INQUIRY INTO PEST PLANTS IN VICTORIA

Submission to Environment and Natural Resources Committee of Parliament of Victoria.

David Holmgren B.A. (Environ. Des.) **(Holmgren Design Services)**

Michael Wilson M. Sc. **(University of Ballarat)**

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Weed invasions are SYMPTOMS of ecological change and imbalance not their CAUSE. Shooting the messenger exacerbates the problems.

We believe this submission addresses directly and indirectly most if not all the terms of reference. The submission follows its own logical structure but is particularly relevant to the following terms of reference:

- 1. Identify the impact of pest plants on the Victorian economy and environment.
- 2. Determine the current and projected costs of control of pest plants on private and public land.
- 3. Assess the adequacy of current information and research on pest plant control strategies.
- 4. Advise on the rationale for classification of pest plants and distinctions between environmental and agricultural weeds.
- 7. Advise on statewide priorities for pest plant control.

If the Committee requires further explanation of this submission we are willing to provide clarification and answer questions in a public hearing.

OVERVIEW

Poor ecological science combined with guilt about the great changes we have wrought on indigenous ecosystems is threatening to sidetrack the real moves towards sustainable land use in Victoria and Australia through a massive expansion of weeds legislation.

The existing weeds legislation provides substantial impediments to sustainable land use by assuming that a plant is inherently bad because it is a problem to current land uses and management strategies. It may be the land use which is the problem.

Examples abound;

- Goats being introduced to sheep grazing properties to control shrub weeds proving a valuable diversification while changing attitudes to the so called pest (fodder) plants.
- Serrated tussock, a dreaded weed for pastoral farmers has led to steep hillsides being "abandoned" and planted to pines which prove to be a more ecologically sound and economically productive land use on such sites (with or without serrated tussock).

Lack of suitable methodologies for assessing the hidden benefits from weed have led to constant underestimation of their contribution to land rehabilitation and future resource use opportunities.

Campaigns to eliminate weeds have generally been unsuccessful despite heroic efforts often by whole communities (eg Ragwort in the Otways).

Entrenched attitudes by land holders combined with poor science has over the decades maintained noxious weeds legislation as a regulatory support for the most powerful primary industries. In New Zealand Pasture Protection Boards were handed over to the pastoral industries to fund and run since most of the proscribed weeds were not problems to either the horticultural or forestry industries (which are emerging as NZ's dominated export industries).

It may be politically unrealistic to reform pest plant control in Victoria according to economic and ecologically rational principles. However the pressure to greatly expand the range of proscribed species by inclusion of "environmental weeds" is alarming and should be rejected as economically and ecologically unsound.

The environmental weed concept[1] is not based on an integrated or complete assessment of environmental impact but simply the likely displacing of indigenous vegetation in "natural" or near natural environments.

This flawed approach is compounded by any weeds legislation which is inevitably based on taxonomic definitions (ie species definitions) rather ecological (functional) assessment on a site specific basis.

A majority of so called environmental weeds are valued species in agriculture, forestry, horticulture and landscaping. In general these species are valued because of their hardy characteristics under prevailing conditions and low cost of establishment and maintenance. (These are the very characteristic used to promote the use of indigenous species).

Prohibitions or impediments to the use of these species will increase the total cost to the Victorian community, economy and environment by both the costs of removal and control and replacement with less well adapted species.

The ecologists and indigenous revegetation experts who developed and promoted the environmental weed concept have openly admitted[2] that legislation will have little real effect in control of environmental weeds but support it for its perceived community education value.

We believe unworkable legislation is a historically proven recipe for misallocation of resources and selective and unjust application.

The State government and CALP Boards should not add any plant species to the Noxious Weeds Lists or any other lists of proscribed plants without a comprehensive environmental impact statement and full and open public inquiry.

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[1]Carr, G.W. Yugovic,J. V. and Robinson, R.. (1992) *Environmental Weed Invasions In Victoria* Department of Conservation and Environment and Ecological Horticulture Pty Ltd Melb.

[2]Robin, J, Robinson, R. and Kern, L. personal communication and public debate.

ECOLOGICAL PREDICTIONS

Our own research and experience suggest naturalisation and spread of exotic and Australian species will continue to increase in Victoria in the foreseeable future irrespective of all but the most massive and extreme control strategies.

We predict that the;

(a) number of species
(b) geographic spread
(c) total populations;

will all increase due to increased seed sources, declines in active land management, and increased dispersal potential.

We do not expect large increases in new naturalisations of herbaceous and grass species, the traditional focus of concern by agricultural industries.

Instead we expect major increases in naturalisation and spread of;

- Australian native tree and shrub species widely planted in the last 30 years especially following bushfires through urban fringe, rural residential, highways, and farms where extensive planting has occurred in recent years.
- Bird distributed berry producing shade tolerate (rainforest analogous spp) trees and shrubs
- Trees and shrubs palatable to grazing animals.

Under prevailing definitions virtually all these naturalised species will be classified as "environmental weeds" while a much smaller number may be considered agricultural and forestry weeds.

Naturalised species should be thought of as "migrant plants" which are in the process of become Australian. The fact that a large number of Australian and even Victorian species are now considered environmental weeds emphasises how counter productive this concept is especially when combined with the taxonomic basis of weeds legislation.

INDIGENOUS REVEGETATION

Current attempts to control spread of environmental weeds focus on the most infested areas especially around settlements and along riparian corridors for political rather than ecological reasons.

Adverse environmental impacts of control methods in these areas are much greater than any environmental benefits for the following reasons;

(a) serious effects of control strategies especially earthworks and herbicides on aquatic ecosystems.

- evidence of links between widespread use of Glyphosate and frog decline
- increased sediment and nutrient loads from herbicide, burning and or earthworks.
- loss of fish habitat by earthworks and bird habitat including predator protection
- loss of efficient nutrient absorbing and erosion controlling species

(b) rapid re-invasion due to elevated nutrients, water and weed seed sources from urban and agricultural runoff.

Successful establishment of indigenous sclerophyll vegetation systems presents severe long term fire hazards especially in urban areas unless active fuel reduction management is implemented.

Study and management of mature examples of weed invaded riparian landscapes in Victoria over a decade[3] show a general ecological pattern ;

(a) closed canopy forest (analogous to rainforest and/or deciduous forest)

(b) open understorey (reduced primary colonisers eg blackberry)

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[3]Holmgren, D. & Morgan, P. (1982) *The Yarra Floodplain: The study of an urban ecosystem* Environmental Studies Ass Melb

Holmgren, D. (1994) *Trees On The Treeless Plains*: Revegetation Manual for the Volcanic Landscapes of Central Victoria. Holmgren Design Services

Holmgren, D. (1996).Management of Public Land Incorporating Biodiversity and Productivity; Spring Creek Community Forest Project Case Study in *Is There A Role For Indigenous Permaculture: Integrating the Goals of Ecological Restoration & Permaculture.* Greening Australia Forum proceedings

(c) humic soil (similar to compost rich garden soil)

With increasing ecological maturity the following beneficial characteristic develop

(a) low fire hazard or fire barrier

(b) high amenity and improved accessibility to people

(c) high nutrient and water holding capacity, efficient purification of toxins

(d) increasing stream bank stability

(e) increasing ecological diversity (total number of species present)

(f) increase resources use potential (animal fodder, timber, food)

Streams dominated by environmental weeds in both urban and agricultural landscapes should be managed for multiple values by low cost skill based minimum intervention to accelerate ecological maturity.

Labour and skill intensive bush regeneration strategies should be concentrated on reserves and other relatively intact remnants of native ecosystems especially those where results will be long lasting.

In particular sites;

(a) of low nutrient status away from stream corridors,

(b)remote from human settlement and intensive agriculture

will be most practical to maintain in an indigenous state.

State and local government funding of departmental, Landcare and other proposals which involve large scale removal of existing perennial vegetation should be dependant on the outcome of a comprehensive environmental impact statement.

The State government should provide funding for development and promotion of more ecological (integrated) approaches to management of riparian and public land around settlements and agricultural areas.

SUSTAINABLE LAND USE AND ENVIRONMENTAL WEEDS

Proscribing the control and/or elimination of these species under the Noxious Weeds Legislation or similar regulations will unnecessarily increase burdens on land holders and the State.

Environmental weeds legislation with State funding of control strategies will result in a permanent weeds eradication bureaucracy or industry able to lobby for endless increasing funding for endless increases in "environmental weeds".

Primary industry can never be competitive unless it uses the most productive biological resources available. Weediness or ability to persist under prevailing conditions is an essential criteria for any species which has the potential to be truly useful to sustainable agriculture and forestry, especially Australian broadacre low input systems.

Most economically useful species are (ecologically) speaking weeds.

For example Victoria's most valuable, pasture legume (Subterranean clover), plantation timber (Radiata pine) and tree crop (Apple), are all environmental weeds.

While use by farmers, foresters and horticulturalists of existing valuable crops species can be expected to be protected by any reasonable changes to legislation and regulations, the effects on innovation could be serious.

Proscribing of environmental weeds will stifle research and development in forestry, fodder and horticultural crops with great potential to contribute to the state economy.

For example

(a) the most useful tree fodders in Victoria (tagasaste and willows) are both regarded by some as "serious environmental weeds"

(b) the best prospective plantation eucalypts (blue gum, spotted gum, sugar gum and mahogany gum) are all environmental weeds

(c) and some of the most prospective commercial "bush tucker" species (Cootamundra wattle) are environmental weeds. Olives probably destined to be one of Australia's most valuable tree crop exports is regarded as South Australia's worst environmental weed.

The state government should focus more of the pest plant control resources on efficient utilisation of so called weeds and integrate this a greater emphasis in agricultural, horticultural and forestry research funding toward the efficient utilisation of plant species already common in Victorian rural environments irrespective of whether these locally indigenous, Australian native or exotic.

CASE STUDY: WILLOWS IN CENTRAL VICTORIA

The following case study illustrates the issues involved in more economically and ecologically rational management of so called environmental weeds by focusing on a species which is a major functional element in Victorian rural landscapes.

THE IMPORTANCE OF RIPARIAN LANDS.

Riparian land, lying next to streams and rivers and around lakes and billabongs, generally has better soils and better water relations than surrounding lands. As such they are highly productive and of special value to primary industries. They also lie at the junction of the terrestrial and the aquatic parts of a landscape. As such they are of particular importance to the ecological processes and biota that occur on both land and water.

This, we believe, would be accepted by all who submit evidence to this committee. The special utilitarian and ecological values of riparian lands behove us to pay special attention to the ecological and utilitarian basis of our management. We suggest that application of a **ecosystem basis** to management can accommodate utilitarian and ecological values without compromise. Focusing on willow lined riparian streams we can illustrate a management approach that overcomes the flaws inherent in identifying a plant as a pest, which is a **taxonomic basis** to land management.

THE ISSUES CONFRONTING A LAND MANAGER OBSERVING WILLOW LINED STREAMS.

Are willows a pest?

Are willows of benefit?

or,

Is there a cost if a willow is growing on a riverbank?

Is there a benefit if a willow is growing on a riverbank?

These are the omnipotent questions in the minds of all good land managers, for the answers to these questions determine the management action. They are, essentially, a site specific cost-benefit analysis. The answers to these

questions may be 'yes' in some locations and 'no' in others. The answers may be 'yes and no' in still other locations. The answers may be 'we don't know' in yet other locations. The answer has less to do with willow itself, but more to do with the catchment and ecosystem conditions in which it occurs.

We can illustrate this in real situations where we are studying the ecology of willow lined streams.

CLEARED VOLCANIC LANDSCAPES IN CENTRAL AND WESTERN VICTORIA

Introduction

An examination of these landscapes is justified, because they contain a number of catchments dominated by willow lined streams. Extensive areas of the agriculturally productive volcanic landscapes of central Victoria were cleared of all native vegetation early in European settlement. Fertile, deep, soils along watercourses were especially valuable and clearing of riparian vegetation was nearly universal. The hydrological, geomorphological and ecological consequences of such clearing are well documented[4] Rainfall is no longer held in canopies or infiltrates as well into the soil, so runs off quickly. Pastures are sparse after dry summers and the runoff carries high sediment loads. The sediments and runoff carry nutrients that lead to eutrophication of aquatic systems. Riverbanks are unprotected by riparian vegetation and erode. This has led to flood outs and thus loss of agricultural land. The aquatic biota dependent on input of litter and woody debris as food and habitat is unable to survive open, turbid, silt lined streams.

Such images of ecological change appear provocative, but are an accurate and well accepted description of the transition that has occurred over the last 10 to 20 decades. The riparian environment of the volcanic landscapes of central Victoria is a highly modified environment. Within this new environment species

[4]Raine, A.W. and Gardiner, J.N. (1995). *Rivercare: Guidelines for Ecologically Sustainable Management of Rivers and Riparian Vegetation*. LWRRDC Occasional Paper Series No. 03/95, Canberra.

are adapting. Indigenous, native and introduced species are all exposed to a new environment, one with altered ecological, hydrological and geomorphological characteristics. The land manager is now faced with a situation that Raine and Gardiner[1] describe as 'the extraordinarily difficult task of trying to restructure a highly degraded system'. We would concur with their view that to 'aspire to rivers that *look* (our emphasis) like those of 200 years ago is a pipe dream'. However, we believe we can aspire to rivers that *function* like they did 200 years ago.

Willows are one of the species that are adapting to the highly modified riparian environments of the volcanic landscapes. They line hundreds of kilometres of streams and rivers in these landscapes. So, what are the answers to the above cost-benefit questions in this new environment?

We would argue that the answers come from an understanding of ecological, geomorphological and hydrological processes. The answers are not found in classification of a plant as indigenous, native or introduced. Let us explore some of the possible answers in the light of current research.

Willows are, obviously, a tree and, as such, are perennial. They are thus a fundamentally different ecosystem component to the non-native pasture species that typically colonise stream and river banks in the volcanic landscapes, wherever vegetation has been removed. Thus our answers to the questions unavoidably require a comparison of willows and non-native grasses. In these landscapes it is not a choice of willows or native vegetation. The ecosystem processes currently in operation are clearly beyond a choice between native vegetation and willows, as there are few, if any unaided native colonisers of riparian lands within the volcanic landscapes.

Stream stabilisation

Two characteristics of willows have been critical in their widespread Australian and global use for river training and erosion control. Firstly they grow rapidly from large cuttings (over 2m in length) that can be driven deep into loose sediments. Secondly they have a mat like root system that has excellent sediment stabilisation and capture characteristics. Other species, including

indigenous ones, are suitable, and arguably necessary, riparian components and should be widely and extensively planted. However, these are not naturally regenerating on the volcanic landscapes. We are faced with a situation where willows and grasses are naturally colonising the riparian zones of these primarily agricultural lands.

Vegetation exerts control over river form and flow. Cummins[5] suggests vegetation stabilises banks through root systems and influences channel structure through large woody debris. To this can be added flow resistance of the above ground parts of plants[6] . The significance of riparian vegetation in controlling channel width is encapsulated in the formulas of Hey and Thorne[7] . In these formulas, vegetation and dominant discharge (Q_b) are the two controlling variables. A river with grassy banks would have a channel width of $4.33Q_b^{0.5}$. However, a river of equal catchment size but with greater than 50% tree/shrub cover would have a channel width of $2.34Q_b^{0.5}$. Thus, there is a calculated 1.8x increase in channel width as a result of clearing riparian trees and shrubs.

If willows were to be removed, grasses would be the primary volunteer. This would result in significant increases in channel width and sediment mobilisation. According to Hey and Thorne's[4] formulae there would be a 1.8x increase in stream and river widths. To place this into context for primary producers, a stream of 10m channel width would expand to cover a hectare of the landscape's most productive land for every 2.25 kilometres of river length, an event of significant economic impact to primary producers The environmental

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[5]Cummins, K,W. (1993). Riparian stream linkages: in-stream issues. In: Bunn, S.E., Pussey, B.J. and Price, P. (eds) *Ecology and Management of Riparian Zones in Australia.* LWRRDC Occasional Paper Series No.05/93, Canberra. pp 5-20.

[6]Thorne, C.R (1990). *Effects of Vegetation on Riverbank Erosion and Stability in Vegetation and Erosion*. John Wiley and Sons, Chichester, U.K.

[7]Hey, R.D. and Thorne, C.R. (1986). Stable channels with mobile gravel beds. *J. Hydraul. Eng*. 112 (8): 671-689.

impacts of the resulting mobilisation of sediment would be great. The answer is obviously replacement of willows with other tree and shrub species. However, the key issue is that if willows are declared a pest then there is a legislative obligation for their removal. There is no similar obligation for replacement or replanting. Experience of existing pest plant control programs indicates that removal or killing of pest species is very rarely voluntarily followed by replanting. This is true for activities at state or local government level and private land management.

The high productivity of riparian lands is especially true for the watercourses draining fertile volcanic landscapes. There are strong economic incentives for land managers in these landscapes to maximise the area of land under pasture or cultivation in the riparian zone. There are very few managers in these landscapes who have fenced out and actively planted riparian zones. Whilst we hope this situation improves, it indicates the understandable reluctance of land managers to voluntarily revegetate productive riparian lands. We would argue that a legislative obligation to remove willows combined with a perception of gaining extra fertile land would result in extensive clearing with no consequential replanting.

Nutrient uptake

Eutrophication of aquatic ecosystems is a critical resource management issue, requiring fundamental changes in catchment management. Toxic blue-green algal blooms are one symptom. The nutrients responsible are from land based activities, and arrive in waterways from point sources (eg, waste water treatment plants, intensive animal industry waste) and diffuse sources (eg broad acre agriculture, urban stormwater and runoff). Massive programs are currently focussing on the sources, movement and potential sinks of nutrients.

Willows are a species that are utilised internationally and locally in waste water treatment systems. Nutrient uptake dynamics in artificial and natural wetlands are not completely understood. However, empirical evidence clearly shows the capacity of willows to capture nutrients. The surface area contact between large willow root mats and overland, ground and stream water is enormous. We would expect nutrient uptake by willows to be very high - a hypothesis confirmed empirically. The nutrient content of willow leaves is high, there is rapid nutrient turnover between leaves and stem storages prior to autumn leaf fall, and growth rates are rapid. As a result of these features, willows represent a massive nutrient sink.

The sediment capture capacity of riparian biota is seen as crucial in controlling diffuse nutrient loads from cropping and grazing. Sediment runoff, a major carrier of nutrients into streams, is captured by a well developed ground cover. Hairsine[8] has shown that grass buffer strips outperform bare ground and near-natural native riparian forest in capturing runoff sediments. The lack of well developed ground cover was seen by Hairsine as the primary reason for the differences. Unmanaged willow dominated stream banks have variable ground cover, with heavy shading a major constraint on its development. We suggest that where willows differ from both indigenous swamp gum and red gum dominated riparian forests and grass lined banks, is the exposed root mat that extends from the trunk over the verge, bank, bed and out into the water. This potentially acts as a final filter of sediments right to and under the water's edge, as well as acting as a proven in-stream filter of water borne sediments.

A dilemma in many revegetation projects is that indigenous species have largely adapted to nutrient poor conditions. Many species do not have the capacity to tolerate, use or store large concentrations of nutrients[9]. It can not be assumed that replacement of willows, having well documented high nutrient tolerance and uptake capacity, with indigenous species will result in equivalent nutrient capture and uptake. Most evidence would suggest this will not be the case. Until more knowledge is available on the suite of indigenous species that can perform nutrient capture and uptake roles in the riparian zone, broad scale willow removal will almost certainly result in an increase in aquatic eutrophication. This, we suggest, will occur even in the unlikely event willows are replaced by indigenous species.

Biota

[8]Hairsine, P.B. (1996). Comparing grass filter strips and near-natural riparian forests for buffering intense hillslope sediment sources. In: Rutherfurd, I and Walker, M. (eds) *Proceedings of the First National Conference on Stream Management in Australia*. Merrijig, 19-23 February. Monash University, Clayton.

[9]Department of Water Resources. (1989). *Water Victoria: an Environmental Handbook.* Department of Water Resources, Victoria.

An underlying speculation by most advocates for indigenous revegetation is that native animals, birds, invertebrates and micro-organisms are adapted to and are dependent on native vegetation. There is intuitive logic in this hypothesis and studies have shown very clear relationships between species. Obligate pollination requirements, such as a particular species of wasp pollinating a particular species of orchid, and obligate habitat requirements, such as in the mallee fowl, show how plants can be dependent on animals and animals can be dependent on plant communities.

The difficulty with this hypothesis, from an ecological perspective, is that nature is not xenophobic. Resources are utilised by organisms wherever there is capacity to do so, and wherever a competitive advantage is gained. Many studies have shown expansion of native species as a result of introduced resources. Native parrot, cockatoo and kangaroo numbers in Australia's grain belt have undoubtable risen in response to an introduced resource, and similarly seagull colonisation of rubbish heaps is an extreme example of non-indigenous resource utilisation.

In ecosystems that have been shifted to a new ecological state up to 150 years ago (eg forest to grassland, native grassland to improved pasture etc) we would expect new species interactions to be in place. This is clearly illustrated in current studies on the western volcanic plains of Victoria. Native pastures have been improved by over sowing with pasture legumes and super phosphate addition. When improved perennial pastures are compared to grazed native grasslands there are no significant differences in species richness of native reptiles, mammals, amphibians and invertebrates[10]. When these perennial pastures are compared to cultivated annual pastures no difference in the invertebrate species richness is observed. Interestingly, it is only in these strongly grazed, agriculturally productive landscapes where the endangered striped legless lizard is found in Victoria. Thus, the complexity of interactions between native organisms and introduced and modified plant communities on these volcanic plains appears to discredit any universal application of the hypothesis that near-natural native plant communities are always of greater benefit to native animals.

[10]Hadden, S. University of Ballarat pers. comm.

What do we know of the interactions between native animals and willows in Australia? There are few quantitative studies that have attempted to observe differences between willow and native communities on comparable sites. Pidgeon and Cairns[11] showed willow leaves to be consumed readily by aquatic macroinvertebrates in the New England region of NSW. This follows Pidgeon's[12] earlier speculation that decreases in total stream productivity under willows compared to native or pasture lined reaches was a result of unpalatable leaves. These contrary observations are yet to be resolved.

Beasley[13] studying the Murrumbidgee River in NSW showed no difference in species richness of aquatic macroinvertebrates amongst the roots of willows, river she oak (*Casuarina cunninghamii*) and red gum (*Eucalyptus camaldulensis*) in autumn. In winter, red gum roots had a higher species richness, but there were no differences in willows and river she oak. The cause for the seasonal difference was not known. However, the comparison of trees hundreds of years old with those only a few decades old could well be an important variable, potentially more important than the taxonomy of the plant.

In terms of vertebrate habitat, the only study we are aware of is Koehn's[14] study of two spined blackfish. Koehn compared blackfish numbers in streams bordered by grasses with little large woody debris or rock habitat with a similar

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[11]Pidgeon, R.W.J. and Cairns, S.C. (1981). Decomposition and colonisation by invertebrates of native and exotic leaf material in a small stream in New England (Aust.). *Hydrobiologia*, 77: 113-127.

[12]Pidgeon, R.W.J. (1978). *Energy Flow in a Small Stream Community: An Evaluation of the Effects of Different Riparian Vegetation.* PhD Thesis, University of New England, Armidale

[13]Beasley, C.H. (1992). *Macro-Invertebrate Assemblages in the Riparian Tree Roots of the Murrumbidgee River, NSW.* BSc (hons) Thesis, Charles Sturt University, Albury.

[14]Koehn, J.D. (1987) *Artificial habitat increases the abundance of two-spined blackfish (Gadopsis bispinosis) in Ovens River, Victoria.* Arthur Rylah Institute of Environmental Management, Research Technical Report Series no. 56

stream reach into which he introduced habitat debris. As an opportunistic addition to the study he also looked at blackfish numbers under willows that had dropped large woody debris into the stream. Blackfish numbers were significantly higher in both the willow and artificially induced habitat reaches than the pasture reach.

Currently, studies are in progress in Tasmania [15] and one of the authors of this submission is studying willow and eucalypt litter dynamics and invertebrate associations in Central Victoria. Until we have a more complete understanding of site specific interactions between biological communities and willows the evidence suggests little biotic disruption in modified landscapes. Thus there is no intrinsic characteristic in willows that makes them antagonistic to native organisms. It is almost always the land use and catchment conditions that determine overall biotic condition, very rarely the presence or absence of an individual organism.

Management implications of an ecosystem based approach to willows on the volcanic landscapes

Ecosystem and catchment wide perspective's were illustrated in the above section. The role of each ecosystem component needs to be evaluated on a functional basis, not on a taxonomic basis, if we are to achieve well managed catchments. If an organism is performing a function that is of ecosystem or catchment benefit, then to have declared it a pest and thus obligated a land manager to remove it, will be counter-productive. The scale of European catchment modification in the volcanic landscapes is such that a taxonomic basis to land management has the potential to critically accelerate existing catchment instabilities.

The willows of the cleared volcanic landscapes are not environmental weeds. They are not invading native communities along the agricultural landscapes; they are colonising bare, pastured or abandoned ('weedy') sites. The ecosystem analysis that is encapsulated in the previous section suggests willows are currently playing a vital role in ecosystem and catchment processes. As such this introduced plant, we suggest, is responsible for vast economic benefit. The benefits are very difficult to quantify, as is usual with ecosystem and catchment processes. However, we can place channel stability, sediment capture, nutrient capture and uptake and structural diversity (a critical influence on habitat

[15]Reed, M. University of Tasmania pers. comm.

values), in the context of national land degradation. Soil loss, eutrophication (including toxic blue green algal blooms) and biodiversity loss are at the core of national sustainability and Landcare priorities. The removal of willows in these agricultural landscapes will thus be counter-productive.

If declaration of willows as a pest, is counter-productive, then acknowledgment of willows as a resource may be productive. Palatability, high nutrient content and late summer vigour means that management of willows for animal feed has economic benefit to graziers, whilst retaining willow root mats on the channel, nutrient capture and uptake and structural complexity in the riparian vegetation.

Willow pollarding for animal feed:

will increase light to the ground, thus increasing ground cover and therefore sediment capture capacity,

will export nutrients from the riparian zone (animals literally walk off with the consumed nutrients) and thus ensure continued nutrient uptake capacity,

allow planting opportunities for other species, including palatable and multi-purpose indigenous species. These become more likely as benefits from existing willows are experienced,

provide late summer and autumn feed at times when pasture based systems are most depleted.

These and other willow fodder systems are well tested, indeed are traditional, in Europe and thus well documented. This approach is in use in Australia and New Zealand, and is further documented in a revegetation manual for the volcanic landscapes[16]. Site specific management techniques will evolve, but the principles are soundly based on ecosystem understanding. A net grazier

[16]Holmgren, D. (1994) *Trees on the Treeless Plains: a Revegetation Manual for the Volcanic Landscapes of Central Victoria*. Holmgren Design Services, Hepburn.

economic benefit, with sound ecological benefits, contrasts with the net costs of willow removal of up to $30 000 per kilometre [17]

POST-GOLD RUSH SEDIMENTARY LANDSCAPES OF CENTRAL VICTORIA.

Introduction

In the higher rainfall parts of the goldfields region of central Victoria a number of catchments with underlying sedimentary geology have a willow presence on creek systems fully worked during last century's gold rushes. The high disturbance, massive creek sediment mobilisation and broad scale clearing that characterised the gold rushes has had ecological consequences still clearly visible. A most significant feature is the resilience of native species to such widespread disturbance, and their continuing presence, even in urban environments that have been continually occupied since that time. This is a fundamental difference to the volcanic landscapes where there is little evidence of native resilience in riparian communities. Forestry dominates these landscapes, with light use agriculturally, and relatively small townships.

However, these post gold rush streams are now very different from their pre-European appearance, and it must be acknowledged that the change is permanent. Only intense activity would maintain an environment free of introduced plants in riparian zones. The wet forest plant communities along the creeks were in the direct path of the miners and were effectively removed from the landscape. The only effective way of returning these species to the streams is by planting.

We thus have a situation where ecological processes, including eutrophication and hydrological changes from altered catchment conditions, are leading to increasingly mesophilic, rainforest-like, riparian communities. Scattered emergent eucalypts have a multi-strata understorey of willow, sycamore, blackwood, silver wattle and ash

[17] Lindberg, L. (1992). *The Current Status of Willows (Salix sp.) in the Lal Lal Catchment, Victoria.* Thesis for the Post-graduate Diploma of Land Rehabilitation, Ballarat University College, Ballarat.

with a ground layer of light stressed blackberry on the outer edges and burdock, periwinkle, mosses and liverworts on deep organic rich soils. Introduced plant removal would simply lead to re-colonisation by the same plant types, for they are well represented in the catchment. Thus, to achieve a non-introduced plant community that would maintain ecosystem and catchment functions at the same level of the existing blended communities, would need extensive and comprehensive planting.

Costs of willow removal and ecological restoration

This is best illustrated by example. Between Daylesford and Hepburn, a distance of only 6km by road there are 22km of stream length with willow presence. At a conservative $15 000/km for removal[18] the economic cost for willow removal alone would be $330 000. Hepburn Shire, we suggest has well over 1000x this stream length with willow presence. A conservative cost for removal would be $15 million. The scale of economic resources needed to address a single species is thus vast. We have no clear costing for the removal of blackberry, ash, sycamore, burdock, periwinkle and other introduced plants. If they together cost the same as the more dominant willow then Hepburn Shire has a very conservative $30 million pest plant removal bill for just stream and river banks.

We argue that, if spent, environmental damage would be the net result, not environmental gain. Thus a replanting program will need to be concurrent, which would at some time in the future maintain ecosystem and catchment functions at the level existing communities currently achieve. The replanting program will, at a very conservative estimate, double the removal costs, and fencing both sides of waterways in all agricultural landscapes would add $2-4000 per lineal km. For Hepburn Shire a total cost to maintain ecosystem and catchment functions of the riparian zone whilst temporarily replacing an introduced plant with a native analogue would be **$30 million, plus fencing costs**. This money would be spent achieving, we argue, **no net environmental gain**. To maintain the riparian zone free of introduced plants will require

[18]Lindberg, L. (1992). *The Current Status of Willows (Salix sp.) in the Lal Lal Catchment, Victoria.* Thesis for the Post-graduate Diploma of Land Rehabilitation, Ballarat University College, Ballarat.

constant and perpetual activity, being such long, narrow, easily invaded communities. The costs of perpetually weeding thousands of kilometres of streams is immeasurable.

Management implications of an ecosystem based approach to willows on post gold rush streams

An appropriate approach is to acknowledge the role species, both introduced and native, are playing in the ecosystem and catchment processes. We can see that in the highly modified creeks of the higher rainfall parts of the goldfields region, a complex, rainforest-like vegetation is evolving. It has structural complexity, diverse floristics, maintains an open ground layer that we have observed is important for koala movement, and allows all fauna, including waterbirds, access to cool shaded pools and riffles. In-stream biological communities under willow and eucalypt dominated riparian forests are the subject of current university research in these streams. Nutrient and water capture and uptake are important functions and are their storage is reflected in the deep organic rich soils that are developing under these riparian forests. A further utilitarian benefit, one with considerable economic and social consequences, is that these forests are fire retarding. For many small rural communities mosaics of fire retarding gullies form natural fire breaks, that are integral to protection of those communities.

Management of the post gold rush gullies, must attempt to maintain these diverse functions. We suggest that:

selective clearing should be undertaken where large woody debris (regardless of the species responsible) is diverting water toward banks and initiating erosion. However, this must be carefully assessed because of the well known ecological benefits of in-stream debris as invertebrate and vertebrate habitat,

supplementary plantings can occur using shade tolerant, fire retarding species, including indigenous rainforest/gully species poorly represented regionally as well as utilitarian species such as food and craft wood timbers.

The implementation of such ecologically attuned management accelerates the succession toward rain-forest like communities, but increases the indigenous component. Given that 150 years of co-evolution has occurred between native and introduced fauna and flora in these blended landscapes care must be taken to not re-initiate a wave of extinctions by dramatic and rapid alteration of existing communities. Rather the approach should be to identify ecological processes and augment these using preferred species.

Local community groups in Central Victoria are actively working with these principles.[19] Increasing indigenous species representation is simply one of the outcomes that we are achieving. At no time do we feel any need to regard any species as a pest. In our experience, actively managing the creeks around Hepburn, individuals of any species can be in a place we would prefer them not to be, and we manage them accordingly.

NATIVE RIPARIAN COMMUNITIES WITH LITTLE OR NO HISTORY OF DISTURBANCE.

Introduction and management implications of an ecosystem based approach to willow management in natural communities.

If willows or other introduced species are invading areas of undisturbed natural or near-natural communities then a conservative ecological approach would be to hand pull small numbers of young at a pace that matches native species regeneration. These principles have been explored in detail by bush regeneration activists and ecologists. The communities where bush regeneration is applicable include high conservation sites, and those with resilience and regeneration ability. Rarely is supplementary planting needed, indeed should be an absolute last resort. The principles of bush regeneration include working from the least disturbed / invaded site and working at a pace that matches natural regeneration capacity. This means resources for introduced plant control should be spent in the most remote sites with least weed cover. In the case of willows, where propagation is primarily asexual, the willow uppermost in the catchment is the most important to remove.

Relatively small resource allocations could maintain vast areas pest plant free. These areas become conservation reserves for native plant communities, regardless of their legislative status. The ecological and catchment processes in near-natural communities will be maintained competently by those

[19]Holmgren, D. Management of Public Land Incorporating Biodiversity and Productivity; Spring Creek Community Forest Project Case Study in Is There A Role For Indigenous Permaculture: Integrating the Goals of Ecological Restoration & Permaculture. Greening Australia Forum proceedings 1996.

communities. We can thus evaluate the arrival and spread of introduced species in those terms, and conclude that they may cause ecological disruption. They should thus be carefully and conservatively removed.

Unmodified landscapes characterised by very low numbers of introduced plants are the priority areas for pest plant removal. Resources devoted to removal of functional monocultures on highly modified landscapes are a gross mis-allocation.

David Holmgren 16 Fourteenth St Hepburn, Vic. 3461 (053)483636

Michael Wilson P.O. Box 20 Hepburn, Vic. 3461. (053)481666