

# THE WINSTON CHURCHILL MEMORIAL TRUST

## CHURCHILL FELLOWSHIP 2002

### INVESTIGATING DEVELOPMENTS IN RIPARIAN VEGETATION MANAGEMENT

*'It is interesting to contemplate an entangled bank, clothed with many plants of many kinds, with birds singing on the bushes.....'*

**Charles Darwin** 'The Origin of the Species',  
The beginning of the concluding chapter.

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## Precis and Acknowledgements

This is a report on the 2002 Churchill Fellowship study tour to investigate riparian (river) vegetation management in selected areas of North America, Europe and Africa. The investigation extended over a twenty-week period from July to November 2002. The aim of the tour was to gain a perspective on riparian management within Australia by looking at selected on-ground conditions and approaches to management in developed and developing countries.

The report aims to convey the perspectives on riparian management gained.

The tour and its success are a direct result of the financial, logistical and moral generosity from the following people and organizations:

- The Winston Churchill Memorial Trust;
- My Australian family, friends and colleagues who provided information contacts and encouragement;
- The numerous people visited who gave of themselves personally and professionally in order to help me gain an appreciation of their country;
- Mr Paul Kelly and Ms Mary Beedle for keeping my business Riparian Australia running;
- My partner Ms Dianne Holyoak for her support.

## Executive Summary

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### Fellowship Objective

To investigate and gain perspectives on riparian vegetation management in agricultural areas.

### Fellowship Highlights

1. Riparian vegetation and floodplain research and implementation associated with the Aquatic Conservation Strategy, Oregon USA.
2. The International Conference - Understanding and Restoring Ecosystems - A Convocation (The 87<sup>th</sup> annual meeting of the Ecological Society of America and the 14<sup>th</sup> Annual International Conference of the Society for Ecological Restoration), Tucson Arizona USA, August 4-9 2002 and in particular the keynote address by Edward O Wilson.
3. The Masei Mara National Reserve Kenya.
4. Adaptive management for the rivers and the whole of Kruger National Park, South Africa.
5. The Working for Water program in the rural areas of South Africa particularly the Eastern Cape.
6. River reinstatement in the Meuse River catchment of the Netherlands.
7. Plant / animal interactions throughout the countries visited in Africa.

My fellowship was taken over the period from early July to late November 2002. The Fellowship provided the foundation and impetus for my riparian travels. I doubled the duration through self-funding. I travelled primarily in North America and Africa spending approximately two months in each continent. My aim was to be extended by the experience so I deliberately avoided visiting programs that approximated the Australian experience of riparian vegetation restoration. I sought not to view, for example, large-scale plantings - a now very familiar feature of Australian river restoration programs. Coming from a highly specialized, newly formed and evolving niche industry in which I had been totally immersed for 15 years, I was keen to visit places and meet with people who were not treading the same path and that would challenge my small world view.

My greatest learning has always been from onsite inspection. My idea was to restrict myself to a number of biogeographic regions with similar ecology and visit a number of disparate sites in some detail looking at different aspects of research, planning, and

implementation accompanied by knowledgeable people to act as 'landscape interpreters'.

Travelling to places at the fringe of the restoration/management movement was expected to refresh and invigorate and be hopefully less complex. The complexity is important because the condition and situation of today's riparian vegetation is a byproduct of its history and its current management a product of those involved. Both are often complex, the more complex requiring more people to give a rounded picture. I needed simpler systems that would enable ready comprehension. Importantly I needed exposure to that which was not available from other sources (e.g. Internet).

## Findings

The findings are personal reflections on the state of riparian vegetation rehabilitation in agricultural areas of southeastern Australia following a period of questioning through observation and contemplation on foreign shores. I suggest the following are my findings:

- Biological processes have radically changed since European settlement and that it will be difficult to maintain biodiversity within our agricultural bound riparian vegetation remnants in such radically changed conditions;
- Current understandings of remnant riparian communities and their management particularly on low land and middle catchments that are derived from observations of indigenous animal denuded landscapes are likely to be distorted because in southeastern Australia we simply do not have animal rich reference sites;
- It is the persistent grazing by domestic animals over time on indigenous riparian vegetation that is the degrading factor rather than grazing as such. Episodic grazing may have some compatibility with retention of riparian vegetation diversity.
- Throughout, the value of using indigenous vegetation species in riparian vegetation rehabilitation is affirmed repeatedly.
- Riparian zones in the southeastern Australian landscape are relatively rare fertile, well-watered areas making them comparatively more important than in the more fertile areas visited.
- The remnant riparian vegetation of Australia's cleared agricultural landscapes has commonality with relic riparian desert populations of the southwestern USA (of thousands of year prior). Like the San Pedro riparian forest they are of a past time. Our riparian zones are a relic of previous woodland dominated landscape that were converted to grassland dominated landscapes through clearing less than 100 years ago.
- The role of monitoring in waterway rehabilitation is poorly understood in many projects. The more successful programs viewed are generally long on planning and establishing, objectives and management frameworks and put an inordinate emphasis in establishing a monitoring program as an integral component and key to adjusting ongoing management.

- The most success programs experienced put emphasis on creating pre-conditions which will allow stream and vegetation processes to re-establish a desired state when the right combination of circumstances dictate (climatic, seeding, etc.,) rather than directly attempting to engineer the system.
- Open, accountable, inclusive and iterative processes appear to be the best approaches to achieving stream rehabilitation. Command and control methods familiar to engineering projects appear less suited to the management of ecological processes such as riparian vegetation rehabilitation.
- Overriding impressions are that finance alone is ineffective without the coordination and shared clarity of purpose that allows both landholders and government authorities to work towards the one goal.
- Australia would appear to be in one of the better positions worldwide to successfully manage the riparian vegetation resource. We lack the impediments of the American situation, which are rooted in the overwhelming complexity and I suspect a more combative national attitude. We also lack the social situation of African countries, which is truly overwhelming. The population responsible for land management in Australian agricultural areas has a generally open and cooperative attitude required to move from established practice and conditions.
- Australia is well placed to take the advantage of the worldwide advancements in ecological understanding and ecological restoration process. We have a relatively well-educated population when it comes to the appreciation of the commonsense of riparian vegetation management.
- Australia's problem would appear to be of both resourcing and approach. There are simply not sufficient dollars applied to undertake the actions known to be required to effect rehabilitation, nor is the expenditure available over time. We often continue to labour under the delusion that riparian rehabilitation is a series of discrete stand-alone projects, stand-alone from each other, from the surrounding landscapes and from the people of the catchment.

#### Seminars

A of series seminar is planned for the Catchment Management Authorities across Victoria.

#### Publications

A professionally produced DVD is in production based on over twenty hours of video footage taken throughout the Fellowship.

Articles are planned for several river management publications.

## Programme

Juneau Alaska USA	US Forest Service Juneau Glacier Bay Gustavus
Portland Oregon USA	US Forest Service Portland US Forest Service Oregon State University Corvallis
Tucson Arizona USA	Understanding and Restoring Ecosystems - A Convocation. The 87 <sup>th</sup> Annual Meeting of the Ecological Society of America and the 14 <sup>th</sup> Annual International Conference of the Society for Ecological Restoration, August 4-9 2002
Sacramento California USA	Landholders, riparian and vegetation management consultants and practitioners representatives of State Government departments and agencies administering riparian vegetation management programs.
Netherlands	River Rehabilitation agencies
Arusha Tanzania Africa	8 <sup>th</sup> International Conference on Wetland Systems for Pollution Control 16 <sup>th</sup> -19 <sup>th</sup> September 2002
Kenya Africa	Various locations in the watersheds, farms, Rift Valley Lakes and Parks
South Africa	Various locations from Kruger National Park to Cape Town meeting with researchers, practitioners in riparian and catchment management.

## Introduction

All waterways and wetlands have vegetation growing in the wetted soil associated with them. This is the riparian vegetation. The riparian zone is typically wetter and more nutrient rich than the surrounding lands. It is relatively rare that vegetation of some kind will not grow in these environments. Usually it is Charles Darwin's 'entangled bank' with the impediment of any plant species establishing being competition; from other plants, from animals, from water, or from man.

In our more settled areas riparian vegetation rises to prominence. Flying over our agricultural landscapes riparian vegetation is seen as a distinct readily identified feature. All but the most peripheral of waterways have a tracery of trees growing on their banks. The drier the landscape, the more prominent the riparian vegetation. Often in the cleared cropping and grazing landscape riparian vegetation is (with roadside vegetation) the only remnant of our original vegetation.

Across Australia we have recognised that management is required in order to maximise the benefits riparian vegetation provides to the broader community. Of all the vegetation that may grow in the riparian zone a diverse mix of indigenous vegetation has been recognised as providing the maximum all round benefit to society. Management therefore centres on retaining and or rehabilitating the indigenous riparian vegetation.

The benefits to society of riparian vegetation are diverse, they are both direct and indirect, short-term and long-term, site specific and regional (or even national) in character. In the Australia agricultural landscape the most prominent contributions are to water quality and wildlife conservation (aquatic and terrestrial). Both benefit most from continuous, wide, diverse indigenous vegetation across the riparian elements of the agricultural landscape.

Riparian vegetation in agricultural areas provides longterm public benefit on essentially private land. To maximise the benefits consistent management at landscape scale beyond that of the individual landholder is essential. Regional programs are therefore government driven while effective onground management is effectively in private hands. The scale is enormous when the number and length of waterways is considered and after 150 years the level of degradation is now appreciated. From recognition support has grown, funding has followed.

Management of riparian vegetation has attracted a diverse range of disciplines. This is a result of riparian vegetation management actions being incidental to other dominating (usually adjacent) landuses. For example, a farmer may manage riparian vegetation e.g. spraying blackberries, as a small component of his farming operation. Practitioners of riparian management have evolved from many different professions at many levels from site specific, onground managers to regional level planners. A broad diverse discipline of 'riparian managers' from many backgrounds has consolidated over the past decade.

Riparian vegetation management is not 'rocket science' but, as in many facets of endeavour, it is not what you do but the way that you do it that matters. In Australia we have been developing the discipline of riparian management by increments over the past decade, picking up approaches, methods and techniques from other disciplines and

applying them. It has been happening overseas as well in much the same way. Or has it?

I sought to gain a perspective on riparian vegetation management, as I know it in Australia. By looking at what was going on overseas I wanted to reflect on our Australian condition.

On my tour I took a riparian perspective on the world, I set out to meet people operating in the riparian zone and get a look at what was going on onground. I needed to find the people, get access to what was going on in the landscape (and importantly) how it got to be that way, what they considered important and what was being done. In this I did not see the necessity to restrict myself to the agricultural landscape. I had no desire to see replication of the familiar. I chose to be shaken by my experiences.

# United States of America

## The Northern Pacific Coastal Region

The region includes all of the land between the Pacific Ocean and the coastal mountains, from Anchorage, Alaska, including coastal British Columbia, Canada south to Eugene, Oregon. It includes some of the oldest and largest trees and most highly productive ecosystems on earth. It is characterised by a cool, wet (1,000 to 5,000 mm), but relatively moderate climate. The Pacific coastal forests owe their composition to a long and often idiosyncratic history of disturbance and succession. Landslides, avalanches, fire (in the south), floods volcanic eruptions and windstorms (in the north) all induce disturbance.

Common streambank vegetation includes Willow (*Salix* spp.), Alder (*Alnus* spp.), and Poplar (*Populus* spp.). A ubiquitous indigenous plant of the riparian zones and marshes are Horsetails (*Equisetum* spp.). Willows and Poplar are weeds of Australian rivers. Horsetails are a potential weed in the Australian context that we are actively seeking to exclude from establishing.

Two areas were visited in the Northern Pacific Coastal Region one centred on Juneau, Alaska the other around Portland, Oregon - over 2,000 kilometres apart.

### Alaska

The capital city of Alaska is Juneau (population 30,000) located on the protected coast in the southeast of the State. The region is dominated by the coastal islands, inlets and fjords and the St Elias Mountains. It supports some of the most diverse and abundant wildlife and fish resources in the USA. The vegetation includes high elevation habitats and coniferous forests, the rivers are glacial and riparian lands are small, diverse and highly productive.

The towns are located on estuaries on the scarce, flat land. All are within the Tongass National Forest, America's largest temperate rainforest (6.9 million hectares) which was 100 years old in 2002. Most towns are not accessible by road (unique in the USA). Timber, mining and fishing were formative and now largely declining industries whereas tourism, largely cruise-ship based, is expanding rapidly.

As expected, there is an excellent riparian vegetation corridor along most waterways. Planting of Willow cuttings and brush is used to treat minor erosion. The main issues relating to riparian vegetation management are improving fish passage and habitat and the maintenance of the riparian corridors for the future.

Pacific Salmon fisheries historically were heavily exploited and by the 1970's considerable efforts were made to improve stocks by establishing hatcheries and even instream sorting of gravels in pristine rivers by bulldozers mounted with screens. Efforts appear to have been very Salmon specific rather than ecosystem-based.

Timber harvesting may also have had an effect on fish stocks. Some indication of the difference in thinking between now and then may be gained by the fact that clearing of timber from rivers was included as a condition of contract for timber harvesting.

By contrast considerable effort is now expended to maintain fish passage, not just in rivers but into what would be considered quite minor drainage lines. Culverts under roads must be built to allow migration of fish at all stages. Basically the natural bed form must not be altered from the natural watercourse. Installing such devices increases culvert costs ten fold. Pipes must also now be corrugated, the variable velocities created by the corrugations allowing fish fry to rest as they travel upstream.

The US Forest Service is also seeking to monitor the remote rivers. The Juneau office has elected to use aircraft mounted video (linked to GPS and GIS) so that they may geographically locate and record features over time. This is an example of a convergence of thinking between two very different locations as a similar solution was developed by Riparian Australia to assess hundreds of kilometres of waterways through agricultural areas in Victoria.

Despite the vastness and low population of the region wildlife and people both place high value on the same restricted landform - the flat land of the estuaries and riparian zone. In summer the riparian lands support high wildlife diversity, as grazing animals feed on sedges and grasses and bears feed on the Salmon (to 30 +pounds) as they swim upstream to spawn.

Access to the riparian areas during the short summer period is critical for wildlife survival. Inevitably this leads to conflict and when Grizzly Bears and Moose are among the wildlife humans give way. Remarkably few human losses are reported.

#### Glacier Bay

Most of Alaska is publicly owned land, however land sales are occurring. The switch to private ownership has to be carefully made to maintain the riparian links. The compounding factor not experienced in Australia is isostatic rebound. Isostatic rebound is literally a lifting of the land following the melting of the Glaciers.

In 1794 when George Vancouver first sighted the Icy Straits it was full of glacial ice over 1,000 m thick, 30 km wide and extended more than 160 km to the St. Elias Range of Mountains (with Glacier Bay a mere indentation). By 1879 the ice had retreated 77km and now is over 100 km from the Bay's mouth. At Gustavus (population 400) at the southern end of Glacier Bay National Park two hundred years ago, hundreds of feet of ice covered the landscape.

Relieved of the pressure of the ice the land lifts at up to 3.8 centimetres each year. As a result whole landscapes, drainages and even shorelines change in years. A dynamic, young fresh land is the result, quite bizarre when compared to crusty old Australia. Add to the isostatic rebound plant succession - bare, glacial-ice scoured rock to plant community in 10 years. Bacteria-fungi -bryophytes - to higher plants in 10 years. Maturing spruce forests evolving to Hemlock forest at the Bay mouth that was ice covered in 1794.

Just as there is a change in the ecology, so the political landscape is also changing. Gustavus is to be made a city and taxes introduced. So when the locals of Gustavus go

to secure public land which is up for sale to retain as a wildlife corridor - its tricky. The parcels have to be big enough so that the open meadows, riparian zones and shorelines are retained over time. Its tricky, because, unlike Australia where both cadastral (title) and ecological boundaries remain relatively static over time, at Glacier Bay the landform and the ecological boundaries are on the move - and fast. So what may be a drainage line today may be forest in 10 years.

As for the rivers, as far as I could tell, the beds remain reasonably stable (with the continual water erosion) but the banks rise, so they entrench. A block of land retained as wildlife corridor may end up as forest (and there is no shortage of that) if they don't leave the ecological boundaries room to move. Maybe this is what lays ahead for our national parks and reserves with global warming causing ecological boundaries to become more mobile, hence the need for careful off-reserve networks including river corridors through agricultural areas.

## Oregon

There was a dramatic contrast between the emerging 'city' of Gustavus, on the edge of the Glacier Bay National Park, and the heavily exploited rivers and timber resources of the equally magnificent country around Portland, Oregon, on the Columbia River at the southern edge of the Northern Pacific Coastal Region.

The timber rich areas of the Pacific Northwest states of Oregon, Washington and Northern California have been the centre of environmental conflict for decades. Conflicts involving timber interests, Salmon interests and wildlife and habitat preservation interests created a crisis situation that by the early 1990's demanded intervention by the then President of the United States, Bill Clinton.

The result of the Presidential intervention was the formation of the North West Forest Plan which fundamentally changed forest resource management over 5.6 million hectares of Oregon, Washington and northern California now managed by the US Forest Service and Bureau of Land Management. It reduced timber harvest levels by eighty percent, united management under a consistent framework and it made sustained production of aquatic and riparian dependent resources the primary use of lands adjacent to waterways. Riparian management moved from a peripheral to a central activity.

The Plan also introduced the Aquatic Conservation Strategy a new paradigm for Salmon and watershed management.

The strategy has eight ecological objectives and four primary sets of activities. The activities consists of:

- Key Watersheds - selection and maintenance of a network of the best remaining habitats to function as refugia for fish stocks
- Riparian Reserves - establishment of reserves adjacent to streams, lakes and unstable hill slope areas
- Watershed analysis - implementation of an interdisciplinary analysis process to gauge the condition and health of entire watersheds and to provide a context for future management and restoration

- Watershed Restoration - integrated, strategic restoration of whole watersheds to speed long-term recovery.

This drastically revised approach to the protection and restoration of aquatic resources is now in its eighth year of implementation. Annual funding has averaged fifteen to twenty million dollars a year with 60 per cent going to road related activities and 30 percent to riparian and floodplain related activities. Much of the road expenditure is to improve fish passage as in Alaska. A large amount of the riparian activities are devoted to increasing the complexity of aquatic habitats and floodplains using large wood.

Timber use in riparian rehabilitation in Australia is increasing and the North West Forest Plan area is a leading centre of innovation. My host, Mr Dave Heller, Regional Fisheries Program Leader, U.S. Forest Service based in Portland Oregon, introduced me to the work of the Strategy through site inspections around the volcanic Mt Hood of the magnificent Cascade Mountain range. Mr Heller is a great supporter of the Plan, which saw changes in a few years that may not have been expected in a lifetime of incremental change.

The geology and the rivers are entirely different to southeastern Australia. Sediment loads in some rivers off Mt Hood are astronomical, and the timber volume used in restoration maybe equally huge in some areas. It is a messy business timber is given limited anchorage and is largely left to find its own place by water flow. They work on setting up the conditions for stream processes to create the desired conditions rather than directly engineering them. In this there are similarities between the approach to riparian vegetation restoration advocated by Riparian Australia.

The contrast with the geology of Australia was further reinforced by an inspection of Mt St Helen, another volcano of the Cascade Range. It blew apart in 1980. The plant succession is equally dramatic (and much studied). Wind borne Willows and Alders, Sedges and Grasses growing on the sediments which are worked and reworked by waterflow. The nitrogen-fixing Pentstemons (an ornamental garden plant here) forms large mats.

Riparian vegetation research by the US Forest Service is centred at Oregon State University at Corvallis. Excellent work is being undertaken, with many the same problems addressed such as the effects of cattle grazing and the invasion of exotic blackberries (*Rubus* spp.). Approaches to rehabilitation are far more long-term than that undertaken in Australia. For example, considerable research work was being expended on techniques for re-establishing tree species that will not mature for eighty years or more. The Service is also addressing the legacy of high intensity planting intended for now defunct timber production regimes through a program of thinning of the riparian zone. Different densities are being trialled to measure the affect on light and therefore the affect on regeneration of indigenous species. The work has considerable relevance for Australia.

## Arizona

I travelled to Tucson Arizona to attend the combined 87<sup>th</sup> annual meeting of the Ecological Society of America with the 14<sup>th</sup> Annual International Conference of the Society for Ecological Restoration. The international conference entitled 'Understanding and Restoring Ecosystems - A Convocation' ran from August 4<sup>th</sup> to the 9<sup>th</sup> 2002 and attracted 3,500 participants.

There was a day of field trips to surrounding riparian desert areas followed by a packed program of fifteen concurrent seminars, workshops and poster sessions. It was a powerful experience of great value. It provided an overview of riparian restoration in the USA and the rest of the world and was an invaluable source of contacts for California and Africa.

My personal highlight of the conference was sitting in the front row for the keynote presentation by Edward O Wilson. Dr Wilson, a Harvard Professor of over thirty years standing, is a student of the social insect (ants), a philosopher and, at seventy-two a man who still retains the wonder. He was the one at thirteen years of age who discovered and reported the first infestation of imported fire ant in the USA (the same ant that is now in Queensland and which has gone on to devastate the Southern states of the United States).

On the morning of his presentation he was on his hands and knees at dawn outside the Radisson Hotel at a crack in the footpath from which the native fire ant was emerging for its mating flight. Due to the spread of the aggressive imported fire ant he had not seen the native ant in forty years. I liked that aspect of him, and besides, he made an awful lot of good sense, preached the doom and gloom but also had the optimism of solution.

My impression of the ecology of this hugely rich and impressive country (the USA) from the conference is that there is not a place that hasn't been exploited, much of it comprehensively. That with a population of more than 220,000,000 there are just too many people combined with vested interests, and the status and standing given such interests a continual downhill slide appears inevitable. There is not, from impressions gained, a readjustment happening, a pulling back from past excesses. Rather the interest groups that have formed as a consequence of development reluctantly concede a few concessions. Because of this, the massive exploitation (for the money and scale expended on development you just can't go past the Americans) is too complicated to wind back to any degree. Even in Oregon powerful forces are compromising aspects of the revolutionary North West Forest Plan.

An interesting aspect that came out of the conference was a discussion on the nature of the science of ecological restoration. The argument approximates the following - Ecological Restoration is different to other scientific disciplines because it is an adaptive process. Contrast that to the physical sciences which are predictive or, for example, the experimental basis of molecular biology. If, however, Ecological Restoration is such an adaptive process, then the basis of adaptation surely should be monitoring. The impression from this conference was that monitoring is a neglected aspect of nearly every project and is not set up to steer subsequent management actions. This is entirely consistent with the Australia riparian restoration experience.

## San Pedro River

The San Pedro River illustrates the significance of the riparian vegetation in desert landscapes. The San Pedro flows for approximately 200 kilometres north from Mexico into the Sonoran Desert of Arizona. To protect and enhance this rare desert riparian ecosystem, it was designated in the USA in 1988 as a Riparian National Conservation Reserve (64 kilometres long and 22,600 hectares in area).

The Upper San Pedro River is free flowing and sustains one of the most important remaining flyways for neo-tropical migratory birds that winter in Mexico and breed in the United States and Canada. This lush Sonoran Riparian Deciduous Forest is renowned for its healthy and extensive Fremont Cottonwood/Gooding-Willow gallery forests (to 30 metres in height), riverine marshlands and native alkali Sacaton grasslands. The forest represents what survives in the arid west of the formerly widespread Early Tertiary mixed mesophytic forest which once covered most of North America. These relic forests have retreated to corridors like this, where the archaic warm, temperate climate still persists.

The corridor is one of the richest and most biodiverse in North America and is second only to the Costa Rican cloud forests in diversity of mammalian species. Nearly 400 species of birds (two-thirds of the inland species in North America) have been observed. It is also a vital habitat for its year round residents - 100 bird species, 82 species of mammals and 43 species of reptiles and amphibians use the area for nesting, foraging, water and shelter. With more than 90 percent of Arizona's riparian areas degraded or destroyed, the San Pedro River stands out as the last best example of a highly productive natural riparian community in the southwestern United States.

The river is fed by a regional aquifer which sustains a year round flow. It is now threatened by over allocation from groundwater pumping by nearby towns, farms and other facilities. The substantial groundwater deficit that existed when the San Pedro Riparian National Conservation Area was designated remains today, despite many water conservation and groundwater recharge efforts. Profligate water use in the desert environment continues. Some efforts continue to coordinate a means of minimizing the effect including the use of stormwater to recharge the aquifer.

## California

Following meeting many people from the riparian industry at The Conference I travelled to Sacramento in California's Central Valley to get an overview of the riparian situation in one of the highest productivity agricultural areas of the world.

I concentrated on the Sacramento-San Joaquin Delta. The Delta covers approximately 300,000 hectares interlaced with hundreds of kilometres of waterways. Much of the land is below sea level and relies on more than 1,600 kilometres of levees for flood protection. Its land and waterways support communities, agriculture, and recreation, and provide habitat for fish and wildlife. The peat soils are up to 18m thick, in places the level has subsided up to 4.5 m through oxidization. It supports irrigated crops including corn, grain, sugarbeets, alfalfa, pasture, tomatoes, asparagus, fruit, safflower, and nuts.

The Delta is an integral part of California's water system. It receives runoff from about 40 percent of the State's land area including flows from the Sacramento, Mokelumne, Cosumnes and Calaveras rivers. The Delta is the major collection point for water that

serves over 20 million people, two-thirds of the State's population. Agriculture in the Delta is threatened by urban expansion.

More than half of California's threatened and endangered species rely on wetlands and more than 65 percent of the states remaining wetlands are on private lands. Only 5 percent of the original Riparian Oak Forest has been retained in the Central Valley. Riparian forests were once a prominent feature in the landscape and were described by John Muir as being like "jungles of tropical luxuriance". They are now one of the rarest habitats in the State of California.

I met with representatives of a range of government and non-government agencies, restoration ecologists, plant suppliers and farmers. I paddled the American River by raft, hiked into the headwaters, canoed reclaimed wetlands, walked at dusk through Creek revegetation projects on farms and walked in the heat of the day through the cool Wild Grape festooned riparian Oak forest of the last remnants at Caswell State Park.

As would be expected in such a high productivity agricultural environment within one of the world's most developed communities' conservation management issues are complex. Water conservation issues in California are particularly complex, with litigation relating to water between local authorities, cities, between States and between Countries (USA and Mexico).

Funding and incentives for conservation on agricultural lands are from multiple sources, from all levels of government and non-government sources. Relative to Australia the dollar amounts are large.

In the Delta the riparian vegetation rehabilitation approach familiar to Australian waterways appears inappropriate. With so much historic levying and land subsidence, continuous linear vegetation has limited application. Rather, property purchase for block conservation was prominent, with non-government organisation (NGO) the Nature Conservancy in particular purchasing whole properties for multiple millions of dollars. In this way a variety of environments of conservation significance are being preserved including riparian zones and a wide variety of wetlands. Wetlands, including 'vernal pools' - which are ephemeral water bodies in paddocks - are given high priority for conservation - more prominently than in Victoria, Australia.

I was somewhat overwhelmed by the scale and complexity of management relating to the riparian zone. It reaffirmed my initial approach of seeking out less complex environments.

## Netherlands

The Limburg region of the Netherlands is a region of hills towards the Belgium border. Waterway rehabilitation has been actively pursued over the last decade. The Overmass Water Board is driving the rehabilitation. Creeks, drainage lines and wetlands were historically drained. The consequence was a lowering of the watertable and loss of habitat for flora and fauna species.

Through a detailed consultative and design process a multi-disciplinary team undertakes to re-engineer straight channels to emulate the sinuosity of natural waterways. The new waterways are designed to accommodate the increased flow patterns resulting from urban and industrial development while introducing instream diversity. Wet meadows, fens and wetlands are being recreated by excavation to lower the soil level in order to reach the lowered ground watertable.

Previously regionally rare species of both plants and animals are responding to the creation of new environments. For example kingfishers are digging nest holes into eroding outer bends of the new waterways and rare species of Rush (*Juncus* spp.) have germinated in large number in the newly created wetlands.

The Water Boards work with the landholders abutting the creeks as well as with the local community to effect what is a radical remake of waterways. The parallels with the cooperative models between private landholders and public authorities in Victoria were familiar. Relationships are trust based, negotiations are one on one.

Vegetation management is minimal on the new waterways. The wind blows in Willow and Alnus seeds, which establish rapidly on the bare banks, wetland species regenerate rapidly following disturbance. Blackberry (*Rubus* Spp) is again a weed of waterways. Weed control is largely restricted to the use of grazing - horses are agisted to keep the vegetation open .

## Tanzania

I travelled to Arusha, Tanzania, to attend the 8th International Conference on Wetland Systems for Pollution Control Conference hosted by the International Water Association (IWA), the University of Dar es salaem and the Royal Danish School of Pharmacy. The macrophyte (large wetland plant) group of the IWA ran the conference, and it was an extremely well run program.

It was an odd juxtaposition to find myself on day three in Africa being introduced, in detail to the vertical flow, wastewater treatment wetland systems of the sub-Arctic Nordic regions. It matched somewhat the curious and eclectic mix of 120 in attendance spanning many disciplines and both hemispheres including representatives from Zambia, Uganda and Tanzania and Sth Africa

A great range of wetland systems was presented, dedicated to many different purposes, and with many aspects of design presented and dissected. In summary, wetlands for water treatment have developed down two radically different lines. The wetland scene in Europe is dominated by the compact, subsurface, sand-bed systems (vertical and horizontal), while the more familiar (to Australians), open-water systems dominate in the USA and Australia where space is not at a premium.

The compact, subsurface, sand-bed systems have been used in Europe for decades for the final treatment of domestic sewerage and are really a more sophisticated version of - and play the same role as-our infiltration trenches that treat the flows from septic tanks. Their scale varies upwards from single-household systems and they are also used to treat waste such as dairy and mine effluent. The open-water systems are also used to treat domestic sewerage after first passing through conventional sewerage treatment plants (to city scale e.g. Tucson USA) and they are also used for other purposes such as stormwater and road runoff, very familiar uses in Australia.

Macrophytes are used in all wetlands but are clearly peripheral to microbial activity in the sandbed systems. Nothing exemplifies this fact more than images of snow-covered wetlands with long dormant Phragmites emerging from the snow. These systems continue to treat water efficiently throughout the Nordic winter.

The fascinating microbial world of biofilms was explored and presented. Biofilms are a mix of algae, bacteria, fungi, virus and protozoa which live within the slime-like layer known as EPS - the Extra-cellular Polymeric Substances which are the powerhouse of wetland water treatment systems. Both the sand-bed and open-water systems have biofilms, the former coating the sand particles and the latter the plant stems. Researchers, including several from Griffith University in Brisbane, have undertaken some really elegant work and their presentations were really helpful in revealing the hidden water treatment workings of wetlands

## Serengeti

I could not go so close to the Serengeti without going. Four days of aging Landrover borne dust, rattle and roll - to Lake Manyara, the Serengeti, Olduvai Gorge and the Ngorongoro Crater. All in the presence of big animals and about 100 bird species as only Africa can provide.

It was the dry season. I didn't expect a riparian management experience, but because it is so dry everything happens in the riparian zone. Both sides of the small waterways visited were heavily tracked as four-wheel drive, tourist-stuffed vehicles searched for animals along the waterways. From the vehicle it appeared that everything lives around the waterways of the Red Grass (*Themeda triandra*) dominated grasslands. It is the same species that we have in Australia, we call it Kangaroo Grass.

However, trashing of the riparian zone vegetation is not the sole preserve of the tour vehicles. Trashing does not get much better than when done by a herd of elephants. Elephants demolish the thorniest of Acacia trees to strip and eat the bark, twigs, branches and leaves. Everything is more extreme than in Australia as the mammals are bigger, more diverse and more numerous than at home. Because their actions are far from subtle the influence of animals on plant community evolution is brought to the fore.

## Kenya

The areas of Kenya that I visited were at high altitude (2-3,000 m) and straddled the equator producing an excellent year-round climate. As a former British colony (independence 1963) Kenya has an administrative legacy in relation to the riparian zone not unlike that of the state of Victoria. Laws, however, in relation to the clearing and treatment of riparian vegetation have been as disregarded in Kenya as they have been in Victoria. It now appears that Kenya is beset by a myriad of social issues that it appears will overwhelm the once truly abundant and magnificent natural legacy.

For nearly a month I camped across several of Kenya's watersheds with a Kenyan who works in water projects. It included the watershed around Mt Kenya, the source of Nairobi's water, the lakes of the Rift Valley and the Mau watershed that is the source of many rivers including the Mara River, which flows through the Masai Mara National Reserve.

Kenya is facing a water crisis, threatening its status as the biggest horticultural exporter to Europe and longer term the future of the wildlife dependent tourist trade. However, amidst the overwhelming social problems some outstanding examples of riparian management were visited.

### Lake Baringo

The Rehabilitation of Arid Environments Charitable Trust works to rehabilitate the overgrazed and eroded areas around Lake Baringo. The Lake is rapidly silting and the semiarid surrounds are bare earth. Working with the local participants, recent transformations have been nothing short of remarkable. Simple fencing, planting indigenous vegetation - mainly grasses - and introduction of controlled grazing has created a productive base for the local participants. It is apparent that continual, uncontrolled domestic stock grazing (sheep, cattle, and goats) in the riparian zones of Kenya is just as destructive as it is in Australia. This is despite the vegetation, unlike in Australia, having evolved with large, diverse mammal populations.

### Lake Naivasha

I stayed with Joan Root who, with her husband Alan, made many wildlife films in the 1960's. She lives on the shores of Lake Naivasha in a house built in 1917 with a hippo lawn. Joan is a great champion of the riparian zone and personally funds a patrol to warn off poachers who breakdown the papyrus around the Lake edge (100km around). An observation on the foreshore exposed the ability of indigenous riparian vegetation to withstand continuous grazing of the indigenous hippopotamus population but on the neighbouring property with continuous cattle grazing it was highly degraded.

There is also a Lake Naivasha Riparian Association formed in 1926 by the riparian owners. There are interesting parallels with the Victorian management in this group. Last year they won the 1999 RAMSAR Wetland Conservation Award. The horticulture around the Lake is huge, principally cut flowers for European export. Most are members of the very active Association.

### The Mau Watershed

I visited with Friends of the Mau Watershed, stayed with commercial dairy farmers and stayed at and met the directors of the Mara Conservancy. These are people concerned with the upper, middle and lower reaches of the watershed respectively. All are seeking to arrest environmental decline and establish sustainable ongoing development.

The forests of Kenya are diminishing rapidly. Rapid population growth and small time subsistence farming is pushing into the hills. Charcoal burners who denude large areas precede the farmers. These are the principle concerns of the Friends Group who are active politically at the national level and locally via extension programs. Wildlife has declined rapidly in the last generation. Now in the well-watered regions of Kenya most bush and wildlife are restricted to Parks. As an example the last rhinoceros on the farm was observed only 20 years ago, although to the consternation of many several elephants had travelled into the area recently.

I stayed in the Mara Triangle, it's about 510 sq. km of the Masai Mara, which is the Kenyan extension of the vast Serengeti. A private group, the Mara Conservancy, is managing this section. They had been in place just over a year and they have made real inroads into improving the visitor experience directly providing graded roads and clean, uncrowded bush camps. The contrast with the Serengeti experience could not have been greater. They have also enacted successful poaching patrols to reduce the harvesting of bush meat, which was taking a devastating toll on the wildlife.

While there I was witness to one of the great migration events in the world - said to number 1.2 million wildebeests plus zebras and more. It was a privilege. Particularly as I was able to fly over the spectacle including several passes over the Mara River in a light plane. By coincidence this is the same plane we have been considering using for video survey of rivers in Australia. It proved a very stable platform from which to video the river.

With so many animals the riparian zone is comprehensively disturbed. For example, hippopotamus tracks from the river up the banks are huge, continual watering by 10's of thousand's of hard hooped animals leave the banks denuded. Coupled with the movement of the river across the floodplain there is not a continuous strip of riparian vegetation along both banks. The aerial view reveals that many banks have no trees at all. This situation contrasts with treed envelope along similar sized rivers of the Murray-Darling Basin.

## South Africa

The Republic of South Africa is a country I sought to visit because it is a society on the edge of change. It is also a country with many parallels with Australia. I travelled down the length of the East Coast from near the Mozambique border to Cape Town. I have had a wholly positive experience. I found South Africa to be an exciting and dynamic place with a good deal of positive energy. And positivism is the commodity needed in abundant supply to meet the enormous social issues confronting the country.

The change in regime in 1996 has allowed for the implementation of innovation rarely if ever afforded a chance to be taken on in Australia and elsewhere. It was put to me that the bureaucrats were befuddled by the change and that looking for direction,, individuals with vision within the ecological community seized the day.

One of the cases is the change in management at Kruger National Park where, based on the research work on their rivers, they have moved from a command and control model of management to adopt adaptive management as the management model for the whole Park.

The other case is the Work for Water program - about an \$80,000,000 a year program involving 20,000 people. Having an exposure to the drivers of these programs has positively affected my attitude. It is difficult for me to imagine what living under the old regime was like, but I strongly suspect that the term - command and control management means an awful lot more of both than we have ever experienced in Australia. In this context it makes the adoption of adaptive management even more radical. We in Australia have much to learn about boldness.

Working for Water faces a task equivalent to the degradation of our river systems - Murray Darling included (by way of size comparison, South Africa fits within the Murray Darling basin). I have barely seen so many Eucalypts or Acacias in my life (only a slight exaggeration). I passed rivers in the South Africa wheat belt that, had I not been there myself, I would have taken for any one of our northern Victorian rivers (more hills though), mature River Red Gum (*Eucalyptus camaldulensis*), complete with Acacia understorey. Australian species including Acacia, Eucalyptus, Leptospermum and Hakea are among the principle weeds of the country.

The program marries water yield, biodiversity improvement and rural poverty alleviation. The principle tool is the manual clearing of weeds from riparian zones commencing in the headwaters, working from the least to the most infested areas. The program as presented has a well-considered approach of initial clearing with follow-up treatments. As a person experienced in the early days of managing such long-term unemployment programs in riparian rehabilitation in Australia, there are certain familiarities.

In one of the major wilderness area of the Eastern Cape (near Port Elizabeth) I was presented with the delicious irony of Black Wattle (*Acacia mearnsii*) control amongst Cape Willow (*Salix mucronata ssp. Capensis*) - almost the exact opposite to the riparian vegetation management program on the Genoa River in Victoria. Biological control has also been used with marked success on many weed species including *Acacia saligna*.

Unfortunately South Africans have treated their urban waterways in much the same ways as Victorians but they are now beginning to address the legacy. I had the good fortune to join with Dr Mandy Uys and an expert team including a geomorphologist, fish, riparian vegetation and other specialists on the first four days of a program to remodel a 5 km urban stream in the city of East London. All the traditional uses of urban waterways were in evidence - unregulated and domestic industrial dumping, garden refuse disposal, urban road drainage, sewerage lines and filling for sports fields etc, etc. With all of the attendant direct and cumulative consequences making for a narrow dangerous valley with a greatly deepened, sewage polluted waterway. What a delight the remnant vegetation patches and the resilience and cleansing ability of the waterway.

## Footnotes in the history of Riparian Degradation

### **A Tale of Two Rabbits**

In Australia the introduced European Rabbit has made a stronghold in the steep, soft riverbanks amongst the riparian vegetation. The grazing and digging of the rabbit has been, and remains as a major degrading force of our riparian vegetation. So for Australian's the demise of two specialist indigenous riparian rabbit species in two countries on different continents is particularly ironical. The perilous state of both populations is a direct consequence of habitat loss. Their decline indicates the general demise of riparian vegetation in agricultural areas in both the countries visited.

In California the Riparian Brush Rabbit is described as one of the most threatened species in the State. In South Africa the Riverine Rabbit is one of the most threatened terrestrial mammals and noted as a globally threatened species with probably no more than 500 individual remaining. All populations are restricted to private farmland. There currently no public reserves with suitable habitat.

### **Blackberry a transcontinental riparian dominator**

In temperate southeastern Australia, the principle weed of the riparian zone is the Blackberry *Rubus fruticosus spp.agg.*. It is not one species but a collection of difficult to distinguish species of European origin. It grows as a perennial sprawling shrub of prickly bearing herbaceous canes. In the riparian zone in particular the plant is highly vigorous and grows to dominate all other species. Observations suggest that once established as the dominant plant in the riparian zone the process of plant succession is severely curtailed. The weed thrives on natural disturbance such as flooding or man induced domestic stock grazing or cultivation and with rapid growth, out-competes all others to form an almost exclusive cover of canes.

The Blackberry was found to be a major riparian weed of the riparian zone in Oregon USA, the Netherlands and in Kenya. Researchers in Oregon reported exactly the same phenomenon of successional hiatus in vegetation dominated by Blackberry as observed in Australia. Anecdotal reporting attributed the Oregon and Kenyan infestation to species of Asian origin and The Netherlands infestations to species of American origin.

## Riparian Perspective's

The Fellowship gave me the rare privilege of gaining a broader perspective on approaches to the rehabilitation of riparian vegetation in agricultural landscapes with which I was previously familiar in the southeastern Australian context. It enabled selection and travel to locations where change, generated by either landscape or management evolution, is given dramatic and therefore readily appreciated effect. It allowed for the taking of a series of comparative snapshots worldwide to reflect on the Australian condition.

Among the reflective perspective's gained are the following:

### The Changed conditions

The dramatic nature of the African wildlife excites speculation in regard to changes to our own wildlife since settlement and the subsequent affect on plant-animal interactions.

Like landscapes of the South African Eastern Cape region, which lost their mega fauna populations as long as 100 years ago (animals over 1,000 kilograms eg. rhinoceros and elephants), southeastern Australia has lost species and suffered dramatic declines in native animal densities since European settlement. Like Africa our plant communities evolved under the pressures of indigenous animals.

Similarly our current concepts of plant communities and their management that are derived from observations of indigenous animal denuded landscapes may be distorted. In southeastern Australia we simply do not have animal rich reference sites.

Densities of animals, cover abundance of different plant species and plant forms and volumes of fallen timber on the floodplain floor may well have been dramatically, and not just marginally, different. The biotic landscapes we are dealing with today are likely to be changed greatly from pre-settlement conditions.

This has been bought to the fore by having seen the devastation of a herd of elephants feeding on the heavily armoured, thorny Acacias and having seen the same Acacia species growing in a riparian landscape long-denuded of elephants. There is obvious immediate disturbance and nutrient recycling associated with elephant feeding. There are also many far more subtle effects. The structure of the plant communities and the opportunities for plant species evolved with disturbance and the animals (including insects and higher animals) that feed on these plants are among these.

For current-day managers of both continents, the challenges of attempting to maintain vegetation and animal diversity in a changed landscape are huge. Our systems are far less dramatic but the changes may be expected to be similar. For example, how do we maintain vegetation diversity when key conditions for success in their reproductive cycle may now be absent.

### The grazing regimes

On a number of occasions in Africa the impact of grazing patterns on the indigenous flora were highlighted. The indigenous riparian vegetation appeared very resilient

despite the dramatic size of indigenous wildlife and the occurrence of dramatic numbers of migrating herds.

The examples of degradation observed were linked more with the continuity of grazing by domestic animals (sheep, cattles, donkeys and goats) rather than with the species. It appears to support the contentions that it is persistent grazing that indigenous vegetation is unable to withstand.

#### Indigenous vegetation species in riparian vegetation rehabilitation

Throughout the world the value of using indigenous vegetation species in riparian vegetation rehabilitation was repeatedly affirmed.

#### Geographic

After the volcanism of the western United States and east Africa and the newness of these evolving landscapes, the ancient, stable nature of the Australian landscape contrasts starkly. The realisation that the riparian zones of these countries, because of the relatively high general fertility of the newly evolving soils, may not be as significant as the Australian riparian zones. Riparian zones in the southeastern Australian landscape are relatively rare fertile, well-watered areas making them comparatively more important than elsewhere.

The remnant riparian vegetation of Australia's cleared agricultural landscapes have more in common with the San Pedro River of the desert of the southwestern USA. Like the San Pedro riparian forest they are relic populations of a past time. The San Pedro forests of a wetter climate thousands of years ago. Our riparian zones a relic of previous woodland dominated landscape that were converted to grassland dominated landscapes through clearing less than 100 years ago.

#### Management process

The role of monitoring in waterway rehabilitation is poorly understood in many projects.

The most successful operations are not projects but programs. Project orientation is towards discrete starts and finishes. River rehabilitation is inherently unsuited to this approach requiring an iterative process more an ongoing program. The more successful programs viewed are generally long on planning and establishing, objectives and management frameworks and put an inordinate emphasis in establishing a monitoring program as an integral component and key to adjusting ongoing management.

The most success programs experienced were in Oregon and Kruger National Park. Where managers put emphasis on creating pre-conditions which will allow stream and vegetation processes to re-establish a desired state when the right combination of circumstances dictate (climatic, seeding, etc.,) rather than directly attempting to engineer systems.

Open, accountable, inclusive and iterative processes appear to be the best approaches to achieving stream rehabilitation. Command and control methods familiar to engineering projects appear less suited to the management of ecological processes such as riparian vegetation rehabilitation.

#### Resourcing

It is apparent that money is not the only commodity required for riparian rehabilitation to be successful. Resourcing of individual river rehabilitation in both Oregon USA and the Netherlands illustrates the scale of resourcing required for rehabilitation management. By contrast, in southeastern Australia, we consistently do riparian rehabilitation on the cheap. However the overriding impression from California is that finance alone is ineffective without the coordination and shared clarity of purpose that allows both landholders and government authorities to work towards the one goal.

#### Capacity

Australia would appear to be in one of the better positions worldwide to successfully manage the riparian vegetation resource. We lack the impediments of the American situation, which are rooted in the overwhelming complexity of an advanced economy and I suspect is also influenced by the national attitude. We also lack the social situation of African countries, which is truly overwhelming.

Australia is well placed to take the advantage of the worldwide advancements in ecological understanding and ecological restoration process. I perceive that we have a relatively well-educated population when it comes to the appreciation of the commonsense of riparian vegetation management. The population responsible for land management in agricultural areas also has a generally open and cooperative attitude required to move from established practice and conditions.

Our problem would appear to be of both resourcing and approach. From my experience there are simply not sufficient dollars applied to undertake the actions known to be required to effect rehabilitation nor is the expenditure available over time. We also often continue to labour under the delusion that riparian rehabilitation is a series of discrete stand-alone projects, stand-alone from each other, from the surrounding landscapes and from the people of the catchment.

Taking from the experiences of the North West Forest Plan where resource targeting and monitoring are integral components of management and the adaptive management approach as experienced in Kruger National Park would appear to provide a direction for riparian vegetation rehabilitation in the Australian context.