

# NSW Threatened Species Scientific Committee

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## Conservation Assessment of *Persoonia bargoensis*

Eren Delgado<sup>1</sup> and Steve Douglas<sup>2</sup> 15/07/2020

<sup>1</sup>NSW Threatened Species Scientific Committee

<sup>2</sup>Surveys and Planning

### ***Persoonia bargoensis* P.H. Weston & L.A.S. Johnson (Proteaceae) (Bargo Geebung)**

Distribution: Endemic to NSW

Current EPBC Act Status: Vulnerable

Current NSW BC Act Status: Endangered

Proposed listing on EPBC Act: Endangered

### **Conservation Advice: *Persoonia bargoensis***

#### **Summary of Conservation Assessment**

*Persoonia bargoensis* was found to be eligible for listing as Endangered under Criterion B1ab(iii,v) +2ab(iii,v) and Criterion C2a(i).

The main reasons for this species being eligible are: i) it has a highly restricted geographic distribution; ii) the species occurs at less than five locations based on the threat posed by repeated fires and the impact of the introduced European honeybee (*Apis mellifera*) on seed set; iii) there is continuing decline in the area/extent/quality of habitat and number of mature individuals due to habitat loss and modification, adverse fire and disturbance regimes, predicted reduced fruit set due to European honeybees (*Apis mellifera*), and habitat fragmentation; and iv) it has a small number of individuals.

#### **Description and Taxonomy**

*Persoonia bargoensis* (Family Proteaceae), also known as the Bargo Geebung, is described in PlantNET (2019) as “erect shrub, young branchlets sparsely to moderately hairy. Leaves linear-lanceolate to lanceolate, 0.8–2.4 cm long, usually 1.0–2.0 mm wide, flat or convex, with recurved margins, sometimes recurved towards the tip, glabrous to sparsely hairy when immature, glabrescent when mature, smooth. Inflorescences growing on into a leafy shoot; flowers mostly subtended by leaves; pedicels 3–7 mm long, spreading to recurved, glabrous. Tepals 7–10 mm long, shortly caudate, glabrous. Ovary glabrous.”

“The Bargo Geebung superficially resembles *Persoonia nutans* of western Sydney (NSW NPWS 2000ad), but the latter mostly has lanceolate to linear-lanceolate leaves whereas the former has linear-oblong leaves” (DEE 2019).

#### **Distribution and Abundance**

The NSW Scientific Committee (2000) states that “*Persoonia bargoensis* is restricted to a small area south-west of Sydney within the area bounded by Picton, Douglas Park, Appin, Cataract River, and Yanderra”. The Bargo Geebung occurs between 100-300m above sea level (Weston and Johnson 1991).

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In absence of a full representative census, a total population size of 250-500 mature individuals is estimated with a moderate level of uncertainty based on expert's knowledge (IUCN Unpublished February 2019). McKenna (2007) tagged two sites of 208 and 85 plants of *P. bargoensis* but did not differentiate between mature plants and juveniles. Significant declines of the total population have occurred, and further declines are likely (IUCN Unpublished February 2019). Populations of this species are likely very small and scattered (IUCN Unpublished February 2019).

“Most records are outside National Park and Wildlife Service (NPWS) estate” (NSW SC 2000), and “a large portion of the species occur on road verges, indicating that the species may be dependent on a disturbance regime” (DoE 2014). For example, 26 sites occur on Road and Maritime Service (RMS) or Wollondilly Shire Council managed land (road verges), and eight sites occur on TransGrid managed land (powerline easements) that are slashed every 1–2 years (DoE 2014). A further seven sites are on private land (DoE 2014). However, too frequent disturbance potentially threatens these populations (see Threats section).

The Extent of Occurrence (EOO) of this species was estimated to be 418 km<sup>2</sup>. EOO was calculated based on a minimum convex hull polygon containing all the known sites of occurrence as recommended by IUCN (2019).

The Area of Occupancy (AOO) was estimated to be 176 km<sup>2</sup>, based on the species occupying 44 2 x 2 km grid cells, the spatial scale of assessment recommended by IUCN (2019).

## Ecology

The NSW Scientific Committee (2000) states that “*Persoonia bargoensis* grows in woodland to dry sclerophyll forest, on sandstone and clayey laterite on heavier, well-drained, loamy, gravelly soils of the Hawkesbury Sandstone and Wianamatta Shale in the catchments of the Cataract, Cordeaux and Bargo Rivers.”

*Persoonia bargoensis* flowers are hermaphroditic (Field *et al.* 2005), and the “peak of the flowering period is from December to March with each plant remaining in bloom for 10–18 days when more than 100 flowers may be open on a single plant at a given time (D. L. Field, personal observation)” (Field *et al.* 2005). “The fruit reaches maturity 7–8 months after flowering, hangs on the plant for an indefinite period and produces a single seed (Blombery and Maloney 1992)” (DoEE 2019). “The longevity of individuals of this species above ground is expected to be about 20 years” (NSW OEH 2019).

“*Persoonia bargoensis* is best surveyed when flowering in summer and autumn” (Weston and Johnson 2000) as “it can be very difficult to detect when not in flower or during the later stages of fruiting as it lacks strongly distinctive features” (Weston and Johnson 2000).

*Persoonia bargoensis* is primarily pollinated by specialist native bee *Leioproctus* species (*Colletidae*; subgenus *Cladocerapis*) (Bernhardt and Weston 1996). *Leioproctus* species “carry their pollen loose in granular masses between hair tufts ornamenting the hind legs and underside of the abdomen” (Bernhardt and Weston

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1996). “These bees may transfer *Persoonia* pollen more easily when they scrape or rub the basal portion of their hindlegs or abdomens against the stigma while searching for nectar or dehiscent anthers” (Bernhardt and Weston 1996).

However, a study by Field *et al.* (2005) observed that floral visitations to *Persoonia bargoensis* were dominated by the generalist *Apis mellifera* (Introduced European honeybee). Rymer *et al.* (2005) found the honeybee’s method of pollen collection makes effective pollination unlikely in *Persoonias*. *Apis mellifera* forages actively for pollen and its body contacts the stigma of the plant during pollen harvest or nectar consumption (Bernhardt and Weston 1996). While “*Apis mellifera* collects pollen, it moistens grains with nectar and transfers them to corbiculae on the hindlegs moulding them into damp pellets” (Bernhardt and Weston 1996). “The sugar in the nectar will cause the grains to hydrate early so they will lose viability in transfer” (Bernhardt and Weston 1996). *Apis mellifera* and *Trigona carbonaria* are the only insects observed to use this method (Bernhardt and Weston 1996). “The effectiveness of *Apis mellifera* as a pollinator of *Persoonia* would appear to depend on the quantity of grains that adhere to the bee’s head and thorax but miss the combing process and transfer to the corbiculae” (Bernhardt and Weston 1996).

Field *et al.* (2005) studied the effects of local *Persoonia bargoensis* plant density on pollinators (including *Leioproctus* species and *Apis mellifera*). They reported that when local plant density varies within populations it is likely to influence the quantity and effectiveness of pollinator activity and consequently the reproductive output of plants. The proportion of flower visitations within-plant ranged from 7% in the highest density environment to 22% in the lowest local density environment, and this proportion decreased significantly as the number of flowers within the local environment increased (Field *et al.* 2005). “Pollinators are likely to be less disposed to cross between plants when the local environment has a lower density of flowers, because it would be more efficient to forage more flowers within a plant before moving the greater distances to the next plant” (Field *et al.* 2005). In addition, Rymer *et al.* (2005) noted that native bees (*Leioproctus* species) visited less *Persoonia* flowers within a single plant and moved greater distances between plants of the same population while foraging than did the introduced European honeybee (*Apis mellifera*). Therefore, “native bees are expected to be more effective in promoting outcrossing” (Rymer *et al.* 2005).

Field *et al.* (2015) reported that *Persoonia bargoensis* is self-compatible but that this species is more effectively pollinated by outcrossing. They showed that outcrossed flowers had a higher number of pollen tubes than self-crossed ones, with less abnormal development.

*Persoonia bargoensis* fruits are known to be “dispersed by large birds like Currawongs, and possibly dispersed by large mammals” such as wallabies, kangaroos, possums, etc (Benson and McDougall 2000). “The fruit is consumed, and the seed is deposited away from the parent” (Rymer *et al.* 2005).

*Persoonia bargoensis* is a fire-sensitive obligate seeder with adult plants killed by fire and recruitment occurring from a soil stored seed bank (DoEE 2019), and it is likely to have a persistent seed bank (Auld *et al.* 2000, 2007). In *Persoonias*, seed banks

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can take approximately 10 years to replenish after disturbance and there are records of seed dormancy of up to 20 years (NSW DEC 2007). The seeds germinate in response to fire (Weston and Johnson 2000; NSW DEC 2007), however, to allow for seed production and replenishment of seed bank reserves, *Persoonia bargoensis* appears to need a minimum inter-fire interval of 10-15 years (Weston and Johnson 2000; NSW TSSC 2000). For *Persoonia bargoensis*, consultation with experts indicates that generation length is between 10-20 (even 25) years. This is based on the estimated long-term fire regime in the species' habitat and response to fire (P. Weston and T. Auld pers. comm. February 2019).

### *Fire history*

Based on the NPWS fire history (SEED 2019) there have been several events (Table 1) that impacted the species throughout its distribution (see also Appendix 2 for maps showing the extent of fires);

<b>Year</b>	<b>Fire name/ID</b>	<b>Fire type</b>	<b>Sites</b>
1968-69	Metropolitan	Wildfire	South Tahmoor through Bargo and south Pheasants Nest
1968-69	Warragamba	Wildfire	Southwest Tahmoor, northwest Bargo
1974-75	Metropolitan	Prescribed burn	South Appin
1977-78	2489	Wildfire	Southwest Tahmoor, northwest Bargo
1978-79	Metropolitan	Prescribed burn	Southeast Bargo
1980-81	2793	Wildfire	West Pheasant Nest, south Wilton
1981-82	21390	Prescribed burn	Southeast Bargo
1983-84	21712	Prescribed burn	South Appin
1984-85	3246	Wildfire	South Appin, south Douglas Park, through Wilton, northeast Pheasant Nest
1984-85	3249	Wildfire	North Appin
1984-85	21773	Prescribed burn	South Appin
1993-94	22708	Prescribed burn	Southeast Bargo
1994-95	4893	Wildfire	South Appin
2001-02	5978	Wildfire	West Picton, southwest Tahmoor, west Bargo
2002-03	Bellambi west	Wildfire	South Douglas Park, southwest Appin

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2003-04	Condell Park	Wildfire	South Douglas Park
2013-14	Hall Road Balmoral	Wildfire	Through Bargo, through Pheasant Nest, south Wilton, southwest Appin.
2019-20	Burnt areas from 1 July 2019 – 9 March 2020	Wildfire	Southwest Tahmoor though west Bargo and north Yanderra

Table 1 Records of fires impacting on sites occupied by *P. bargoensis*.

## Threats

### *Habitat Loss and Fragmentation*

The populations of *Personia bargoensis* have become progressively smaller and more isolated as ongoing habitat destruction and modification (primarily by rural and rural-residential activities and by road and rail corridors) has significantly fragmented this species' range (Weston and Johnson 2000). This has also disrupted the capacity for effective pollen and seed dispersal between remnant patches of habitat containing *P. bargoensis* (Weston and Johnson 2000; Rymer *et al.* 2005). Very small populations and fragmented distribution increase the likelihood of inbreeding depression, reproductive failure and make the species more vulnerable to stochastic events, hence increasing the probability of extinction (Rymer *et al.* 2005).

### *Introduction of Apis mellifera (European Honeybee)*

*Apis mellifera* was introduced to Australia in the 1820s to provide honey and pollination of certain agricultural crops but it escaped to the wild and became established as a feral species (Pyke 1999).

*Apis mellifera* are often abundant at flowers and often remove or utilize high proportions of nectar/pollen (Pyke 1999). It is likely that some plant species that are visited by *Apis mellifera* will experience pollination that differs in nature and/or degree from natural pollination and that this will result in changes to the relative abundances of different plant species (Pyke 1999).

*Apis mellifera* is a generalist pollinator that harvests floral resources from numerous flowering plants in many cases without pollinating them (Paton 1997). Rymer *et al.* (2005) found that in obligate outcrossing *Personia* species, *Apis mellifera* pollination is likely to result in reduced reproductive success relative to native bees as *A. mellifera* generally visited flowers within the same plant increasing self-pollen loads and reducing seed production.

### *Adverse fire regime*

High frequency fire is a threat that occurs in all fire-prone habitats in NSW, especially in the coastal and tableland habitats and adjacent to urban/rural areas (SOS 2019), where hazard reduction burning (prescribed burning) is applied to reduce fuel build up and minimise damage to life and property. *Personia bargoensis* is confined to these habitats and too frequent fire in this obligate seeder would reduce population sizes and plant densities, diminish or exhaust seed banks, and may even lead to localised extinctions (Rymer *et al.* 2005). Fire intervals of less than 10-15 years are likely to be too short to allow adequate time to replenish the soil seed bank to maintain

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the population through the next fire, thus leading to a decline in the population (Weston and Johnson 2000; NSW TSSC 2000). Therefore, recurrent burning at or below the minimum threshold is likely to lead to a critical decline.

The extensive fires during 2019/2020 are estimated to have burnt up to one third of the habitat of *P. bargoensis* (Gallagher 2020). Auld *et al.* (2020) found that the species was at risk from having a large proportion of known sites with immature plants recovering from recent fires (including the 2019/2020 fires) and hence threatened by another fire occurring before plants had matured and adequately replenishing their soil seed banks.

### *Track maintenance (adverse disturbance regime)*

Many individuals of this species occur on road verges indicating that the species may respond to disturbance (DoE 2014). However, too frequent disturbance by track maintenance and slashing is likely to prevent recruiting plants from maturing and replenishing the soil seed bank (Weston and Johnson 2000).

### *Climate change*

*Persoonia bargoensis* is likely to be threatened by climate change as it has a small distribution, it occurs in an increasingly fragmented landscape and it has reproductive constraints (i.e. specific pollinator, suffers nectar theft and reduced effective pollination from European honeybees). Butt and Gallagher (2018) assessed *Persoonia bargoensis* as having the highest level of vulnerability to the effects of climate change. McKenna (2007) noted that “rare *Persoonia* are less able to buffer the effects of drought by maintaining consistent survival. There are also potential detrimental effects on pollinators under climate change (i.e. altered flower, nectar, and pollen production due to warming) and seed vectors (Weston and Johnson 2000; McKenna 2007; Steffen *et al.* 2009).

### *Diseases*

There are no current data on the sensitivity of *Persoonia bargoensis* to infection by *Phytophthora cinnamomi*, however many other *Persoonia* species are known to be killed following infection by this pathogen (DoE 2014). Infection of native plants by *Phytophthora cinnamomi* is listed as a Key Threatening Process and NSW SC (2003) lists *Persoonia bargoensis* as occurring in the vicinity of infestations or in habitat vulnerable to it and indicates that it “may be adversely affected either because of direct infestation or degradation of habitat”. Metabolic stresses associated with increasing temperatures and decreased rainfall may make the species more vulnerable to pests and disease, including Cinnamon Fungus.

## **Assessment against IUCN Red List criteria**

For this assessment it is considered that the survey of *Persoonia bargoensis* has been adequate and there is sufficient scientific evidence to support the listing outcome.

### *Criterion A Population Size reduction*

**Assessment Outcome:** Data Deficient

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Justification: To be listed as threatened under Criterion A, the species must have experienced a population reduction of at least  $\geq 30\%$  over three generations or 10 years (whichever is longer).

## *Generation length*

Generation length is estimated to be 10-20(25) years (P. Weston and T. Auld pers. comm. February 2019). Therefore, three generations are 30-60(75) years.

## *Reduction*

It is likely that *Persoonia bargoensis* has undergone population decline and is still in decline. However, there are no census data available to quantify any reduction.

## *Criterion B Geographic range*

Assessment Outcome: Endangered under Criterion B1ab(iii,v)+2ab(iii,v)

Justification: *Persoonia bargoensis* is endemic to a restricted area in NSW. The Extent of Occurrence (EOO) is estimated to be 418 km<sup>2</sup>, based on a minimum convex hull polygon containing all the known sites of occurrence as recommended by IUCN (2019). A species with an EOO of less than 5,000 km<sup>2</sup> qualifies for the Endangered threshold.

The Area of Occupancy (AOO) of *P. bargoensis* is estimated to be 176 km<sup>2</sup> based on 2 x 2 km grid cells as recommended by IUCN (2019). A species with an AOO of less than 500 km<sup>2</sup> qualifies for the Endangered threshold.

In addition to these thresholds, at least two of three other conditions must be met. These conditions are:

- a) The population or habitat is observed or inferred to be severely fragmented or there is 1 (CR),  $\leq 5$  (EN) or  $\leq 10$  (VU) locations.

Assessment Outcome: sub criterion met at the Endangered threshold (less than five locations).

Justification: Location: *Persoonia bargoensis* occurs at less than five locations, as defined by the most plausible threat/s – adverse repeated fires (wildfires and prescribed burns) combined with reduced seed set due to introduced *Apis mellifera* (European Honeybee).

## *Frequent fire*

Fire at less than 10-15 year intervals may result in a reduction of the population size and plant density, decline in the seed bank and possible localised extinction as there is not enough time between fires for plants to replenish the soil seed bank sufficiently to maintain a sustainable population.

Known sites of *Persoonia bargoensis* are located within areas that have been subject to repeated fires (wildfires and prescribed burns) at frequencies of less than the recommended minimum inter-fire period of 10-15 years (SEED 2019):

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- Tahmoor (south), Bargo, Pheasants Nest, and Wilton (west): 2x 1968-69, 1977-78, 1981-82, 1993-94, 2001-02, 2013-14 and 2019-20.
- Wilton (east), Douglas Park (south), and Appin (west): 1980-81, 1984-85, 1993-95, 2 x 2002-03 and 2013-04.
- Appin: 1974-75, 1983-84, 2 x 1984-85 and 1994-95.

## *Introduction of European Honeybee (Apis mellifera)*

Poor reproductive success of *Persoonia bargoensis* is thought to be associated with low pollinator effectiveness as flower visitations are dominated by *Apis mellifera* (introduced European honeybees) as has been shown in other *Persoonia* species (Rymer *et al.* 2005). This is likely to lead to reductions in the magnitude of the soil seed bank and in the species' ability to buffer against the impacts of frequent fire.

The combined effect of frequent fire and reduced seed set represents a form of 'interval squeeze' (*sensu* Enright *et al.* 2015) where the fire frequency interval that permits persistence of the species is narrowed. This is particularly an issue when climate warming affects the likelihood of fire in the near future. Consequently, *Persoonia bargoensis* is considered to occur at less than five locations (see Appendix 3 – map with locations).

## *Severe Fragmentation*

There is currently no evidence that *Persoonia bargoensis* is severely fragmented, however, long term viability of populations is unknown.

- b) Continuing decline observed, estimated, inferred or projected in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent and/or quality of habitat; (iv) number of locations or subpopulations; (v) number of mature individuals

Assessment Outcome: sub criterion met for (iii), (v).

Justification: A continuing decline is observed, estimated and predicted in the following;

iii) area, extent and/or quality of habitat: The habitat of this species has been significantly cleared, modified and fragmented by urban and rural-residential developments and there is ongoing loss of habitat.

v) number of mature individuals: Individuals of *Persoonia bargoensis* are adversely impacted by habitat loss, adverse fire regime, inappropriate disturbance regime (road work maintenance and slashing), off road vehicles, grazing and other farming activities, pollination disruption by *Apis mellifera*, and predicted modifications to rainfall and fire frequency expected under climate change.

- c) Extreme fluctuations.

Assessment Outcome: sub criterion not met



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Justification: There is no evidence of extreme fluctuations in abundance or distribution of *Persoonia bargoensis*.

## *Criterion C Small population size and decline*

Assessment Outcome: Endangered under criterion C2a(i)

Justification: A species with less than 2,500 mature individuals meets the threshold for Endangered. The total population size of *Persoonia bargoensis* is estimated to be 250-500 mature individuals with a moderate level of uncertainty based on experts' knowledge (IUCN Unpublished February 2019).

At least one of two additional conditions must be met. These are:

- C1. An observed, estimated or projected continuing decline of at least: 25% in 3 years or 1 generation (whichever is longer) (CE); 20% in 5 years or 2 generations (whichever is longer) (EN); or 10% in 10 years or 3 generations (whichever is longer) (VU).

Assessment Outcome: data deficient.

Justification: *Persoonia bargoensis* has had declines of the total population and is still in decline. However, there are no census data available to quantify any decline.

- C2. An observed, estimated, projected or inferred continuing decline in number of mature individuals.

Assessment Outcome: sub criterion met.

Justification: A continuing decline is inferred and projected as individuals of *Persoonia bargoensis* are adversely impacted by habitat loss, inappropriate fire regime, inappropriate disturbance regime (road work maintenance and slashing), off road vehicles, grazing and other farming activities, pollination disruption by European honeybee and predicted modifications to rainfall and fire frequency expected under climate change.

In addition, at least 1 of the following 3 conditions:

- a (i). Number of mature individuals in each subpopulation  $\leq 50$  (CR);  $\leq 250$  (EN) or  $\leq 1000$  (VU).

Assessment Outcome: met at endangered threshold.

Justification: Most populations are very small with the largest thought to be in the order of 300 plants, including juveniles.

- a (ii). % of mature individuals in one subpopulation is 90-100% (CR); 95-100% (EN) or 100% (VU)

Assessment Outcome: sub criterion not met.

Justification: No populations are thought to contain 90-100% of the mature individuals.

- b. Extreme fluctuations in the number of mature individuals

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Assessment Outcome: sub criterion not met

Justification: There is no evidence of extreme fluctuations in the number of mature individuals of *Persoonia bargoensis*.

*Criterion D Very small or restricted population*

Assessment Outcome: Vulnerable under Criterion D1.

Justification: A species with less than 1,000 mature individuals meets the threshold for Vulnerable. The total population size of *Persoonia bargoensis* is estimated to be 250-500 mature individuals with a moderate level of uncertainty based on expert's knowledge.

*Criterion E Quantitative Analysis*

Assessment Outcome: Data Deficient

Justification: There is insufficient data available for *Persoonia bargoensis* to estimate the risk of extinction under this criterion.

## **Conservation and Management Actions**

There is a NSW Saving our Species program (SOS 2018) and a Commonwealth Conservation Advice (DoE 2014) for this species.

### Habitat loss, disturbance and modification

- Following burning, protect populations (where possible) from further fires until the majority of plants have reached reproductive maturity and effectively replenished their soil seed banks (likely to be 10-15 years post-fire).
- Ensure there is no detrimental disturbance in areas where *Persoonia bargoensis* occurs, excluding necessary actions to manage the conservation of the species.

### Invasive species

- Develop and implement a livestock management plan for roadside verges.
- If livestock grazing occurs in the area, ensure land owners/managers use an appropriate management regime and density that does not detrimentally affect this species.

### Ex situ conservation

- Establish an *ex-situ* seed bank collection with genetic representation from across the full distribution of the species.

### Stakeholder Management

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- Inform land owners and managers of sites where there are known populations and consult with these groups regarding options for conservation management and protection of the species.
- Ensure that personnel involved in planning and undertaking hazard reduction burns are able to identify the species and are aware of its habitat and the requirement not to burn the species or its habitat too frequently (minimum free-fire interval is 10-15 years).
- Where appropriate, erect on-site markers to alert maintenance staff and road users to the presence of this species.
- Ensure protection measures occur for populations across the range of the species.
- Raise awareness of *Persoonia bargoensis* within the local community.
- Land management consultation: ensure land management is sympathetic to the long-term requirements of the species; reduce the risk of adverse fire at the site; minimise accidental damage on road/track edges.
- Ensure mature adults are not burned more frequently than 10-15 years. Liaise with NSW Rural Fire Services (RFS) to ensure that the species requirements are met across the site, excluding tagged individuals in all burns and/or pre-burn lashing/disturbance activities.

## Survey and Monitoring priorities

- Monitoring for increased habitat degradation/condition.
- Monitor populations for the impact of European Honeybees (*Apis mellifera*) and Cinnamon Fungus (*Phytophthora cinnamomi*).
- Undertake survey work in suitable habitat and potential habitat to locate additional populations.
- Monitor known populations to identify key threats at each site.
- Monitor the effectiveness of all management actions and the need to adapt them if necessary.
- Monitor disturbance impacts, minimise accidental damage along road/track edges.
- Monitor population abundance, growth, survival and plant fecundity.
- At known sites, monitor for any recruitment, particularly immediately post fire (or other disturbance) and subsequently every six months for three years.

## Information and Research priorities

- Undertake seed germination and/or vegetation propagation trials to determine the requirements for successful establishment.
- Identify, time to fire flowering post-fire, time to peak reproduction, time to replenish soil seed bank (vegetative regrowth and/or seed germination).

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Identify the relationship between density of soil seed banks and aboveground vegetation.

- Identify optimal fire regimes for regeneration, including potential impacts of fire severity and season.
- Undertake genetic analysis to:
  - Assess current gene flow using markers and analyses capable of distinguishing population divergence on an evolutionary timescale, from that which might be due to more recent impacts.
  - Identify populations with low genetic diversity that might benefit from the introduction of genetic material from other populations from which they have relatively recently diverged.
- Investigate formal conservation arrangements, management agreements and covenants on private land, and for crown and private land investigate and/or secure inclusion in reserve tenure if possible.
- Determine the susceptibility of *Persoonia bargoensis* from outbreaks of dieback caused by to *Phytophthora cinnamomi*.
- Investigate options for linking, enhancing or establishing additional populations.
- Implement national translocation protocols (Commander *et al.* 2018) if establishing additional populations or enhancement of existing populations is considered necessary and feasible.

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## Expert Communications

Peter Weston, Royal Botanical Gardens, Sydney

Tony Auld, Department of Primary, Industries and Environment

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## Appendix 1

### Assessment against NSW *Biodiversity Conservation Act* criteria

#### Overall Assessment Outcome:

*Persoonia bargoensis* was found to be eligible for listing as Endangered under Clause 4.3 (b)(d)(e)(i)(iii), Clause 4.4 (b)(e)(i)(ii)(A)(II) as well as Vulnerable under 4.5 (c).

Clause 4.2 – Reduction in population size of species

(Equivalent to IUCN criterion A)

Assessment Outcome: Data Deficient.

<b>(1) - The species has undergone or is likely to undergo within a time frame appropriate to the life cycle and habitat characteristics of the taxon:</b>			
	(a)	<del>for critically endangered species</del>	a very large reduction in population size, or
	(b)	for endangered species	a large reduction in population size, or
	(c)	for vulnerable species	a moderate reduction in population size
<b>(2) - The determination of that criteria is to be based on any of the following:</b>			
	(a)	<del>direct observation,</del>	
	(b)	<del>an index of abundance appropriate to the taxon,</del>	
	(c)	<del>a decline in the geographic distribution or habitat quality,</del>	
	(d)	<del>the actual or potential levels of exploitation of the species,</del>	
	(e)	<del>the effects of introduced taxa, hybridisation, pathogens, pollutants, competitors or parasites.</del>	

Clause 4.3 - Restricted geographic distribution of species and other conditions

(Equivalent to IUCN criterion B)

Assessment Outcome: Endangered.

<b>The geographic distribution of the species is:</b>			
	(a)	<del>for critically endangered species</del>	very highly restricted, or
	(b)	for endangered species	highly restricted, or
	(c)	for vulnerable species	moderately restricted,
<b>and at least 2 of the following 3 conditions apply:</b>			
	(d)	the population or habitat of the species is severely fragmented or nearly all the mature individuals of the species occur within a small number of locations,	
	(e)	there is a projected or continuing decline in any of the following:	
		(i)	an index of abundance appropriate to the taxon,
		(ii)	<del>the geographic distribution of the species,</del>
		(iii)	habitat area, extent or quality,
		(iv)	<del>the number of locations in which the species occurs or of populations of the species,</del>

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	(f)	<del>extreme fluctuations occur in any of the following:</del>	
		(i)	<del>an index of abundance appropriate to the taxon,</del>
		(ii)	<del>the geographic distribution of the species,</del>
		(iii)	<del>the number of locations in which the species occur or of populations of the species.</del>

Clause 4.4 - Low numbers of mature individuals of species and other conditions  
(Equivalent to IUCN criterion Clause C)  
Assessment Outcome: Endangered.

<b>The estimated total number of mature individuals of the species is:</b>			
	(a)	<del>for critically endangered species</del>	<del>very low, or</del>
	(b)	<del>for endangered species</del>	<del>low, or</del>
	(c)	<del>for vulnerable species</del>	<del>moderately low</del>
<b>and either of the following 2 conditions apply:</b>			
	(d)	a continuing decline in the number of mature individuals that is (according to an index of abundance appropriate to the species):	
		(i)	<del>for critically endangered species</del> very large, or
		(ii)	<del>for endangered species</del> large, or
		(iii)	<del>for vulnerable species</del> moderate
	(e)	both of the following apply:	
		(i)	a continuing decline in the number of mature individuals (according to an index of abundance appropriate to the species), and
		(ii)	at least one of the following applies:
		(A)	the number of individuals in each population of the species is:
			(I) <del>for critically endangered species</del> extremely low, or
			(II) <del>for endangered species</del> very low, or
			(III) <del>for vulnerable species</del> low
		(B)	<del>all or nearly all mature individuals of the species occur within one population,</del>
		(C)	<del>extreme fluctuations occur in an index of abundance appropriate to the species.</del>

Clause 4.5 - Low total numbers of mature individuals of species  
(Equivalent to IUCN criterion D)  
Assessment Outcome: Vulnerable.

<b>The total number of mature individuals of the species is:</b>			
	(a)	<del>for critically endangered species</del>	<del>extremely low, or</del>
	(b)	<del>for endangered species</del>	<del>very low, or</del>
	(c)	<del>for vulnerable species</del>	<del>low.</del>



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Clause 4.6 - Quantitative analysis of extinction probability  
(Equivalent to IUCN criterion E)  
Assessment Outcome: Clause not met.

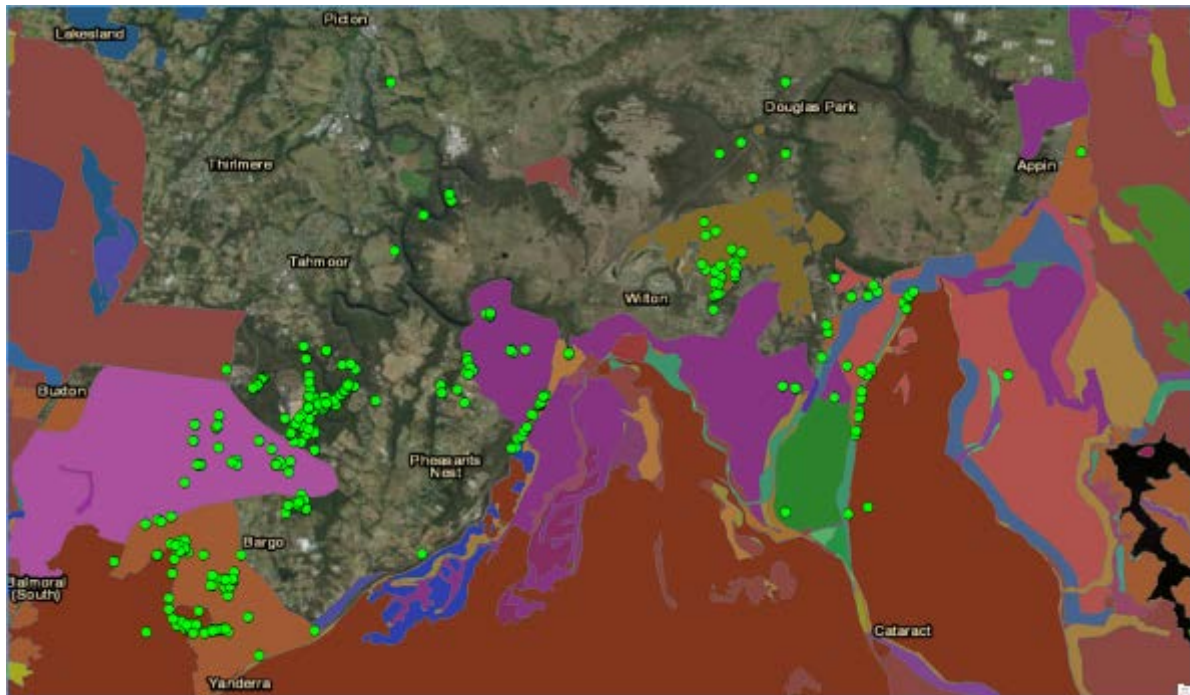
The probability of extinction of the species is estimated to be:			
	(a)	for critically endangered species	extremely high, or
	(b)	for endangered species	very high, or
	(c)	for vulnerable species	high

Clause 4.7 - Very highly restricted geographic distribution of species  
(Equivalent to IUCN criterion D2)  
Assessment Outcome: Clause not met

For *vulnerable species*, the geographic distribution of the species or the number of locations of the species is very highly restricted such that the species is prone to the effects of human activities or stochastic events within a very short time period.

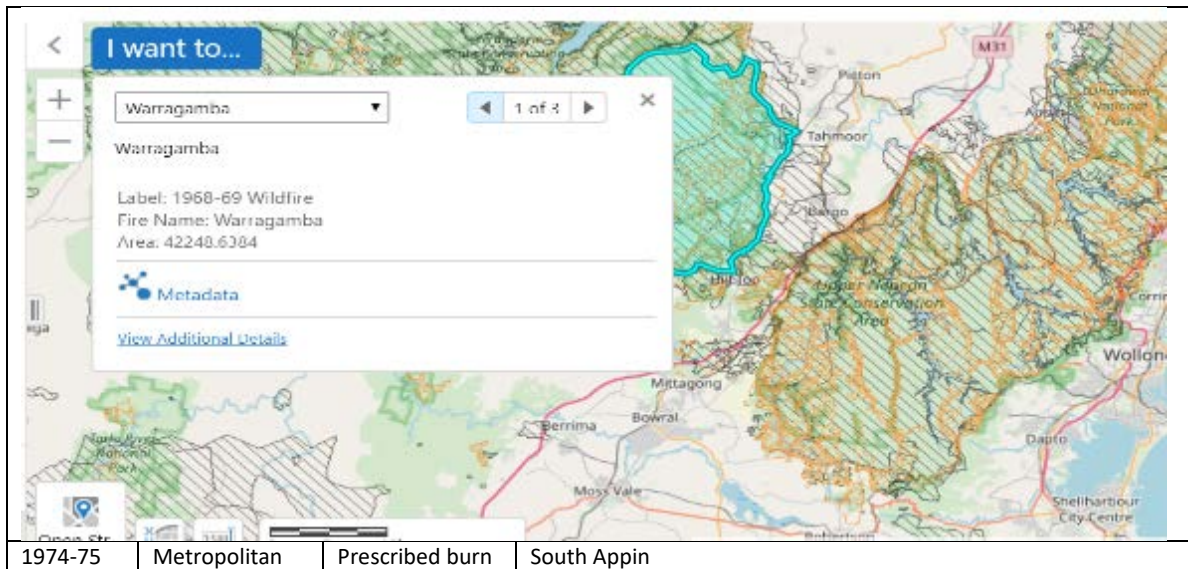
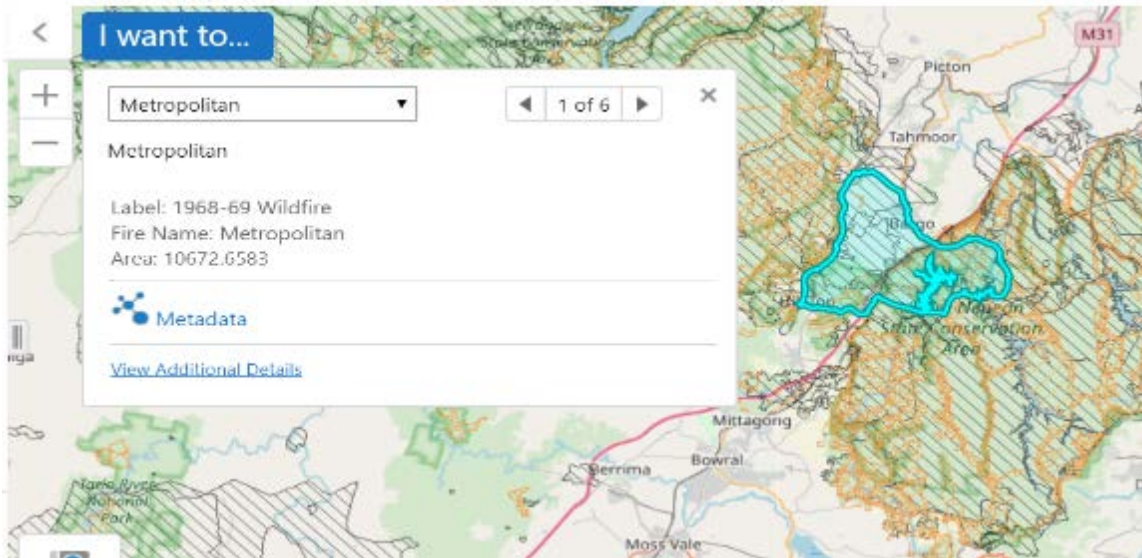
## Appendix 2 NPWS Fire History – Wildfires and Prescribed Burns

Distribution of *Personia bargoensis* – NPWS Fire History (not all fires are included in this layer) (OEH Corporate layer)

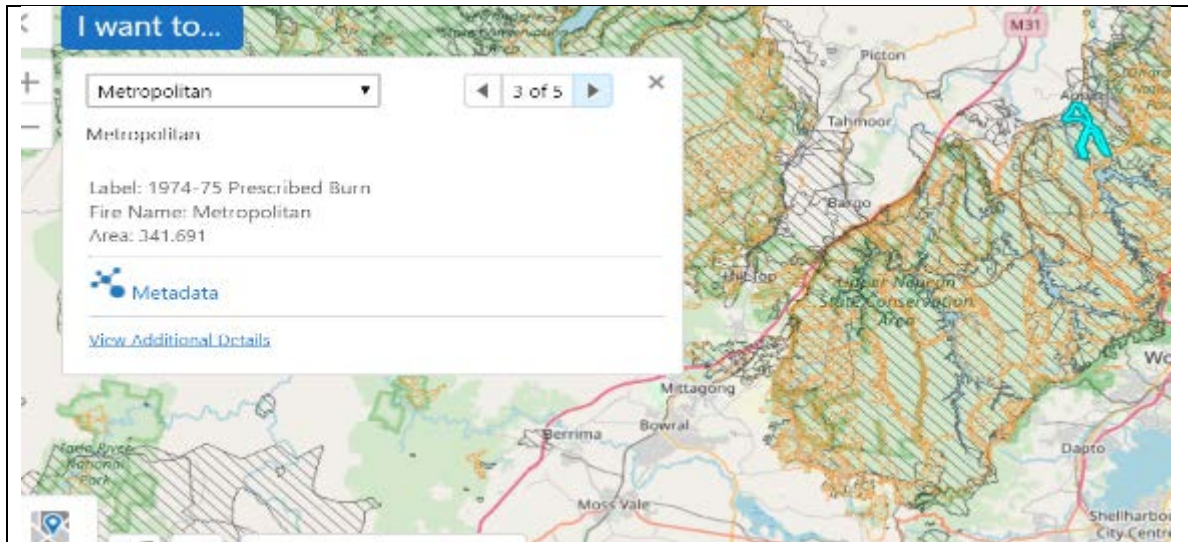


Wildfires and Prescribed burns – Individual fires information (all records of fires available) (SEED 2019)

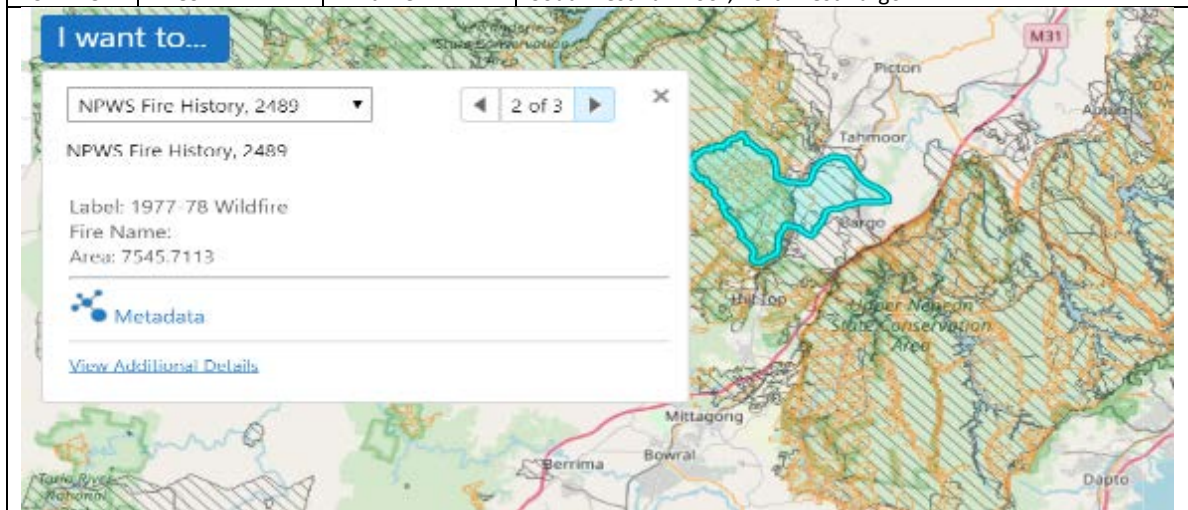
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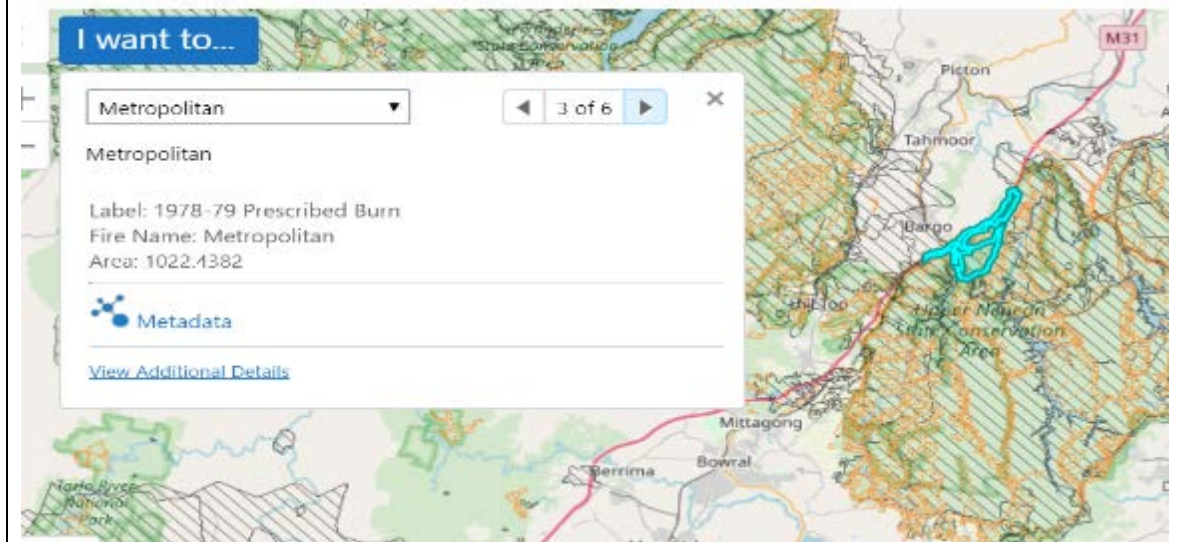
# NSW Threatened Species Scientific Committee



1977-78	2489	Wildfire	Southwest Tahmoor, northwest Bargo
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1978-79	Metropolitan	Prescribed burn	Southeast Bargo
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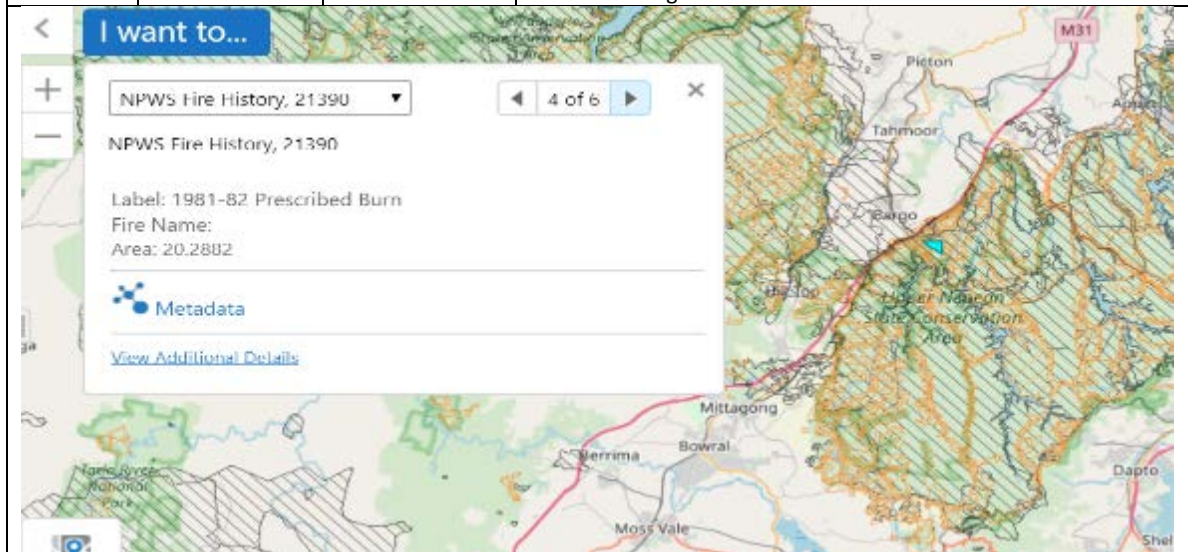


1980-81	2793	Wildfire	West Pheasant Nest, south Wilton
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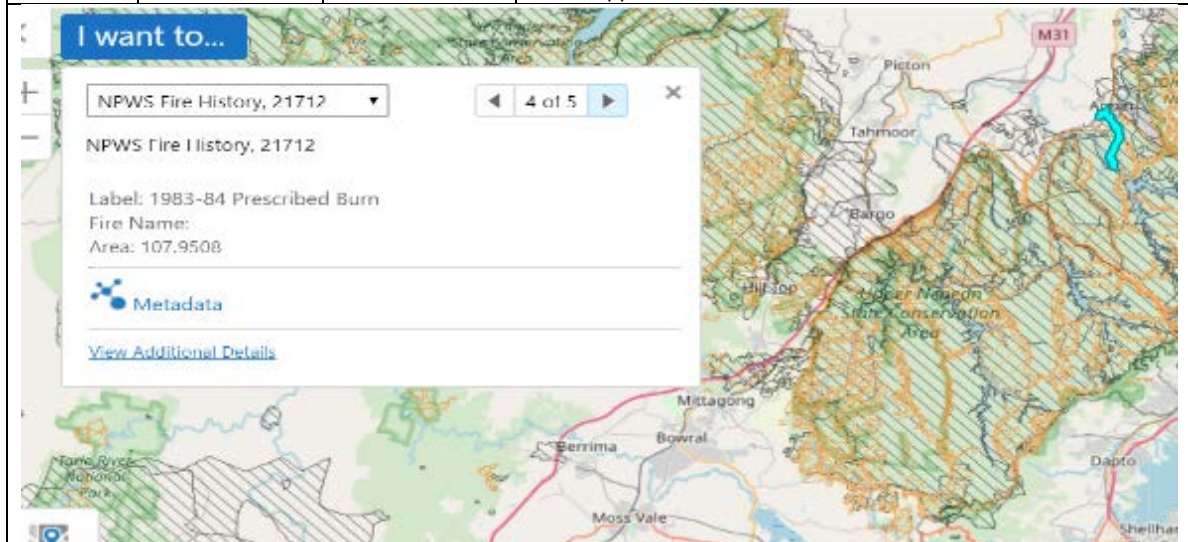
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1981-82	21390	Prescribed burn	Southeast Bargo
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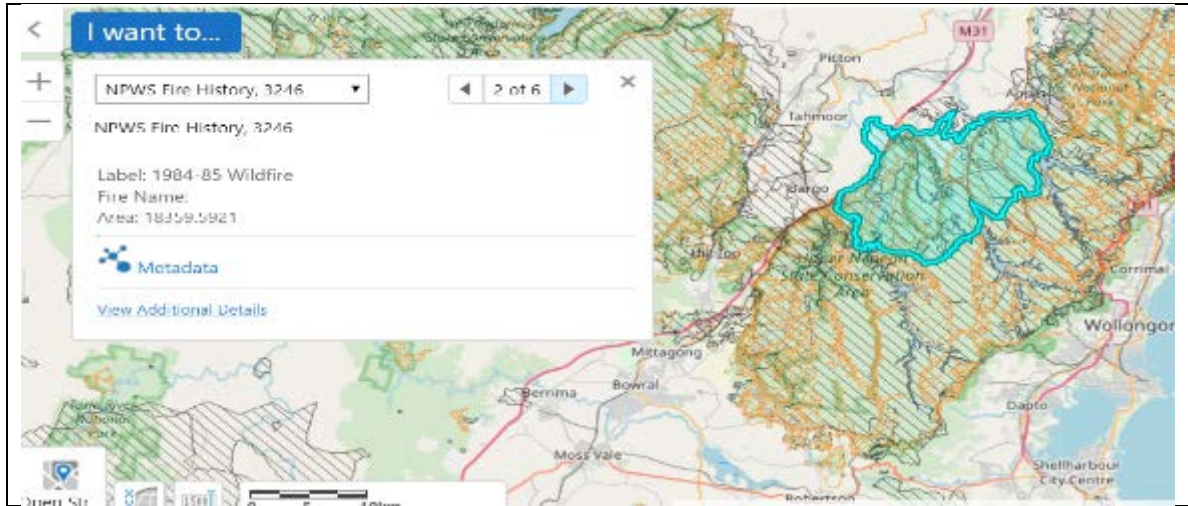


1983-84	21712	Prescribed burn	South Appin
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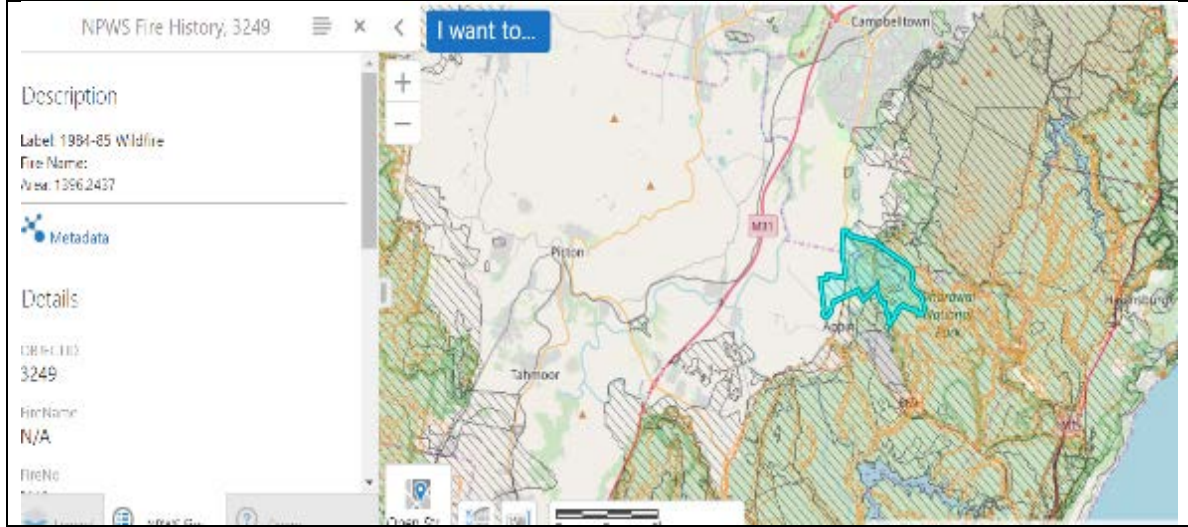


1984-85	3246	Wildfire	South Appin, south Douglas Park, through Wilton, northeast Pheasant Nest
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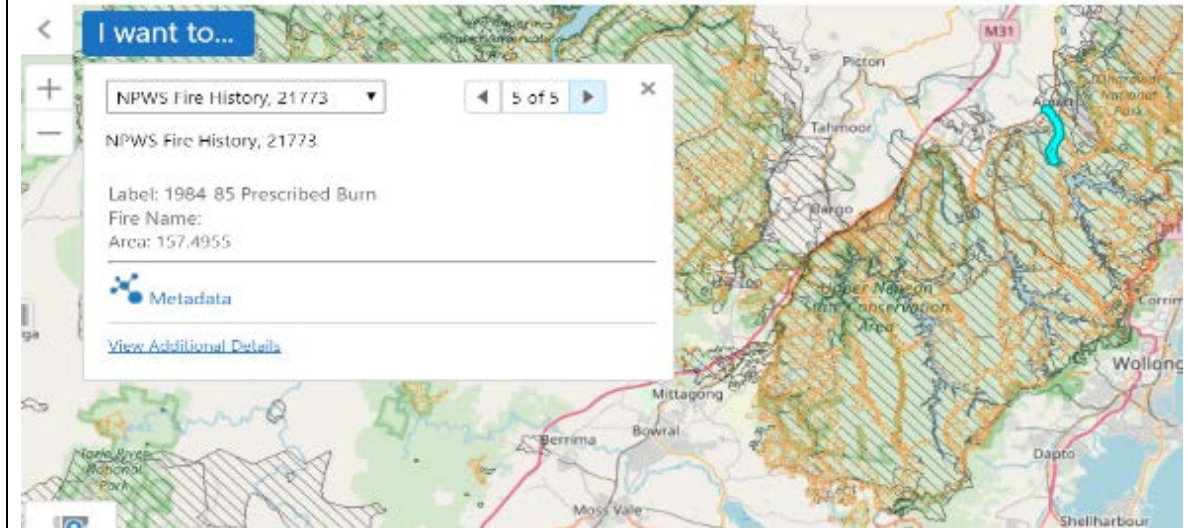
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1984-85 | 3249 | Wildfire | North Appin

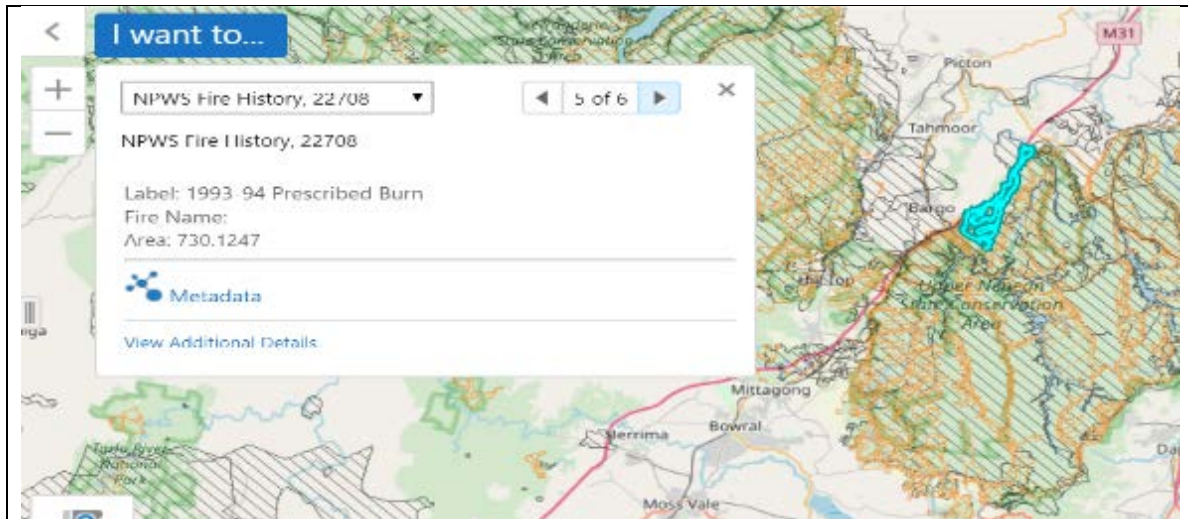


1984-85 | 21773 | Prescribed burn | South Appin

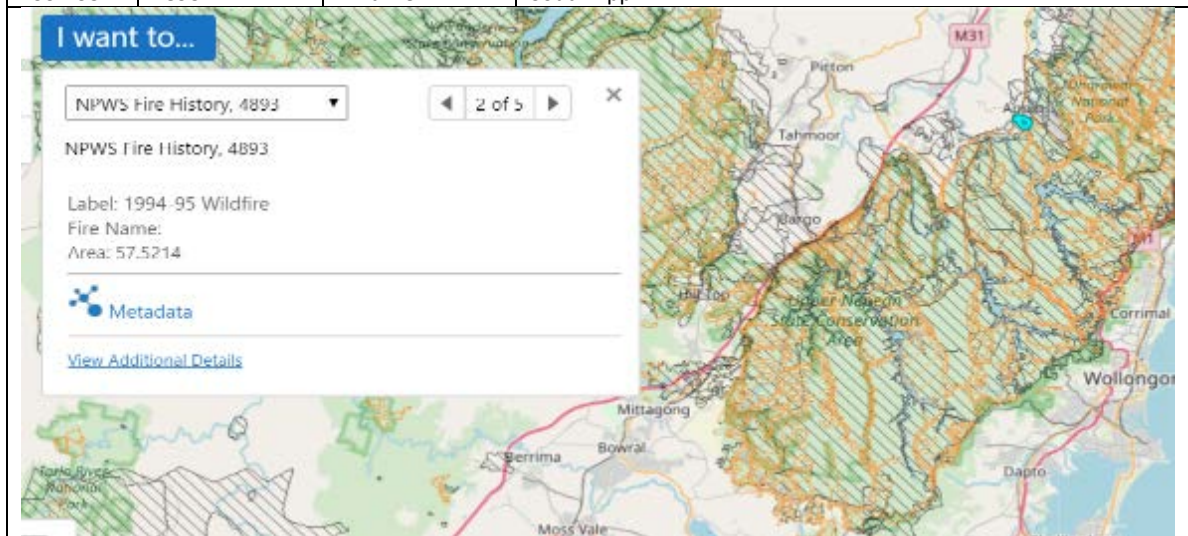


1993-94 | 22708 | Prescribed burn | Southeast Bargo

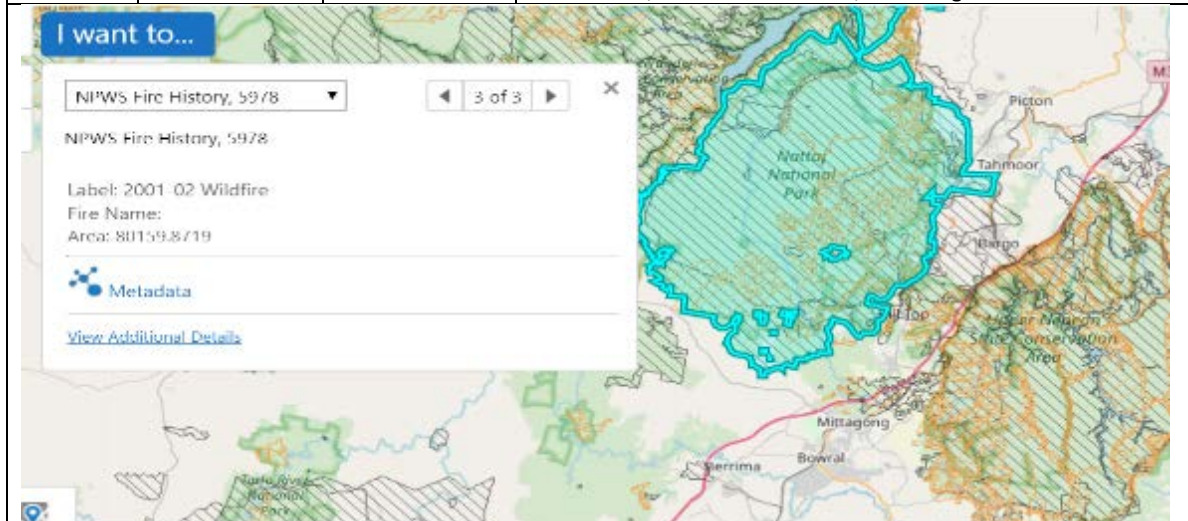
# NSW Threatened Species Scientific Committee



1994-95 | 4893 | Wildfire | South Appin

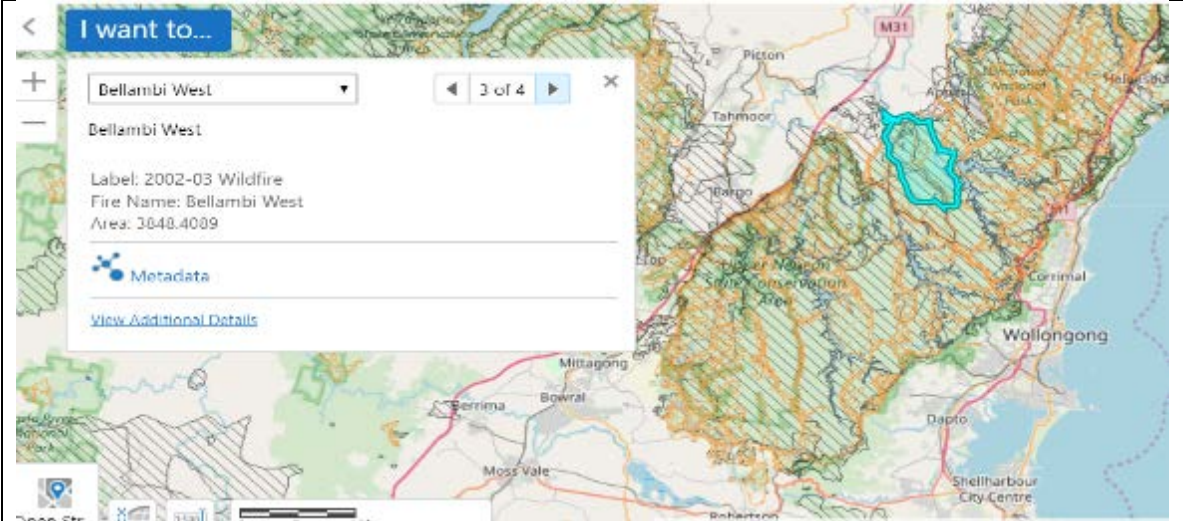
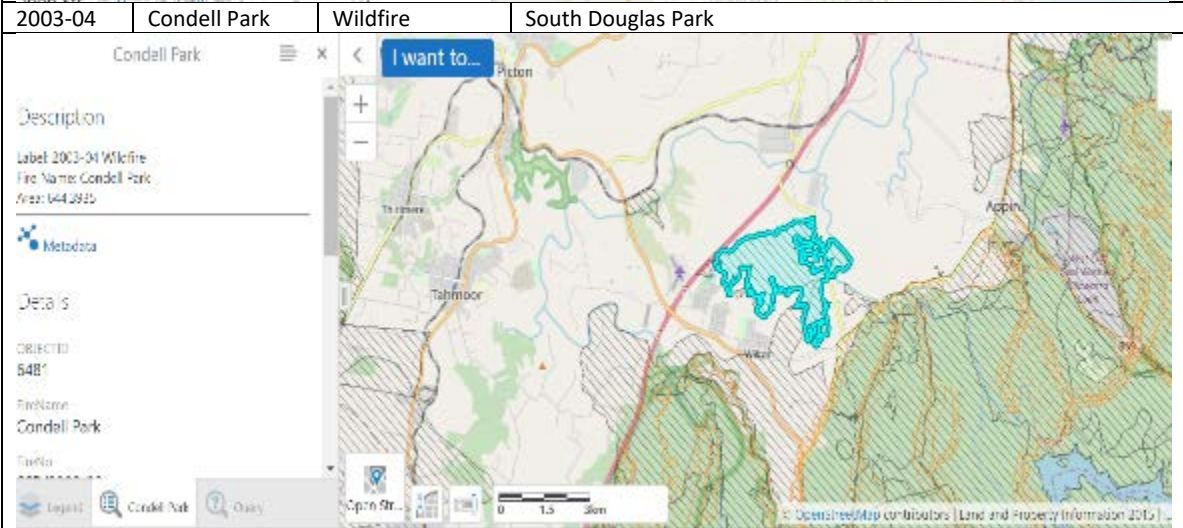
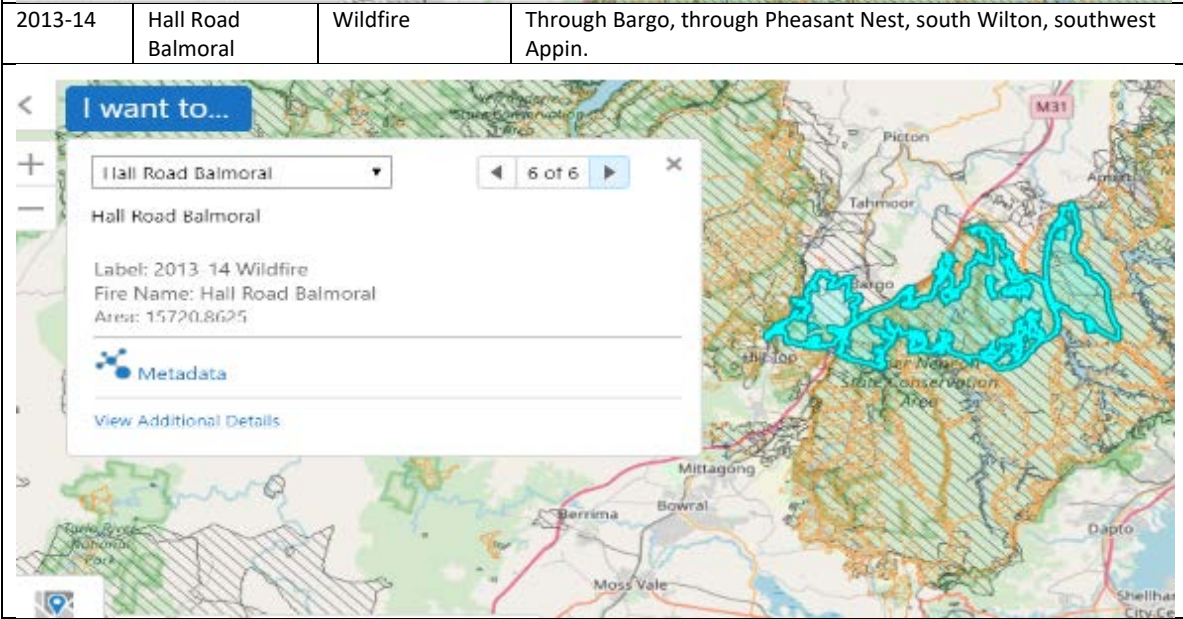


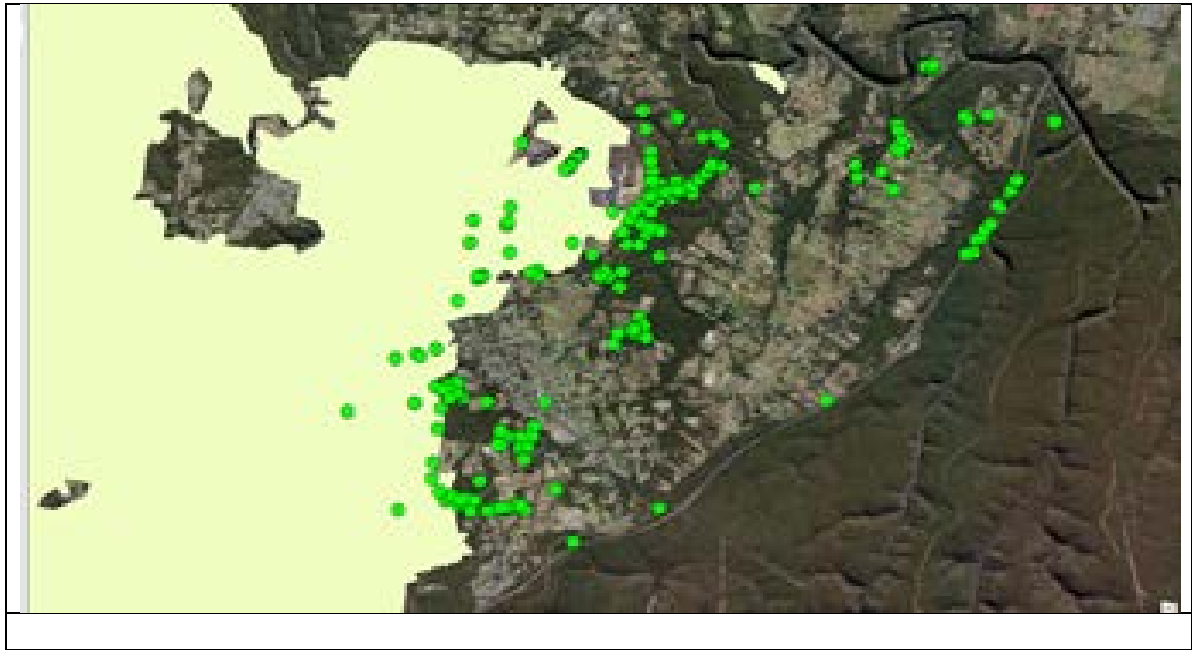
2001-02 | 5978 | Wildfire | West Picton, southwest Tahmoor, west Bargo



2002-03 | Bellambi west | Wildfire | South Douglas Park, southwest Appin

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	<p>I want to...</p> <p>Bellambi West</p> <p>Bellambi West</p> <p>Label: 2002-03 Wildfire Fire Name: Bellambi West Area: 3648.4009</p> <p>Metadata</p> <p><a href="#">View Additional Details</a></p>	<p>3 of 4</p>	<p>2003-04</p> <p>Condell Park</p> <p>Wildfire</p> <p>South Douglas Park</p>
	<p>Condell Park</p> <p>Description</p> <p>Label: 2003-04 Wildfire Fire Name: Condell Park Area: 144.895</p> <p>Metadata</p> <p>Data's</p> <p>COLLECTED 548°</p> <p>Problems Condell Park</p> <p>Tools</p> <p>Legend</p> <p>Condell Park</p> <p>Open Str...</p> <p>0 1.5 3km</p> <p>© OpenStreetMap contributors   Land and Property Information 2015</p>	<p>I want to...</p>	<p>2013-14</p> <p>Hall Road Balmoral</p> <p>Wildfire</p> <p>Through Bargo, through Pheasant Nest, south Wilton, southwest Appin.</p>
	<p>I want to...</p> <p>Hall Road Balmoral</p> <p>Hall Road Balmoral</p> <p>Label: 2013-14 Wildfire Fire Name: Hall Road Balmoral Area: 15720.8625</p> <p>Metadata</p> <p><a href="#">View Additional Details</a></p>	<p>6 of 6</p>	<p>2019-20</p> <p>Burnt areas from 1 July 2019 – 9 March 2020</p> <p>Wildfire</p> <p>Southwest Tahmoor though west Bargo and north Yandarra</p>



**Appendix 3**

**Number of location for *Persoonia bargoensis***

Distribution of *Persoonia bargoensis* – **less than five locations** based on fire history and experts opinion.

