Wetland research usefulness to end-users: Survey from the Landcare Research/NIWA FRST-funded research programme

Pond surrounded by jointed twig-rush (*Baumea articulata*) and bamboo spike-sedge (*Eleocharis sphacelata)* flanked by manuka (*Leptospermum scoparium*), Waitahora Lagoon complex, Northland 2009.

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NIWA Project: LAN10501

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Prepared for

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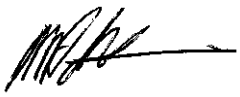

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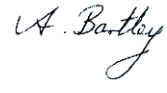

Executive Summary

Landcare Research and the National Institute of Water and Atmospheric Research (NIWA) have conducted a joint wetland restoration research programme that aimed to increase the protection and restoration of wetlands by providing scientifically based guidelines to landowners, managers and policy makers. Whilst the wetland restoration research has predominantly been funded by the Foundation for Research, Science and Technology (FRST), there have also been strong links and financial support from end-users and stakeholders. An audit of end-users was conducted by NIWA to determine the usefulness of outputs produced from the wetland research programme over the last five years; and to seek input on research gaps for the next wetland FRST bid.

A survey questionnaire was circulated via email to a list of 30 identified end-users on 14 December 2009. DOC staff completed the first part of the survey, to evaluate the usefulness of research outputs, and sent this directly to NIWA. Responses to research gaps were sent to Hugh Robertson for compilation into an amalgamated DOC response.

The total of 16 survey responses was received. In addition, DOC submitted an amalgamated gap analysis on future research requirements. Interim results were fed into the FRST bid in February 2010.

Respondents were very aware of research outputs produced. The Johnson & Gerbeaux (2004) wetland classification system ranked highest for both awareness and usefulness, followed by the wetland monitoring handbook by Clarkson et al., (2004). Wetland restoration papers had the lowest awareness, although usefulness was rated as moderate to high. Research outputs have primarily been used by end-users for planning and management, and to a lesser extent policy and restoration purposes.

Accessibility of research outputs was by far the largest barrier identified by respondents. Research information available on the internet was the preferred means of access for most respondents followed by well illustrated publications available both online and in print. The combination of web-based resources coupled with interactive, practical workshops were the optimal means for end-users to learn, understand and implement tools produced from the FRST wetland research programme.

The majority of wetlands under restoration have shown improvement in biodiversity condition (73.8%) or have remained at the same level (9.5%). One third of participants used the monitoring handbook to determine changes in wetland biodiversity condition.

Research gaps identified by respondents covered a range of themes with wetland policy and protection the most frequent followed by hydrology. General comments included the need for national leadership; an integrated national repository of information; and to widen the primarily plant based research to include fauna. Feedback from the end-user survey has identified current wetland issues and research gaps at a national scale, which will be used to guide priorities for future research.

1. Introduction

Landcare Research and the National Institute of Water and Atmospheric Research (NIWA) have conducted a joint wetland restoration research programme that aimed to increase the protection and restoration of wetlands by providing scientifically based guidelines to landowners, managers and policy makers. Team members included Bev Clarkson (leader), Corinne Watts, Jake Overton and Garth Harmsworth from Landcare Research; Brian Sorrell (co-leader), Alastair Suren, Cathy Kilroy and Kerry Bodmin from NIWA with contributors from other organisations such as the University of Waikato, New Zealand Landcare Trust, the Department of Conservation (DOC) and Te Wananga o Awanuiarangi. The research examined major wetland types along the swamp – fen – bog gradient, with restoration focused on lowland and coastal wetlands, as these wetlands have been depleted or degraded the most. Whilst the wetland restoration research has predominantly been funded by the Foundation for Research, Science and Technology (FRST), there have also been strong links and financial support from a number of end-users and stakeholders.

The FRST contract Restoring Wetland Ecosystem Functioning (C09X0508) was funded from 2005 – 2010. As part of this contract, an end-user survey was conducted on the usefulness of the wetland research of the current programme. The survey was conducted in two parts:

1. an evaluation of the usefulness of outputs produced from the wetland research programme over the last five years; and

2. to seek input on research gaps for the next wetland FRST bid.

The end-user survey was conducted on behalf of the Landcare Research / NIWA joint programme by Kerry Bodmin, NIWA.

2. Methods

A survey questionnaire (Appendix 1) was circulated via email to a list of 30 identified end-users on 14 December 2009 (Appendix 2). Participants were asked to have their responses submitted by 13 January 2010, although responses were received and accepted after this date.

Part one of the survey evaluated the existing research outputs:

- awareness of outputs;
- usefulness of the outputs;
- areas of work where research outputs were used;
- which outputs worked the best;
- which outputs worked the least work;
- what were the barriers to using those outputs; and
- potential solutions to overcome these barriers.

Respondents were also asked to:

- identify how they would prefer to receive research outputs (information transfer); and
- to evaluate whether biodiversity condition had changed for wetlands under restoration using actual measures or professional judgement.

Part two of the survey related to development of the next wetland FRST bid. Respondents were asked to identify research gaps they had encountered and any priority areas of research they were particularly interested in.

DOC had a slightly different format for conducting the survey. Hugh Robertson (Wetland Scientist, DOC) emailed the relevant staff internally with instructions to complete the first part of the survey, to evaluate the usefulness of research outputs, and send this directly to NIWA. The second part of the survey on research gaps was sent to Hugh Robertson for compilation into an amalgamated DOC response.

3. Results

The end-user audit survey was sent to a total of 30 individuals and organisations. The total number of survey responses received was 16. In addition, DOC submitted an amalgamated gap analysis on future research requirements. Responses were received from:

- Regional councils (6).
- DOC responses to the current programme, part one of the survey (6).
- Non-governmental organisations (3).
- Individuals (1).

Not all parts of the survey were completed by all participants therefore, total responses range from 10 to a maximum of 16 responses per question. The results section follows the two part layout of the survey.

3.1 Usefulness of research outputs

This section evaluated respondents awareness and use of research outputs produced; what barriers, and potential solutions to these barriers, may exist to output use; how best to transfer research information; and the change in biodiversity condition of wetlands under restoration.

3.1.1 Programme awareness and usefulness of outputs

Respondents were very aware of research outputs produced (Fig 1). The Johnson & Gerbeaux (2004) wetland classification system ranked highest for both the number of respondents aware of this book (Fig 1) and for its usefulness (Fig 2). This was followed by the web available wetland monitoring handbook by Clarkson et al., (2004). Wetland restoration papers had the lowest awareness, although approximately two thirds of respondents were aware of some of the papers, with usefulness rated as moderate to high (Fig 1 & 2). None of the research outputs were rated as not useful.

Research outputs have primarily been used by end-users for planning and management, and to a lesser extent policy and restoration purposes (Fig. 3). The wetland classification system has aided wetland description and assessment of significance. The monitoring handbook has been used to monitor and manage

wetlands from a site specific scale up to state of the environment reporting. Both the wetland classification system and the monitoring handbook have been widely used for resource consent assessments, requirements, restrictions, conditions and compliance. Both of these publications and scientific papers have been used by several regional councils as a basis for development of policies for regional plans and regional policy statements.

The monitoring handbook was identified as the research output that has worked the best for end-users, followed by the wetland classification system (Fig. 4). Several end users commented that a strength of the monitoring handbook was that it was based on scientific literature distilled into a practical, "how-to" guide that allowed comparisons of a site both across time and with other wetlands from a local to a national scale. The wetland classification system strengths were its usefulness to:

- gain an overview of wetland composition, diversity and significance;
- describe wetlands; and
- this reference was written specifically for the New Zealand environment.

The sedges and rushes training course was mentioned several times as a very valuable course although the cost was often identified as prohibitive.

Scientific papers were identified as the research output which worked the least well for respondents (Fig. 5). The main criticisms were lack of time to find and read scientific papers; they were too technical in nature; and papers required interpretation to understand implications for practical implementation or management.

Both the wetland monitoring handbook and classification system were identified as providing an essential resource but were selected a least useful because they were of a more technical or academic nature and could be improved with practical information for non-specialists.

One general comment about research outputs was that activities within a catchment largely determine the condition of a wetland and that assessment of catchment level impacts is not provided for in current research outputs.

Accessibility of research outputs was by far the largest barrier identified by respondents (Fig. 6). Access to information can be limited, or bear a financial cost (scientific papers), or is scattered across a variety of sources. Focussed, practical

workshops were clearly identified by respondents as the best solution to overcoming uptake barriers (Fig. 7). A touring seminar or workshop focused on public and agency staff separately, similar to that undertaken by the Dunes Trust, would work well. This could be supported by DOC, regional and local government with in-kind support, facilities and local sites for demonstration.

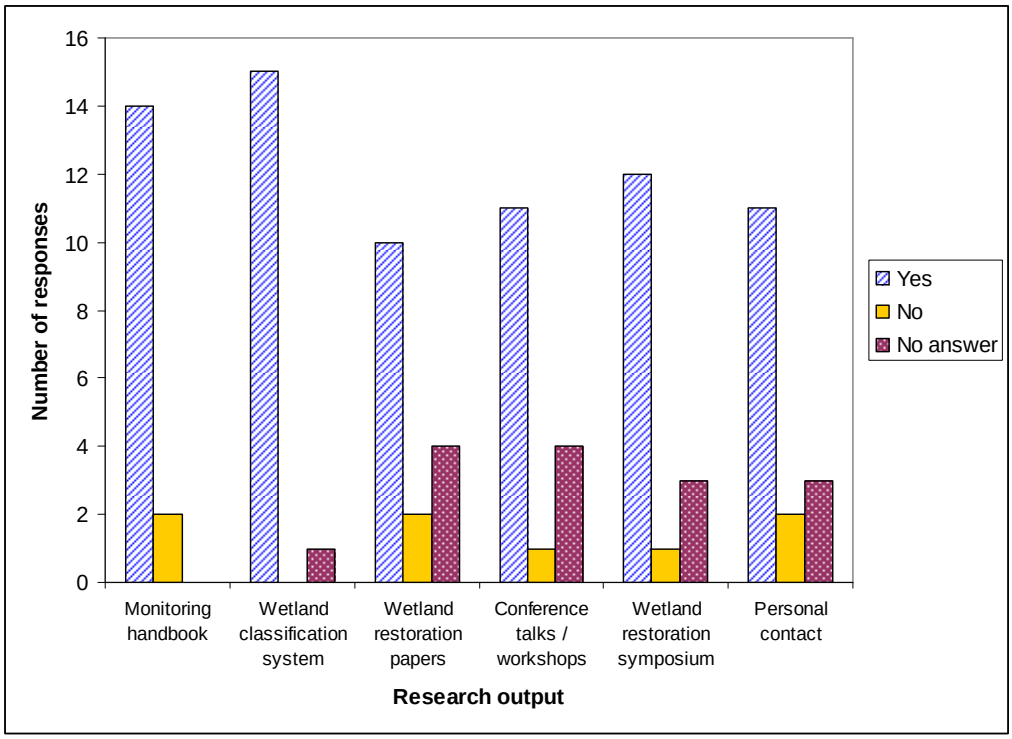

Figure 1: End-user awareness of FRST research outputs 2005 to 2010.

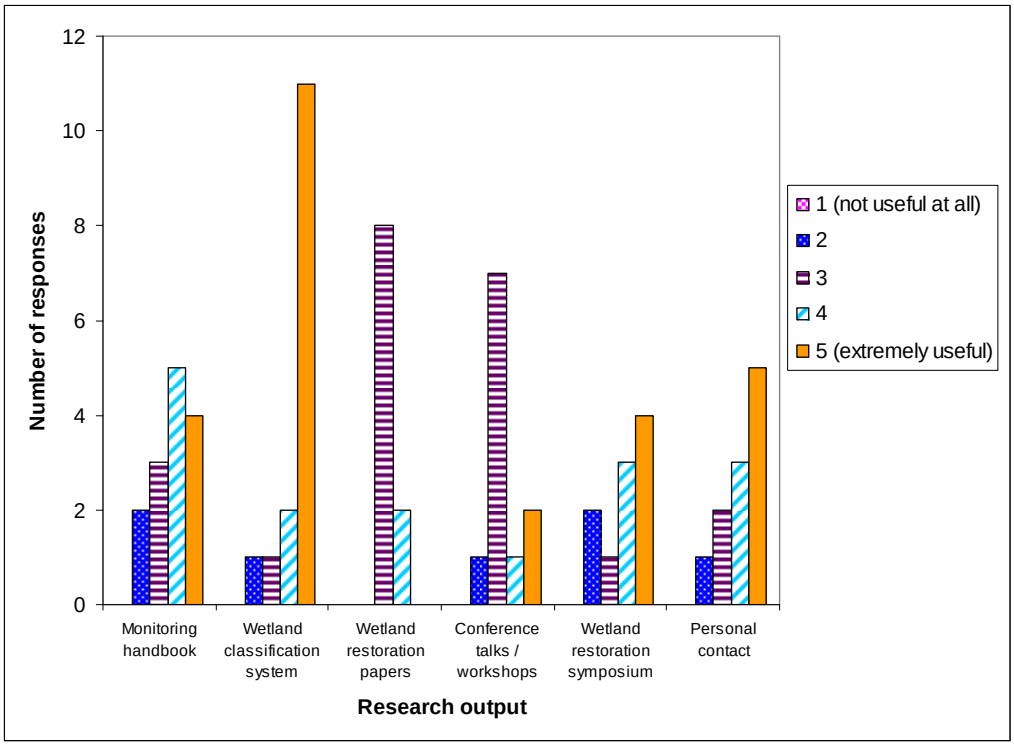

Figure 2: End-user evaluation of usefulness of FRST research outputs 2005 to 2010.

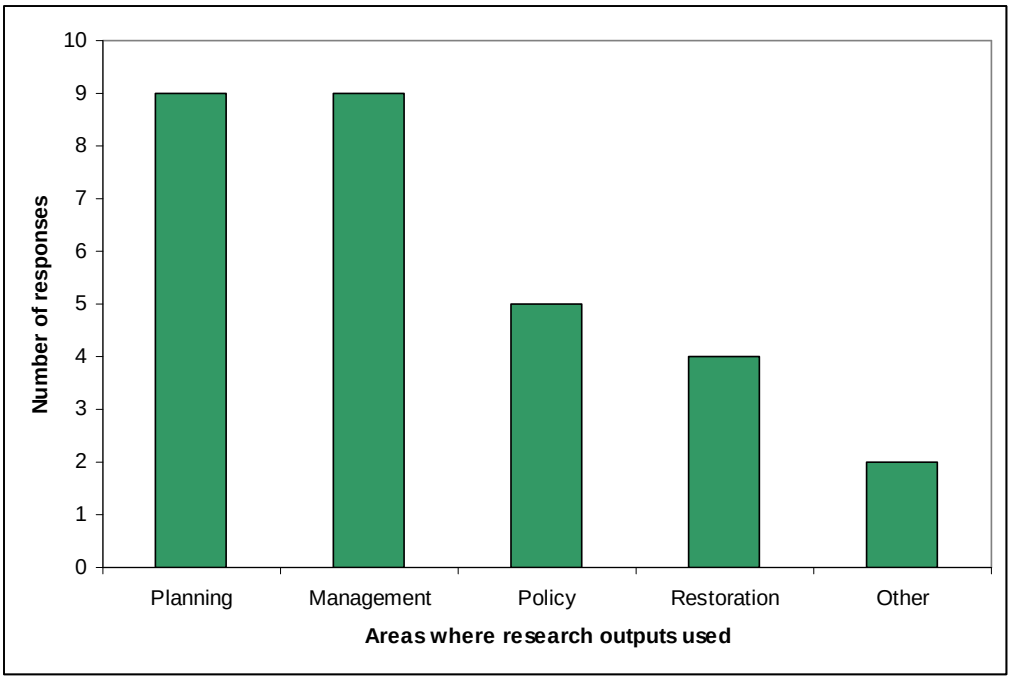

Figure 3: Areas of work where FRST research outputs (2005 to 2010) were incorporated by end-users.

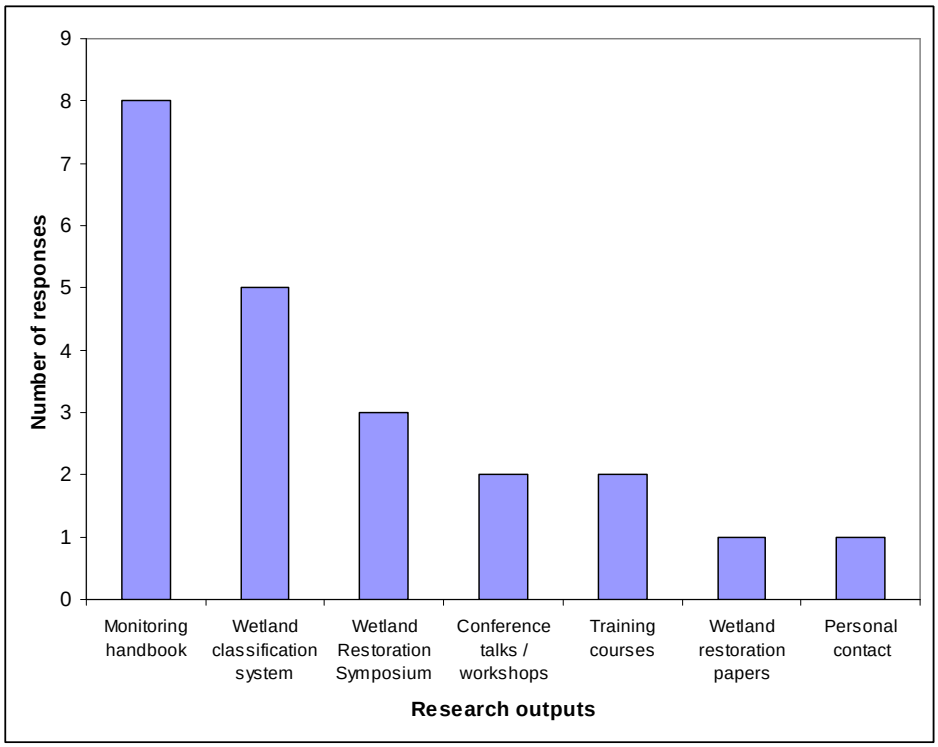

Figure 4: FRST research outputs from 2005 to 2010 that worked best for end-users.

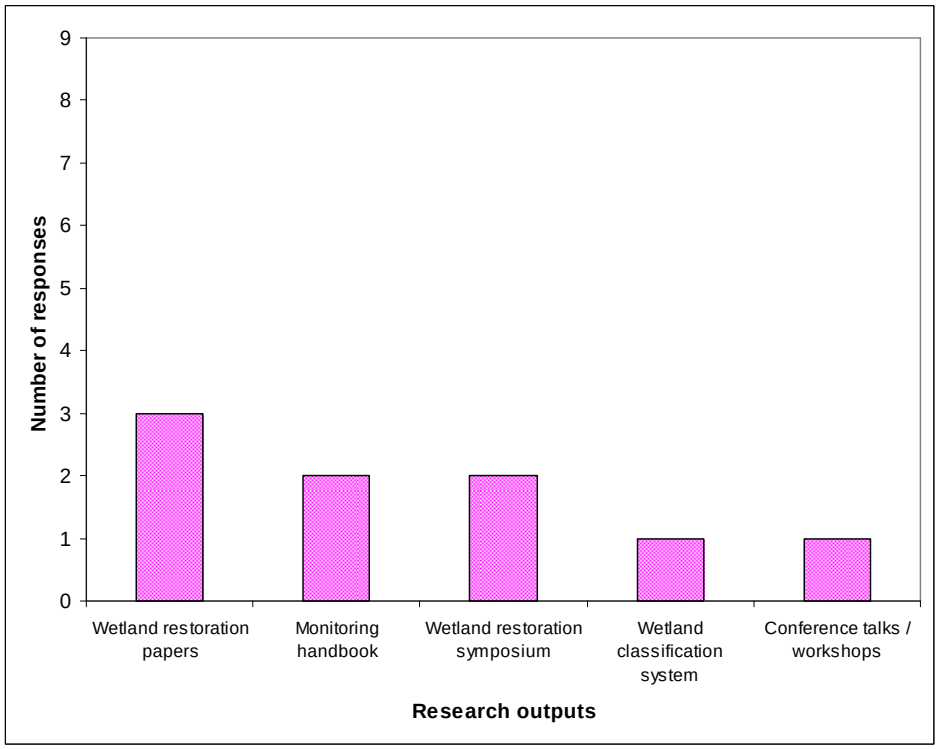

Figure 5: The least useful FRST research outputs from 2005 to 2010 for end-users.

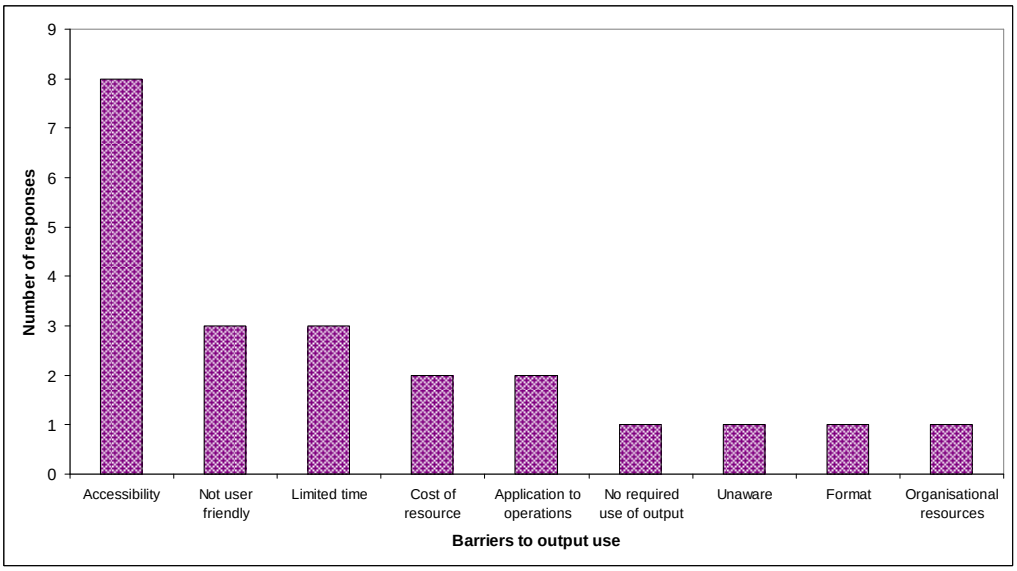

Figure 6: Barriers to uptake of FRST research outputs from 2005 to 2010 as identified by end-users.

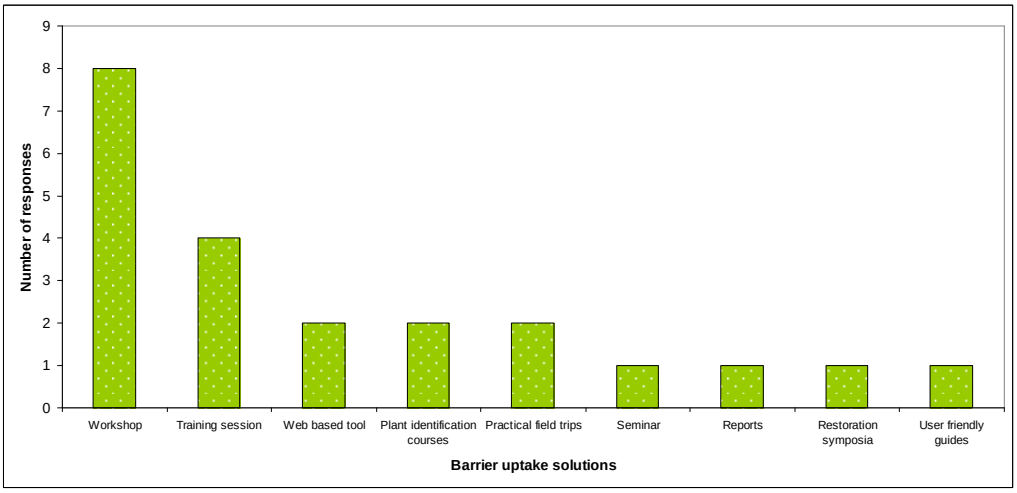

Figure 7: Potential solutions to overcome uptake barriers of FRST research outputs from 2005 to 2010 as identified by end-users.

3.1.2 Information transfer

Research information available on the internet was the preferred means of access for most respondents (Fig 8). Published books, guides and reports with good illustrations were also rated highly as they are easy to pick up and read. Ideally these publications would be web-based, formatted for viewing both online and able to be downloaded or printed. Feedback on handbooks indicated two types were required by end-users; one at a more technical level that collated and interpreted information initially presented as

papers; and one at a more operational level that focused on practical implementation, such as gaining resource consents for hydrological restoration or the specific nutrient / water requirements of different species, communities and ecosystem types (e.g., *Carex* sedgelands require inundation X times per year for Z number of days).

Workshops, conferences and presentations were ranked lower as a preferred means of receiving information transfer due to financial cost, time and the risk of not receiving timely notification of an event.

Scientific journals and papers were one of the least preferred forms for information transfer as they can easily be missed in day to day work, are not always free to access and often require some additional interpretation to translate the results of research into management actions.

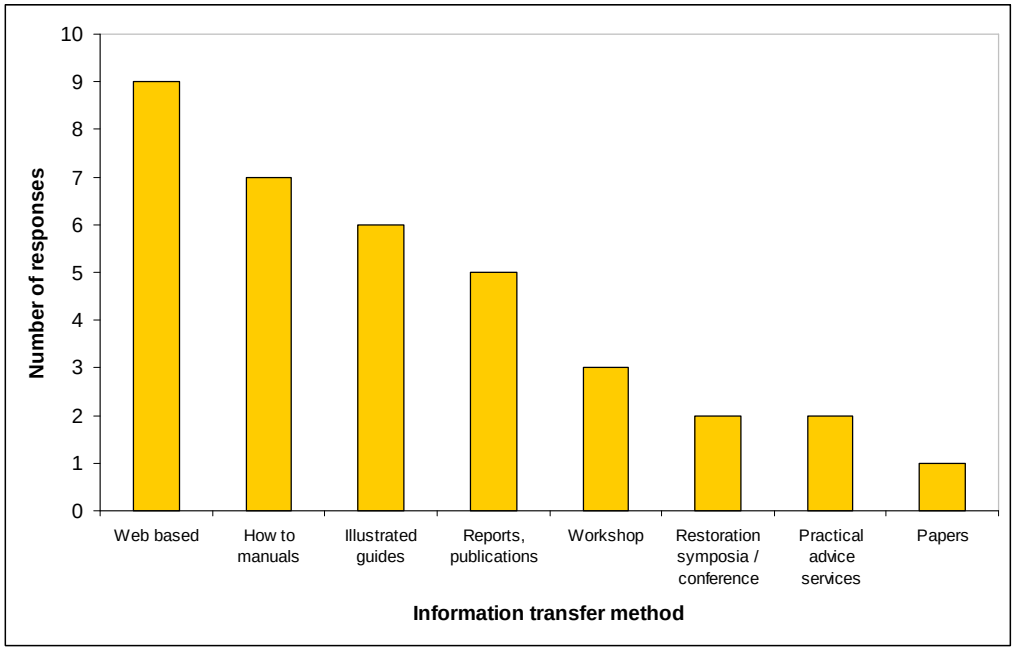

Figure 8: Preferred means to transfer research information as identified by end-users.

3.1.3 Biodiversity condition of restoration wetlands

Nine respondents provided some level of information on the biodiversity condition of wetlands in their area under restoration (Fig 9). The majority of wetlands under restoration have shown improvement in biodiversity condition (73.8%) or it has remained at the same level (9.5%). Causes of wetland biodiversity condition decline (16.7%) were noted for two regions: pressure from dairy farming; and vegetation clearance or fire, with management initiatives only recently implemented.

How respondents measured the change in wetland biodiversity condition varied widely from an overall professional assessment of their region's performance, to use of the Clarkson et al., (2004) handbook to monitor 13 specific wetland sites within a region. Just over one third (37.5%) of respondents used the Clarkson et al., (2004) handbook for monitoring specific sites. Most respondents not using the Clarkson et al., (2004) handbook had no monitoring system in place, although a couple indicated that a monitoring system may be established in the near future that would use the handbook or a modified version of it.

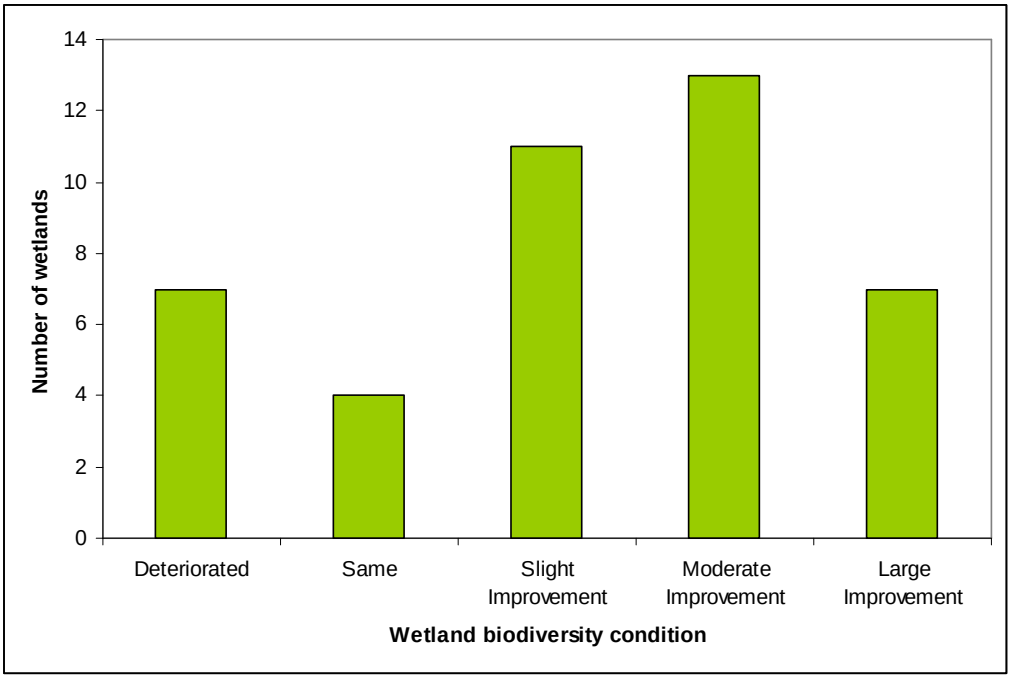

Figure 9: End-user evaluation of wetlands under restoration and the changes in biodiversity condition from 2005 to 2010.

3.2 Future research needs

This section asked respondents what research gaps they had encountered, with no lists or prompting of topics. Future research needs have been grouped into broad categories and listed from highest to lowest response frequency:

- Policy and protection (15);
- Hydrology (10);
- Wetland function and services (9);

- Weeds (7);
- Restoration (6);
- Nutrients (6);
- Indicators (5);
- Buffers (4);
- Climate change and carbon sinks (4);
- Other (13; species recovery, pests, fire and iwi).

A list of research gaps identified by respondents and DOC was consolidated with the results presented in Table 1.

Table 1: Consolidated list of future wetland research needs from survey respondents and DOC staff.

Theme	Description
Policy & protection	There is ongoing loss and modification of wetlands in New Zealand. Some of this loss is approved through RMA consents, despite legislated wetland protection in the RMA and Regional/District Plans. A national review of wetland loss is recommended including an inventory of district plan provisions for wetlands. More information is needed on the value and significance of wetlands to support planning and consent processes, with specific guidance on impacts (drains, weeds, fragmentation) and appropriate catchment land use including buffer zones. Information is needed to support the development of policy and effective mechanisms for protection and restoration of degraded wetlands, such as guidance on wetland restoration for private landowners; identifying significant natural areas with indigenous vegetation cover; and methodologies for assessing the mitigation costs related to wetland destruction and damage. This may incorporate an updated wetland policy and action plan at national and regional/district levels. Defining the ecological values of unique, small and degraded wetlands is needed (e.g., drained and farmed systems which still retain elements of wetland character and function). Coverage of common wetland types is also useful as that is commonly the subject for management, e.g., higher nutrient swamp systems. Additional work on the definition of site selection criteria for freshwater ecosystem management is advocated, such as an expansion of the FENZ[1] project to evaluate and prioritise the best wetlands of each wetland class, nationally and regionally. This would also provide a framework for management, restoration, monitoring and protection.
Hydrology	Assessment of the vulnerability (and resilience) of wetland ecosystems to altered hydrology considering both catchment scale and site level issues and taking into account cumulative impacts. For example, research to assess resilience of intact vs modified wetlands to changes in the extent, frequency and duration of inundation events, particularly for wetlands linked to riverine systems under pressure from changes in water use and at threat from drainage. Aligns with FRST freshwater research priorities and may support the NES[2] on environmental flows and water levels. Other hydrological research needs include: analysis of the impact and management options for deep drains and peat mines; the effect of hydrological manipulation on peat shrinkage and ecological changes; identifying minimum water regime requirements for threatened species and habitats; understanding the role of hydrology in managing weed invasion; and the impact of groundwater abstraction on floodplain, coastal (dune) and other wetlands with a high degree of connectivity. For example, Regional Councils through NZ undertake drain maintenance programmes. What is the extent of these programmes and what are the ecological effects vs. economic benefits.

[1] Freshwater Environments of New Zealand.
[2] National Environmental Standard.

Theme	Description
	Guidelines that describe specific methods and provide practical examples of restoring the hydrology of wetlands are also recommended, such as restoring the water regime of modified wetlands, perched wetlands and successfulness in re-establishing wetland function and biota. Examine the interface/connection between lacustrine wetland and lake ecology research.
Wetland functions & services	Quantification of economic values of wetland ecosystems, including their role in the provision of ecosystem services (such as carbon sequestration, water filtration and water storage) as well as wider social, cultural and environmental values. This information on the value of wetlands would support planning, resource consents and general advocacy.
Weeds	Research into best practice methods for weed control and the restoration of native vegetation post-weed control including tools to promote reestablishment of native vegetation in different wetland types (e.g., frequently inundated vs. ephemeral wetlands). Weed control priorities include further guidance on well known species such as comparison of willow control methods and the associated effects on native understorey species and fauna, as well as new information for control of lesser known weeds such as: Heath rush (*Juncus squarrosus*); exotic grass and herb invasion of lake margins; and woody weeds of peat bogs.
Restoration	Identify wetland restoration priorities, best practice techniques and appropriate measures of restoration success (restoration endpoints). This may include bioregional assessment of the ecological integrity (condition) of wetland ecosystems and subsequent priorities for restoration. This may also facilitate improved information of pressure-state relationships for different wetland types and assist development of new tools to prioritise restoration efforts based on known pressure-state relationships. Field based research of wetland restoration techniques are needed, including restoration of burnt, cultivated, drained and weed dominated wetlands. For example, peat mines; cushion bogs invaded by woody weeds; drained swamps.
Nutrients	Information on the impact and management of direct and indirect nutrient/sediment discharges to wetlands, at both the catchment and wetland scale. This includes further research on nutrient/sediment contribution to wetland degradation; the effectiveness and design of silt/nutrient traps; hydrological manipulations; and nutrient binding chemicals (e.g., zeolite). This is important to assist with RMA consent applications and regional/district policies. Water quality: Further assessment of the relationship between water quality and wetland functioning. Including the refinement of methods to monitor wetland water quality, e.g., development of wetland 'MCI'.
Indicators	Further guidelines to assist in wetland monitoring and the delineation of wetlands. This includes the use of plant functional types (e.g., obligate; facultative functional classes) and indicator species (e.g., to detect terrestrialisation, nutrient enrichment and distinguish wetland types) that can be applied as indicators of changes in wetland condition. Linked to refinement of wetland condition monitoring methods and the integration of national wetland databases (e.g., integrate wetland condition data with NVS, FBIS, etc.). May lead to national guidelines for DOC to apply in assessing the state of a wetland and reviewing the effectiveness of restoration work.

Theme	Description
Buffers	What buffers are appropriate for different activities adjacent to wetlands and for different wetland types. For example, the role of riparian buffers in mitigating water quality impacts and to protect hydrological regimes (e.g., optimal width, influence of soils, slope, flood frequency, importance of revegetation, drain buffer zone). This includes information to inform the resource consent process – e.g., clearance of vegetation and drainage to the edge of wetlands.
Climate change & carbon sinks	Understanding the role of different wetlands in carbon accumulation and the impact of peatland development on peat decomposition and loss of carbon. Investigation of economic incentives to conserve wetlands and promote carbon sinks, and other climate change related work – benefits of wetlands (C-sinks) versus exacerbations (methane emissions) especially for wetlands versus forest / shrubland.
Species recovery (flora)	Conservation of threatened wetland plants including: *Thelypteris confluens* (e.g., impact of grey willow control on light levels and vegetation); *Amphibromus fluitans* (understanding hydrological needs); *Corybas carsei* (propagation, translocation, site management); *Lycopodiella serpentina* and *Utricularia delicatula*. This includes research on threatened plants in modified landscapes.
Species recovery (birds)	The importance of different wetland areas to populations of cryptic wetland birds (e.g., bittern, fernbirds, spotless crake) and approaches to habitat manipulation.
Species recovery (fish)	Research to determine habitat requirements and support recovery of threatened and vulnerable freshwater fish e.g., mudfish and non-migratory galaxids.
Pests	Relationship between predators and wildlife populations, including cats, mustelids and rats.
Fire	Analysis of vegetation response to fire, including the use of fire to control large woody weeds in wetlands
Iwi	Wetlands and tangata whenua. There are significant challenges with engaging tangata whenua in for example, restoration symposia. To date, only one or two time slots have been available to cover general information on the cultural use and values of wetlands.

4. Discussion

The most well used and beneficial research outputs for end-users were the wetland classification system (Johnson & Gerbeaux, 2004) and the monitoring handbook (Clarkson et al., 2004). Both of these publications directly aided end-user management of wetlands through the science based knowledge presented in a comprehensive manner with practical examples given. Both publications were of a more technical nature and could be further improved for non-wetland specialists by inclusion of more basic explanations of terms, visual guides or pictures and further local examples from throughout New Zealand.

Research outputs that worked the least well for respondents (Fig. 5) were expected to have had an inverse relationship to those research outputs that worked the best (Fig. 4). However, the responses received did not reflect this. Respondents often listed more than one output that worked well, but only listed one or none outputs as least useful.

End-users were sometimes not aware of research outputs, particularly scientific papers, but also presentations and workshops. Research output awareness and accessibility could be improved by a web-based central repository for information with regular notifications, such as:

- A national wetland website (e.g., National Wetland Trust) that is a central repository for wetland information including research outputs, best practice restoration and monitoring methods, other resource tools, frequently asked questions etc;
- Email list notifications;
- Announcements at conferences, workshops, newsletters;
- A report that provides an update on research work and key findings including successes, issues and opportunities;
- Hard copies of outputs could be bound together and distributed annually to research partners; and
- Research outputs communicated at both a technical level and at an operational level.

Web-based information was the preferred means of information transfer as it is easily accessible and can provide a repository for manuals, guides, reports etc. Workshops provide excellent opportunities to upskill, network, collaborate, have access to experts and the opportunity to participate. Workshops were not a preferred means of receiving information transfer (Fig. 8), but were identified as the most preferred potential solution to overcome uptake barriers (Fig. 7). Workshops were identified as the best solution to overcome uptake barriers if they were practical, field-based, gave guided experience on the use of tools (such as the monitoring handbook) and with advice for the non-specialist. In particular, several respondents would like subsidised plant identification courses available for volunteers and community groups. A low cost refresher sedge and rush course would be valuable and more easily accessible if incorporated in the wetland restoration symposia.

The combination of web-based resources coupled with interactive, tailored workshops seemed to provide the optimal means for end-users to learn, understand and implement tools produced from the FRST wetland research programme.

Research gaps identified by respondents covered a wide range of themes with the most frequent responses received for wetland policy and protection followed by hydrology. The gaps identified for research varied from broad ranging topics to highly specific issues. Work on some of the research gaps identified by respondents was not included in Table 1 as it has already been undertaken by other research programmes or agencies. For example, management of farm nutrient discharges has been extensively reviewed with detailed information compiled on techniques, cost, area required, effectiveness and assumptions by McKergow et al., (2007). Reports and resources on nutrient management guidelines, nutrient budgets, best management practices and regional rules can also be found on websites such as Dairy New Zealand (http://www.dairynz.co.nz) under publications.

General comments around future research included the need for national leadership or directive both in the protection of wetlands and in the adoption of tools developed (e.g., wetland monitoring handbook); national co-ordination and repository of information; and national integration of databases. Also highlighted was the need to expand wetland research to include, in particular, the influence of hydrology and nutrients on wetland values, and to widen the primarily plant based research to include birds, fish and invertebrates.

The end-user survey feedback provides a valuable synthesis of usefulness of the FRST wetland research programme to date, and includes recommendations for improved research uptake. It also identified current wetland issues and research gaps at a national scale, which will be used to guide priorities for future research.

5. Acknowledgements

Thanks to Bev Clarkson (Landcare Research) for feedback on the survey design and review of the report; Hugh Robertson (DOC) for contacting the appropriate DOC staff and co-ordinating the DOC research gap response; to Paul Champion (NIWA) for his review of the report; and many thanks to all those who took part in the survey and provided valuable feedback.

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6.1 Appendix 1 – End-user survey

Programme outputs & usefulness

Based on the list of programme outputs below:

(1) Are you aware of the outputs? (Yes / No).

(2) Please rank how useful have you found these outputs using a 1 – 5 ranking (where 1 = not useful at all, 5 = extremely useful, often referred to or have incorporated it into policy / planning / operations).

List of the programme outputs	Aware of output Yes /No	Usefulness 1 – 5 ranking 1 = not useful at all 5 = extremely useful
Monitoring handbook (Clarkson et al., 2004)		
Wetland classification system (Johnson & Gerbeaux, 2004)		
Wetland restoration papers*		
Conference talks / workshops*		
Wetland Restoration Symposium*		
Personal contact with team members e.g., advice, reports, training		

* List of books, papers, presentations and workshops at the end of the survey.

Have you incorporated any of the programme outputs into the following areas?

Areas where research outputs used	Details of what was used (e.g., management used monitoring handbook for wetland condition)
Policy	
Planning	
Management	
Restoration	
Other	

Please provide feedback on the outputs:

Which outputs have you found worked best and why?

Which outputs didn't work?

What are the barriers to using these outputs?

Do you have any suggested solutions to overcome these barriers? e.g., training, workshops.

Information transfer

What form(s) would you prefer wetland restoration information to be available?

Assessment of your current wetland restoration work

Of those wetlands that are being restored:

Has the overall biodiversity condition of your wetlands that are being restored improved since 2005? (Please use professional impressions or actual measures).

Deteriorated	Same	Slight Improvement	Moderate Improvement	Large Improvement

Comments:

Do you use the monitoring handbook to assess wetland biodiversity condition?

Future bid development

We would appreciate input to develop the next wetland research bid. Our high level concept for wetland ecosystem biodiversity research (Restoring Wetland Ecosystem Functioning) was submitted to FRST in August 2009. We have been successful in this high level phase and are now progressing to the full bid proposal, due on 5 March 2010. The full bid covers the next 6 years of research. A copy of the high level concept document is attached for your reference.

What are the research information gaps you have encountered?

Are you interested in having input into the direction of the wetland research programme (due to FRST March 2010)?

Yes / No

If yes, what priority areas of research are you particularly interested in?

Any other comments:

Books or Chapters

Clarkson, B.R.; Sorrell, B.K.; Reeves, P.N.; Champion, P.D.; Partridge, T.R.; Clarkson, B.D. (2004). Handbook for monitoring wetland condition. Coordinated monitoring of New Zealand wetlands. A Ministry for the Environment Sustainable Management Fund Project. 74 p.

Johnson, P.N.; Gerbeaux, P. (2004). Wetland types in New Zealand. Wellington, Department of Conservation.

Peters, M.; Clarkson, B.R. (eds). Wetland restoration: a handbook for New Zealand freshwater systems. (In press).

Papers

Clarkson, B.; Watts, C.; Sorrell, B.; Bartlam, S.; Thornburrow, D.; Fitzgerald, N.; Chague-Goff, C.; Bodmin, K.; Champion, P. (2008). Biotic composition of New Zealand lowland wetlands: I vegetation and II invertebrates. *Landcare Research Contract Report LC0708/142* for Department of Conservation.

Clarkson, B.R.; Schipper, L.A.; Silvester, W.B. (2009). Nutritional niche separation in co-existing bog species demonstrated by 15N-enriched simulated rainfall. *Austral Ecology 34*: 377–385.

Fritz, C.; Campbell, D.I.; Schipper, L.A. (2007). Oscillating peat surface levels in a restiad peatland, New Zealand—magnitude and spatiotemporal variability. *Hydrological Processes 22*: 3264–3274.

Kapa, M.M.; Clarkson, B.D. (2009). Biological flora of New Zealand 11. Eleocharis sphacelata, kuta, paopao, bamboo spike sedge. *New Zealand Journal of Botany 47*: 42–53. Also known to Waikato-Tainui as ngaawhaa.

Sorrell, B. (2008). Effects of land uses and discharges on wetland water quality. *NIWA Client Report CHC2008-074* for Environment Canterbury. 49 p.

Sorrell, B.K.; Clarkson, B.R.; Schipper, L.; Chagué-Goff, C. (2008). Wetlands of New Zealand: Nutrient availability and vegetation N:P ratios in freshwater palustrine environments. Wetlands Ecology and Management, invited paper, submitted.

Sorrell, B.K.; Partridge, T.R.; Clarkson, B.R.; Jackson, R.J.; Chagué-Goff, C. Ekanayake, J.; Payne, J.; Gerbeaux, P.; Grainger, N.P.J. (2008). Soil and

vegetation responses to hydrological manipulation in a partially drained polje fen in New Zealand. *Wetlands Ecology and Management 15*: 361–383.

Suren, A.M.; Lambert, P.; Image, K.L. & Sorrell, B.K. (2007). Variation in wetland invertebrate communities in lowland acidic fens and swamps. *Freshwater Biology 53*: 727–744.

Suren, A.M.; Lambert, P.; Sorrell, B.K. The impact of hydrological restoration on benthic aquatic invertebrate communities in a New Zealand wetland. Submitted to Restoration Ecology *(accepted)*.

Suren, A.M.; Sorrell, B.K. (2009). Aquatic invertebrate communities of lowland wetlands in New Zealand: characterising spatial, temporal and distribution patterns. *Science for Conservation Report*, prepared for the Department of Conservation.

Van Bodegom, P.M.; Sorrell, B.K.; Oosthoek, A.; Bakker, C.; Aerts, R. (2008). Separating the effects of partial submergence and soil oxygen demand on plant physiology. *Ecology 89*: 193–204.

Watts, C.H.; Didham, R.K. (2006). Rapid recovery of an insect–plant interaction following habitat loss and experimental wetland restoration. *Oecologia 148*: 61–69.

Watts, C.H.; Clarkson, B.R.; Didham, R.K. (2008). Rapid beetle community convergence following experimental habitat restoration in a mined peat bog. *Biological Conservation 141*: 568–579.

Presentations

Bodmin, K.A.; Champion, P.D. (2009). Willow management at Whangamarino Wetland. Oral paper at NZ Freshwater Sciences Society Conference, Whangarei, November 2009.

Clarkson, B.R.; Overton, J.M.; Sorrell, B.K.; Chague-Goff, C.; Barlam, S.; Bodmin, K. (2009). Understanding pattern and function to inform wetland conservation. Oral paper at NZ Freshwater Sciences Society Conference, Whangarei, November 2009.

Clarkson, B.R. (2009). Society of Wetland Scientists 2009. Symposium: Wetland ecosystem services in agricultural landscapes – comparing approaches in USA and New Zealand. Annual Conference Madison, WI, USA, 22–26 June 2009.

Sorrell, B.K. (2009). Society of Wetland Scientists 2009. Symposium: Wetland ecosystem services in agricultural landscapes – comparing approaches in USA and New Zealand. Annual Conference Madison, WI, USA, 22–26 June 2009.

Suren, A.M. (2007). Bugs in Mud. Oral paper at the New Zealand Freshwater Sciences Society Conference. Queenstown, 3–7 December 2007.

Suren, A.M. (2008). Invertebrate communities of pristine New Zealand wetlands. Oral paper at NZ Freshwater Sciences Society Conference, New Plymouth, November 2008.

Suren, A.M.; Sorrell, B.K.; Wech, J.A.; Lambert, P. (2009). Wetland condition: how it influences invertebrate communities. Oral paper at NZ Freshwater Sciences Society Conference, Whangarei, November 2009.

Workshops

Champion, P.D.; Bodmin, K.A. (2008). Identification of sedges and rushes. Workshop at Wetland Symposium, Christchurch, February 2008.

Clarkson, B.R.; Sorrell, B.K.; Champion, P.D.; Bodmin, K.A. (2008). Co-ordinated Monitoring of New Zealand Wetlands training/workshop and Travis wetland tour. Field trip at Wai Wetland Symposium, Christchurch, February 2008.

Clarkson, B.R.; Bodmin, K.A. (2008). Wetland monitoring. Field trip at NZ Freshwater Sciences Society Conference, New Plymouth, November 2008.

Several other regional/ local workshops and/or field training on wetland restoration, monitoring and assessment, e.g., Gisborne (Te Wherowhero Lagoon), Environment Southland/ Southland DOC Conservancy (wetland assessment, monitoring, mapping, prioritizing), Taranaki Regional Council, Greater Wellington, EBOP, DOC (Ramsar sites), Nga Uri o te Ngahere.

7. Appendix 2

End-users that the survey was emailed to, with responses indicated by * proceeding their name. Note that for DOC staff, * indicates a response to the first part of the survey (usefulness of research outputs) was received. Many DOC staff did not complete part one of the survey but did send research gaps to Hugh Robertson for compilation into the amalgamated DOC response for part two of the survey.

* Department of Conservation (* Hugh Robertson; Southland: Brian Rance, Eric Edwards; Waikato: * John Gumbly, Kevin Hutchinson, * Mike Lake, * Cynthia Roberts; East Coast Bay of Plenty: * Paul Cashmore; Nelson: * Martin Rutledge; West Coast: Phillipe Gerbeaux; Southland: * Emily Atkinson; other freshwater, biodiversity, area and regional staff)

MfE (Tanya Gray)

* Fish and Game (Neil Deans)

* Landcare Trust (Monica Peters)

* National Wetland Trust (Karen Denyer)

Northland Regional Council (Lisa Forester)

* Auckland Regional Council (Brenda Osborne)

* Environment Waikato (Catherine Beard, * Yanbin Deng)

Waipa District Council (Tony Roxburgh)

* Environment Bay Of Plenty (Nancy Willems)

* Taranaki Regional Council (Shay Dean)

* Horizons Regional Council (Fleur Maseyk)

* Greater Wellington (Tim Park)

Tasman District Council (Trevor James)

Environment Canterbury (Adrian Meredith)

West Coast Regional Council (Johnny Horrix)

Environment Southland (Bonnie Rowell)

Tainui (Donna Flavell, Taipu Paki, Cheri van Schravendijk)

Golder & Associates (Sarah Flynn)

Wildlands (Sarah Beadel)

University of Waikato (Louis Schipper)

Auckland University of Technology (Mere Roberts)

* Keith Thompson