

aerial mapping of riparian vine weeds

Tweed Shire Council

A decorative horizontal band with a repeating pattern of green leaves, each with a black outline and a central vein. The leaves are arranged in a dense, overlapping manner.

ecosure

Revision History

Revision number	Revision date	Details	Prepared by	Reviewed by	Approved by
00	15.04.2009	Draft report	Carla McKeivitt	Julie Whelan	Neil Taylor CEO
01	27.05.2009	Final report	Ecologist	Environmental Scientist	

Distribution List

Copy number	Date	type	Issued to	Name
1	27.05.2009	electronic	Tweed Shire Council	Tom Alletson
2	27.05.2009	hard copy	Tweed Shire Council	Tom Alletson
3	27.05.2009	electronic	Ecosure	Carla McKeivitt



citation: Ecosure(2009), Aerial mapping of riparian vine weeds, Report to Tweed Shire Council, Ecosure West Burleigh

Report compiled by Ecosure Pty Ltd.

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E35_TSC_Report_Rev01_260509

Digital Data Collected and Compiled
by Rod Tansley of Asset Mapping



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Executive Summary

In July 2008, Tweed Shire Council contracted Ecosure Pty Ltd to survey and map the extent of riparian vine weeds in approximately 730 km² of the Tweed Shire catchment.

The aims of this project were to identify and map the extent of Cats Claw Creeper (*Macfadyena unguis-cati*) and Madeira Vine (*Anredera cordifolia*) infestations within the study area.

During the aerial surveys, we identified and mapped 521 ha and 172 isolated infestations of the target weeds within the riparian zones of the following catchments: the Mid and Upper Tweed River, Smiths Creek, Rolands Creek, Doon Doon Creek, Byrill Creek, Brays Creek, Lower and Upper Oxley Creek, Lower and Upper Rous River, Hopping Dicks Creek, Crystal Creek and Nobbys Creek. Generally, both weeds occur on or near waterways with only a few patches found terrestrially as an ornamental specimen in gardens.

The Oxley River had the highest incidence of weed infestations, with 268 ha cover and 70 isolated infestations. The Tweed River had weed occurrences covering 209 ha and 72 isolated infestations of riparian weeds. The Rous River also had infestations of the target weeds, with a combined total of 44 ha and 30 isolated points of infestations.

We recommend the strategic treatment and removal of all weeds, starting at the upstream locations and progressing downstream. As both target weeds predominantly grow in the riparian zone and seed and tuber dispersal is predominantly via the waterways, this approach will reduce the likelihood of the weeds reinfesting work areas by the transportation of seeds from upstream populations. When planning the strategic treatment of these weeds, consideration should also be given to the protection of areas of conservation value.

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1 Introduction

In July 2008, Tweed Shire Council (TSC) contracted Ecosure to survey and map the locations of Cats Claw Creeper (*Macfadyena unguis-cati*) and Madeira Vine (*Anredera cordifolia*) (the target weeds).

This report outlines how this survey was performed and the results obtained during this project.

1.1 The Target Weeds

Cats Claw Creeper and Madeira Vine are both exotic deleterious vines found within the Tweed Catchment predominantly within the riparian zones. These weeds pose a significant threat to biodiversity in riparian and rainforest communities (DPI&F 2008).

TSC would like these infestations to be accurately mapped within the catchment prior to developing a strategic control program.

1.2 Aerial Surveying

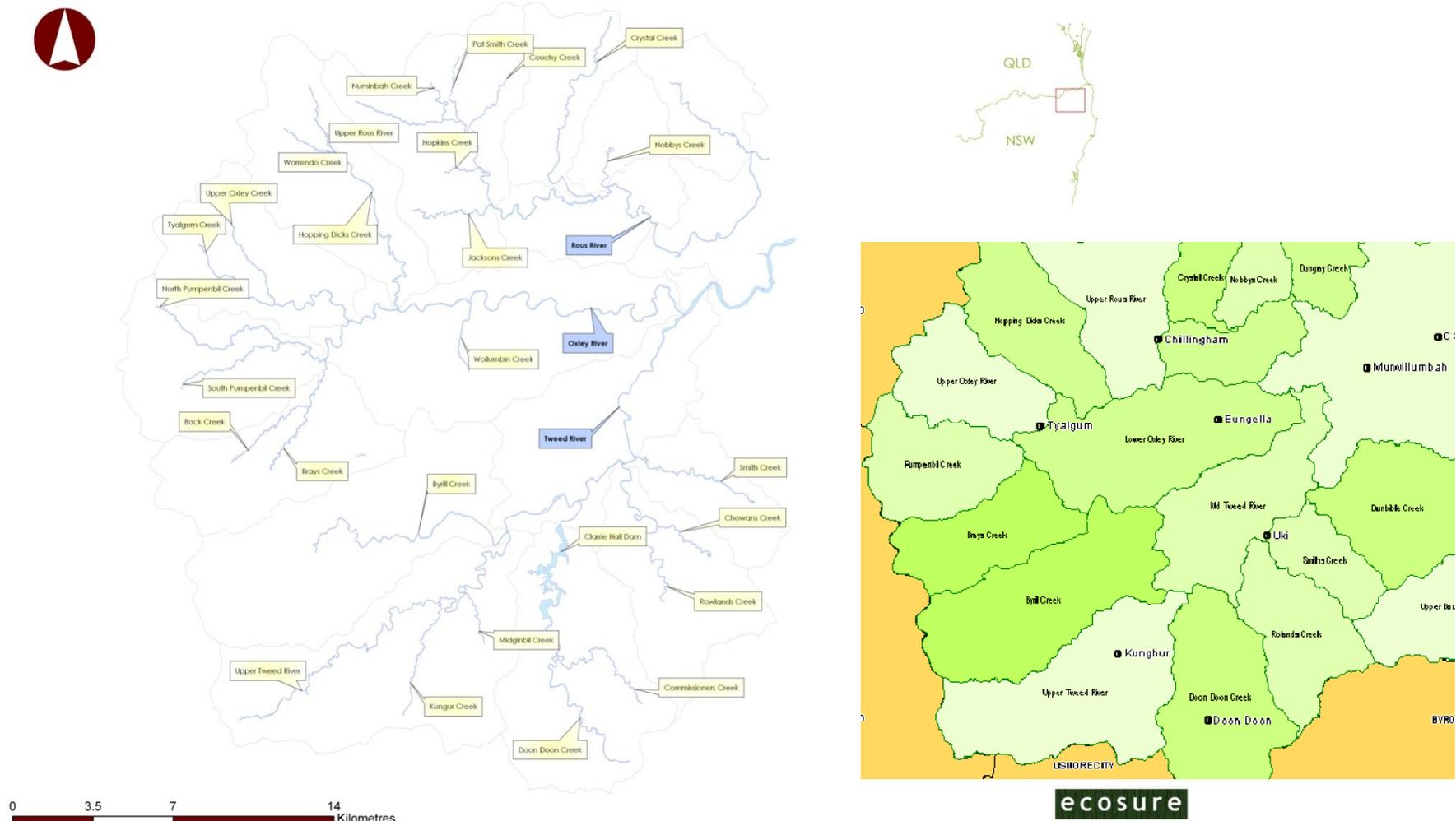
Both Cats Claw Creeper and Madeira Vine are often interspersed within the canopy of native species and generally are difficult to discriminate from other vine species without close inspection. However, both species present distinguishing colour displays when flowering (Figures 2a and 3a) and their in situ distribution can be estimated by mapping the extent of the flowers. Flowering periods vary between three and six weeks, but flowering may be asynchronous. Variations in flowering times are caused by the elevation, aspect of habitat towards the sun, water and nutrient availability of each population of vine species. Flower retention may also vary with ambient conditions. Due to this variability, most areas need to be surveyed at least twice during the flowering period to account for this dissimilarity. The method of aerial surveying was selected because:

1. The large study area could be searched twice within the nominal flowering window of each species.
2. The flowers of both species within a severe infestation are often more visible from above the canopy than below, thus detection rate from the air is likely to be higher than from the ground.
3. Much of the study area, particularly in the headwater regions, is relatively inaccessible by foot or vehicle.

By surveying the project area by helicopter, it negates the problems of passing through hard terrain, dense vegetation on ground and gaining land owner permission to access private land. Helicopters also allow for a high level of speed and manoeuvrability that are ideal for surveying the terrain within the Tweed Shire.

1.3 The Project Area

The focus of this project is the upper reaches of the Tweed River and its two major tributaries, the Oxley and Rous Rivers (Map 1). The convergence of the Oxley and Tweed Rivers was the designated eastern boundary for this project area. The eastern boundary for the Rous River, is its convergence point with Dungay Creek. The project area includes the small tributary waterways of the Tweed, Oxley and Rous Rivers, as shown in Map 1 below.



Map 1 The major waterways of the Tweed Catchment (left) and the sub-catchments (right)

1.4 Project Aims and Requirements

The main aim of this project is to identify and map the locations of the target weeds within the project area to enable TSC to produce a strategic control program.

Specifically the requirements for this project are:

- Design a flight plan, highlighting the extent of the project area to be surveyed, which will be determined by the budget. This was provided to TSC for review, prior to commencement of the aerial surveys.
- Map existing infestations of the target weeds within the project area.
- Estimate the severity and spatial extent of all located infestations.
- Prepare GIS compatible maps showing the location, extent and density of weed infestations.
- Provide digital data of the target weed's location, extent and density to TSC.
- Provide a report describing the methods used to map the target weeds and any limitations of the project including any potential budgetary constraints.

2 Methods

2.1 Aircraft and Crew

Ecosure employed an R44 helicopter (Figure 1) and pilot to conduct the aerial surveys with a survey team consisting of the same two people throughout the project to ensure consistency. The survey team comprised of a primary spotter and a data recorder capturing the locations of weeds as GPS points.



Figure 1 R44 Helicopter and primary spotter

Two survey events were conducted to correspond with the flowering periods of the two target weeds Cats Claw Creeper (September – October 2008) and Madeira Vine (March 2009).

To effectively survey and map the target weeds, the timing of the surveys is essential to ensure they take place during the flowering period. This requires communication between people on the ground, the surveyors and the helicopter company.

2.2 Flight Planning

The methods used to survey the targets weeds were described in the Flight Plan (Ecosure 2008), which was submitted to TSC on the 4th of September 2008. The draft content of this flight plan was presented to the TSC project manager, Tom Alletson during a meeting on the 26th of August 2008. This presentation and following discussions enabled Ecosure to ensure all of TSC's requirements were taken into consideration when planning the surveys.

The flight plan was approved by TSC on the 29th of September, with the priority areas for surveying being confirmed as the whole of the Oxley River and the Tweed River upstream of the Oxley River convergence. Once these river systems had been mapped, any remaining hours were to be spent surveying the Rous River. The budget allowed for 33 hours of survey time.

As the two target species flower at different times of the year, the budgeted surveying time of 33 hours was divided between the two flowering windows, thereby providing 16.5 hours of survey time per weed species. To allow for the known variation of flowering periods, it is essential to survey the project area at least twice to identify the extent of the weed cover (i.e. 8.25 hours per scan period).

In summary, there were 8.25 hours allocated to each scan period, with two scan periods for each of the target weeds.

2.3 Identifying Weed Distribution

Identification was based on growth form and the presence of flowers. The yellow flowers of Cats Claw Creeper (Figure 2) and the white drooping flowers of Madeira Vine (Figure 3) were both visible from the highest flight altitude of 1000 ft above ground level and at speeds of between 30 to 50 knots per hour.



a



b

Figure 2 'a' Cats Claw Creeper from a distance and 'b' close up



a



b

Figure 3 'a' Madeira Vine from a distance and 'b' close up

2.4 Ground Truthing

Eight hours of ground surveys were performed for each target weed species. This was to ensure that the species mapped from the air as Cats Claw Creeper and Madeira Vine were correctly identified. We also surveyed random sites to confirm that there were no target weeds in areas that we had mapped as being absent. The locations of the ground surveyed sites can be seen in blue on Map 2 in Section 3.

2.5 Weed Categorisation

The patch size and relative density of each weed infestation was assessed and attributed to the location at the point of data capture. This delineation allowed the production of the maps included in this report which illustrate the position, density and size of each weed patch. This information has also been provided to TSC in the form of digital data in Mapinfo format to enable its inclusion into TSC in-house maps.

Different symbols have been used to represent the size and density of weed patches within the catchment and these symbols are described in Table 1.

Table 1 Description of Symbols Used to Identify Weed Patch Size and Density

Weed Species	Symbol Example	Label	Description
			<p>Polygons: Represent vine infestations greater than 20 linear metres.</p> <p>The length of a polygon represents a stretch of weed that is relatively continuous within the area mapped, with the density of growth depicted by the below shadings.</p>
MV CCC		Heavy density	Vine obscuring 80% or more of the vegetation it is growing over throughout the mapped patch
MV CCC		Moderate density	Vine observed continuously throughout the mapped patch, but obscuring less than 80% of vegetation
MV CCC		Scattered density	Vine seen throughout the mapped patch, but not as a continuous stretch of weeds
			Points: Represent isolated vine populations less than 20 linear metres

The primary spotter determined the weed description attributes throughout the project to ensure consistency.

2.6 Data Recording



Figure 4 Recording Data on the Ground using an ike Laser GPS

We used an ike 305 laser GPS with an integrated 3.2 mega pixel camera, a 905nm (invisible infrared) laser rangefinder (1000m), a digital compass and an inclinometer (Survey Lab in New Zealand) (Figure 4). This unit can capture positions remotely with offset positions calculated in real time. The unit was coupled with a Sokkia AXIS3 Differential unit that receives real time correction through the OmniSTAR Virtual Base Station system that allows for sub-metre precision.

The capture software was ike GPS version of GBM Mobile (MapInfo). It was customised as necessary to suit the project, allowing specific attributes of each weed to be captured in the field as meta data.

3 Results

The digital data created by this mapping process and all relevant metadata has been included in this report as Appendix A in an electronic format. This will enable TSC to create their own maps and data layers from the information obtained during this project. This same data was used to create the following maps, which highlight the location, density and extent of the two target species throughout the project site. Maps 3 and 4 show an overview of the whole project area and the occurrence of Cats Claw Creeper and Madeira Vine respectively. Map 5 shows the breakdown of the project area into ‘study areas’ (SA), which are nominated areas that have been used to provide more detailed information on each waterway. SA 1 shows the infestations along the Rous River. SA 2 is the upstream infestations along the Oxley River, with SA 3 being those infestations in the most downstream locations of the Oxley River within the project area. SA 4 is the upstream infestations along the Tweed River, with SA 5 being those infestations in the most downstream locations of the Tweed River within the project area.

Maps 6 to 10 show the Cats Claw Creeper infestations within SA 1 to 5. Maps 11 to 15 show the Madeira Vine infestations within SA 1 to 5.

3.1 Target Weed Locations

Both of the target weeds were identified on each of the main waterways, the Rous, Oxley and Tweed Rivers (see Maps 3 to 15 in Section 3).

Table 2 Density/Area of weeds within each waterway system (area ha of each categorisation)

Cats Claw Creeper

	Dense	Moderate	Scattered	Total Area	Cats Claw point	
Tweed	2.3	18.5	73.1	93.9	43	
Oxley	18.6	81.4	104.1	204.1	29	
Rous	1	1.3	27.4	29.7	9	
				327.7	81	Totals

Madeira Vine

	Dense	Moderate	Scattered	Total Area	Madeira point	
Tweed	11.2	92.2	11.9	115.3	29	
Oxley	1.7	22.7	39.3	63.7	41	
Rous	0	14.2	0	14.2	21	
				193.2	91	Totals

Cats Claw Creeper

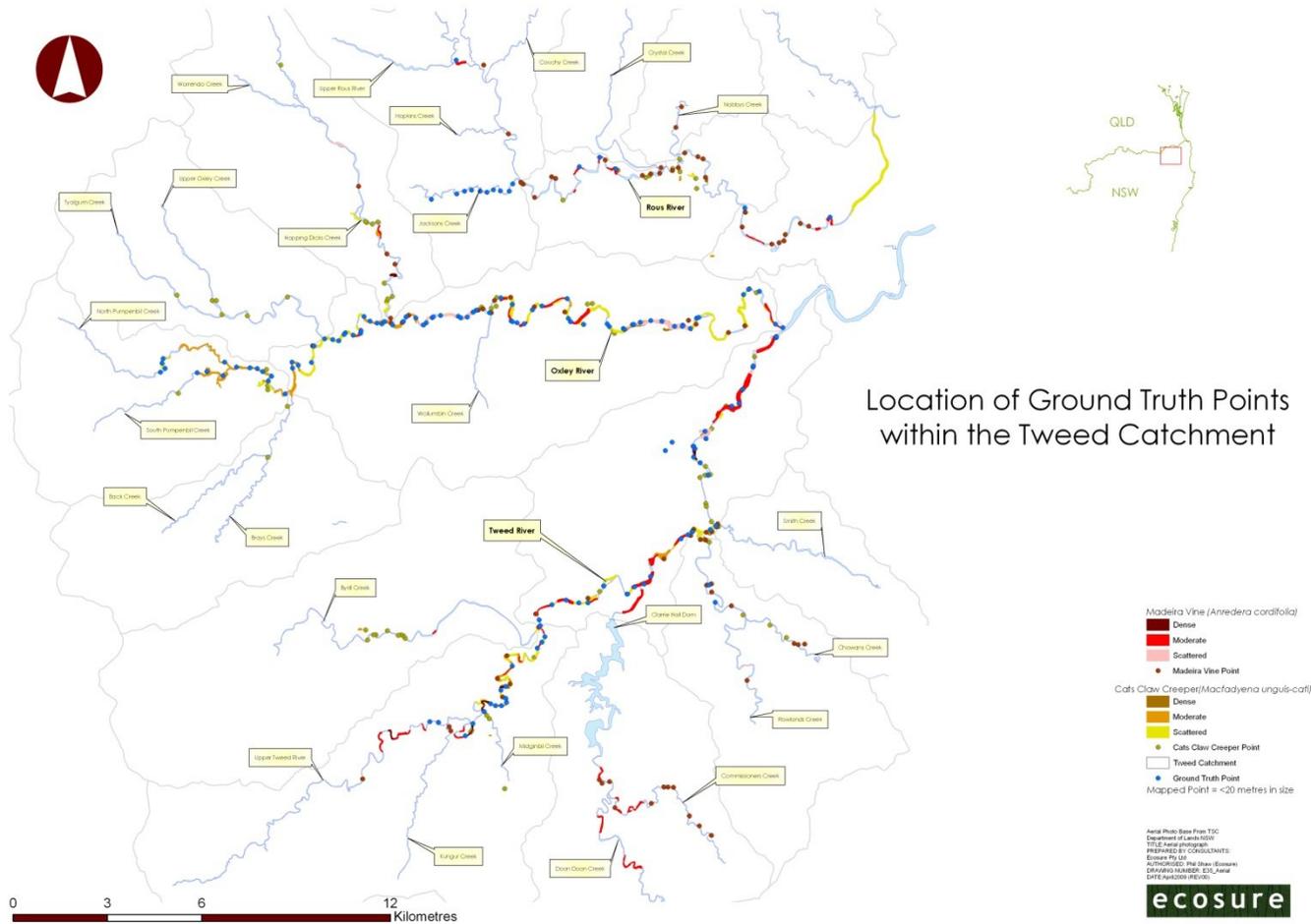
The highest occurrence of Cats Claw Creeper was found on the Oxley River and its tributaries and catchments, with 204.1 ha of mapped coverage. A majority of Cats Claw Creeper along this waterway was considered to be of a scattered density. There were also 29 isolated incidences of this target weed along the Oxley River. The Tweed River has the next highest occurrence of Cats Claw Creeper, with 93.9 ha coverage and 43 isolated points.

Madeira Vine

The highest occurrence of Madeira Vine was found on the Tweed River and its tributaries and catchments, with 115.3ha of mapped coverage. A majority of Madeira Vine along this waterway was considered to be of a moderate density. There were also 29 isolated incidences of this target weed along the Tweed River. The Oxley River has the next highest occurrence of Madeira Vine, with 63.7ha coverage and 41 isolated points.

3.2 Ground Truth of Data

One day was spent in the field during each of the two flowering periods (October 2008 for Cats Claw Creeper and March 2009 for Madeira Vine). This enabled us to confirm that what is on the ground is what we had mapped in the air for each species. Approximately 50 locations were assessed from the ground within the project area for each of the two target species. Each assessment involved determining whether an infestation that was identified in the air was the target weed species and whether areas that were determined to be free from the target weeds in the air were actually weed free.



Map 2 Location of Ground Truth Points

3.3 Maps of Target Weed Infestations

Map 3 Location of Cats Claw Creeper infestations in the Tweed Catchment

Map 4 Location of Madeira Vine infestations in the Tweed Catchment

Map 5 Locations of Survey Area Plots within the Tweed Catchment

Map 6 Location of Cats Claw Creeper infestations in Study Area 1 of the Tweed Catchment

Map 7 Location of Cats Claw Creeper infestations in Study Area 2 of the Tweed Catchment

Map 8 Location of Cats Claw Creeper infestations in Study Area 3 of the Tweed Catchment

Map 9 Location of Cats Claw Creeper infestations in Study Area 4 of the Tweed Catchment

Map 10 Location of Cats Claw Creeper infestations in Study Area 5 of the Tweed Catchment

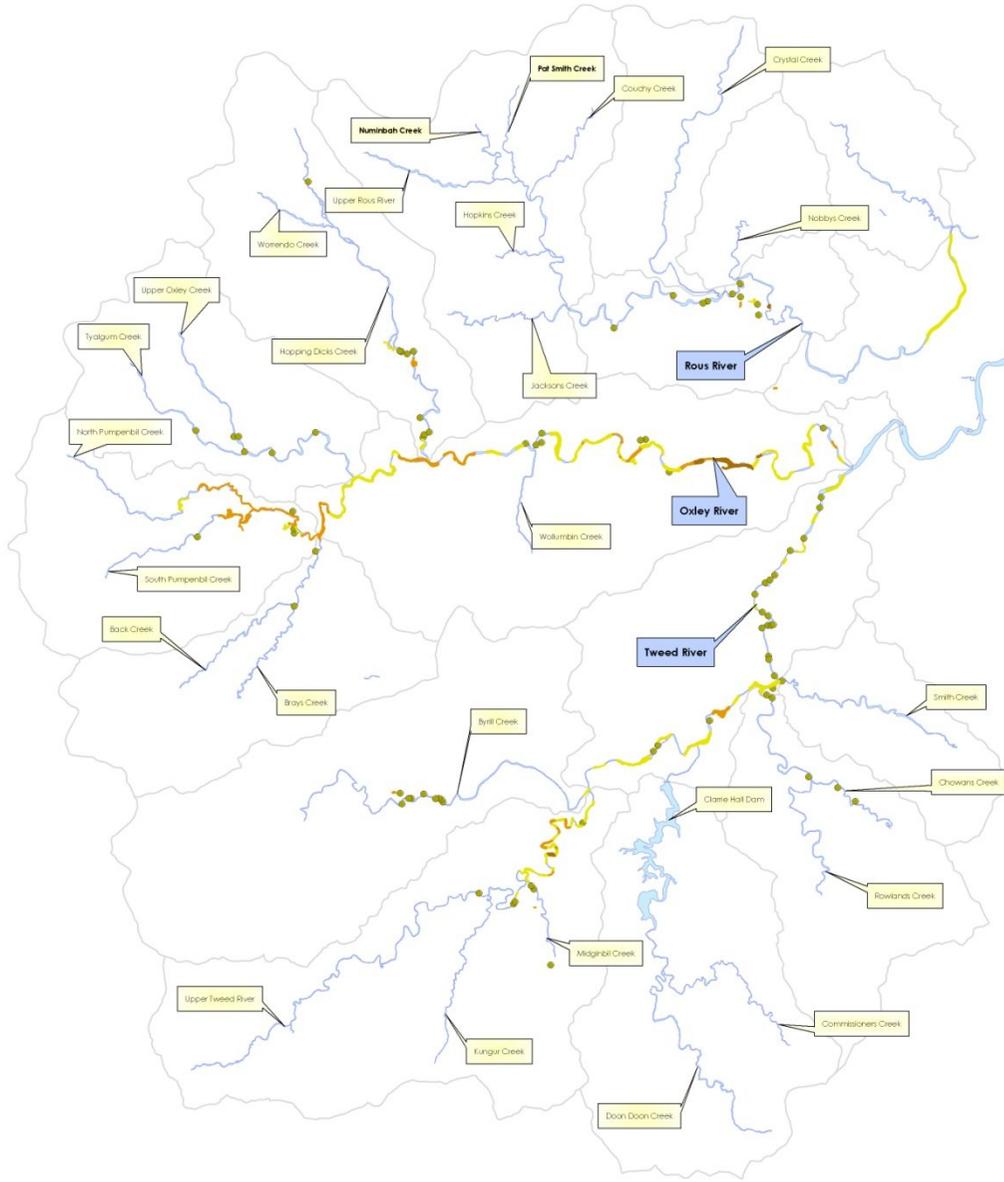
Map 11 Location of Madeira Vine infestations in Study Area 1 of the Tweed Catchment

Map 12 Location of Madeira Vine infestations in Study Area 2 of the Tweed Catchment

Map 13 Location of Madeira Vine infestations in Study Area 3 of the Tweed Catchment

Map 14 Location of Madeira Vine infestations in Study Area 4 of the Tweed Catchment

Map 15 Location of Madeira Vine infestations in Study Area 5 of the Tweed Catchment



Locations of
Cats Claw Creeper
(*Macfadyena unguis-cati*)
within the
Tweed Catchment



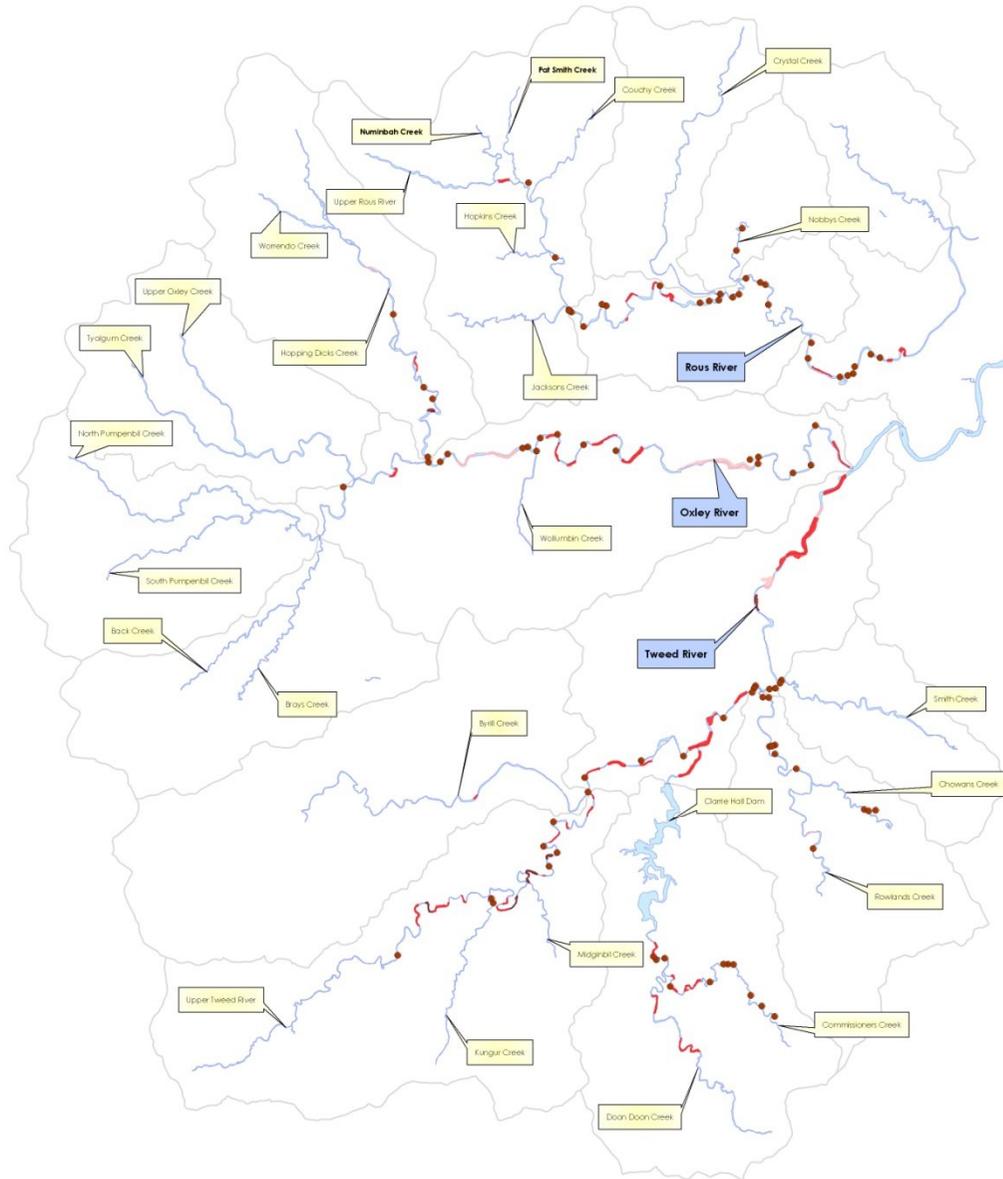
Cats Claw Creeper (*Macfadyena unguis-cati*)

- Dense
- Moderate
- Scattered
- Cats Claw Creeper Point
- Tweed Catchment

Aerial Photo Base From TSC
Department of Lands 18/04
TITLE Aerial photograph
PREPARED BY CONSULTANTS:
Ecosure Pty Ltd
AUTHORISED: Phil Shaw (Ecosure)
DRAWING NUMBER: E35_Aerial
DATE: April 2009 (REV00)



Map 3 Location of Cats Claw Creeper infestations in the Tweed Catchment



Locations of Madeira Vine (*Anredera cordifolia*) within the Tweed Catchment

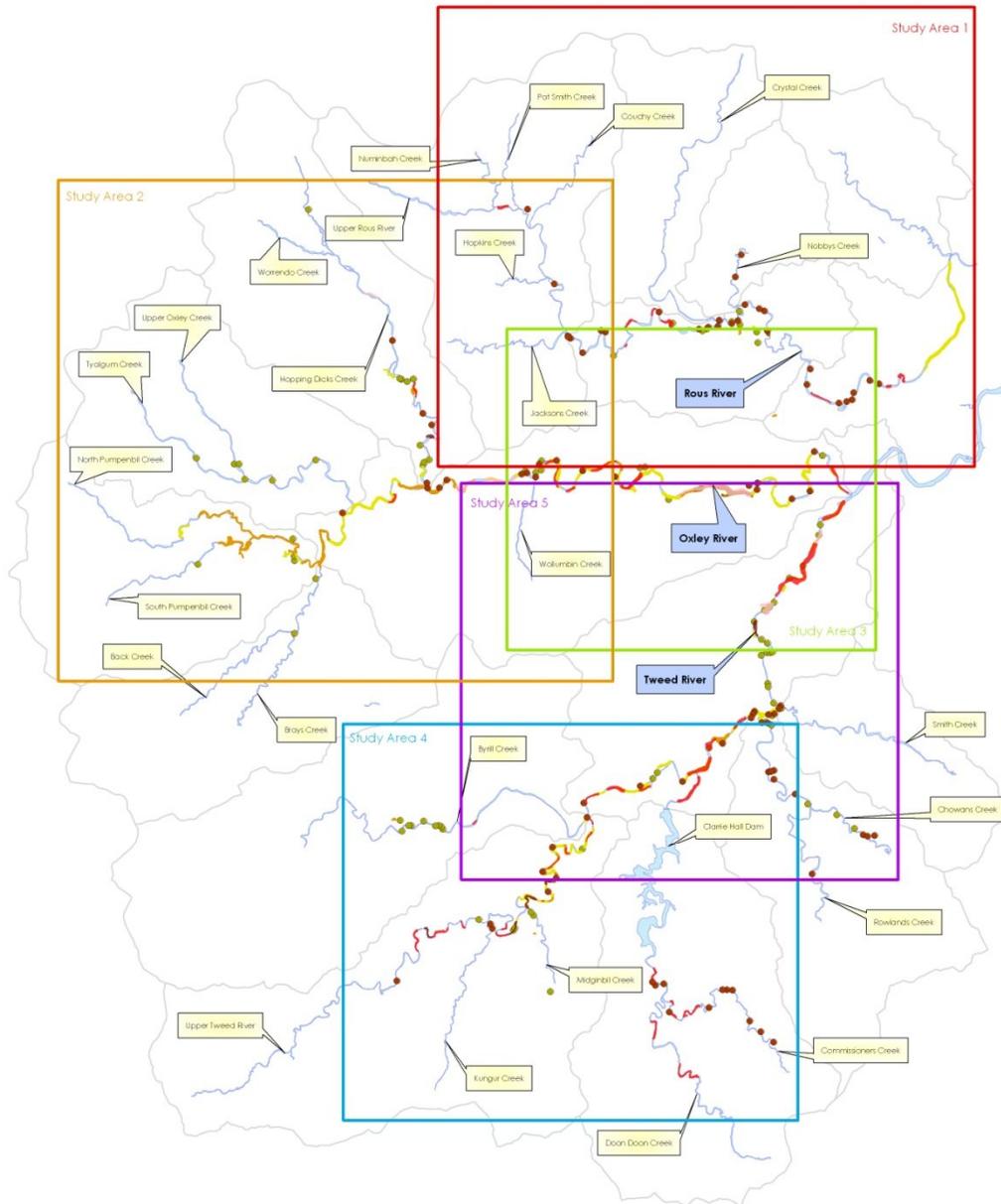


- Madeira Vine (*Anredera cordifolia*)
- Dense
 - Moderate
 - Scattered
 - Madeira Vine Point
 - Tweed Catchment

Aerial Photo Base From TSC
Department of Lands NSW
TITLE: Aerial photograph
PREPARED BY: CONSULTANTS:
Ecosure Pty Ltd
AUTHORISED: Phil Shaw (Ecosure)
DRAWING NUMBER: E35_Aerial
DATE: April 2009 (REV:00)



Map 4 Location of Madeira Vine infestations in the Tweed Catchment



Location of Study Areas used to map Cats Claw Creeper and Madeira Vine within the Tweed Catchment

- Study Area 1, the Rous River
- Study Area 2, upstream sections of the Oxley River
- Study Area 3, downstream sections of the Oxley River
- Study Area 4, upstream sections of the Tweed River
- Study Area 5, downstream sections of the Tweed River

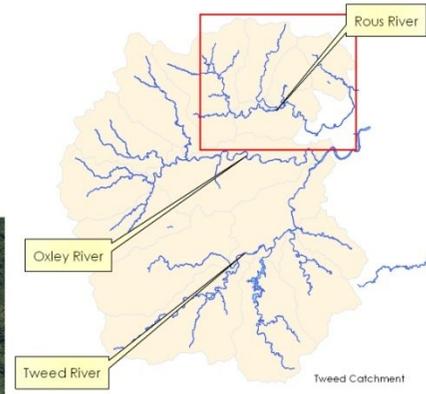
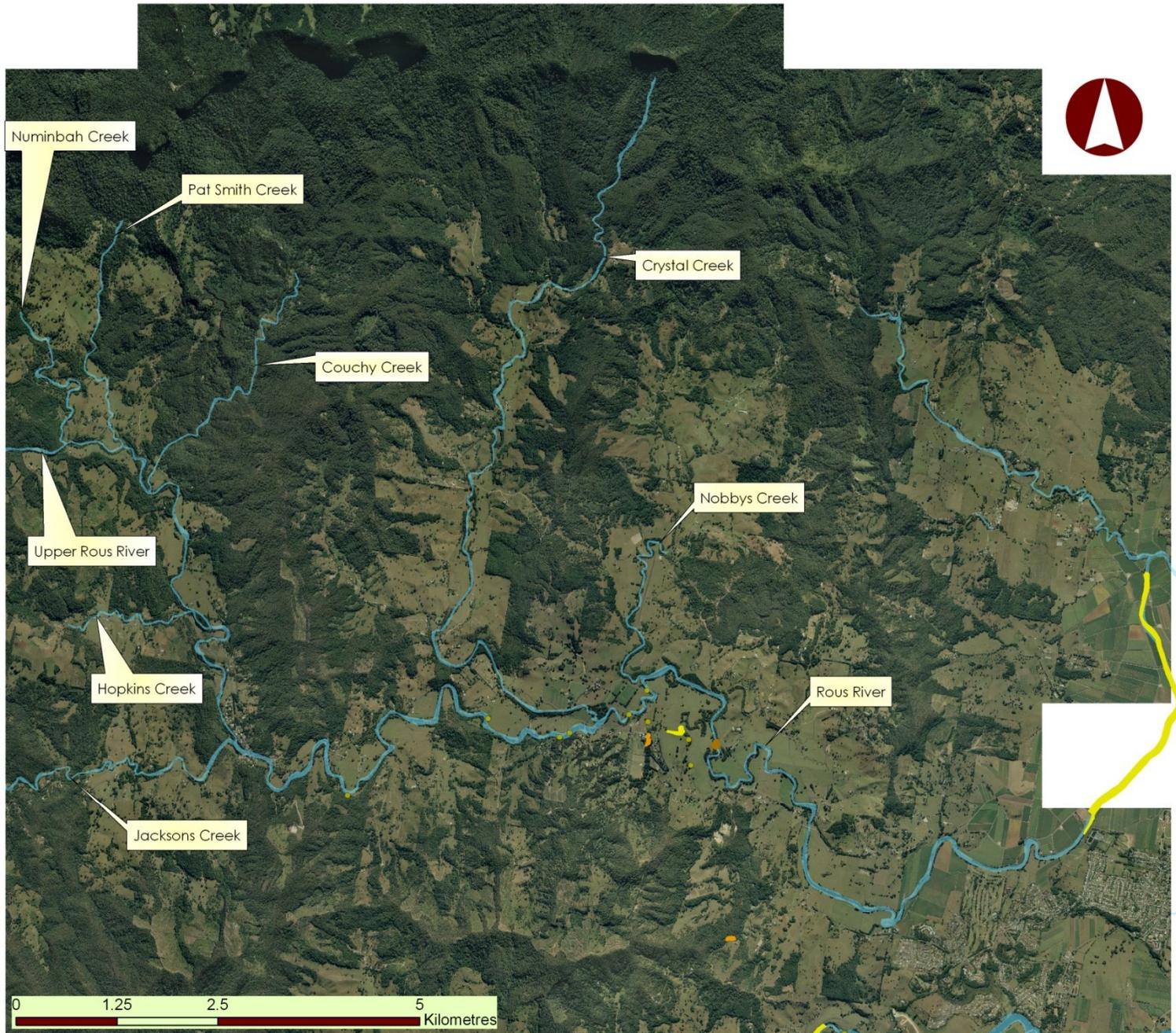
- Madeira Vine (*Anredera cordifolia*)**
 - Dense
 - Moderate
 - Scattered
 - Madeira Vine Point
- Cats Claw Creeper (*Macladyena unguis-cati*)**
 - Dense
 - Moderate
 - Scattered
 - Cats Claw Creeper Point
- Tweed Catchment
- Mapped Point = <20 metres in size



Aerial Photo Base From TSC
 Department of Lands NSW
 TITLE: Aerial photograph
 PREPARED BY: CONSULTANTS:
 Ecosure Pty Ltd
 AUTHORIZED: Phil Shaw (Ecosure)
 DRAWING NUMBER: EIS_Aerial
 DATE: April 2009 (REV:0)



Map 5 Locations of Survey Area Plots within the Tweed Catchment



Locations of
Cats Claw Creeper
(*Macfadyena unguis-cati*)
along the Rous River
within the
Tweed Catchment
Study Area 1

Cats Claw Creeper (*Macfadyena unguis-cati*)

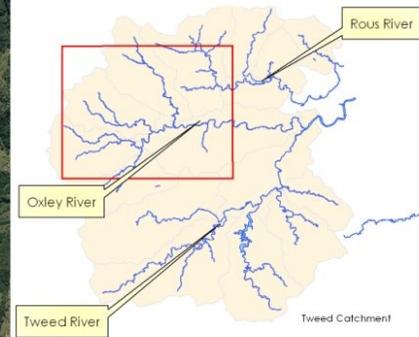
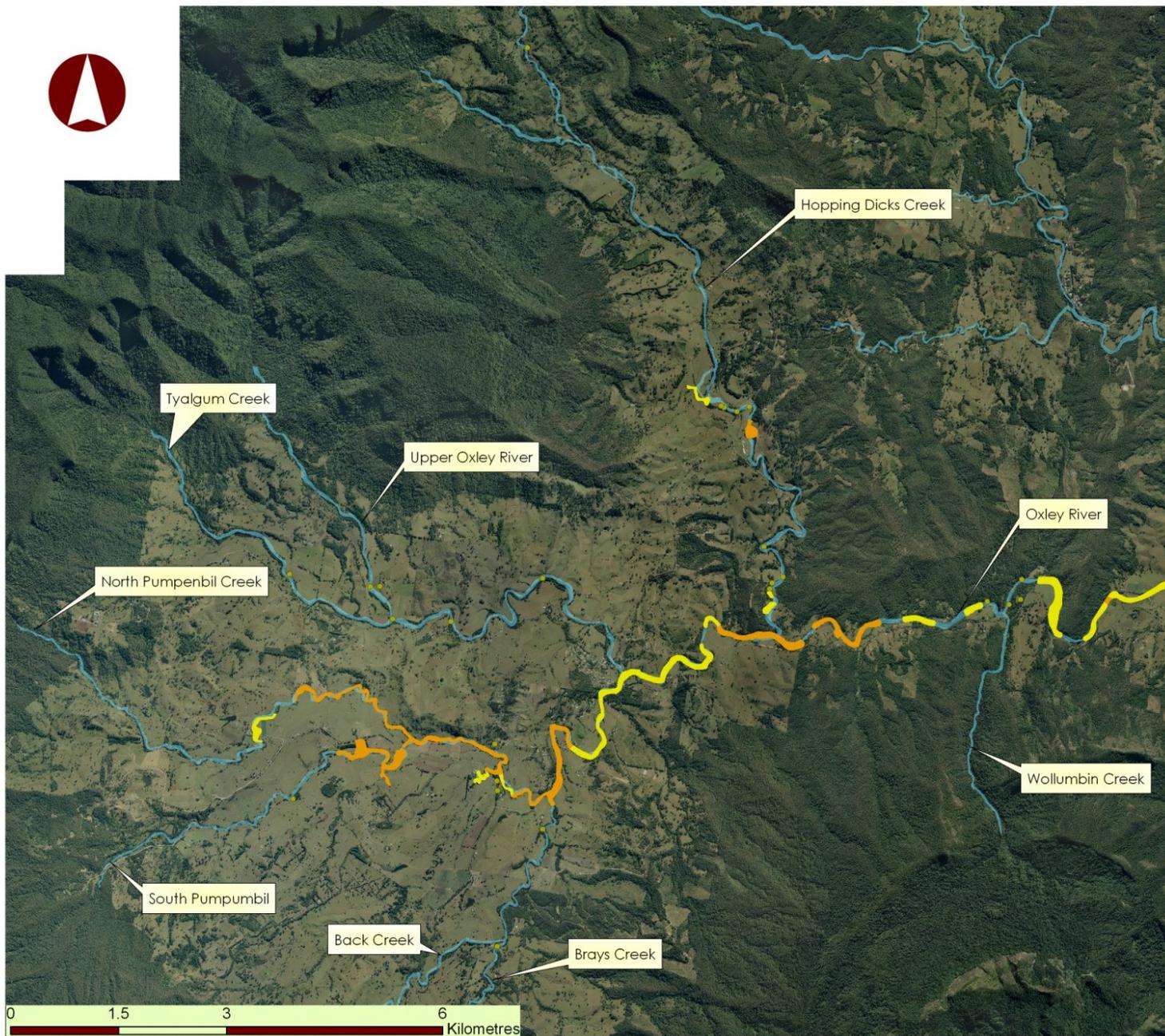
- Dense
- Moderate
- Scattered
- Cats Claw Creeper Point

Mapped Point = <20 metres in size

Aerial Photo From TSC
Department of Lands NSW
TITLE: Aerial photograph
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Map 6 Location of Cats Claw Creeper infestations in Study Area 1 of the Tweed Catchment



Locations of
Cats Claw Creeper
(*Macfadyena unguis-cati*)
along the Tweed River
within the
Tweed Catchment
Study Area 2

Cats Claw Creeper (*Macfadyena unguis-cati*)

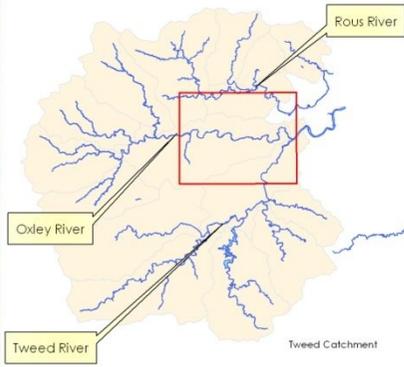
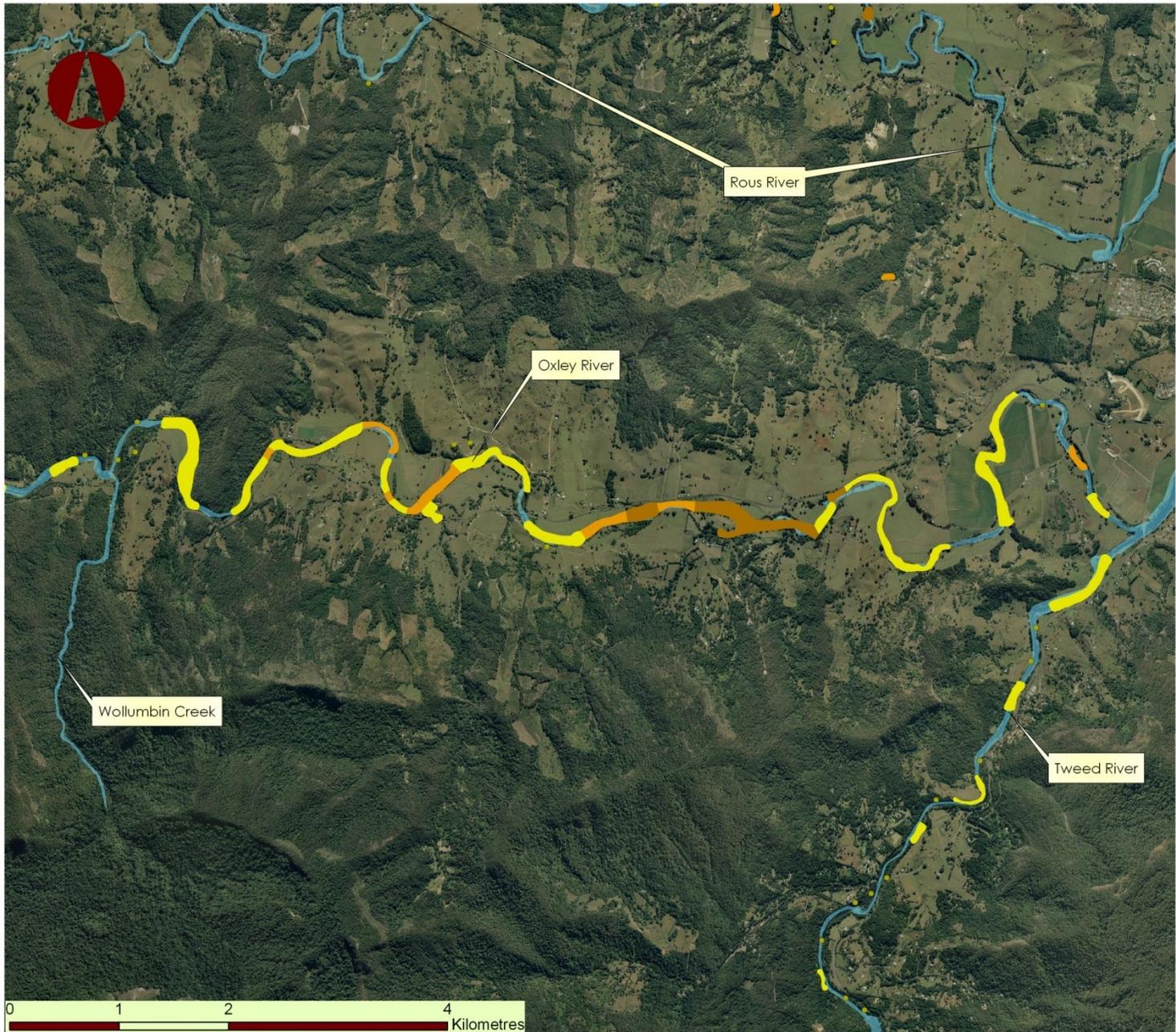
- Dense
- Moderate
- Scattered
- Cats Claw Creeper Point

Mapped Point = <20 metres in size

Aerial Photo from TSC
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DATE: 04/2009 (REV00)



Map 7 Location of Cats Claw Creeper infestations in Study Area 2 of the Tweed Catchment



Locations of
Cats Claw Creeper
(*Macfadyena unguis-cati*)
along the Oxley River
within the
Tweed Catchment
Study Area 3

Cats Claw Creeper (*Macfadyena unguis-cati*)

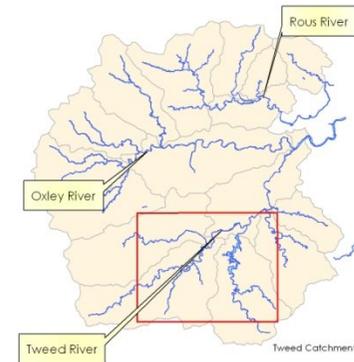
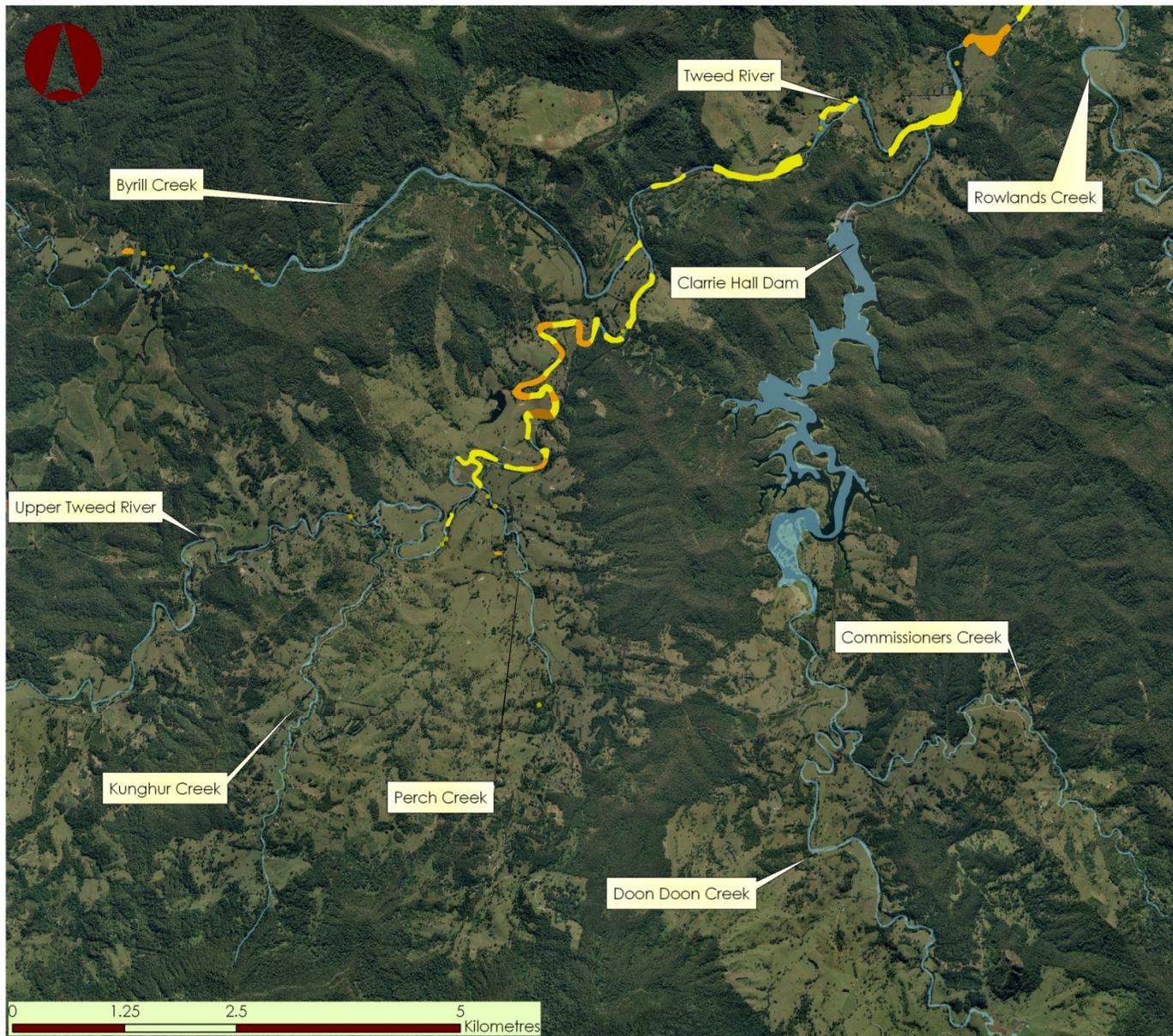
- Dense
- Moderate
- Scattered
- Cats Claw Creeper Point

Mapped Point = <20 metres in size

Aerial Photo from TSC
Department of Lands NSW
TITLE: Aerial photograph
PREPARED BY CONSULTANTS:
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DATE: 04/2009 (REV00)



Map 8 Location of Cats Claw Creeper infestations in Study Area 3 of the Tweed Catchment



Location of
Cats Claw Creeper
(*Macfadyena unguis-cati*)
along the Tweed River
within the
Tweed Catchment
Study Area 4

Cats Claw Creeper (*Macfadyena unguis-cati*)

- Dense
- Moderate
- Scattered

Cats Claw Creeper Point

Mapped Point = <20 metres in size

Aerial Photo Base From TSC

TITLE: Tweed River

PREPARED BY CONSULTANTS:

Ecosure Pty Ltd

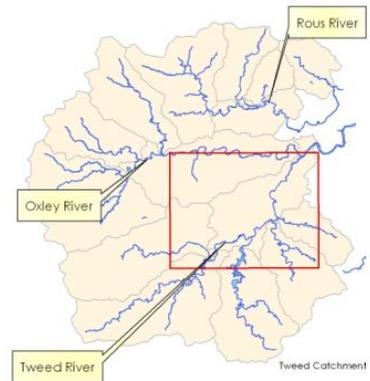
AUTHORISED: Phil Shaw (Ecosure)

DRAWING NUMBER: E35_SA4

DATE: April 2009 (REV00)

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Map 9 Location of Cats Claw Creeper infestations in Study Area 4 of the Tweed Catchment



Location of
Cats Claw Creeper
(*Macfadyena unguis-cati*)
along the
Tweed River
within the
Tweed Catchment
Study Area 5

Cats Claw Creeper (*Macfadyena unguis-cati*)

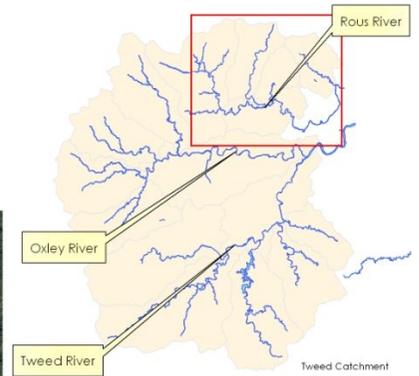
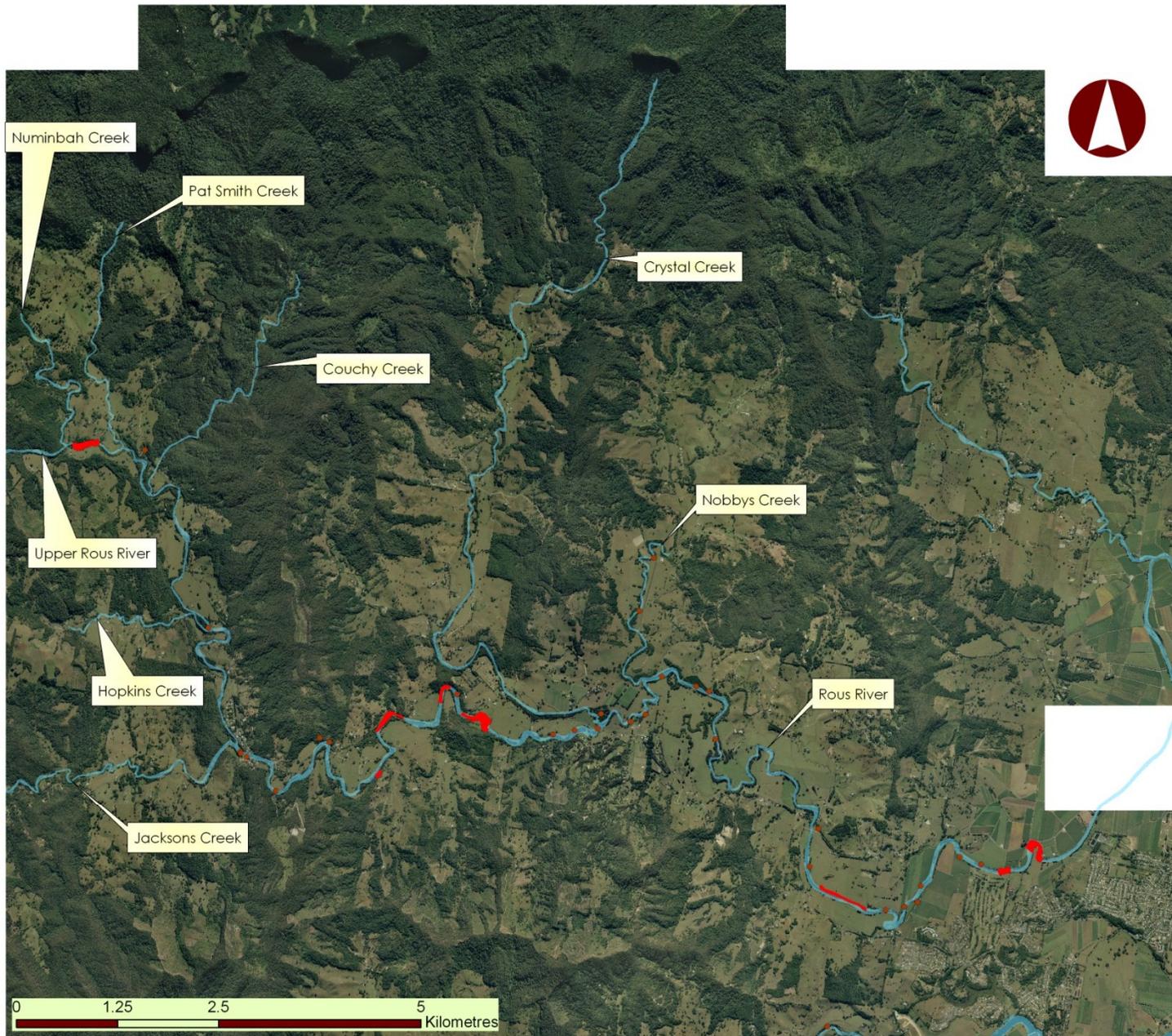
- Dense
- Moderate
- Scattered
- Cats Claw Creeper Point

Mapped Point = <20 metres in size

Aerial Photo Base From TSC
TITLE: Tweed River
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AUTHORISED: Phil Shaw (Ecosure)
DRAWING NUMBER: E35_SA5
DATE: April 2009 (REV00)



Map 10 Location of Cats Claw Creeper infestations in Study Area 5 of the Tweed Catchment



Locations of Madeira Vine (*Anredera unguis-cati*) along the Rous River within the Tweed Catchment Study Area 1

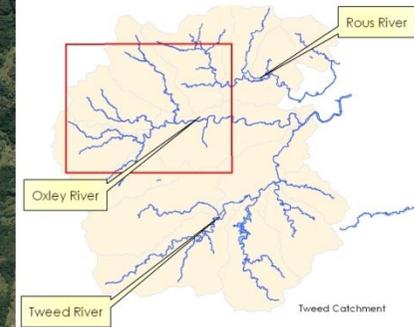
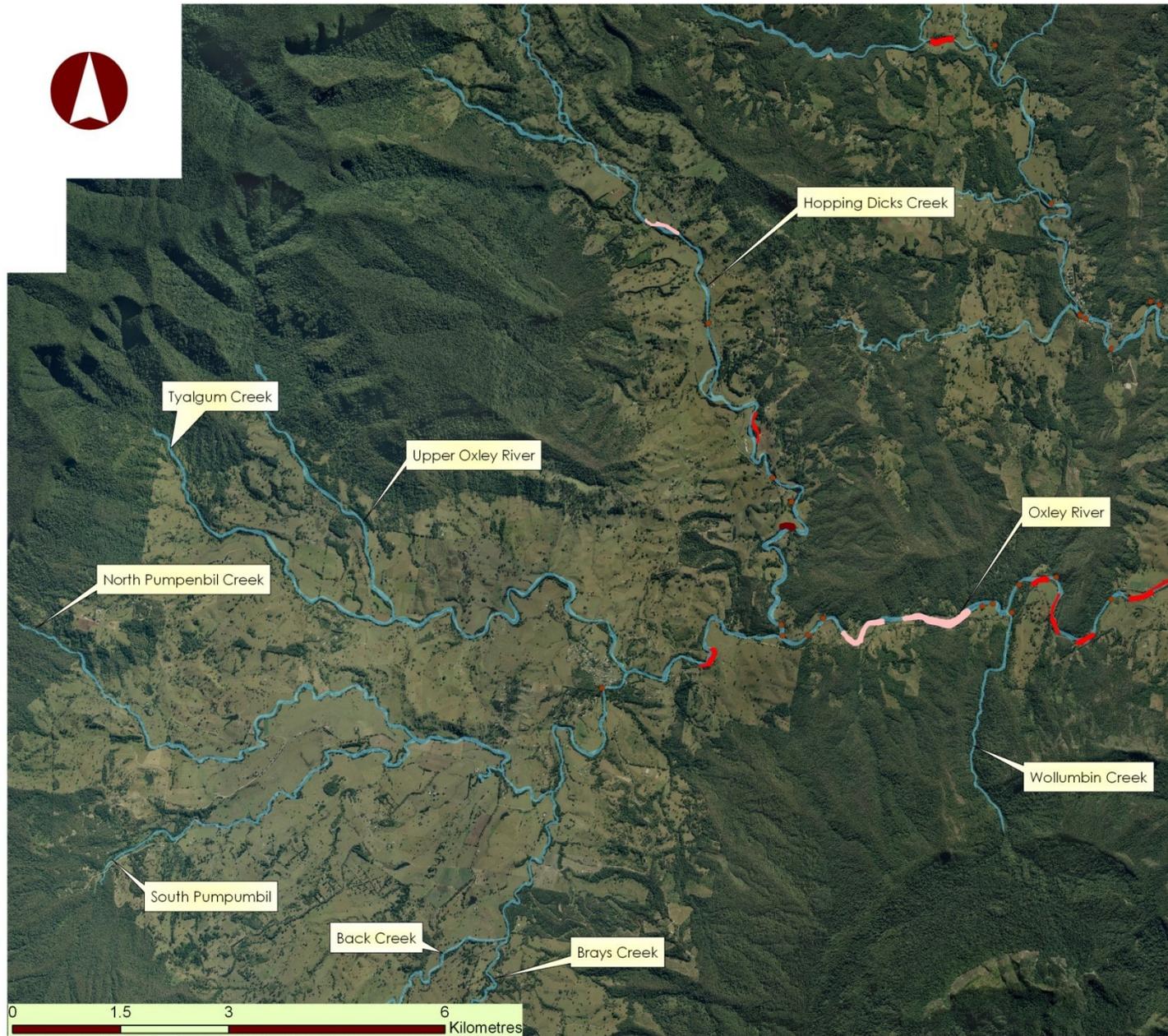
Madreira Vine (*Anredera cordifolia*)

- Dense
 - Moderate
 - Scattered
 - Madeira Vine Point
- Mapped Point = <20 metres in size

Aerial Photo From TSC
 Department of Lands NSW
 TITLE: Aerial photograph
 PREPARED BY CONSULTANTS:
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 DRAWING NUMBER: E35_ST1
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Map 11 Location of Madeira Vine infestations in Study Area 1 of the Tweed Catchment

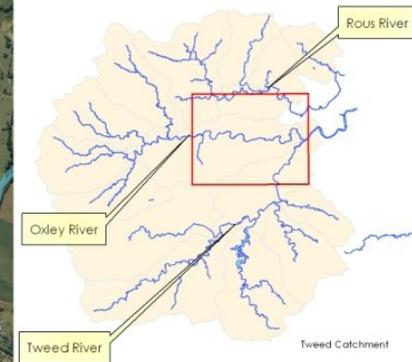
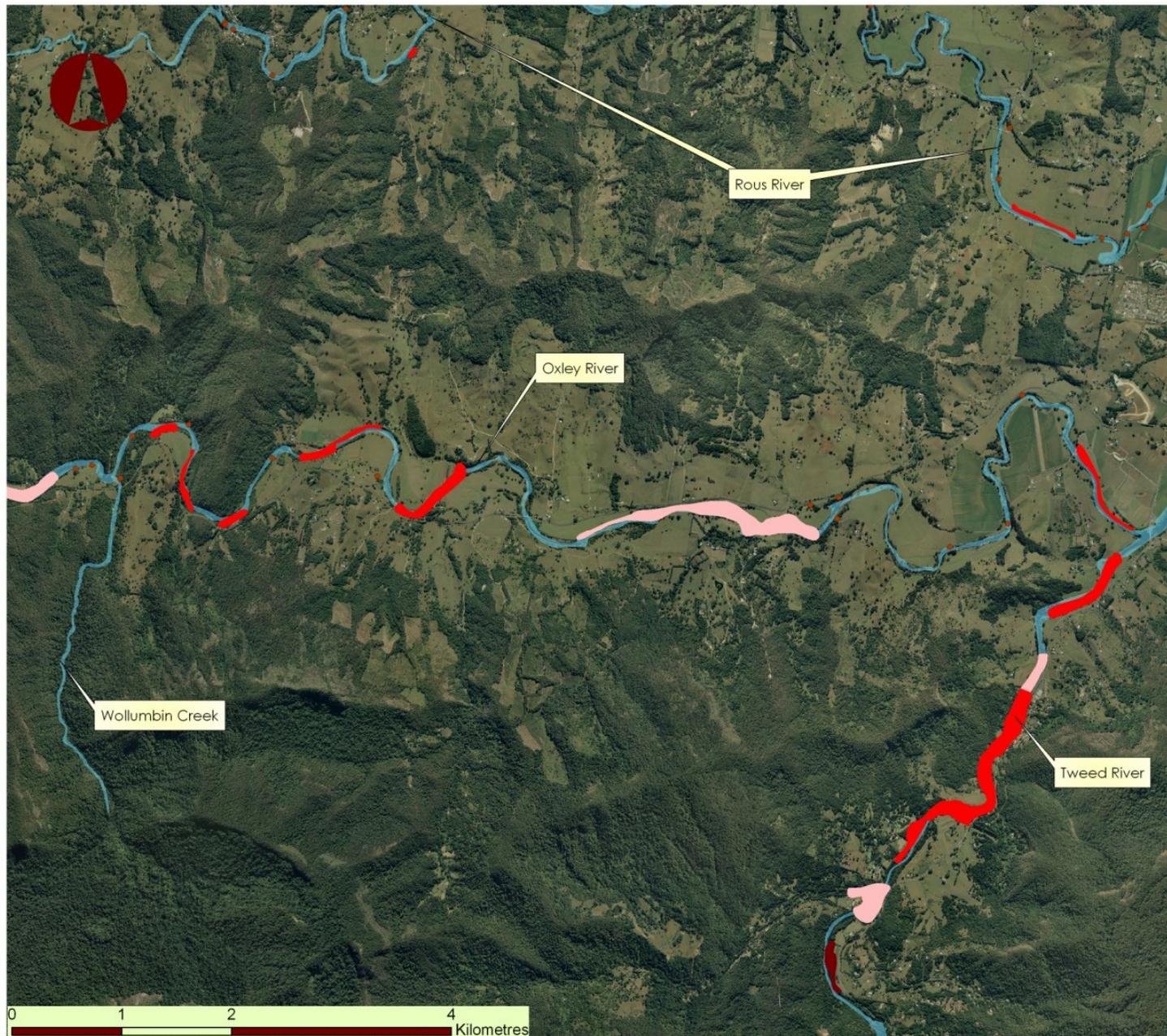


Locations of Madeira Vine (*Anredera cordifolia*) along the Tweed River within the Tweed Catchment Study Area 2

Madeira Vine (*Anredera cordifolia*)
 ■ Dense
 ■ Moderate
 ■ Scattered
 ● Madeira Points
 Mapped Point = <20 metres in size
 Aerial Photo from TSC
 Department of Lands NSW
 TITLE: Aerial photograph
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 AUTHORISED: Phil Shaw (Ecosure)
 DRAWING NUMBER: E35_SA2
 DATE: 04/2009 (REV00)



Map 12 Location of Madeira Vine infestations in Study Area 2 of the Tweed Catchment



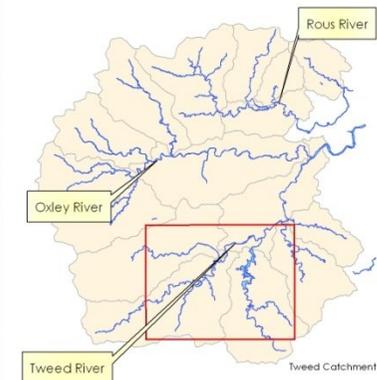
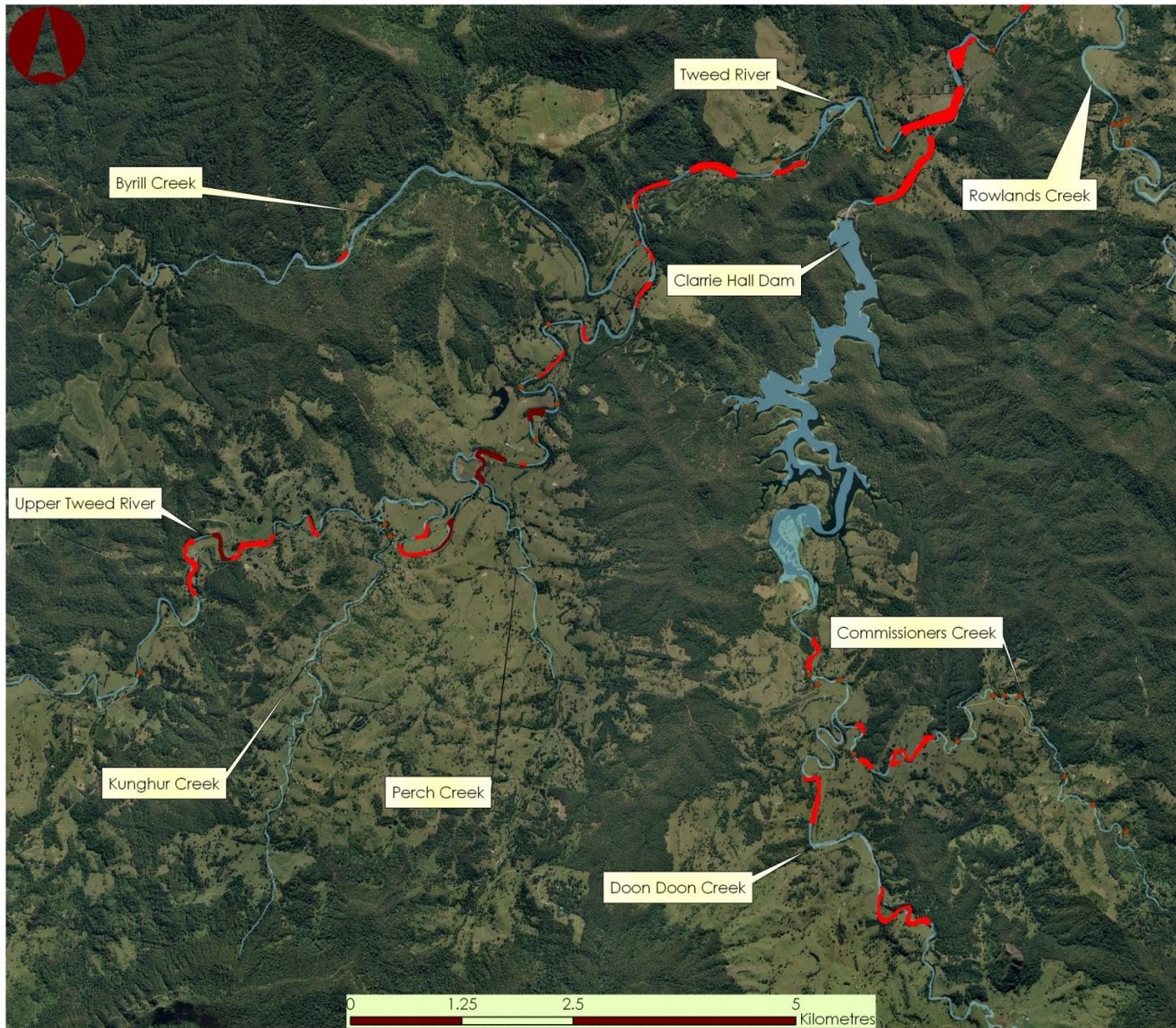
Locations of Madeira Vine (*Anredera cordifolia*) along the Oxley River within the Tweed Catchment Study Area 3

- Madeira Vine (*Anredera cordifolia*)
 ■ Dense
 ■ Moderate
 ■ Scattered
 ● Madeira Vine Points
 Mapped Point = <20 metres in size

Aerial Photo from TSC
 Department of Lands NSW
 TITLE: Aerial photograph
 PREPARED BY CONSULTANTS:
 Ecosure Pty Ltd
 AUTHORISED: Phil Shaw (Ecosure)
 DRAWING NUMBER: E35_SA3
 DATE: 04/2009 (REV00)



Map 13 Location of Madeira Vine infestations in Study Area 3 of the Tweed Catchment



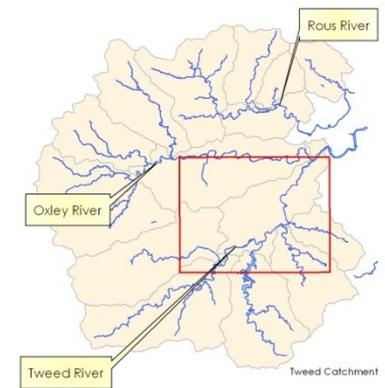
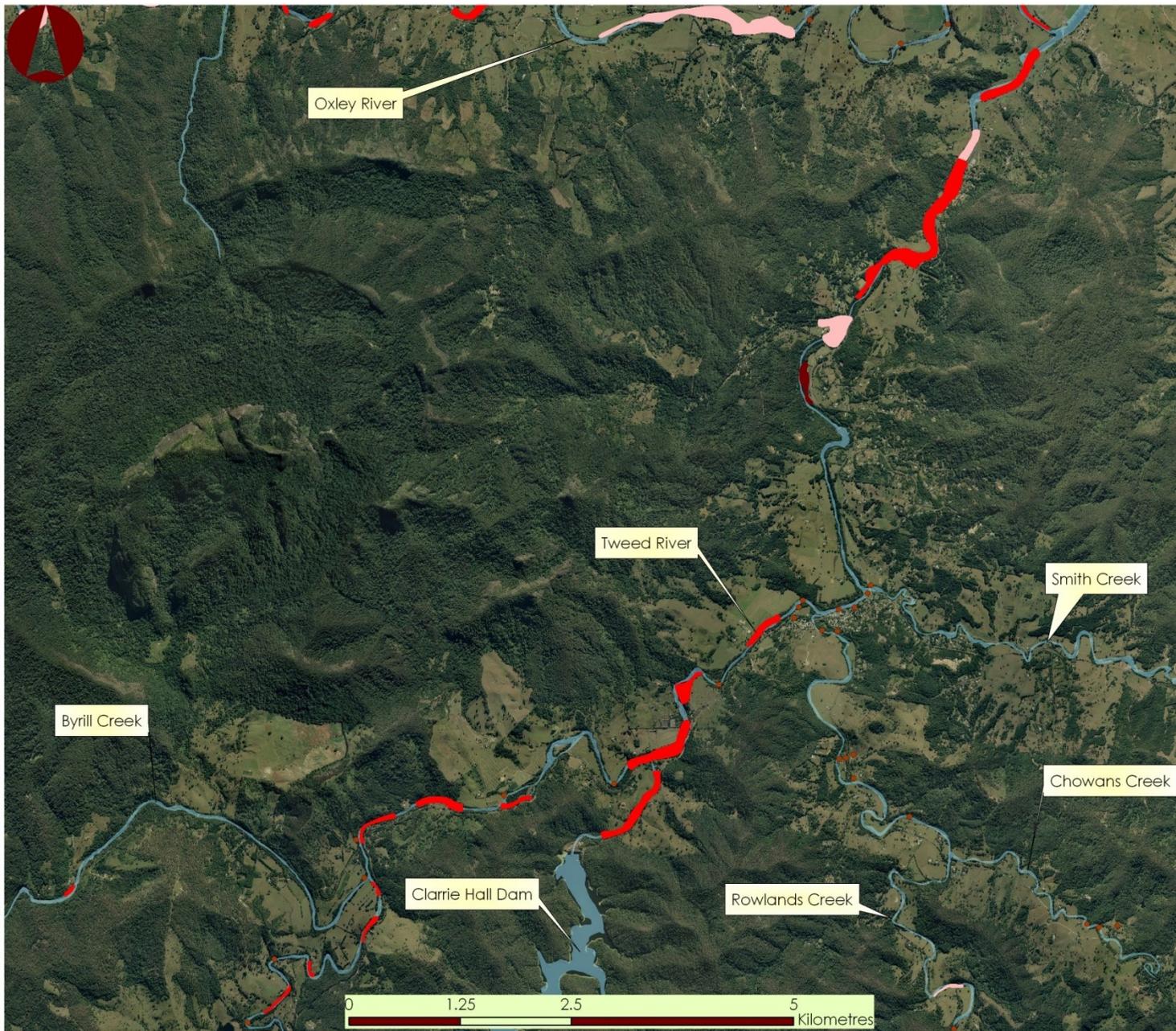
Location of Madeira Vine (*Anredera cordifolia*) along the Tweed River within the Tweed Catchment Study Area 4

Madeira Vine (*Anredera cordifolia*)
 ■ Dense
 ■ Moderate
 ■ Scattered
 ● Madeira Points
 Mapped Point = <20 metres in size

Aerial Photo Base From TSC
 TITLE: Tweed River
 PREPARED BY CONSULTANTS:
 Ecosure Pty Ltd
 AUTHORISED: Phil Shaw (Ecosure)
 DRAWING NUMBER: E35_SA4
 DATE: April 2009 (REV00)



Map 14 Location of Madeira Vine infestations in Study Area 4 of the Tweed Catchment



Location of Madeira Vine (*Anredera cordifolia*) along the Tweed River within the Tweed Catchment Study Area 5

Madeira Vine (*Anredera cordifolia*)
 ■ Dense
 ■ Moderate
 ■ Scattered
 ● Madeira Points
 Mapped Point = <20 metres in size

Aerial Photo Base From TSC
 TITLE: Tweed River
 PREPARED BY CONSULTANTS:
 Ecosure Pty Ltd
 AUTHORISED: Phil Shaw (Ecosure)
 DRAWING NUMBER: E35_SA5
 DATE: April 2009 (REV00)



Map 15 Location of Madeira Vine infestations in Study Area 5 of the Tweed Catchment

4 Discussion/Recommendations

This section provides a brief discussion on the outcomes of the project, including any limitations and recommendations.

4.1 Meeting the Aims of the project

The main aim of this project was to identify and map the locations of the target weeds within the project area to enable TSC to produce a strategic control program. The data produced during this project and this report illustrates how this aim has been met.

Specifically this project has:

- Produced a flight plan, highlighting the extent of the project area to be surveyed, which was determined by the budget. This was approved by TSC prior to commencement of the aerial surveys.
- The existing infestations of the target weeds within the project area have been surveyed and the data collected.
- The severity and spatial extent of all located infestations has been estimated and is contained with the data, plus this information has been described within Section 3 of this report.
- GIS compatible maps showing the location, extent and density of weed infestations have been prepared and are shown in Section 3 of this report.
- Digital data of the target weed's location, extent and density has been provided to TSC via the CD in Appendix A of this report.
- This report describes the methods used to map the target weeds and any limitations of the project including any potential budgetary constraints.

4.2 Distribution of the Target Weeds

Both of the target weeds are distributed throughout the three main waterways surveyed, the Oxley River, the Tweed River and the Rous River. Section 3 contains the maps showing the locations, extent and density of these weed within the project area.

The only waterways where the target weeds were not identified were tributaries to the Rous River (namely Back Creek, Worrendo Creek, Numinbah Creek, Pat Smith Creek and Couchy Creek). All others contained some level of infestation, although some only had the target weeds at the very downstream section, where it joined to the main waterways (such as Smith and Kungur Creek on the Tweed River, Wollumbin and Brays Creek on the Oxley River and Hopkins Creek on the Rous River).

4.3 Determining Accuracy

As described in our initial proposal and the flight plan (Ecosure 2008), the budget constraints did not allow sufficient ground truthing to precisely determine the accuracy of the survey methods.

To obtain quantifiable data on the accuracy of the surveying effort, at least another three days per species would have been spent on the ground; however budget constraints did not support the required effort in this case.

Eight small patches of Madeira Vine and four small patches of Cats Claw Creeper were identified on the ground that were not seen from the air. These sites were not mature infestations, with the majority of the weed's mass not having reached the canopy. This is a known limitation of aerial surveys where vines growing beneath the canopy may be shielded from aerial view. Once the target weeds become mature and reach the canopy, a majority of the flowers will be produced in the canopy and will be visible from the air. As the target for this project was to "map the location and extent of severe (predominantly canopy and in tree infestations) Madeira and Cats Claw Creeper infestations" (TSC 2008), we are confident that the aerial surveying techniques achieved this. Clearly the inclusion of target weeds in the understory may confound the accuracy estimates if we were aiming to detect all target weed locations and not just the severe infestations.

Accuracy

As TSC's initial brief was to map the severe infestations, we can determine accuracy based on the absence or presence of mature infestations located during ground truthing.

Of those points surveyed the sensitivity was 93% and 98% for Madeira Vine and Cats Claw Creeper respectively while the specificity was 88% and 100% respectively. The sensitivity measures the proportion of actual positive weed locations, which are correctly identified as such, where the specificity measures the proportion of sites determined to be free of weed infestations that were correctly identified. Together, these two calculations provide an accuracy rating for the survey method for weed mapping. The overall detection accuracy for the areas mapped was 95% and 99% for Madeira Vine and Cats Claw Creeper respectively.

As the ground truthed areas did not cover all sections of the project area, these accuracy results cannot truly reflect the whole site, but only those areas with easy access. Ideally, the extremities of the waterways should also be surveyed to ensure accuracy at all locations.

As previously mentioned, a number of small infestations in the understorey were located during the ground truth surveys, these were not taken into account when calculating the above accuracy levels as they were outside the original scope of the project. Therefore, across the project area, there is likely to be a number of smaller, under canopy infestations that have not been mapped.

4.4 Project Limitations

- One limitation for aerial surveys is the undetectability of weed populations that have not yet reached the canopy layers. Although this is a limitation, the knowledge of the mature infestation locations within the catchment is an extremely useful tool. This tool will aid in the planning and management of future weed control programs.
- The asynchronous nature of the target weeds flowering means that the surveys need to be performed over a sufficient range of the flowering period to detect all populations. If a period of the flowering range is not surveyed, this may be a factor for error and potential inaccuracy of mapping.
- Helicopters are unable to fly in bad weather conditions such as heavy rain, storms or strong wind. This can hinder the timing of surveys and cause complications if bad weather coincides with the flowering period of the weeds.
- Budget constraints restricted the survey effort to the main waterways and the larger tributaries only (as shown on Map 3). Opportunistic observations of the target weeds on smaller waterways were mapped as we flew over, but other infestations may have been missed.
- Budget constraints also restricted the ground truth survey efforts. We were only able to calculate the accuracy of the aerial mapping for the limited area that was ground truthed. However many of the waterways remain unvisited and therefore the accuracy of the mapping in these areas cannot be calculated. The results of the accuracy calculations were high for the areas ground truthed, but this accuracy can not necessarily be extrapolated to all sections of the project area.

4.5 Recommendations

We recommend further ground truthing, which can be performed by TSC staff. Priority areas for ground truthing may be selected by a correlation analysis of positive detections against elevation, rainfall and wind speed during the survey periods. The latter will depend on the resolution of the weather data available. As a rough rule of thumb it would be good to prioritise further ground truthing in areas where there are large tracts of double negatives (i.e. areas where no infestations were mapped from the air, nor seen during ground truthing). This will ensure that these areas were not considered to be vine free only because they were not in flower during the surveys. This ground truthing will enable accuracy to be determined by cross referencing information on the target weed locations gained by TSC field staff with the data presented in this report.

The TSC layers of significant areas, such as endangered ecological communities, threatened fauna species locations and conservation areas such as National Parks locations can be used to determine priority areas for treatment.

TSC could collate data on any new infestations of the target weeds, if and when they are located. The database created from the data collected during this project could be adapted to produce a 'living spreadsheet', that is updated on a regular basis to give an estimated current condition and extent of Cats Claw Creeper and Madeira Vine.

We recommend that repeat aerial surveys are performed in the future to assess the rate of spread and/or the rate of management success of the target weeds.

A comprehensive strategic plan should be developed using the outcomes of this survey to prioritise the management and control of these target weeds. TSC have indicated that they will be developing such a strategic plan.

References

Ecosure (2008) Flight Plan, Aerial mapping of riparian weeds, Report to Tweed Shire Council, Ecosure West Burleigh.

Tweed Shire Council (2008) Consultation Brief Riparian Vine Weed Aerial Mapping, Murwillumbah