aquatic plant biomass that

affected water quality and the suitability of the habitat for trout spawning. Over the long term, the growth of riparian trees and shrubs led to a drop in water quality because of reduced biomass of nutrient-stripping plants in the stream, but led to an improvement in habitat for fish and terrestrial animals.

McBride *et al.* demonstrate the utility of mathematical modelling to quantify the likely effects of various restoration options for an impounded stream in southwest Auckland. This approach coupled with experimental releases of water indicated that restoration of riparian shading rather than increasing compensation flows would be the most effective option for reducing nuisance growths of periphyton in that stream. Such modelling techniques will play an increasingly important role in designing restoration projects in the future. The process of community consultation in achieving an acceptable flow for the stream modelled by McBride *et al.* is discussed in the final paper by Thomas.

Roper-Lindsay describes some techniques used in the restoration of urban stream banks in Christchurch, and provides a thought-provoking discussion of the associated philosophical issues. The importance of defining the values to be managed and the objectives of restoration is highlighted in this paper. She points out that the objective for urban stream restoration may not be to return the system to a pristine 1850s condition but to achieve a "New Zealand-2000" system which accommodates a mixture of plants and animals capable of living in a modified environment. Community involvement in defining the goals of restoration, communication between environmental managers and maintenance crews, and a multidisciplinary approach to create the right habitat conditions are seen as important.

The role of the community in defining and achieving restoration goals is examined in more detail by O'Brien for riparian zones in Marlborough. The community there showed an unexpected level of awareness of the local river landscape and various associated issues (particularly water quality, guardianship and access), but displayed some conflict with the regulatory authorities and this appeared to be impeding change. The community indicated a need for education and encouragement, and a recasting of the issues into a more achievable series of "small wins". It is clear from this paper that consideration of social attitudes and perceptions is important in ensuring the successful implementation of restoration projects, particularly in agricultural and urban areas.

CONCLUSIONS

The papers in this proceedings identify many important issues that are relevant to future restoration projects. The major points can be summarised under four broad headings.

- Good **communication** must be maintained at all stages of the restoration project. This includes the canvassing and consideration of community attitudes to reduce potential conflicts, and the implementation of education programmes to increase the understanding of the project at all levels.

- The **goals** of the project must be clearly defined and appropriately focussed. This involves identifying the limiting factor(s) which must be remedied to achieve the desired outcome(s). The goals should be phrased in such a way that they identify a series of

achievable "wins" to maintain public interest, and create realistic expectations of the timeframes involved.

- The planning and implementation phases of the restoration project require a **multidisciplinary approach** that recognises the complexity of the systems that are being managed. The expertise of aquatic and terrestrial ecologists, ecosystem modellers, geomorphologists, hydrologists and, in the urban environment, landscape architects should be included.

- Scientifically-based **monitoring** of the ecological outcomes of restoration projects is necessary for the continuing development of successful techniques that are tailored to the New Zealand environment, and the refinement of ecosystem models. Monitoring should be built in to the costs of projects at the planning stage. It is important to report failures as well as successes so that lessons can be learned from both.

In New Zealand, greatest modification to freshwater habitats has occurred in agricultural and urban landscapes, and it is these areas that are likely to be the main focus of habitat restoration in the future. However, work in less developed areas may also be required to restore ecologically acceptable conditions for endangered species or communities. Many of the papers in this proceedings focus on riparian management, and this is likely to be an important tool in future restoration efforts. It is my hope that this proceedings will stimulate greater activity in aquatic habitat and ultimately whole ecosystem restoration in New Zealand, and provide more people with the opportunity to experience the sense of wonder that so moved Siddhartha.

ACKNOWLEDGMENTS

Thanks to all the authors of the papers in this proceedings; without your efforts this would not have been possible. The Department of Conservation kindly shared the editing and production costs with the New Zealand Limnological Society.

REFERENCES

Boubee, J. and Mora, A. 1993. Restoring fish passage at hydro dams (Abstract). *New Zealand Limnological Society Newsletter 29*: 23.

Collier, K.J. 1993. Linking the mountains to the sea – conserving New Zealand's rivers. *Forest and Bird November 1992*: 26-32.

Leopold L.B., Wolman, M.G., Miller, J.P. 1964. Fluvial processes in geomorphology. W.H. Freeman, San Francisco, California.

Lowe, D.J. and Green, J.D. 1987. Origins and development of the lakes. In Viner, A.B. (Ed), Inland waters of New Zealand, pp. 1-64. DSIR Science Information Publishing Centre, Wellington.

Mitchell, C.P., Huggard, G., Davenport, M. 1984. Home grown fish pass helps eels get by. *Freshwater Catch (N.Z.) 24*: 21-22.

Molloy, L.F. and Forde, B.F. 1980. Land alone endures. DSIR Discussion Paper No. 3, Wellington, New Zealand: 1-64.

National Research Council 1992. Restoration of aquatic ecosystems. National Academy Press, Washington.

Rawlings, M. 1993. Lupins, willows, and river Recovery: restoration in the upper Waitaki. *Forest and Bird (November 1993)*: 10-15.