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Tylophora linearis Restoration and Translocation Strategy



2024 Annual Report

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COVER PANNEL	Left – a <i>T. linearis</i> in flower (J. Brien-Cooper) Middle – a developing <i>T. linearis</i> follicle (J. Brien-Cooper) Right – a mature <i>T. linearis</i> follicle shedding seed (J. Brien-Cooper)			
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Glossary and abbreviations

Acronym	Description
BC Act	NSW <i>Biodiversity Conservation Act 2016</i>
BMA	Biodiversity Management Area
BMP	Biodiversity Management Plan
MCCM	Maules Creek Coal Mine
PTP	Propagation and Translocation Program – <i>Tylophora linearis</i> (Ecoplanning 2024a)
TFPP	Threatened Flora Project Plan (Ecoplanning 2024a)
WHC	Whitehaven Coal Pty. Ltd.
RTS	Restoration and Translocation Strategy – <i>Tylophora linearis</i> (WHC 2017 – Appendix C)

Executive Summary

In accordance with Section 4.1.2 and Section 6.14 of the approved Biodiversity Management Plan (BMP; WHC 2017) for the Maules Creek Coal Mine (MCCM), a *Tylophora linearis* Propagation and Translocation Program was prepared and included as Appendix C of the MCCM BMP (WHC 2017). The MCCM BMP is supported by the Threatened Flora Project Plan (TFPP) prepared by Ecoplanning (2021a). The TFPP outlines how WHC will monitor the threatened flora (including *T. linearis*) – and implement actions to manage threatened flora species, within and adjacent to WHC mining operations and Biodiversity Management Area (BMAs). This report has been prepared to document results of the *T. linearis* Propagation and Translocation Plan at the MCCM in 2024.

In 2024, ongoing monitoring and management of *T. linearis* has demonstrated that individuals within WHC BMAs have continued to complete elements of their life cycle including production of new stems and flowering. During 2024, there was also the production of at least 20 mature follicles where 23 seeds was collected for a propagation trial, an event which has not occurred for several years. Initially, 11 of these collected seeds germinated, however, by the end of 2024 only three of the *T. linearis* have survived.

The continuation of the growth study has identified that stem numbers within monitored sub-populations of *T. linearis* are highly variable over time. Stem numbers have generally declined during dry periods and increased following wet periods. During the variable conditions in 2024, with above average rainfall in autumn and winter and dryer periods across spring and summer, stem abundances mirrored the pattern of rainfall. However, this pattern does not appear to affect the development of mature follicles. During 2024, individual *T. linearis* stems from in situ populations within WHC BMAs were tagged to allow for more detailed monitoring of individual plants and stems in future seasons, which may help inform future management of the species on WHC BMAs.

During 2024, the ongoing monitoring of the translocation trials which commenced in 2015, identified some continued success of the trial, with eight plants from this trial observed during 2024. The continued occurrence of *T. linearis* within multiple enclosures across WHC BMAs, as detected during quarterly searches for reproductive material, indicates that the populations of *T. linearis* on WHC BMAs remains healthy, given the high number of stems observed, and development of flowers and mature follicles. Overall, the ongoing conservation of habitat for *T. linearis* aligns with the stated aims for the translocation program which was to “...support the conservation of *T. linearis*, and to maintain a self-sustaining, genetically diverse population of the species within the WHC Offset Properties”.

1 Introduction

Tylophora linearis is a threatened species listed as vulnerable under the NSW *Biodiversity Conservation Act 2016* (BC Act) and endangered under the Commonwealth *Environment Protection and Conservation Act 1999* (EPBC Act). The species is a twiner or subshrub with cylindrical stems, up to 3 mm diameter, with linear-lanceolate leaves up to 10 cm long and 4 mm wide (PlantNET 2025). The species has been recorded between Armidale and Temora in dry scrub and open forests in association with *Eucalyptus sideroxylon*, *E. fibrosa*, *E. albens*, *Callitris endlicheri*, *C. glaucophylla*, and *Allocasuarina luehmannii*.

Recent studies of the Tylophorinae (Liede-Schumann *et al.* 2016; Liede-Schumann and Meve 2018) found the previously unrelated genera *Tylophora* and *Vincetoxicum* to be intermingled and all species within the *Tylophora* genus were renamed as members of the *Vincetoxicum* genus. As part as these studies, *T. linearis* was renamed *Vincetoxicum fosteri* (Liede-Schumann and Meve 2018). While this name change has been adopted by the Council of Heads of Australasian Herbaria and the Commonwealth Department of Climate Change, Energy, the Environment and Water (Comm. DCCEEW), it has not yet been adopted by the BC Act, PlantNet (RBGDT 2025), or the documentation of the NSW Department of Climate Change, Energy, the Environment and Water (NSW DCCEEW). Naming throughout this report follows the current listing of the species under the BC Act, as *T. linearis*.

T. linearis was identified at Maules Creek Coal Mine (MCCM) during pre-clearing surveys in 2014 and 2015. On 14 May 2014, the former NSW Department of Planning and Environment (DPE) requested an addendum to the MCCM Biodiversity Management Plant (BMP) to document a propagation and translocation program for *T. linearis*. The propagation and translocation program are made up of the following stages outlined in **Table 1.1** (WHC 2017- Appendix D).

Table 1.1: Stages of the MCCM *Tylophora linearis* propagation and translocation program; green rows indicate completed stages and blue rows indicate stages which are currently ongoing

Stage	Description
1	Root architecture and growth study
2	Seed production
3	Seed collection
4	Seed propagation
5	Translocation trials

Stages 2-4 of the previous *T. linearis* propagation and translocation program have been completed and documented in previous annual reviews (WHC 2019). During 2023, WHC (through its specialist consultants) continued research into Stages 1 to 5 of the propagation and translocation program, these efforts are ongoing.

In 2020 and 2021 an updated TFPP (Ecoplanning 2021a) and “*Tylophora linearis* Restoration and Translocation Strategy” (RTS; Ecoplanning 2021b) were prepared to support the previous documents (WHC 2017- Appendix D, 2019). In 2024, the TFPP was updated (Ecoplanning 2024b) and the RTS was superseded by the “Propagation and Translocation Program –

Tylophora linearis" (PTP; EcoPlanning 2024b) so future conservation works relating to *T. linearis* could be informed by the most recent findings of previous works.

Ongoing monitoring and management actions outlined within the updated TFPP (EcoPlanning 2024b) and PTP (EcoPlanning 2024b) for *T. linearis* are as follow:

- Ongoing monitoring of the translocated individuals for life cycle/ecological analysis.
- Surveillance of natural populations of *T. linearis* to continue to monitor seed production and germination, identify any threats to threatened flora and to increase knowledge of each species' ecology and reproductive habits.
- Further translocations of *T. linearis* via multiple methods including salvage translocations of whole plants and seed collection to enable further germination trials.

This annual report has been prepared to collate the results of the management actions and monitoring efforts for *T. linearis* during 2024, and to summarise the quarterly reports prepared by (EcoPlanning 2024c, 2024d, 2025a, 2025b).



2 Methods

2.1 Growth study

The growth study involved quarterly monitoring of a natural population of *T. linearis* within the Wollandilly BMA (Wollandilly H enclosure) to count the number of stems present. The location of the natural population is shown in **Figure 2.1**. Previous monitoring of sub-populations within Leard State Forest was discontinued in 2021 as detailed within the 2020 Annual Report (Ecoplanning 2021c).

2.2 Translocation trials

Translocation trials for *T. linearis* are informed by the TFPP (Ecoplanning 2024b) and PTP (Ecoplanning 2024a).

2.2.1 Seed propagation and translocation

The ongoing translocation trials in 2024 involved monitoring of individuals translocated from seed collection and propagation in addition to topsoil translocation sites (see previous reviews for details of the methods for these translocations). Monitoring of *T. linearis* individuals translocated from seed collections is conducted quarterly each year and involves recording remaining stem numbers and stem height of the original 77 plants. Additional information recorded included vegetative condition and reproductive status. The natural population of *T. linearis* in the Wollandilly H enclosure was used as a reference population to compare the 77 plants to.

2.2.2 Topsoil translocation

Topsoil from within the MCCM 2019 preclearance area, which had known records of *T. linearis*, was translocated to the Teston South Biodiversity Management Area (BMA) and deposited within enclosures 1-5 (**Figure 2.2**). Since its establishment in 2019, there has been no recorded *T. linearis* stems from within the Topsoil Translocation Trial enclosures, despite each enclosure being surveyed for *T. linearis* stems quarterly each year. As such, it was decided that the Topsoil Translocation Trial be decommissioned and will no longer be documented in the *T. linearis* annual reports.

2.2.3 Salvage translocations

During the 2024 preclearance of MCCM, 56 *T. linearis* stems were recorded within the MCCM 2024 surface development area. It was decided that 20 of the *T. linearis* stems within the MCCM 2024 surface development area were selected to be part of salvage translocation trial. The largest stems were selected for translocation as it was assumed that they would have the greatest chance of survival. These stems were translocated to the Teston South 1-5 enclosures (discussed in **Section 2.2.2**) following the method outlined in section 5.2 and monitored following section 4.1 of the Translocation Strategy (Ecoplanning 2021b).

2.3 Hand-pollination trials

In accordance with the updated TFPP (Ecoplanning 2024b), all BMA populations were inspected at least once during 2024 in search of seed for translocation trials. Where flowering

plants were detected more regular inspections were undertaken to identify follicle and seed development. Where multiple plants in flower were in close proximity (<50 m apart), pollinia was exchanged between plants. These plants were then monitored for the remainder of the 2024 monitoring period to determine if any fertile follicles had developed.

2.4 Seed collection

In accordance with the updated TFPP (Ecoplanning 2024b), all BMA populations were inspected at least once during the monitoring period of 2024 in search of seed for translocation trials. Where flowering plants were detected more regular inspections were undertaken to identify follicle and seed development. Additionally, searches for *T. linearis* with follicles were conducted within the Maules Clearing Area in January 2024 as part of pre-clearance surveys. The purpose of these surveys was to enable seed collection and plant 'salvage' prior to vegetation clearance.

Any seed collected would form part of the seed propagation and translocation trials discussed in **Section 2.2.1**.



Figure 2.1: Location of the *T. linearis* enclosures within the Wollandilly BMA which form part of the growth study.

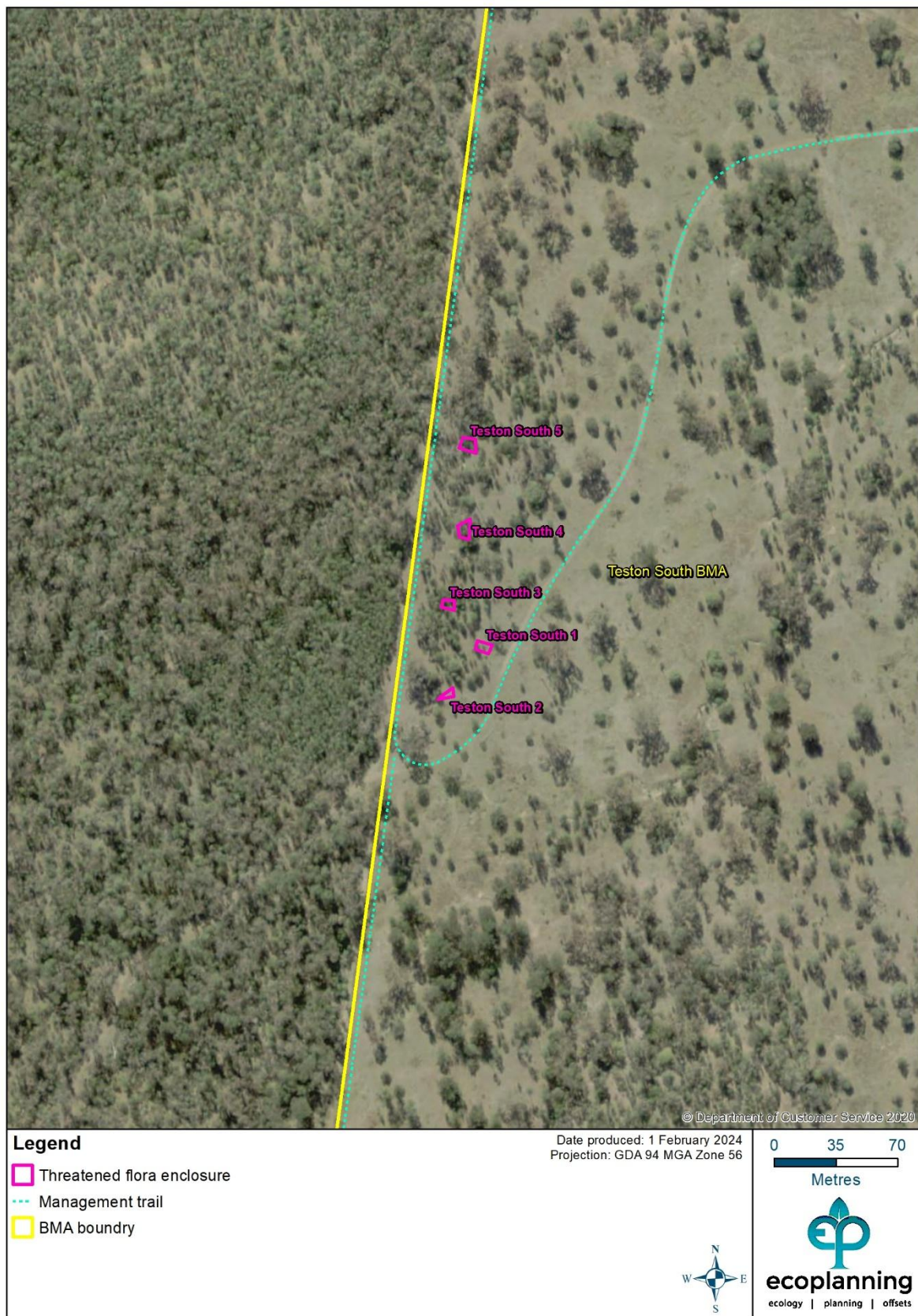


Figure 2.2 Location of the *T. linearis* enclosures within the Teston South BMA which form part of the soil translocation study.

2.5 Weather observations

As noted in previous annual reports climatic conditions are suspected to be the primary influence on monitoring projects (Ecoplanning 2021c, 2022, 2023, 2024e). During the 2024 monitoring period weather observations (viz. monthly rainfall and average maximum temperature) were recorded at WHC weather stations located at the Rosevale and Wollandilly BMA (data provided by Advitech [2025]; **Figure 2.3**). Weather observations collected on WHC BMAs was compared to climatic means from the Gunnedah Airport (Weather Station 055202 [BOM 2025]).

Total 2024 rainfall received at the Wollandilly BMA was 22 mm less than the climatic mean (549 mm at Wollandilly and 571 mm Climatic mean). The majority (304 mm) received at Wollandilly occurred during the first six months of 2024. The majority of rainfall received in the first six months of 2024 at Wollandilly BMA occurred during April, where 102 mm of rainfall was recorded (18.5% of the 2024 rainfall received).

Comparing the patterns of rainfall to that received during 2023, total rainfall received at Wollandilly in 2024 was 82 mm less than what was received in 2023 (631 mm fell in 2023), the majority of their 2023 rainfall during the first six months of that year.

When examining the maximum mean temperatures observed at Wollandilly BMA, months during the cooler parts of the year (April to September) tended to be similar to or lower than the climatic mean. However, during the month of August, mean maximum temperatures at both BMAs were higher than the climatic mean (21.6°C at Rosevale and 22.1°C at Wollandilly).

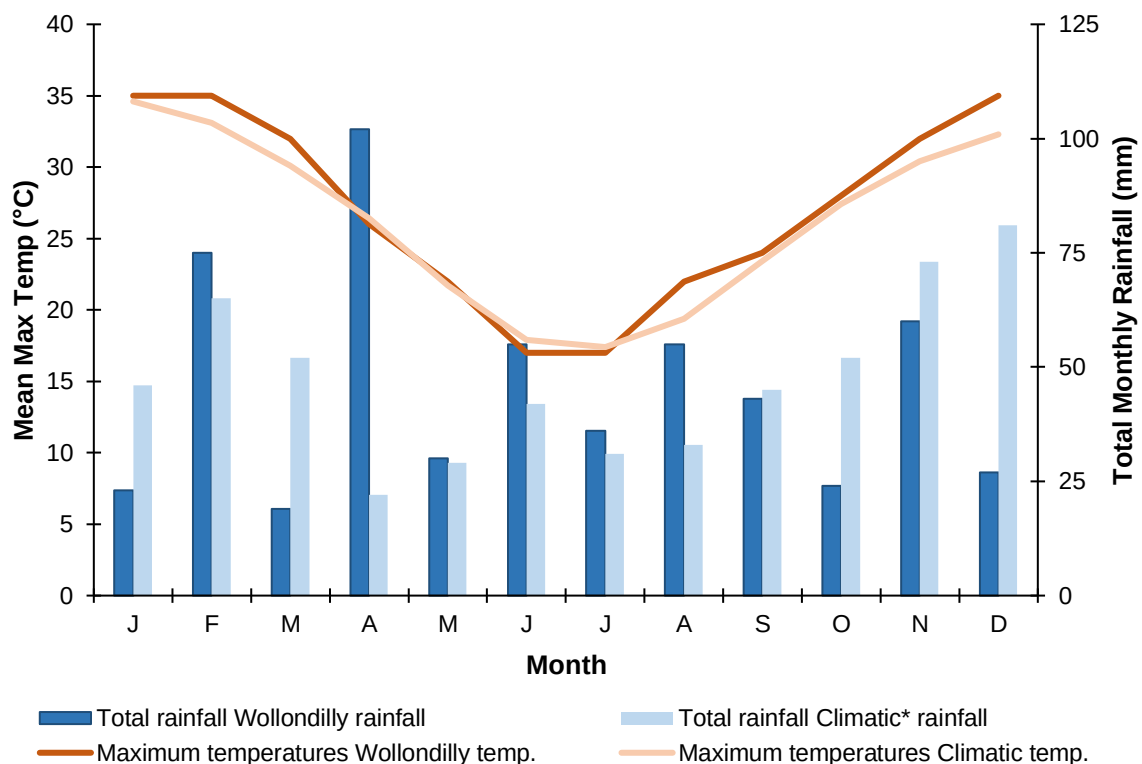


Figure 2.3: Monthly rainfall total and maximum temperatures from the Wollandilly BMA weather station and climatic patterns from Gunnedah Airport (BOM station: 055202).

3 Results and discussion

The results of the ongoing translocation trials, representing Stage 5 of the RTS, are presented in **Table 3.1**. Results of each trial as of 2024 and ongoing work conducted across the reporting period are detailed in the following sections.

Table 3.1: Summary of the 2024 *T. linearis* translocation program

Provenance	Translocation date	Number translocated	Translocation method	Surviving plants	Count of surviving plants
MCMM project boundary	December 2015	77	Seed collection and propagation	6/77	6
	February 2024	20	Salvage translocation	18/20	18
Cumulative Total as at the end of December 2024					24

* Based on max number of plants up to December 2024 with above ground growth. However, this study has found plants can go up to 3 years without above ground growth, so the maximum number of plants with above ground growth in last year has been 8.

3.1 Growth study

The abundance of *T. linearis* stems observed during surveys within the Wollandilly H enclosure is shown in **Figure 3.1** along with the quarterly rainfall patterns. Previous results have identified that increased number of stems within the Wollandilly natural population are commonly associated with periods of increased rainfall, although this was not the case during the very wet conditions during 2021 and 2022 (which was attributed to competition from other groundcover species which responded to prolonged wet conditions). During 2023, the number *T. linearis* stems within the Wollandilly H enclosure was closely related to rainfall with stems numbers peaking during Q2 after the wet conditions experienced during autumn. However, in 2024, the abundance of *T. linearis* stems recorded seemed to have a negative correlation with rainfall. The greatest amount of rainfall was recorded during Q2 (187 mm) which correlated with the greatest number of *T. linearis* stems (30), Q3 had a decrease in the number of stems (26), and Q1 and Q4 had the lowest number of stems (both 14). The first, third, and fourth quarters of 2024 each had comparable levels of rainfall (115 mm, 134 mm, and 111 mm, respectively).

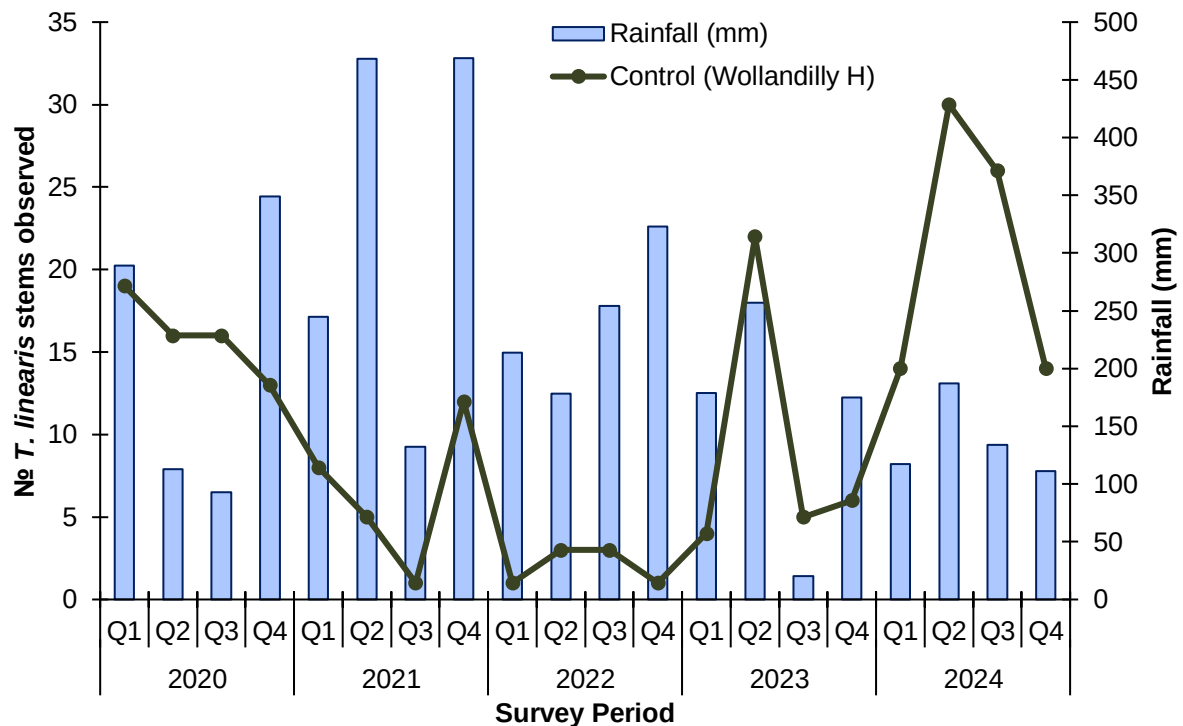


Figure 3.1: The number of *T. linearis* stems observed in the Wollandilly H enclosure compared to the total monthly rainfall observed at the Gunnedah Airport weather station (BOM station: 055202).

3.2 Translocation trials

3.2.1 Seed propagation and germination

Eight *T. linearis* from the 2015 translocation trial were observed at least once above ground during 2024 (**Table 3.2**). Four plants (A2, A7, G8, and G13) were observed in all four monitoring periods of 2024, B4 and G12 were observed in three monitoring periods (Q2, Q3, and Q4), while G1 was observed only during Q2 of 2024. The results of 2024 for the propagation trial were broadly similar to previous monitoring periods (dating back to 2019) in that five to eight plants were observed during those periods.

Four plants (A2, G8, G12, and G13) developed flowers at least once during 2024. G8 had flowers in Q1, Q3, and Q4 and G12 was flowering in Q3 and Q4. The remaining two plants were observed flowering during only on quarter (**Table 3.2**). No plants from the 2015 translocation developed follicles during 2024.

Table 3.2: Translocated *T. linearis* part of the growth study observed in 2024 (cells in “Blue” indicate the plant was flowering during that quarter).

Plant number	Q1*	Q2*	Q3*	Q4*
A2	150 cm	120 cm	118 cm	120 cm
A7	50 cm	70 cm	63 cm	70 cm
B4	-	30 cm	30 cm	35 cm
G1	50	-	-	-
G8	70 cm	80 cm	82 cm	77 cm
G9	30 cm	-	-	-
G12	-	60 cm	132 cm	140 cm
G13	100 cm	110 cm	85 cm	110 cm

*Recorded plant height indicates that the specified plant was observed above ground during the quarter

3.2.2 Salvage translocation trials

Of the 20 plants which were salvaged from the MCCM development area in February 2024, only one was not observed after being translocated (**Figure 3.2**). Eleven were seen in all four quarters, seven were seen three times, and one (plant 15) was only observed in Q4. Plant 19 was not observed above ground during 2024 after the translocation event. It should be noted that it is likely that plant 19 may still be alive, as *T. linearis* has been observed to remain dormant for up to three years.

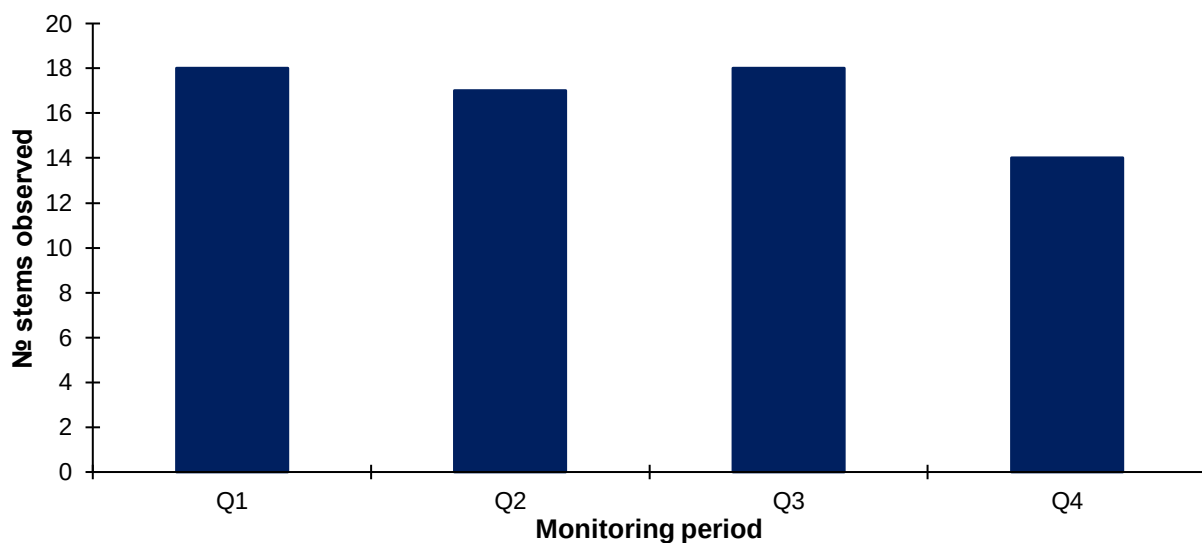


Figure 3.2: Number of *T. linearis* from the 2024 translocation event that were observed with above ground material for each monitoring period of 2024.

Table 3.3: Translocated *T. linearis* part of the 2024 salvage translocation trial observed in 2024, Blue cells indicate the plant was not observed in that monitoring quarter.

Plant number	Q1	Q2	Q3	Q4
1	45	40	35	
2	20	18	16	15
3	35	64	54	54
4	55	9	28	
5	120	124	3	109
6	150	60	65	42
7	40	33	33	21
8	40	-	40	7
9	35	34	35	
10	50	44	45	39
11	140	50	45	44
12	40	40	35	34
13	30	27	28	30
14	80	23	24	
15				8
16	50	51	43	40
17	20	25	25	
18	70		16	9
19				
20	90	44	48	47

3.3 Seed collection

During 2024, there was only one opportunity for *T. linearis* seed to be collected. During the first quarter 20 follicles, five *T. linearis* plants in the Wollandilly M enclosure, were observed to be either developing, shedding seed, or spent; two of these plants had seed collected. One plant (labelled Plant 40) had seven follicles; five had opened prior to the Q1 inspection. The remaining two follicles from Plant 40 had seed collected on two separate occasions (**Figure 3.3**): on 23 February and on 15 April 2024. The other plant to have seed collected was Plant 38, which had 11 seed collected on 23 February 2024. In total, 23 *T. linearis* seeds were collected in 2024. The amount of seed collected from *T. linearis* during 2024 was below the recommended 20% of total seed produced, as recommended by Commander *et al.* (2018).

Initially, 11 of the 23 *T. linearis* seeds collected in 2024 germinated. By the end of Q2, two of the 11 germinants had died, however, by December only three germinants remained.



Figure 3.3: Left – image of a developing *T. linearis* follicle (Plant No. 40; 23 February 2024). Right – fully developed *T. linearis* follicle which has opened exposing seed (Plant No. 40; 25 March 2024).

It is unclear why such a high abundance of follicles developed in early 2024. Previously, the absence of pollinators as hypothesised to be the reason for a lack of follicle production. However, the pollinator of *T. linearis* is yet to be identified and the relationship of this pollinator (or pollinators) is yet to be studied. It may be the favourable climatic conditions (e.g. warm temperatures and high rainfall) triggered the development of follicles. For example, in the four months prior to the high abundance of follicles (February 2024) there was higher than average rainfall received, and temperatures were warmer what would be expected (**Figure 3.4**). In contrast, rainfall was lower than average in the months preceding the observation of the lone follicle in December 2024, however, temperatures were higher than the expected climatic mean. As such, there appears to be a more complex relationship between *T. linearis* reproduction and weather patterns. Closer analysis of follicle development compared to weather observations should be completed to determine if climate is the main cause for follicle development or if other, unknown factors, is the main cause.

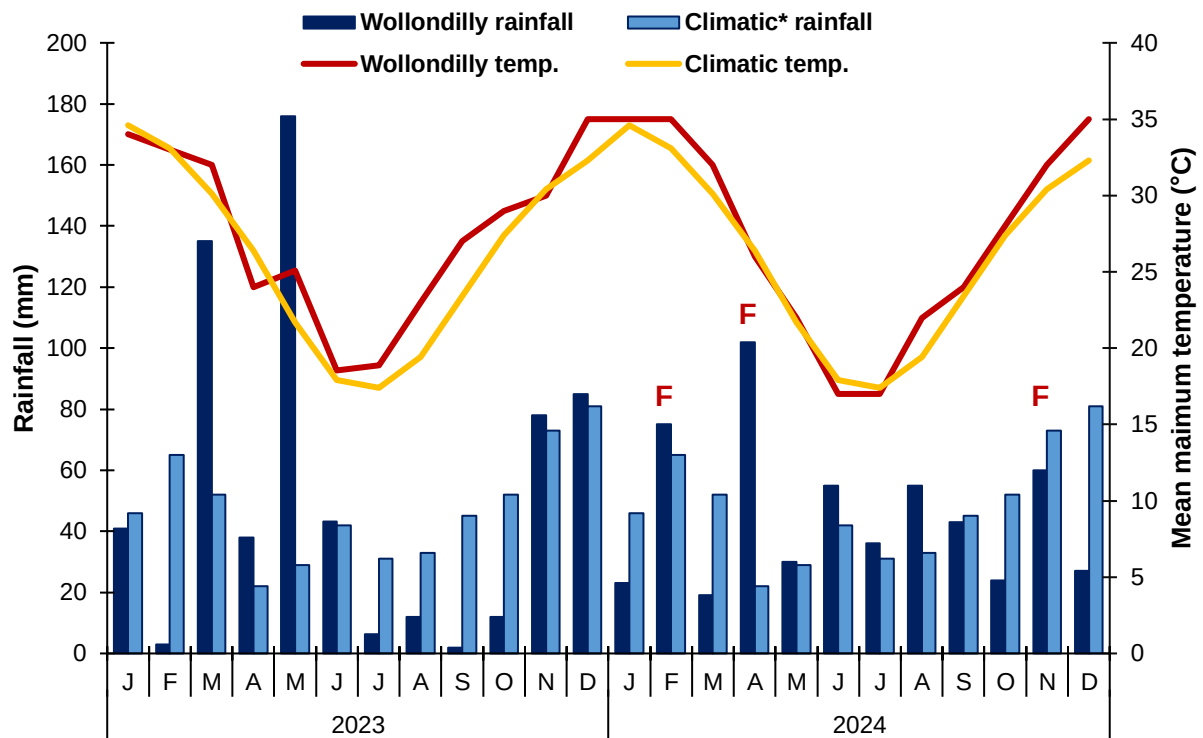


Figure 3.4: Monthly rainfall received at the Wollondilly BMA and the climatic mean monthly rainfall (BOM 2025), months marked with a red “F” indicate that *T. linearis* follicles were observed

3.4 Hand pollination trials

During 2024, only one hand pollination was attempted on 17 May. During this hand pollination event, pollen was transferred between two nearby plants in the Wollondilly M enclosure, however, neither plant developed follicles after being hand pollinated.

4 Conclusions and recommendations

The overall aim of the *T. linearis* PTP (Ecoplanning 2024a) – and previous *T. linearis* RTS (Ecoplanning 2021b) – is to directly support the conservation of *T. linearis*, and to maintain a self-sustaining, genetically diverse population of the species within the WHC BMAs, which are capable of surviving in the long term.

The continued occurrence of *T. linearis* within multiple enclosures across WHC BMAs, as detected during quarterly searches for reproductive material, indicates that the populations of *T. linearis* on WHC BMAs remains healthy, given the high number of stems observed, and development of flowers and mature follicles. Although at least 20 mature follicles developed during 2024, the reproductive health of the population remains unclear as little is known on the reproductive cycle of the species. There is a lack of knowledge on the reproductive ecology of *T. linearis* in the published literature (e.g. the main pollinator is unknown), so it is unknown whether the observed abundance of follicles that developed and seed produced is typical of the species and part of its natural life cycle. It is unclear if the abundance of follicles observed in 2024 is due to the increased presence of pollinators or if pollinators have always been present but favourable growing conditions (i.e. increased rainfall) were more favourable in 2024 than in previous monitoring periods. Further investigation into the relationship of follicle production to weather patterns is required. In addition, planned ecological burns required as part management of WHC BMAs may provide opportunities to determine if resumption of natural disturbance plays a role in the life cycle of the species.

To support the overall aim of the strategy, one of the objectives of the strategy is to guide the successful translocation of *T. linearis* individuals grown from seed, stem cuttings, or soil seedbank transfer, to suitable habitat within the protected areas that form part of the WHC BMAs. The source of regenerative material for *T. linearis* within the strategy is to include material collected from natural populations across WHC BMAs, State Forests (i.e. Leards State Forest), and populations identified within approved mine disturbance footprints ('salvage'). In 2024, one salvage opportunity was exploited, where 20 *T. linearis* stems were translocated from the 2024 MCCM surface development area to the Teston South BMA. Nineteen of the 20 plants translocated were observed to be growing after translocation. Additionally, approximately 23 *T. linearis* seeds were collected in early 2024, and of the 11 seeds that germinated three plants remain alive for future translocation. Pre-clearance inspections of the MCCM in early 2025 may present salvage opportunities for WHC Biodiversity, with either follicles which may be harvested or whole plants which can be transferred to enclosures within identified target locations in WHC BMAs.

Recommendations

Based on the results of this year, the following recommendations are made to continue to achieve the aim of the strategy and the objective to undertake further translocations:

- As per the TFPP, continued quarterly surveillance of naturally occurring populations should occur to observe patterns of these populations and to identify opportunities for seed collection and propagation. The collection and propagation of seed from naturally occurring populations of *T. linearis* remains the least invasive way to support *T. linearis* conservation without impacting naturally occurring populations.

- As per the *T. linearis* PTP, where inspections of naturally occurring populations in 2024 detected limited seed production, propagation via stem cuttings should be trialled from healthy and robust individuals of the species. Cuttings should either be taken by qualified horticulturalists, or under their direction, ensuring that resources and materials are ready and available to receive the cuttings.
- As per the *T. linearis* PTP, identification of *T. linearis* should be undertaken as part of pre-clearance surveys in 2025. Any *T. linearis* within approved MCCM disturbance footprints should be translocated via a combination of seed collection (where seeds are present), stem cuttings, and whole plant translocations.
- As per the TFPP, there is the opportunity to take advantage of the ecological burns required as management of WHC BMAs, to understand how fire interacts with the life cycle to *T. linearis*. This should be explored in 2025, with the results helping to inform future management practices.



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