

Productive Grazing, Healthy Rivers

Project Overview

Victorian grazing industries

The intensive grazing industries, comprising primarily the dairy and meat enterprises, are a significant contributor to the Victorian economy, amounting to in excess of 2.85 billion dollars. The meat industry (beef and lamb) contributed 1.6 billion dollars in 2002/2003, while dairy products comprise the single biggest export earner leaving the port of Melbourne. These production systems are expected to intensify into the future, with evidence of this intensification including increases in the average dairy herd sizes from 190 to 250 cows, as well as the recent greater acquisition of land by the sheep and beef industries. The grazing industries in the high rainfall areas of Victoria (>750mm rainfall per annum) are generally characterised by greater inputs such as fertiliser and bought-in feed supplements. Along with larger herds and increased stocking rates, intensification of these industries is expected to involve an increased use of inputs, and accordingly, the potential to increase the export income earned by these industries.

Despite the economic value to the state and nation, grazing systems have the potential to pose a significant threat to the environment. Clearing of native vegetation, loss of soil due to overstocking, and stock accessing waterways have contributed to changes in ecosystem function, loss of ecological communities and declines in biodiversity, both on a farm scale and in the broader landscape. Current management of grazing properties can result in an accumulation or depletion of nutrients on farm depending on whether there is a net import or export of nutrients. Within intensive grazing systems, there is usually a net import with a potential for losses to the environment. The propensity for increased intensification of these industries will tend towards a greater accumulation of nutrients and greater threats to the environment.

Industry perspective

The grazing industries have recognised their current and potential impact on the environment. The 'Sustaining Our Natural Resources – Dairying for Tomorrow' project report identifies water quality and biodiversity as two of the "focal issues" for the dairy industry into the future. A national strategy for sustainable resource management by the dairy industry was developed out of the research for this report, and led to a series of regional action plans. The GippsDairy and WestVic Dairy regional boards (both located in southern Victoria) developed action plans identifying the importance of protecting riparian ecosystems, water quality and increasing biodiversity within their eight key 'Action' areas, with targets of:

- 80% of remnant vegetation and 50% of waterways fenced by 2005
- 100% of remnant vegetation and waterways fenced by 2015.

In a less formal sense, Meat and Livestock Australia (MLA) has supported the importance of biodiversity management as evidenced by its commitment to create producer manuals encouraging the industry to consider biodiversity as part of their enterprise. The MLA publication 'Prograzier' gave this issue prominence as recently as 2002, where the importance of managing riparian zones and remnant vegetation was supported by both landholders and scientists.

Government support

While acknowledging the importance of these industries to Victoria's economy, the Department of Primary Industries also recognises the importance of reducing the ecological footprint of the grazing industries. The Ecologically Sustainable Agriculture Initiative (ESAI) was established in July 2001 in response to support by State, local and national governments to 'ecologically sustainable development', and as an acknowledgment that loss of biodiversity is a serious environmental issue in Australia.

The Victorian Flora and Fauna Guarantee Act (1988) has as one of its goals the '*reversal, across the entire landscape, of the long-term decline in the extent and quality of native vegetation, leading to a net gain with the first target being no net loss by the year 2001*'. The creation of the Act was endorsed by the development of the

National Strategy for the Conservation of Australia's Biological Diversity (1996) in which national agreement was reached to 'achieve the conservation of biological diversity through the adoption of ecologically sustainable agricultural and pastoral management practices'. Subsequently Victoria's Biodiversity Strategy (1997) was released to fulfil the requirements of the Flora and Fauna Guarantee Act.

The impacts of agriculture on native biodiversity and the importance of private land for the protection of threatened species was recognised as a result of biodiversity information collated for the strategy. For example, the second largest percentage (29%) of threatened species populations occur on private land in Victoria, and grazing stock contribute to the decline of 35% of native species in all state bioregions¹.

To begin to address these threats, the ESAI supported six biodiversity projects, commencing in 2001. These projects aimed to improve biodiversity management on private agricultural land.

Riparian management in the high rainfall bioregions of southern Victoria was identified as a key area for research, extension and development. The threat posed by stock in the high rainfall regions of southern Victoria was considered a priority due to the greater inputs and intensities of the industries in this location.

High rainfall was defined as greater than 750mm, representing the Gippsland Plain, Strzelecki Ranges, Warrnambool Plain, and Otway Plain bioregions (Figure 1). These bioregions are located in the Glenelg Hopkins, Corangamite, West and East Gippsland and Port Philip and Westernport Catchment Management Authority areas, and include regions managed by the Melbourne Water Corporation.



Figure 1. Study bioregions: Warrnambool Plain (red), Otway Plain (blue), Gippsland Plain (green) and Strzelecki Ranges (yellow).

Riparian management

Riparian areas (land that adjoins, directly influences, or is influenced by a body of water) are unique due to their position in the landscape, allowing interaction and interrelationship between terrestrial and aquatic components while acting as corridors within the landscape². Riparian zones depend on biodiverse communities, ecosystems and habitats to ensure efficient functioning of these unique systems. As a consequence, improving management of riparian areas can deliver the multiple environmental benefits of improved water quality, reduced climate change impacts and provision of wildlife corridors by virtue of their connectivity within the broader landscape.

The tendency of stock to gather near water points degrades both the riparian zone and waterway health³. Uncontrolled stock access to streams can lead to:

- excessive nutrient inputs from urine and dung,
- trampling and pugging of banks,
- overgrazing of riparian vegetation and
- passage of disease to other stock,

all of which contribute to a number of potentially threatening processes identified in Schedule 3 of the Flora and Fauna Guarantee Act. Therefore, stock exclusion from riparian areas by fencing is an important requirement for improving riparian habitat on grazing properties.

¹ Lowe, K., Preece, K., Amos, N. and Parkes, D. 2000. Victoria's biodiversity reporting system: a bioregional approach to supporting to refining priorities and partnerships for biodiversity conservation. The 2nd Southern Hemisphere Ornithological Conference, Griffith University, Brisbane.

² Malanson, G. 1993. Riparian Landscapes. HJB Birks and JA Wiens Press Syndicate of the University of Cambridge, Cambridge.

³ Jansen, A. and Robertson, A. 2001. Relationships between livestock management and the ecological condition of riparian habitats along an Australian floodplain river. *Journal of Applied Ecology*, **38**, 63 - 75.

Productive Grazing, Healthy Rivers

The Productive Grazing, Healthy Rivers: Improving riparian and in-stream biodiversity (PGHR) project was developed as a means of improving the health and biodiversity of riparian land while assisting the grazing industries to work towards achieving ecologically sustainable agriculture. The project was one of the six biodiversity sub-projects developed for the ESAI, and it commenced in October 2001 with an initial 'scoping' or 'review' phase which was followed by three years of project activities based on the findings of this phase. The project aimed to improve riparian and in-stream biodiversity in high rainfall, intensive grazing systems through better management of riparian land and native riparian remnant vegetation. The five core objectives were:

1. To contribute to improvements in riparian and in-stream biodiversity and water quality within intensive grazing properties in southern Victoria.
2. To investigate and research previously identified knowledge gaps to generate new information targeted towards increasing riparian and in-stream biodiversity.
3. To develop and trial on-farm riparian management practices that deliver improved riparian and in-stream biodiversity on subproject sites.
4. To create awareness and encourage riparian and in-stream biodiversity management practices within industry and natural resource management service providers, stakeholders, subproject site landholders and the general community.
5. To extend and encourage adoption of the information generated to industry and natural resource management service providers, stakeholders, subproject site landholders and the general community.

The project supported nine staff located in Ellinbank, Leongatha, Frankston, Nicholson Street, Heidelberg and Warrnambool from DPI (Primary Industries Research Victoria, Catchment and Agriculture Services) and the Department of Sustainability and Environment (DSE) including the Arthur Rylah Institute. The budget for the project included contributions from DPI, DSE, Dairy Australia, GippsDairy, Monash Churchill, Land and Water Australia, the CRC for Weed Management, the West Gippsland Catchment Management Authority and GippsLandcare, amounting to a total of \$1,961,897 over the four years of the project.

Year One

Project review phase

During the 'review' phase of this project (October 2001 - June 2002) examination of relevant literature and databases and stakeholder consultation culminated in the design of the research, development and extension activities for the subsequent 3 years (July 2002 – June 2005). Current literature, databases, extension information and guidelines were reviewed.

The review included the extent of biodiversity (native, introduced, threatened species and communities) in riparian land and associated remnant vegetation within the bioregions of this study. The primary management issues associated with riparian land on grazing properties were reviewed and the best practice riparian management guidelines extended were compared with current practices adopted on-the-ground. Market research into the 'broad' segmentation of farmers in these industries, based on their motivations and barriers was also reviewed.

The outcomes of the scoping phase are briefly described in the following two paragraphs. Details of the information collated in this phase was published in the document 'Biodiversity conservation in intensive grazing systems: riparian and in-stream management', and is available on the project website www.dpi.vic.gov.au/vro/biodiversity/riparian.

Outcomes of the project review phase

In brief, the results of this phase are as follows. Estimates of the biodiversity present in the four project study bioregions were collated using GIS data, the web-based mapping system BioMap, and DSE flora and fauna databases (Wildlife Atlas, Flora and Fauna Information System, Aquatic Fauna Information System). Results

indicated that few flora and fauna surveys had been conducted on riparian land, and that very little biodiversity information was available in these databases for most areas of private land.

The primary issues for riparian and in-stream biodiversity management within intensive grazing industries were reviewed and the following eight key management issues identified.

1. Stock and grazing management
2. Establishment of buffer strips
3. Weed management
4. Planting and/or retaining native riparian vegetation
5. Waterway modification
6. Management of habitat trees
7. Control of feral animals
8. Conflict with native fauna.

The evaluation of previously commissioned market research on natural resource management and associated on-farm management issues identified that farmer groups should be segmented based on their regard for natural resource management and the motivations driving their actions (ie. environment vs profit).

Consultation with key stakeholders including landholders, industry groups and natural resource managers in the study bioregions was undertaken in 2 regional facilitated workshops in April 2002. The aim of the workshops was to compare the information gathered during the review phase with actual on-farm research and management priorities, and more specifically to:

- Provide information about PGHR to farmers, extension officers, scientists and project managers
- Invite discussion of the management issues, research, and knowledge gaps related to riparian management
- Engage stakeholders in the process of project development and priority setting of management issues
- Identify previous and existing riparian related projects specific to each bioregion
- Provide an opportunity for continued involvement.

Project development

The outcomes of the workshops combined with the knowledge gained during the review phase were used to develop seven (7) project modules:

Module 1 - Quantifying on-farm riparian biodiversity

Module 2 - Wood to water: Habitat creation within replanted riparian land

Module 3 - Regeneration in remnant vegetation: Overcoming the barriers

Module 4 - Riparian weed management system: Development of an on-farm management tool

Module 5 - Riparian condition and land-use practices: A survey of riparian health and condition on dairy farms

Module 6 - Riparian zone management: Estimation of production losses associated with fencing

Module 7 - Riparian zone management: Reducing water quality impacts of dairy cows.

To undertake all seven project activities required significant co-investment to supplement the ESAI. The team was successful in securing co-investment for all except the sixth research activity. Module 7 - Riparian zone management: Reducing water quality impacts of dairy cows replaced Module 6 and is referred to as such from herein.

The project Evaluation Plan identified extension (NRM and industry) staff as next users and the Communication Strategy incorporated the information from the review of market research to tailor project communication and dissemination activities for the duration of the project.

Years Two to Four

Project outputs

A brief summary of the major findings and developments of PGHR is given below. Details of the PGHR project outputs to date are given in the body of this report. The team's success in securing co-investment for Modules 2, 3, 5 and 6 resulted in different completion dates for these research activities. Modules 2, 3 and 6 concluded in August 2006, April 2006 and December 2005 respectively. Module 5 was completed in April 2002. All other modules concluded at the end of June 2005.

Riparian condition

In addition to the PGHR review of riparian biodiversity information available for grazing properties in southern Victoria, a study was commissioned in 2002 by DPI, GippsDairy, Dairy Australia and Land and Water Australia to ascertain the condition of 107 riparian zones on dairy farms in Gippsland (Module 5). This study was undertaken in conjunction with the Johnstone Centre at Charles Sturt University, Wagga Wagga, NSW using a Rapid Assessment of Riparian Condition technique developed by Professor Alistar Robertson and Dr. Amy Jansen.

Results indicated that riparian areas were generally in poor condition on Gippsland dairy farms, even where waterways had been fenced. This was most likely due to the recent nature of the fencing, as the condition scores of riparian areas that had been fenced for more than 16 years approached those of reference sites in the region. Fencing to widths of 30 metres either side of the waterway was also recommended for sites to approach an excellent condition score.

...condition scores of riparian areas that had been fenced for more than 16 years approached those of reference sites...

Using a surrogate for stocking rate (number of cow pads in the riparian zone), the results indicated that riparian condition was **not** linked to dairy cow stocking rate. While stock access degraded riparian condition, increasing stocking rates did not lead to a significant decrease in riparian condition scores.

Farm management and water quality

Farmers and natural resource managers strongly support the need for riparian management to be integrated within productive grazing systems. Central to this is an understanding of the farm management activities that impact on riparian zones and waterways and developing practical recommendations based on this knowledge. To further investigate this, a study co-funded by Dairy Australia, GippsDairy, Land and Water Australia and the West Gippsland Catchment Management Authority was established on two commercial dairy farms in West Gippsland. This study aimed to identify the dairy farm management activities that can degrade riparian zones, and to monitor the on-going changes that occur along a riparian zone after improved management (Module 6).

The farms are located at the base of a dairy-dominated catchment with a beef property upstream of the site and another at the headwaters. The farm management activities targeted include tracks crossing over a creek, management of effluent ponds and dairy sheds upslope and adjacent to the creek, effluent irrigation of riparian paddocks and paddock management including fertiliser application and stock management. These farm activities are common to dairy farms in high rainfall zones and some activities (eg. track management) are ubiquitous on beef and dairy properties.

Data from the first year of monitoring at this site showed an uneven distribution of nutrients had occurred, as indicated by soil tests of the paddocks surrounding the creek. This pattern of nutrient distribution is most likely due to the upslope location of the dairy shed and the nutrients deposited by cows on the way to and from milking and the likely movement of nutrients across the landscape.

These areas of high nutrient accumulation pose a threat to the riparian zone and waterway...

Stock camps and night paddocks are also areas where nutrients are likely to accumulate in the soil. These high nutrient accumulation areas occur at this site. Water sampling data indicates that high soil nutrient areas compromise water quality, with increased total nitrogen concentrations recorded in the creek during elevated baseflow conditions. Median creek Total Phosphorus concentrations are only slightly greater than EPA targets, but Total Nitrogen concentrations are much greater than EPA targets. Creek nutrient concentrations increased when stream flows were elevated.

The site was rehabilitated at the end of the first year of monitoring, with the willows removed, the site revegetated with species of local provenance and fences erected to restrict stock access to the creek. Monitoring continued at the site, with changes in canopy cover and stream temperature fluctuations observed.

Riparian biodiversity

The lack of an immediate measurable response in biodiversity and riparian condition after fencing and/or re-vegetation is a common frustration of many land managers. Farmers and natural resource managers at the April 2002 facilitated workshop were uncertain about the benefits (improved native biodiversity) and disadvantages (increased pest animals) associated with fencing riparian zones, although anecdotal evidence for riparian biodiversity improvements associated with stock exclusion from waterways and riparian land is frequently asserted.

Fenced riparian land had significantly greater small mammal, bird and floristic (ie vegetation) biodiversity.

A survey and comparison of the riparian biodiversity (flora and fauna) found on 36 fenced and grazed (unfenced) beef and dairy properties in Gippsland and south west Victoria was undertaken (Module 1). Fenced riparian land had significantly greater small mammal, bird and floristic (ie vegetation)

biodiversity. In addition, abundance, species richness and diversity of native small mammals increased in fenced compared with grazed sites while those of introduced species (eg. rats and mice) remained the same. This indicates that despite the perception that fenced riparian areas provide a harbour for pest species, the abundance of introduced small mammals did not differ between fenced and grazed riparian land.

Significant improvements in vegetation quality (as measured by Habitat Hectares), richness, diversity and recruitment highlighted that the protection of valuable remnant vegetation is a management priority. This was further emphasised by the relationships observed between small mammal abundance and various habitat attributes. In addition, significant increases in forest and woodland bird abundance were observed in fenced riparian areas while open country and farmland birds decreased.

In contrast macroinvertebrate biodiversity was not significantly different in fenced or grazed riparian sites; potentially due to the influence of upstream catchment activities on the waterways on these survey farms. For maximum benefit, riparian management needs to be considered at a landscape and catchment scale.

Aquatic biodiversity

Management guidelines for fenced and replanted riparian zones commonly focus on the terrestrial component of the area, disregarding the aquatic component. This is compounded by past in-stream management practices which resulted in the detrimental removal of wood from within waterways.

While many streams have recently been fenced and replanted, the number of years (> 16) required before these sites reach excellent condition is an indication of the length of time before replanted trees are likely to be actively contributing to in-stream biodiversity. This contribution occurs through the addition of woody debris (branches, leaves, tree trunks etc.) to the waterway. The feasibility of improving in-stream biodiversity through the introduction of small woody debris (SWD) into streams that were recently fenced and replanted was investigated.

The addition of SWD can increase in-stream biodiversity, and can easily be replicated by landholders ...

The addition of SWD to recently replanted waterways (3 to 7 years old) increased the number of in-stream macroinvertebrate families and brought the in-stream biodiversity of agricultural sites closer to that of sites in natural condition (Module 2). This method of providing habitat and complexity to streams can increase in-stream biodiversity, and can easily be replicated by landholders wishing to enhance the in-stream biodiversity value of their stream. This is particularly important as macroinvertebrates surveyed in Module 1 (above) were not significantly more abundant in fenced compared with grazed sites, indicating the complexity of riparian ecosystems.

An holistic approach to riparian biodiversity management is required which considers the communities and habitats and their interactions as part of a functioning ecosystem.

Weed competition

With the complexities associated with riparian ecology, it is no surprise that farmers expressed concerns about the management of native biodiversity within riparian fenced areas. On-going weed management is a significant constraint to improved management of riparian areas. Despite the considerable anecdotal evidence regarding the impact of weeds on native tree recruitment, seedling establishment and survival in riparian areas, no scientific evidence existed to support this.

...competition from weed species during the recruitment and establishment of native species was high...

The results of research demonstrated that bare ground (disturbance) was one of the factors associated with the recruitment of native tree seedlings in fenced riparian areas (Module 3). The potential for competition from weed species during the recruitment and establishment of native species was high, supported by the presence of exotic species as a significant component of these sites.

Weed invasion into bare ground restricted native tree establishment with *Eucalyptus* sp. being more susceptible to weed competition than *Acacia* spp. Recommendations to maximise seedling survival and establishment in riparian zones included keeping the area weed free for at least 3 months, or ensuring an initial clearing of at least 120 cm in diameter.

Weed management guidelines

The long-term and on-going nature of weed management required within riparian areas was of particular concern to farmers as stated by industry and natural resource management stakeholders. Weed management was a significant barrier to farmers undertaking improved on-ground works. As demonstrated in Module 3, some of this concern is well-founded but to some extent it results from land managers having less knowledge or understanding of weed management in a riparian zone compared with 'production' weed management.

A decision support tool titled 'Weed management in riparian zones' was developed after extensive consultation (Module 4), and provides regionally-specific guidelines (one version for Gippsland and one for south west Victoria) for weed management within fenced riparian areas on grazing properties.

'Weed management in riparian zones' regionally-specific guidelines for weed management within fenced riparian areas...

The guidelines include a series of flow charts that present in a step-wise manner the decisions required when establishing weed management goals, setting up a weed management plan and monitoring and refining the management plan. The weed management guidelines also provide information about prohibited weeds, the response of weeds to the removal of grazing and their impact over time on the subsequent replanted native vegetation.

Implications of PGHR

The economic value of the intensive grazing industries to the state is well recognised and suitable management of riparian areas is an important means of ameliorating potentially negative impacts of these industries on the environment. Productive Grazing, Healthy Rivers provided information and tools that assisted these industries to reduce their environmental impact and support improved riparian management.

Fencing is the first step towards improving riparian condition, but improvement takes time and widths of 30m appear to be optimum for obtaining excellent condition scores that approach those of reference sites occurring in State and National Parks. Bearing in mind the small farm size associated with beef and especially dairy farms in the southern regions of Victoria, widths of this size could have a negative impact on productivity and profitability and is a clear barrier to farmers fencing these areas to exclude stock. This information supports the need to understand the production losses associated with fencing, and through this, develop alternative farm management strategies to negate any losses. This is a clear requirement from farmers and natural resource managers and will have policy implications regarding fencing priorities for state and regional authorities.

Along with the potential for productivity losses, other barriers to fencing given by farmers and natural resource managers include the possibility for increased pest species and their associated management requirements. This project showed that introduced trappable small mammals, which were expected to take advantage of the habitat created in these fenced areas, prefer disturbed environments and did not increase in abundance relative to unfenced riparian land. The increase in native biodiversity demonstrated in this project suggests that the environment in fenced riparian zones supports their existence. For farmers that are motivated by environmental objectives, the increase in biodiversity within these zones will be a significant driver to fencing riparian land, as indicated by the level of interest at field days and other dissemination activities.

The technique used in this general survey of biodiversity did not specifically target foxes and rabbits. Although introduced small mammals did not increase, no conclusions can be made about foxes and rabbits and the implication for production losses, especially in prime lamb enterprises. Further research is required into the perception that fenced riparian zones become “fox highways” in the landscape.

Important gaps in knowledge arising from this project include determining the ecosystem services benefits within the farm and the broader landscape associated with the increased biodiversity observed in fenced zones. In other words, do farmers who fence, protect and enhance riparian zones contribute ecosystem services benefits to their neighbours, and therefore, the wider community and what value should be placed on that contribution? This information will lead to policy strategies such as the development of a ‘tender’ system that recognises this contribution at various levels.

Management within fenced riparian zones is an important part of successful riparian rehabilitation and the timeframes identified by this project (approximately 16 years) is an indication of the commitment required by farmers and land managers. This information needs to be considered in policy mechanisms to encourage farmer uptake and maintenance of riparian management programs. Information about management of seedling recruitment and establishment as well as the potential for increases in biodiversity through small woody debris introduction will be integrated into riparian management information disseminated to farmers and should be incorporated into support mechanisms for farmers.

The weed management guidelines provided are a first in terms of providing farmers and natural resource managers with specific tools to assist in planning weed management in fenced areas, ie goal setting, monitoring and evaluation of the weed plan. While the individual guidelines are regionally specific, the principles associated with the flow charts are an excellent management tool that can be adapted and extended to other regions of the state.

The impact of withdrawal of grazing is hypothesised in the guidelines, with suggestions given as to the weeds likely to proliferate. Actual data on weed succession in fenced, ungrazed riparian zones and their likely consequence both for riparian and production environments is information that is required by farmers and will further assist with farmer uptake of riparian management programs.

Very little on-ground information regarding the impacts of farms on riparian zones and waterways existed in these regions prior to this project. The relationship between grazing management activities (eg. stock camps, stand-off areas) on soil fertility and the potential for losses to the environment, applies to both dairy and beef enterprises. The development of best management practices associated with improved riparian zone management at the project site needs to be further explored to provide where possible sound recommendations that can be adopted by farmers. The benefits at a catchment scale of adoption of best management practices such as improved riparian management should be quantified to provide the data to support farmer action on the ground. There is currently little or no information describing either the time scale of changes associated with riparian rehabilitation as well as the spatial changes in catchment nutrient loads contributed by the farm. The tools required to extend the information from this site to similar rainfed catchments across southern Victoria needs to be explored.

Future recommended riparian activities

Recommendations for future riparian activities include those that have implications for policy development based on a better understanding of the costs and benefits associated with improved riparian management, as well as the value of extending this project information to other regions of Victoria. The previous discussion described the policy related research activities, which briefly are:

- Production losses associated with fencing and development of alternative strategies to compensate for these losses, if applicable
- Ecosystem services benefits both on-farm and within the wider landscape of improved management of riparian zones
- Impact of fencing on feral pest species such as foxes and rabbits
- Impact of fencing (ie withdrawal of grazing) on weed invasion and establishment, both in riparian and production environments.
- Water quality benefits at a catchment scale of improved riparian management on farms

The information from the Productive Grazing, Healthy Rivers project is very relevant to other regions of Victoria where improved management of riparian zones will likewise confer multiple benefits including reduced environmental impacts of agricultural systems. The north of the state, specifically North Central Victoria, is an ideal location to expand the research from this project. This region offers the opportunity to work with mixed industries, grazing and cropping, and to link in with a large riparian project (Riparian Restoration Project) that has secured significant investment into the short and long-term management at a number of sites in the region.

Communication Activities

An important component of Productive Grazing, Healthy Rivers was the dissemination of project information. The identification of NRM and industry extension providers as next users of project outputs lead to the formation of Technical Reference Groups in south west Victoria and Gippsland. These groups consisted of 17 extension providers representing 15 natural resource management and industry organisations. The project team met with these groups twice each year to provide project updates and to consult regarding project activities. The contributions of the TRGs were critical to the success of this project.

In addition the team used a variety of communication activities to disseminate project information including project flyers and brochures, field days, the establishment and updating of the project website (www.dpi.vic.gov.au/vro/biodiversity/riparian), media articles (newspaper and radio), workshops and conferences, industry newsletters, scientific publications.

The extension and dissemination of the messages from the Productive Grazing, Healthy Rivers project to the stakeholders and end users of this information needs to form an integral part of future activities. The next users of the project information should include natural resource managers who have networks established to communicate with farmers, and will act as the primary means for ensuring project information results in on-ground action. Other users should include industry service providers such as factory field officers and agricultural consultants, who may not actively seek this information, but who are more likely to come into contact with 'production-oriented' farmers who may chose not to attend project dissemination activities. Policy analysts in both the Departments of Primary Industries and Sustainability and Environment should also be targeted to assist with the incorporation of project information into policy formulation as well as the involvement of these groups in the development and outcomes of future activities.

Conclusions

The Productive Grazing, Healthy Rivers project made significant contributions to riparian knowledge for high rainfall areas, where previously very little information existed despite the potential for improved management to contribute significant environmental benefits. Project outputs give natural resource managers the information to address farmer barriers and motivations for improving riparian management, which should ensure an increased uptake of riparian management programs. In addition, the Productive Grazing, Healthy Rivers project outputs have considerable implications for future research and extension activities and for the development of policy mechanisms and tools in the area of improving riparian management within productive grazing systems.