# *Growing revenue using carbon shelterbelts in the Murraylands and Riverland*

## *Project summary*

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Australian Government
Department of Agriculture, Water and the Environment

Future Drought Fund

Ai CARBON
Australian Integrated Carbon

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- *This report provides pricing scenarios to help understand potential revenue returns. We use four pricing scenarios:*
  a) *Auction price of \$17.35/t$CO_2$e - the average price in the last ERF auction in April 2022*
  b) *Low price \$32.00 - \$51.00/t$CO_2$e*
  c) *Base price \$35.00 - \$71.00/t$CO_2$e, Compound Annual Growth (CAG) of 2.8 % over 25 years*
  d) *High price \$42.00 - \$105.00/t$CO_2$e, or Compound Annual Growth (CAG) of 3.3 % over 25 years.*

  *The Low, Base and High scenarios are based on pricing information obtained from Reputex, which provides a subscription service to market participants and governments on carbon market dynamics, trends and outcomes. The pricing was current on 22 July 2022. More information about Reputex can be found at https://Reputex.com.*

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- *This report uses carbon yields calculated using the Clean Energy Regulator's carbon assessment tool (FullCAM), the outputs of which may vary depending on a range of input variables. Carbon yields cannot be finalised until any Australian Carbon Credit Units (ACCU) volumes have been approved by the Clean Energy Regulator (CER) and/or project auditor. As such, carbon yields per hectare should be considered as estimates at this stage.*

- *AIC is one of the foundational signatories to the Code of Conduct for carbon projects. This Code provides confidence to customers that industry standards and transparency are upheld. The code can be viewed here: http://marketplace.carbonmarketinstitute.org/wp-content/uploads/2018/06/Australian-Carbon-Industry-Code-of-Conduct.pdf.*

### *Background*

The Murraylands and Riverland region of South Australia is a dryland agricultural area with an average rainfall of 300-400mm, but is prone to reduced rainfall during El Nino events. Farms in the area have recently suffered a run of dry seasons. This project was funded by the Department of Agriculture, Water and Environment and the Future Drought Fund to investigate whether carbon shelterbelts could provide a useful income source during dry times.

The simplest approach to engaging in the carbon market is to use methods that conform to Australian Government carbon methods. The approach that relates best to shelterbelts is the Reforestation by Environmental or Mallee Plantings Method (Clean Energy Regulator 2022a) which uses a computer model (Full Carbon Accounting Model, FullCAM) to estimate carbon yield based on location (Department of Climate Change, Energy, the Environment and Water 2022). For projects registered with the Australian Clean Energy Regulator, carbon yields can then be converted to yield in tonnes of carbon dioxide equivalent ($tCO_2e$), with 1 $tCO_2e$ of greenhouse gas storage or abatement generating one Australian Carbon Credit Unit (ACCU, Clean Energy Regulator 2022b).

The aim of this project was to identify 10 case study sites across the Murraylands and Riverland region, then develop a planting layout, use FullCAM to model carbon sequestration, and estimate costs and revenue associated with the planting. The project targeted all six council areas in the Murraylands and Riverland where typical 'mixed farming' occurs, namely, The Coorong, Karoonda East Murray, Mid Murray, Murray Bridge, Southern Mallee and Loxton Waikerie council areas.

There was significant farmer interest in how carbon shelterbelts would affect the farm carbon account if carbon credits are not sold, but are instead used to offset farm emissions. This interest was driven both by a desire to contribute to the effort to reduce global warming, and because farmers may in future be required to offset emissions in order to avoid tariffs in some markets (e.g., the EU, see Martin 2021). In response, case studies were expanded to include a simple farm carbon account, and consideration of how sequestration in shelterbelts may impact net farm emissions.

### *Method summary*

Case study sites were identified in consultation with the Murraylands and Riverland Landscape Board and the Murraylands and Riverland Farm Forestry Landcare Network. The sites were distributed across all six of the targeted council areas (Fig. 1).

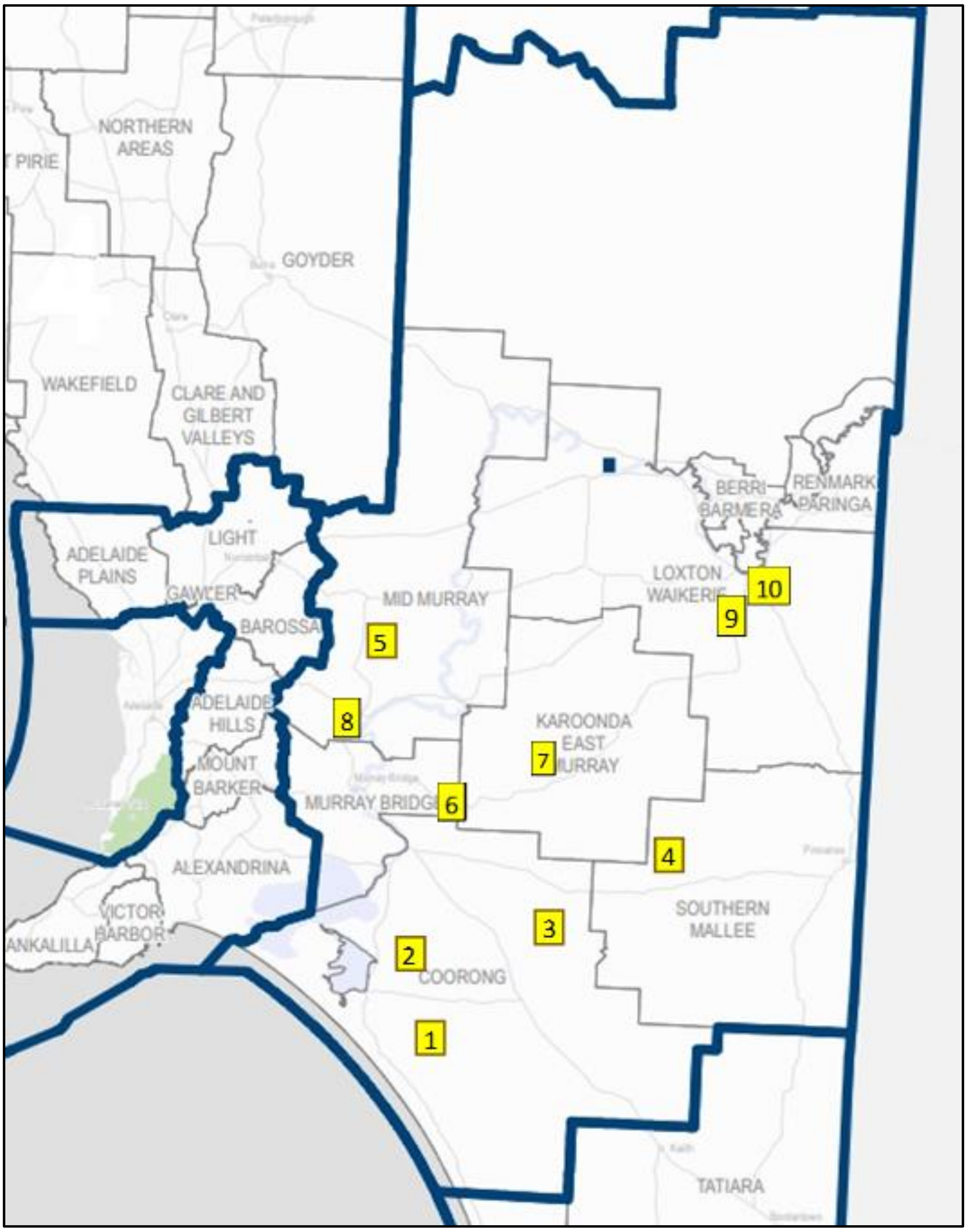


**Fig. 1.** Distribution of case study sites across the six targeted district councils in the Murraylands and Riverland region.

Eight of the case studies were on privately owned individual enterprises: five were typical mixed farms (cropping and sheep), one was a sheep and cattle farm, one was sheep only and one had sheep and poultry. One corporate apple orchard was also included (Case Study 10), as it was in one of the targeted council areas and its owners were interested in the project. For Case Study 9 in the Alawoona district, the study was performed on a hypothetical farm typical of the district rather than any particular farm, as no case study farmer was able to be identified in the time available for the study.

The approach used to design shelterbelts and model carbon revenues was as follows:

- For properties where farm maps were available (eight properties in total), theoretical shelterbelt layouts were drawn up that:
    - maximised protection for stock from cold winds from the south and west
    - planted along existing boundaries to improve biosecurity and reduce fencing costs
    - targeted least productive soils
    - provided wildlife corridors between areas of remnant vegetation.

- For most properties or regions, modelling in FullCAM was conducted using the following settings:
    - tree species set at 'mallee eucalypt species', since local mallee trees are drought and fire resistant (due to their lignotuber), maximise carbon yield, and are easier to establish than many shrubs (Noble and Bradstock 1989)
    - belt planting design
    - planting density <1,500 stems/ha
    - project duration set at 25 years.

- Shelterbelts were designed to be 24 m or 28 m wide, allowing 5 or 6 rows of trees to be planted 4 m apart (the minimum spacing between rows) and keeping the outer rows 2 m from fences. This design is consistent with the Reforestation by Environmental or Mallee Plantings Method (Clean Energy Regulator 2022a).

- For each case study, carbon yield data were generated at four different locations within the farm or district. The four FullCAM yield curves were then converted to yield in $tCO_2e$, and average yields were used to calculate total yield across the project area. These calculations included the 25 % yield reductions applied to 25 year vegetation projects (5 % risk reversal buffer and 20 % permanence buffer, Clean Energy Regulator 2022c, 2022d).

- Costs for establishing projects were based on a seeding cost of $1000/ha, and fencing costs of $5000/km. Some allowance was made for costs of site preparation, post-sowing weed management and fence repairs (generally $7000-$10,000 for smaller projects and $20,000-$30,000 for the larger projects). These costs were offered as a guide and would vary depending on area, soil type, slope and condition of pastures and weeds.

- The ERF is developing a pilot program to assist landholders to enter the carbon market – as of 2022 this is still in a trial phase (Clean Energy Regulator 2022e). Some landholders may require the services of a carbon developer to undertake mapping, carbon modelling, registration, and audits; however, these costs are difficult to define and were not included in this study.

- Carbon prices were based on information from Reputex (https://Reputex.com) on 22/7/2022 and included four different pricing scenarios. The flat price was \$17.35/t$CO_2$e, the average carbon price in the last ERF auction (April 2022); the low price was \$32/t$CO_2$e (current spot price) increasing to \$51/t$CO_2$e; the base price was \$35/t$CO_2$e increasing to \$71/t$CO_2$e; and the high scenario was \$42/t$CO_2$e increasing to \$105/t$CO_2$e.

- Prices were multiplied by average carbon yield to establish different scenarios for carbon revenue. Discussion of revenue and feasibility focussed on the base scenario, which is the carbon price considered to be most likely (\$35/t$CO_2$e increasing to \$71/t$CO_2$e).

To assess the impact of different shelterbelt designs on net farm emissions, basic carbon accounts were developed for all the case study farms. Livestock emissions were estimated based on stock numbers and the Sheep and Beef Greenhouse Accounting Framework (Primary Industries Climate Challenges Centre 2022). Emissions associated with cropping were estimated to be 0.3 t$CO_2$e/t of cereal grain, 0.25 t$CO_2$e/t of pulses, and 0.7 t$CO_2$e/t of oilseeds, based on averages reported for example farms in Western Australia (Western Australian Department of Agriculture and Food 2022).

Exceptions to this general method included:

- For Case Study 3, the farmer had a preference for a mallee planting in a block rather than belt configuration, and FullCAM was run using block planting settings. Preliminary work was also conducted to model carbon yields in a belt layout to see how planting layout affects yield.
- For Case Study 6, the farmer indicated a preference for mixed species environmental plantings rather than mallee eucalypt species, and FullCAM was run using the mixed species environmental planting setting. Preliminary work was also conducted to model carbon yields with mallee plantings to see how species planted affects yield.

- In the final case study, an Apple Orchard at Loxton (Case study 10), only a block planting layout was possible, and the owners had a preference for mixed species environmental plantings, so these settings were used in FullCAM. Preliminary work was also conducted to model carbon yields with block mallee plantings to see how species planted affects yield. No simple method was available to calculate a carbon account for the apple orchard, but some published information was used to estimate the emissions intensity of apple production (Figueiredo et al. 2013).

## *Results*

- An example cumulative carbon yield curve (tC/ha) is shown in Figure 2, and shows rapid accumulation of carbon in trees from years 3 to 12, as well as the steady accumulation of forest debris (example is from Case Study 4 at Lameroo, in 350 mm rainfall).

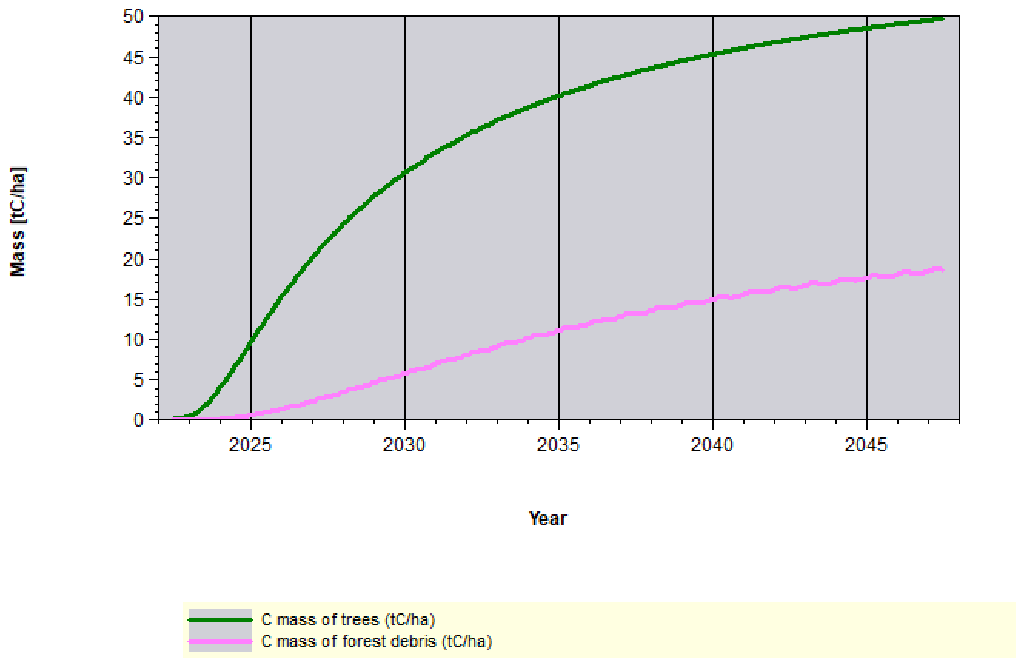


**Fig. 2. FullCAM output from one site at Lameroo showing cumulative carbon yield (tC/ha) over 25 years with mallee eucalyptus species planted in a belt at <1,500 stems/ha.**

- An example of an annual carbon yield chart is shown in Figure 3, again from Lameroo, on a 50 ha project area described in Case Study 4.

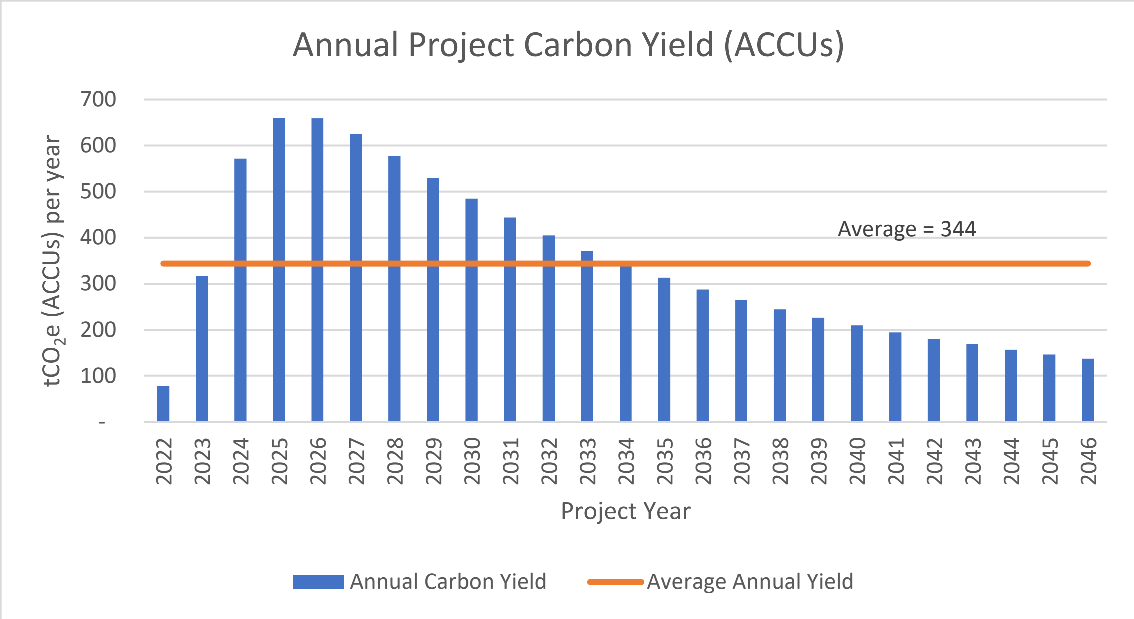


**Fig. 3. Annual carbon yield ($tCO_2e$/yr) calculated from 4 different locations in a 50 ha project at Lameroo over 25 years (see Case Study 4).**

- The main attributes of each case study as well as carbon yields and revenues, and impacts on the farm carbon accounts, are summarised in Table 1.

- Modelling indicated mallee belt plantings yield approximately 7-10 $tCO_2e$/ha/yr across the Murraylands and Riverland region. This figure includes the 25 % yield discount applied to 25 year vegetation projects.

- Assuming carbon pricing follows the 'base scenario', and that the landholder incurs minimal costs for registration, reporting and auditing, the modelled mallee belt plantings would produce carbon revenues in the range 3 to 5 times set-up costs. Set-up costs would be recovered after approximately 6 years.

- The case studies suggest planting around 5 % of a farm to shelterbelts would, on average, offset just over half a typical farm's emissions.

- Farmers identified several obstacles to large scale shelterbelts including high upfront costs, the need to plant large projects all at once, and concerns over registration and reporting requirements.

**Table 1.** Main attributes of the 10 case studies, as well as carbon yields and revenues, and impacts on the farm carbon account. Case study 10 was excluded from the average calculation as it is an orchard and very different to the other 9 enterprises. Potential offset available was calculated by dividing sequestration in shelterbelts by estimated crop and livestock emissions.

| Case study | Region | Property type | Rainfall | Planting type | Farm area | Shelterbelt area | Shelterbelt area | Yield over 25 yrs ($tCO_2e$) | Yield ($tCO_2e$ per year) | Revenue over 25 yrs | Revenue after set-up costs | Ratio of revenue to set-up costs | Years to recover set-up costs | Potential offset available |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Field | Sheep and beef | 450 mm | Mallee belt plantings | 694 ha | 53 ha | 7.6 % | 11,512 | 8.7 | $735,000 | $575,000 | 4.6 | 5 | 57 % |
| 2. | Ashville | Cropping/ sheep | 450 mm | Mallee belt plantings | 6,500 ha | 163 ha | 2.5 % | 30,160 | 7.4 | $1.93m | $1.47m | 4.2 | 6 | 18 % |
| 3. | Sherlock | Cropping/ sheep | 350 mm | Mallee block plantings | 417 ha | 58 ha | 14 % | 8,494 | 5.8 | $563,000 | $419,000 | 3.9 | 8 | 75 % |
| 4. | Lameroo | Cropping/ sheep | 350 mm | Mallee belt plantings | 3600 ha | 50 ha | 1.4 % | 8,591 | 6.9 | $626,000 | $456,000 | 3.7 | 6 | 16 % |
| 5. | Sedan | Sheep/ poultry | 290 mm | Mallee belt plantings | 3400 ha | 57 ha | 1.7 % | 10,624 | 7.5 | $681,000 | $492,000 | 3.6 | 6 | 100 % |
| 6. | Kepa | Sheep | 290 mm | Environmental plantings, belt | 500 ha | 49 ha | 9.8 % | 8,422 | 6.9 | $534,000 | $392,000 | 3.8 | 6 | 96 % |
| 7. | Karoonda | Cropping/ sheep | 330 mm | Mallee belt plantings | 2500 ha | 50 ha | 2.0 % | 13,008 | 10.4 | $833,000 | $648,000 | 4.5 | 6 | 43 % |
| 8. | Sanderston | Cropping/ sheep | 300 mm | Mallee belt plantings | 2600 ha | 50 ha | 1.9 % | 10,096 | 8.1 | $646,000 | $511,000 | 4.8 | 5 | 21 % |
| 9. | Alawoona | Cropping/ sheep | 300 mm | Mallee belt plantings | 4000 ha | 80 ha | 2.0 % | 14,091 | 7.1 | $903,000 | $603,000 | 3.0 | 7 | 39 % |
| 10. | Loxton | Orchard | 260 mm | Environmental plantings, block | 135 ha | 50 ha | 37 % | 4742 | 3.8 | $314,000 | $204,000 | 2.9 | 9 | 16 % |
| **Average (excluding Case Study 10)** | | | | | **2690 ha** | **68 ha** | **4.8 %** | **12,778** | **7.6** | **$828,000** | **$618,000** | **4.0** | **6.1** | **52 %** |

- Preliminary data were also obtained on the impact of planting design (block vs belt planting) on carbon yield (Case Study 3), and the impact of planting type (mallee eucalyptus species vs mixed environmental plantings) on carbon yield (Case Studies 6 and 10). Results suggested planting in blocks reduces carbon yield by 30-40 %, and planting mixed environmental plantings rather than just mallee trees reduces carbon yield by 20-30 %.

### *Main findings*

- The economics of shelterbelts appear attractive, with projects recovering costs approximately 6 years and 3-5 times set-up costs. Co-benefits of shelterbelts such as better animal welfare, water balance and biodiversity conservation would likely generate extra value (see Gregory 1995, Bulman and Dalton 2000, Summers et al. 2019).

- Many farmers are more interested in off-setting their own emissions than selling credits. The planting of around 5 % of a typical farm may allow around half a farm's emissions to be off-set. This could provide access to markets requiring low emissions products and may be an additional driver for adopting shelterbelts.

- The case studies presented here did not include costs for project registration, auditing, reporting or brokerage. This is because costs are currently hard to define and because the ERF is trialling an environmental plantings pilot study (Clean Energy Regulator 2022e). As methods mature, further work will be needed to better define costs involved in registering and running a project. If significant costs are incurred, returns from carbon shelterbelts will be lower than is represented in these case studies.

- Key obstacles to establishing carbon shelterbelts are the need for projects to be large in order to justify running a project, and that large projects need to be planted all at once for efficient project management. The viability of smaller projects would be improved if projects could be aggregated, so that region-specific information and project management could be shared. This approach may also allow shelterbelt establishment to be spread out over multiple years.

- Uptake of shelterbelts will likely increase if the price of carbon goes up beyond the 'base scenario', or if grants or external funding are provided to support set-up costs. In future, private companies may be interested in funding shelterbelts in return for a share of credits generated.

- Though data are preliminary, it was of interest that planting in blocks rather than belts leads to a significant (30-40 %) reduction in carbon yields, presumably because of extra competition between trees for light and water. Since block designs require less fencing and can be planted on poorer soils, they may still be a preferred option for some. Similarly, it was interesting to see that planting mixed environmental plantings rather than mallee eucalyptus species may reduce carbon yields by approximately 20-30 %, presumably due to the lower tree density in mixed plantings. Because of the greater diversity in mixed plantings, biodiversity benefits would be greater, and mixed environmental plantings may still be preferred by some landholders.

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