1999. It is also identified as a species potentially threatened by the listed Key Threatening Process, *Invasion of native plant communities by exotic perennial grasses* (NSWSC 2003).

2.3 Historical Records

A request was made via the Virtual Herbarium (www.anbg.gov.au/avh.html) for records of *Rutidosis heterogama* within all Australian Herbaria. A total of sixteen records (13 from the National Herbarium of NSW and 3 from the National Herbarium of Victoria) were obtained, indicating that the species has been collected from central Queensland to central NSW, but with the majority of records from the far North Coast and Northern Tablelands of NSW (Figure 4). In the immediate Central Coast/Hunter Valley region, there are two old records from what are now urban Stockton and Mayfield in Newcastle, and two records from now cleared farming land in the Maitland area. One record is from the Nulkaba (Cessnock) area. All of the Central Coast/Hunter Valley records are very old (from 1908 to 1942), and all occur in now developed areas and can be presumed to be extinct. Records from the NPWS Atlas of NSW Wildlife show several reports from the far north coast and northern tablelands of NSW, and appear to be duplicates of herbarium specimens.

Figure 4: Historical records of *Rutidosis heterogama*, from herbarium collections.

3.0 Methods

3.1 Targeted Search

Based on previous experience with *Rutidosis heterogama* in the region, a list of potentially suitable habitat types and blocks of vegetation within Wyong were prepared with the aid of GIS, and the regional mapping of Wyong Shire (Bell 2002). Field assessments were then undertaken within each of these, which involved targeted meanders across the area. At all times, hand-held GPS units were used both to record the location of any plants found, and to record the routes walked at each location. Co-ordinates for both plants and routes were later downloaded into a GIS system to enable plotting of results. For the purposes of this study, there were no study area boundaries as such, although searches were restricted initially to a 5km radius around Warnervale, and ultimately within the northern Wyong-western Lake Macquarie region.

Following the same methodology, targeted searches were also undertaken in Lake Macquarie City in areas adjoining the Warnervale study area (Driscoll & Bell 2004). Both Lake Macquarie and Wyong LGAs were surveyed within the November 2003 – January 2004 flowering period. Historical record locations were also visited to determine their current status.

Brief field inspections were also made in the Cessnock area, to verify existing records and search for new populations. Separate searches were also being conducted by staff from Harper Somers O'Sullivan in and around Cessnock as part of a different project, and results obtained by them have been incorporated into the current report.

3.2 Population Counts

Detailed population counts were undertaken at most known populations within the region; some populations in the Cessnock area were brought to our attention late in the project and consequently could not be assessed in the same way. At each assessed location, the bounds of the population were located through detailed traverses, and recorded using GPS units. If populations were small, an estimate of the population was made simply by counting all plants visible. For larger populations, transects were established throughout the main body of the population, and strip transects or DISTANCE survey techniques (see Buckland *et al.* 2001) were used to estimate the size of the population. The accompanying computer software program, 'DISTANCE' (Thomas *et al.* 1998), has been designed for estimating the numbers of a particular object within a population, and which lends itself to plant species that occur erratically across an area. The model requires only that the full occupancy area of a species be delineated, and that the perpendicular distance of all individuals within sight of designated transects be recorded. Any number of transects can be established across the occupancy area, the more transects established the higher accuracy attained. To our knowledge, this program has been applied only sparingly to threatened plant studies in Australia, and may prove the most appropriate method for many rare and cryptic plant species. Bell and Driscoll (in review) provide an example of the use of this method for estimating population size in the endangered *Acacia bynoeana*. We have also used it for estimating populations of *Hibbertia procumbens* (Bell & Driscoll 2003), and are currently collaborating with the developers of the program in the UK to refine the technique for plant species showing a clustered, non-random distribution.

3.3 Habitat Assessment

Assessment of habitat at each population within the Warnervale area has been undertaken in parallel with studies in Lake Macquarie and Cessnock LGAs. Standard floristic survey plots (0.04ha in size) were placed within the bounds of each population to enable detailed floristic and habitat information to be collected, and compared with each other. Habitat types were also placed within the classifications of NPWS (2000) and Bell (2002) to ascertain the regional vegetation communities in which *Rutidosis heterogama* occurs.

4.0 Results

4.1 Targeted Search

One of the constraints of the targeted survey was that a large amount of potential habitat is in private ownership, and as such was not directly accessible. However road edges, Crown lands, fire trails, powerline easements and reserves were carefully searched, both on foot and in 4WD vehicle. Figure 5 shows the level of survey effort that has been undertaken during searches for the species in recent months, together with known extant populations. Within the region, over 400km of transects have been searched specifically for this species by the authors.

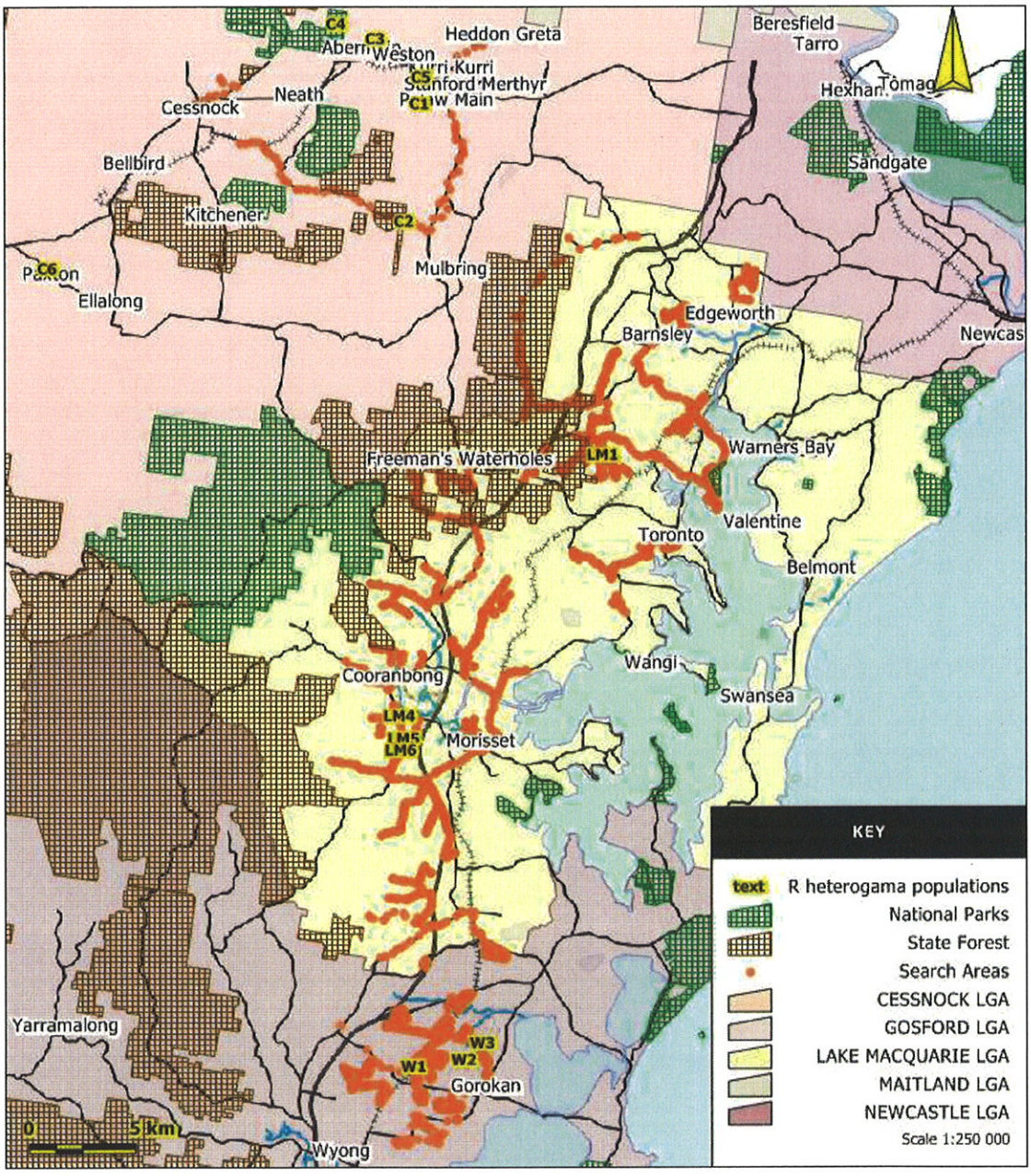

Figure 5: ***Rutidosis heterogama*** **populations (e.g. W1) and search effort.**

4.2 *Population Counts*

As a result of recent searches, several additional populations of *Rutidosis heterogama* have now been recorded within the Wyong-Lake Macquarie-Cessnock region, boosting the number of extant populations from one in 2003, to thirteen (see Figure 5 and Table 1). The locations of the three Wyong populations are shown in Figure 6.

Table 1: Locations of *Rutidosis heterogama* found during searches in Wyong, Lake Macquarie and Cessnock LGAs.

Pop. No.	Location	LGA	Pop. Ass. Method	Pop. Size	Tenure	Month
W1	Sparks Rd Warnervale	Wyong	Distance	~900	DIPNR & State Rail	Oct-03
W2	Hakone Rd Woongarrah	Wyong	Distance	~300	Private	Feb-04
W3	Arizona Rd Charmhaven	Wyong	Distance	~600	Private	Feb-04
LM1	Wakefield	Lake Macquarie	Direct count	10	Energy Australia	Nov-03
LM2	Lot 2 Deaves Rd Cooranbong	Lake Macquarie	Direct count	50	Private	Oct-03
LM3	Deaves Rd Cooranbong	Lake Macquarie	Direct count	40	Council	Jan-04
LM4	Crawford Rd Cooranbong	Lake Macquarie	Strip transect	~300	Council	Nov-03
C1	HEZ Kurri	Cessnock	Visual estimate	>20000 *	Private & NP	Sep-03
C2	Lake Rd Elrington	Cessnock	Visual estimate	~200	SF & Council	Nov-03
C3	Church St Abermain	Cessnock	Not determined **	Not deter.	Private	Mar-04
C4	Werakata NP Abermain	Cessnock	Visual estimate	1000's	NP	Mar-04
C5	Lang St Kurri	Cessnock	Not determined **	Not deter.	Crown	Mar-04
C6	Millfield Rd Paxton	Cessnock	Not determined **	Not deter.	Private	Mar-04

Notes: 'W1' = Wyong LGA population 1, etc; 'Month' indicates the month of detection; 'DIPNR' = Department of Infrastructure, Planning & Natural Resources; 'SF' = State Forest.

* = assessment made by Harper Somers O'Sullivan (2004)
** = populations which have not been assessed

Figure 6: Location of Wyong populations of *Rutidosis heterogama* (see Table 1 for further details).

4.3 Habitat Assessment

Within the regional vegetation classification of NPWS (2000), *Rutidosis heterogama* has been recorded with six vegetation map units (Table 2). Further details on floristics and the observed habitat at each of the thirteen extant populations are also presented following Table 2.

Table 2: Regional vegetation community equivalents of *Rutidosis heterogama* populations in Wyong, Lake Macquarie and Cessnock LGAs.

Pop. No.	Location	LGA	NPWS 2000 Equivalent
W1	Sparks Rd Warnervale	Wyong	Coastal Plains Smooth-barked Apple Woodland (MU30) & Coastal Foothills Spotted Gum – Ironbark Forest (MU15)
W2	Hakone Rd Woongarrah	Wyong	Coastal Plains Smooth-barked Apple Woodland (MU30)
W3	Arizona Rd Charmhaven	Wyong	Coastal Plains Scribbly Gum Woodland (regrowth) (MU31)
LM1	Wakefield	Lake Macquarie	Coastal Plains Smooth-barked Apple Woodland (MU30)
LM2	Lot 2 Deaves Rd Cooranbong	Lake Macquarie	Coastal Plains Smooth-barked Apple Woodland (MU30)
LM3	Deaves Rd Cooranbong	Lake Macquarie	Coastal Foothills Spotted Gum – Ironbark Forest (MU15)
LM4	Crawford Rd Cooranbong	Lake Macquarie	Disturbed roadside easement, probably formerly MU31
C1	HEZ Kurri	Cessnock	Lower Hunter Spotted Gum – Ironbark Forest (MU17)
C2	Lake Rd Elrington	Cessnock	Lower Hunter Spotted Gum – Ironbark Forest (MU17)
C3	Church St Abermain	Cessnock	Form of Kurri Sands Swamp Woodland (MU35)
C4	Werakata NP Abermain	Cessnock	Lower Hunter Spotted Gum – Ironbark Forest (MU17)
C5	Lang St Kurri	Cessnock	Lower Hunter Spotted Gum – Ironbark Forest (MU17) *
C6	Millfield Rd Paxton	Cessnock	Hunter Lowland Redgum Forest (MU19) *

* = information provided by M. Roderick, Harper Somers O'Sullivan

Population W1: Sparks Rd, Warnervale (Wyong LGA)

Approximately 900 plants occur in woodland dominated by *Eucalyptus capitellata, Corymbia maculata, Eucalyptus globoidea, Angophora costata,* and *Eucalyptus fibrosa,* with *Themeda australis, Xanthorrhoea latifolia, Entolasia stricta* and *Joycea pallida* dominating the ground cover (Figure 7). This vegetation type is closest to the Narrabeen Buttonderry Footslopes Forest [Unit 28 in Bell 2002], although here it is ecotonal with the Dooralong Spotted Gum – Ironbark Forest [Unit 30]. At the northern end of this population (which is broken by a small drainage line), *Rutidosis* occurs in classic Dooralong Spotted Gum – Ironbark Forest [Unit 30] habitat, with *Corymbia maculata* and *Eucalyptus fibrosa* dominating over a grassy understorey, and with occasional shrubs of *Melaleuca nodosa* and *Daviesia ulicifolia* (Figure 8).

Figure 7: Sparks Road south (Population W1)

Figure 8: Sparks Road north (Population W1)