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Willow Management for Agricultural Landscapes

By David Holmgren 2008

FOR COMMENT

Background

Over recent years willow removal projects have become a major component of Federal and State funded Landcare programs in south eastern Australia. This work is driven by willows (Salix spp) being classified as a Weed of National Significance [1], and an extensive cross government network to co-ordinate action[2] including adding willows to the noxious weeds list (restricted from sale at this stage[3]). Most of these projects have been in high rainfall agricultural landscapes where willows form riparian forest corridors through grazing land. A smaller proportion has been in urban and peri-urban ungrazed landscapes radically changed by successive adjacent landuses and urban runoff. Some have been in high conservation value streams in national parks, although willow spread in these areas is relatively uncommon.

Jim Crow Ck at Shepherds Flat centra Victoria with mixed native and exotic vegetation including willows typical of grazing landscapes targeted for willow removal.

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[1] See *Willows: Weeds of National Significance Weed Management Guide* Dept of Heritage & Environment http://www.deh.gov.au/biodiversity/invasive/publications/salix.html

[2] See Willows: National Priority Action Framework http://www.weeds.org.au/WoNS/willows/docs/Willows%20Priority_Action_Framework_revised_Oct_2006.pdf

[3] See Vic minister for Environment Media release http://www.dpc.vic.gov.au/domino/Web_Notes/newmedia.nsf/0/6ed557b7e5fbab84ca2570b3000a8246?OpenDocument

Willow management options (other than removal) have not been documented, researched or promoted through Landcare programs. Consequently landholders are effectively discouraged from considering any alternative to official proscriptions (other than default grazing) by the lack of research, information and funding for any alternatives.

There is very little [if any] follow up evaluation of willow removal projects, and little in the way of clear objectives or long term management plans for riparian areas beyond indigenous revegetation. The obvious, but largely unmeasured and undocumented adverse effects of willow removal have led to moderation in advice on removal from some public bodies[4].

This outline of proposed alternatives to current proscriptions builds on previous consultancy and writing on the subject[5] , and experience with observation and informal management of a peri-urban riparian willow forest in Hepburn Springs over 20 years.[6]

The primary focus of these alternatives is on grazed agricultural landscapes because:
- **The majority of public expenditure on willow removal is in these areas**
- **The greatest potential for win win mangement alternatives can be demonstrated is in these areas**

History of Willow Landscapes

Willows form either pure stands, or mixed with remnant and regrowth native trees, along many permanent streams and rivers in higher rainfall areas of SE Australia.

Original removal of native trees along streams, often over 100 years ago, was associated with increased peak flows from cleared catchments which initiated renewed stream downcutting and gully headwall erosion as well as stream bed widening and sedimentation in lower reaches. Therefore most of our riparian environments are not "indigenous" landscapes for more fundamental reasons than the absence of native vegetation. In some regions, such as central Victoria, sluicing for alluvial gold cut all upland streams down to a bedrock base many metres below the original stream level.

Thick grass competition and set stocking removed the native tree seed store and left streams with banks broken and bare from flood erosion and stock. Most of today's stands of willows originate from small plantings for erosion control (as well as for stock shade and drought fodder) since the beginnings of the soil conservation era of the 1930's. Plantings were less common where retention of native regeneration (mostly in exposed banks of downcut streams) had stabilised stream courses. Willows were chosen for erosion control because:
- No other tree has fibrous root mat so effective for binding stream banks
- No other tree can recover stability after major flood damage by resprouting from fallen logs, branches and twigs.
- No other tree can be so easily managed for drought or regular seasonal fodder by pollarding (lopping).

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4 http://www.dpiwe.tas.gov.au/inter.nsf/WebPages/RPIO-4YS9UN?open

5 See recommendation for willow management in Holmgren, D. *Trees On The Treeless Plains: Revegetation Manual for the Volcanic Landscapes of Central Victoria.* HDS 1994

6 See Spring Ck Community Forest webpage http://www.holmgren.com.au/html/SpringCk/SpringCk.htm

- No other tree can be so easily planted from large wood cuttings
- Other vigorous stabilizing species [such as blackberry and gorse] were declared noxious weeds or disliked by landholders [such as root suckering wattles].

The natural spread of willows was slow because of the high palatability to stock and the lack of seed reproduction. Also during the 1950's and 60's high wool and meat prices encouraged high stocking rates, fertilizer application, control of noxious weeds and other factors which prevented willow regeneration. Since the 1970s, less intensive management and periods without stock allowed increased regeneration of noxious species, willows and native vegetation.

Willow root mats captures sediment, rapidly rebuilding stream beds towards their presettlement levels. (ref Wilson?) As trees mature and decline, fallen trees resprout vigorously, slowing the water flow to trap further woody debris, recreating the slow moving wetlands which were characteristic of the indigenous landscapes. This building of the bed increases flooding and new alluvial deposition. In Spring Creek, Hepburn, Vic., willows and blackberry stands less than 50 years old have created new alluvial flats up to 1m deep over piles of stone left behind after gold miners sluiced away the previous flats in the 1870's.

Elevated stream beds can increases the risk of flood break out and streams changing course is a dramatic event and is problematic for farming of valuable alluvial flats. When willow stands were smaller and farm management more consistent, occasional removal of in-stream logs prevented more problematic stream breakouts.

In a few areas, new naturally-occurring hybrids have produced extensive seeding of willows, most notably in the Bega valley.

Interpretation and Response

It is natural that a highly visible bright green deciduous tree spreading along previously bare streams attracts attention as a major change to the environment. As with most cases of so called 'weed invasion', the plant is demonised as the cause of real or perceived changes in the landscape.[7] Demonising willows has been a difficult process giving its utility and widespread planting until recent decades. However the "nativist" ideology which has dominated ecological research and natural resource management in recent decades has provided a powerful force for changing perceptions when backed by government funded community re-education programs.

The importance placed on indigenous biodiversity as the primary measure of ecosystem health has become so over promoted that for many land managers and even ecologists, this simple taxonomic approach is what ecology is all about. This approach is understandable in bureaucratic systems where simple yes/no assessments are easier to manage and evaluate than more complex, contextual and qualitative ones.

It also ignores or underrates the importance of ecosystem service functions of photosynthetic productivity, biomass, water and nutrient storage, total animal biomass etc because it is assumes that indigenous species provide these services in optimum balance even though the more fundamental

[7] Submission to Natural Resources Committee of Parliament of Victoria 1996. David Holmgren & Michael Wilson (Download at http://www.holmgren.com.au/html/SpringCk/SpringCk.htm)

drivers in riparian systems of hydrological dynamics, catchment nutrient sources, fire dynamics have all changed from the state to which indigenous systems were evolved. Further more, climate change and other factors are increasing the power and rate of change impacting on riparian systems. For example increased rainfall intensity will increase the erosive power of flood waters demanding changes in floodplain landuse and riparian vegetation.

The emphasis on indigenous biodiversity has become so extreme that the reasonable assessment (by most aquatic ecologists) that “willow trees along stream course are preferable to no trees” gets reversed when non native naturalised biodiversity (especially of large trees) is treated as a biodiversity negative rather than simply being less valuable than indigenous species. This is partly around the mistaken assumption that the willows (rather than people and livestock) were somehow the primary force causing loss of native vegetation. The fact that the streams with pure willow stands have lower indigenous riparian and aquatic biodiversity is not surprising, given these systems have developed with little in the way of native seed sources for greater diversity, no management to increase diversity and constant stock grazing.

Ecological succession processes towards greater diversity and complexity over time can occur in riparian willow forests (eg Spring Creek Hepburn) and should be expected from basic successional theory. This is typically ignored or regarded as further degradation because of the species in this succession are not indigenous. The possibility that a modicum of management can maintain and enhance the ecosystem service functions of willow riparian forests, increase the indigenous species present and allow greater aquatic diversity by simply managing the canopy are ignored in favour of grand schemes to wipe the slate clean and replant what the pioneer farmers removed.

Ironically it has been independent-minded land rehabilitation[8] work that focuses on rebuilding the hydrologic characteristics of the indigenous landscapes using all available tools, including willows, which is now being recognised as providing new pathways for dealing with a host of land degradation issues including salinity. This work reflects more general permaculture principles of sustainable resource use[9] that recognise willows as part of nature’s self-organising evolution of catchments to more effectively catch and store water and nutrients.

Where native trees have been the primary species colonising streams downcut and degraded by pioneer land use, the rate of rebuilding of stream bed and floodplain hydrology and soils has been slow or even negligible.[10] Naturalised stands of willows on the other hand are a powerful force rebuilding both our ‘gullied-out’ catchment landscapes and our degraded floodplains.

While the hydrological importance of rebuilding downcut streams is only recently been recognised as a pathway to improved hydrological health of our catchments, the importance of nutrient pollution as a primary cause, along with salinity, of degradation of our waterways, is universally acknowledged. As a result many of the management strategies for improving water quality focus on reducing sources of nutrient (especially phosphorous) pollution such as fertilizers, livestock in stream courses, septic and sewerage effluent etc. Riparian vegetation, is universally recognised as providing a filter absorbing sediment and nutrients before they reach streams as well filtering the water itself. Trees and other woody vegetation absorb nutrients over a longer cycle of regeneration and growth than grasses

[8] See Natural Sequence Farming, the work of Peter Andrews http://www.nsfarming.com/andrews.htm

[9] See Principle 2 Catch and Store Energy in Holmgren, D. *Permaculture: Principles & Pathways Beyond Sustainability* 2002

[10] Wilson, Michael *Post gold rush Stream regeneration: implications for managing exotic and native vegetation Centre for Environmental Management*, University of Ballarat (presented at the Second Australian Stream Management Conference in February 1999)

and herbaceous plants before leaf drop and decay balances uptake. Because willows evolved in high nutrient northern hemisphere ecosystems, they can take up more total nutrients than eucalypts and other native trees. These nutrients show up as highly palatable foliage. The massive capture of sediment in willow root mats (40 times greater than eucalypts) is particularly important at stabilising sediment which is the main carrier of phosphorus in streams which in turn feeds algal blooms including toxic blue green algae.

Once willow riparian forests are mature, further uptake of nutrients is not possible (without management to harvest the willow biomass or succession to taller and more nutrient dense forest species). Many willow forests are now mature, and the observation that the leaf litter drop in dry autumn condition can cause nutrient pollution of streams is either a naïve or disingenuous interpretation of nutrient sources and sinks. It like saying that old growth forest are sources of carbon dioxide pollution because of the decay cycle and that we should replace them with grassland (which take up less carbon dioxide).

Publicly funded riparian management

The current orthodoxy is essentially as follows:

- Removal of willows and other exotic vegetation
- Replanting with locally indigenous species
- Fencing to exclude livestock at least for the establishment period

The whole process is costly with willow removal alone using chainsaws, excavators and herbicide costing over $20,0000/km.

The willow removal programs proceed without any independent environmental impact evaluation and without significant monitoring or evaluation of the results. If forest logging contractors were to disturb stream banks in this way, they would be banned from the forest.

Decay of poisoned willow root mats releases tonnes of sediment (and phosphorus) back into the streams. The burning of the vast debris piles releases more soluble ash minerals for washing into the water (and copious greenhouse gases).

Flood events during the removal and revegetation establishment phase can cause major erosion, although these events are less severe than when willow root mats are removed with excavators

The assumption that once established, the native vegetation will be largely self maintaining and that erosion control and nutrient capture benefits will be equal to or better than willows is not supported by any evidence and defies common sense.

Very dense stands of fast growing eucalypts and acacias lead to tall fire prone forests or even collapse of fast grown canopies from insect attack in very fertile soils. Although the total biomass maybe greater than the replaced willow forest, the nutrient holding capacity is much lower. In the absence of grazing and regular herbicide, re-invasion by blackberries etc. will occur. Maintenance work to keep the area free of these species will be ongoing and substantial. If not continued, a full willow canopy eventually re-establishes the shade and absorbs the available nitrogen and phosphorus.

It is interesting that one of the most predominant methods for evaluating environmental programs; net greenhouse gas emissions has not been used to justify willow removal probably because the results would not support the case for removal. The carbon dioxide released today from the burnt willow biomass and decayed root mats would probably not be sequestered by the revegetation for at least 50 years while the production of greenhouse gas from the industrial inputs (fuel, herbicide etc) of the removal and the revegetation would never be rebalanced.

Pollard Management for Stock Fodder

Pollarding of willows for stock fodder can address most of the claimed problems of willows at the same time increasing the sustainability and productivity of pastoral farming on adjacent land.

Pollarding is the regular and hard lopping, generally about head height of trees for fodder or fuel. Regrowth of the willow canopy after pollarding is rapid. Cutting rotation can be 1-3yrs before the proportion of inedible wood becomes excessive relative to edible leaf and twig.

Willow foliage and small twig wood is highly nutritious and productive fodder especially suitable for cattle and goats as well as other livestock. It has long been used as drought fodder, but felling of mature willows in droughts yields more inedible wood than fodder.

There is little research on willow fodder management but yields of over 5 tonnes of edible dry matter per hectare have been measured in New Zealand. While this is less than the best grass/clover pasture, it is complimentary to dry grass in summer and early autumn.

Pollarding can be done with professional forestry loppers or by mechanised trimming in intensive and very large scale operations.

Regular pollarding maintains a stable water edge tree not susceptible to uprooting in extreme winds and floods. Consequently risk of blocking of the stream course and flood breakout risk is much reduced. Willow lined stream banks provide practical insurance against the expected (and already experienced) increase in flood event intensity from climate change.

Willows pollarded for fodder Campbells Ck central Vic from <u>Trees On The Treeless Plains</u> HDS 1994

Depending on the rotation of cutting, pollarding substantially increases the amount of sun reaching the water and riparian zone. This allows for a more diverse aquatic ecology and the natural regeneration or supplementary planting of indigenous vegetation which is the main aim of removal projects.

Pollarding removes a significant proportion of the canopy that would otherwise be shed into the water, a claimed source of nutrient pollution of streams. Even when livestock graze this material in the riparian zone, there should be a net export of nutrients back to the farmland.

Pollarding renews the nutrient uptake capacity of willows that has been shown to be 10 times greater than eucalypts in local streams.[11]

The maintenance of the willow root mat ensures retention of the sediment caught by the willow root mat (which is 40 times greater than that caught by eucalypts in local streams).

Enhanced sequestration of carbon dioxide is another benefit of pollarding because the trees are maintained in their maximum growth phase. By reducing the need for more intensively produced summer fodder (eg irrigated lucerne hay), pollarding also reduces greenhouse gas production in the agricultural economy.

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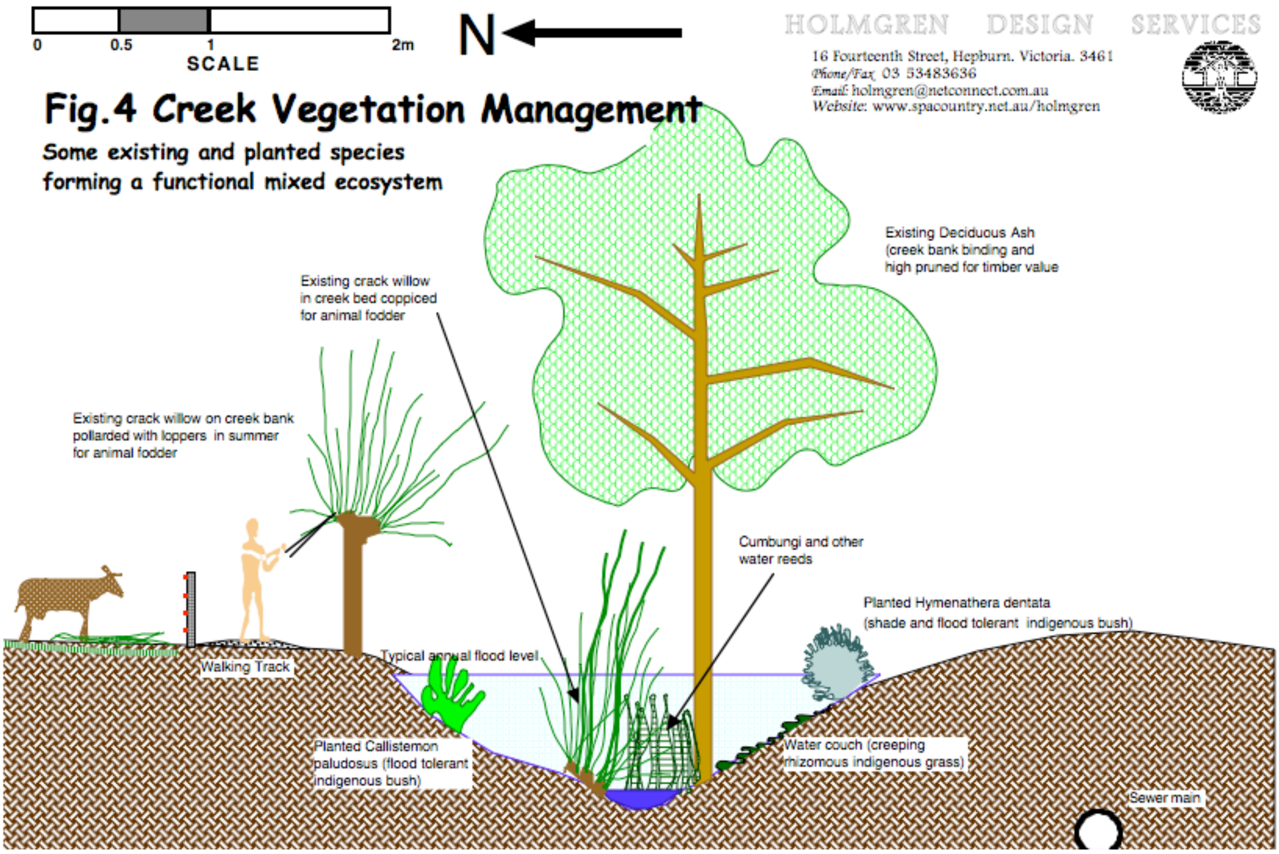
[11] Wilson, Michael Post gold rush Stream regeneration: implications for managing exotic and native vegetation Centre for Environmental Management, University of Ballarat (presented at the Second Australian Stream Management Conference in February 1999)



graphic from Harcourt Park Land Use, Landscape and Environmental Management Plan June 2000

If pollarding of willows is so beneficial why is it not done?
Willows and other deciduous trees were an integral part of pastoral farming in Europe prior to the modern era and their role as a drought fodder reserve in Australia is well known but managed tree fodder system have been uncommon for technical, economic and cultural reasons.

- Farmers have little knowledge of tree management for fodder
- Mechanisation of pasture fodder and its inter-regional transport has provided a cheap buffer to seasonal variability of on farm fodder.
- Low livestock prices have reduced options for labour intensive management

The initial work to renovate old willow stands to managed pollards is substantial, a capital cost of perhaps half that of willow removal. Without higher commodity prices it is probably uneconomic for farmers to renovate existing willow riparian forest without government support. In a future of higher energy costs, pollarding willows will be a sustainable (and economic) source of summer fodder because it can be produced with little or no input of fuel, fertilizer or irrigation water.

Active management of willows for multiple functions in this way would entrench their place as a productive part of the landscape and expose the impossibility of their complete and permanent removal from the landscape. This would unacceptable to many in the revegetation industry and academia who hold a purist ideology seeking a complete and permanent removal of naturalised non-indigenous trees from agricultural landscapes.

Managing Pollarded Willows For Fodder

Renovation of existing stands requires chainsaw felling and extraction of the mature canopy. This would best be done in small sections perhaps one stream bank one year and one the next. Identified wildlife habitat trees and important shade and amenity trees should be left as mature crowns.

Where willows are growing within the stream bed, annual cutting at the base and eventual shading out with revegetation (especially dense canopied trees such as blackwood) could reduce the risk of stream blockage and breakout.

Generally summer would be a preferable time for initial stand renovation, allowing stock to eat available fodder as in traditional drought harvesting. Left over wood could be left to dry out and burnt in piles away from the stream or potentially used to make charcoal, thus reducing greenhouse gas emissions. Salvage use of larger logs for craft use (fence screens, furniture, clogs, cricket bats etc) is another opportunity[12]. Willow wood decays to humus quite rapidly and could be left in the riparian zone although most farmers would consider this a management problem.

Pollarding by hand with long handled double action professional forestry loppers can be very efficient cutting wood up to 40mm. Hydraulic lopper are an option. These willow wands up to 3 m from two years growth will fall freely to the stream bank for direct grazing by livestock following the cutting. Material which falls in the stream does not significantly increase likelihood of willow spread especially if cut in summer. If mob stocking is very brief with stock moved every day or two the impact on the stream banks and other established native vegetation would be minimal.

Moving tree fodder with front end loader Victorian Tree Crop nursery Ellinbank Gippsland 1988

[12] This is already being done by woodworkers in several regions

Where the stream bank is easy to access with tractor, a rack mounted on the front hydraulics could be used to catch lopped material for transfer to a trailer and delivery to grazing paddocks. This “cut and carry” system would recover more fodder, transfer more nutrients away from the stream and prevent stream bank damage by livestock. Interplanting with appropriate indigenous vegetation, mostly understorey species would be possible.

Fencing of the riparian zone would need to allow space for tractor access or alternatively be so close to the willows that the tractor could reach the tree from the paddock. On a smaller scale lopped material could be thrown over a fence to stock in adjacent paddocks.

Mechanised hedging could be developed to more intensively manage willows once the system was well proven.

Jason Jones with woven elm & willow panel screens made from Birches Ck central Vic riparian forest

The following table summaries the indicative costs and benefits of these pollarding management options and several other management options. A rating from 0 to 4 is used, 0 being the most costly or least benefit and 4 being the least costly or greatest benefit.

The management systems compared and their scores are as follows;

Standard Landcare Removal and Replanting; fell willows, heap with excavator and burn tops, poison stumps and replant with tube stock of indigenous veg, fence and followup herbicide of competing vegetation 2 yrs minimum. **Score 19**

Natural Succession: Fence to exclude stock and allow natural succession by bird spread seed over decades **Score 29**
Pollard management for stock fodder 1; Remove crowns and fence. Pollard regrowth (half trees each summer) and crash graze fallen material in riparian zone **Score 30**

Continuous stock access: Existing willow corridor forest with more or less continuous canopy shading out most other vegetation, frequent log falls, occasional stream course changes with stock grazing controlling noxious weed edges and also stock camp manure accumulation. **Score 33**

Fence and periodic crash graze: same system but less bank degradation and more chance of regeneration of native trees and shrubs. **Score 32**

Pollard management for stock fodder 2; Remove tree crowns and fence. Pollard regrowth (half trees each summer) and move to stock paddocks, higher fodder and nutrient recovery, no damage to banks, regeneration of other vegetation **Score 35**

Accelerated Succession; Fence to exclude stock and supplementary plant and/or direct seed with suitable successional species plus release emergent trees. **Score 38**

Not surprisingly current removal and replanting rate very poorly while proposed pollard management with removal of cut material scores very high. **This suggests supporting farmers interested in trial development of these systems would represent better expenditure of public money than willow removal.**

Somewhat more surprising is the relatively good score of the default continuous grazing management and the fence and crash graze approaches. **This suggests doing nothing or fencing alone would be preferable allowing money for stream health and biodiversity to be diverted to other projects.**

The highest score it for the more radical management to accelerate succession using classic permaculture strategies and techniques. **While this approach may not be socially acceptable or technically appropriate in all areas it is particularly relevant to peri-urban high rainfall areas where the willow forests already contain many of the species appropriate to the succession process**. **These areas should be seen as experimental areas for the more rapid evolution of willow riparian ecology towards greater ecosystem service as well as potential yields**.

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Management	Estabish cost	Annual cost	Farm Returns	Erosion control	Sediment & Nutrient Trap	Fire hazard barrier	Aquatic diversity	Aquatic productivity	Indigenous raparian regeneration	Absence of noxious weeds	Amenity value	Level of risk	G/house gas benefits	Score
Default continous stock acccess	4	4	2	3	2	4	0	1	0	4	3	3	3	**33**
Fence & periodic crash gaze	3	4	2	3	3	3	1	1	1	3	3	3	2	**32**
Removal (standard Landcare prescription	0	2	0	1	1	0	3	3	4	2	3	0	0	**19**
Pollard & crash graze	1	2	3	4	3	3	1	2	2	3	2	2	2	**30**
Pollard & Carry	1	0	4	4	4	4	2	3	3	2	3	3	2	**35**
Fence off	3	4	1	3	3	2	1	1	2	0	2	4	3	**29**
Fence & accelerate succession	3	3	2	4	4	4	1	2	2	1	4	4	4	**38**