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Mapping and reservation status of montane bogs in the New England Tablelands Bioregion, Northern New South Wales

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Abstract

Montane peatlands (bogs) are listed as an endangered ecological community in New South Wales. Major occurrences of this endangered system occur in the New England Tablelands Bioregion and adjacent North Coast Bioregion. The current extent, number of hectares and reservation status within these regions is currently unknown. Here using previous survey and mapping programs along with additional new on ground surveys a new mapping program across the region has been conducted. A total of 6216 ha of bogs were mapped of which 51% occurred within 13 different National Parks.

Keywords: montane, bog, peatland, Australia, mapping, reservation.

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Introduction

Australian montane (generally above 800 m) environments are limited in distribution and primarily occur on a belt of uplift along the eastern seaboard. Within northern New South Wales (NSW) and southeastern Queensland (Qld) the dominant uplift area is the New England Tableland Bioregion (NETB). Here a number of mire subtypes occur (Hunter and Hunter 2020). These can be grouped within four forms of non-riverine freshwater wetlands known as lagoons (ephemeral marsh), fens, bogs and sod tussock grasslands which all occur at their northern distributional limits within the New England Tablelands Bioregion (Hunter and Bell 2007, Bell *et al.* 2008; Hunter and Bell 2009; Hunter and Bell 2013; Hunter and Hunter 2016).

Lagoons are usually closed systems within small catchments and are shallow temporary lentic wetlands found predominantly on basaltic soils (Bell *et al.* 2008). The infilling of these lagoons is sporadic with depth, duration and frequency being highly variable and may occur at any time or more than once within a calendar year (Bell and Clarke 2004; Hunter 2021a,b). Fens are usually found along watercourses on flat or concave valley floors with waters that feed them being comparatively mineral rich, alkaline or only moderately acidic (Keith 2004; Hunter and Bell 2009). Sod tussock grasslands occur within winter damp or waterlogged areas often within cold drainage situations above 600 m altitude (Hunter and Hunter 2016). These grasslands often form an intermediary grading to drier non-wetland types and to fens and bogs.

Bogs occur on a broader range of physiographic positions but usually found on nutrient poor soils with feeding waters being acidic and nutrient poor (Keith 2004; Whinam and Hope 2005; Hunter and Bell 2007; Hunter and Bell 2013; Hunter and Hunter 2020). The vegetation is characterised by a component of woody shrubs (Myrtaceae, Fabaceae, Proteaceae and Ericaceae) of various density but with a consistent layer of cyperaceous taxa which commonly include *Empodisma, Lepidosperma, Gymnoschoenus* and *Xyris* (Hunter and Bell 2013; Hunter and Hunter 2020; Figure 1). Though occurrences of *Sphagnum* peat do occur most peat is formed from sedge debris with peat depth being shallow due to frequent fires and less beneficial climatic conditions (Whinam and Chilcott 2002; Hunter and Bell 2007; Hunter and Bell 2013; Hunter 2016). Montane bogs within the Australian context have been given a variety of typological terms including sedgelands, wet heaths, sedge-heaths, heath-swamps and upland peatlands (Beadle 1981, Binns 1995; Benson and Ashby 2000, Clarke *et al*. 1999, Zoete 2000, Williams and Clarke 2006).

The New England Bioregion forms the northern limit of montane mires in Australia likely due to large deficits in seasonal water availability and increasing temperatures (Beadle 1981, Whinam and Hope 2005, Hunter and Bell 2013). Not only are these mires at their geographical limits but they are also disjunct due to the Hunter Valley forming a break in the Great Dividing Range separating the central and northern tablelands occurrences (Hunter and Hunter 2020). Due to this disjunction and climatic differences these northern occurrences of montane mires have been shown to be floristically distinct from their southern counterparts (Whinam and Chilcott 2002, Bell *et al.* 2008, Hunter and Bell 2009, Hunter 2016, Lechner *et al*. 2016, Hunter and Hunter 2016, Hunter and Hunter 2020).

Bogs within the NETB in NSW fall within the listed Endangered Ecological Community 'Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregion' under the NSW *Biodiversity Conservation Act 2016*. The area of montane peatlands and swamps within reservation is considered to be small with losses due to land clearing being considered high (Benson and Ashby 2000, Whinam and Chilcott 2002, Hope and Kershaw 2005, Benson and Baird 2012).

To fully understand the conservation priorities and needs of a vegetation type some basic attributes need to be understood: the floristic nature/distinctiveness of vegetation types and the natural distribution including reservation status. Efforts have been made increasing our knowledge and understanding of the floristic variation within montane bogs of NETB (Whinam and Chilcott 2002, Hunter and Bell 2007, Hunter and Bell 2013, Hunter and Hunter 2020), however, the distribution and extent of occurrence is less understood. For instance, Benson and Ashby (2000) considered bogs were the most common wetland type in northern NSW, with 80% remaining extant. Wall (2000) considered that all montane wetlands combined in northern NSW would only cover 1970 ha. Hunter and Bell (2007) using existing mapping suggested that 10 000 ha of montane bogs occurred in the NETB with approximately 27% found within the reserves. Within the Namoi catchment Hunter (2013) mapped 4490 ha of wetlands and found that fens were the most common montane mire type accounting for 98% of mapped occurrences within this region while bogs accounted for a total of 81 ha of which 99% were found within conservation reserves. Within NSW five plant community types (PCTs 3934, 3936, 3937, 3952, 4136) describe montane bogs in the NETB and are predicted to cover 6412 ha cumulatively (BioNet, accessed 11 Jan 2025). Suggestions of the extent of northern montane bogs have been largely based on modelling and or speculation derived from limited surveys. Currently more on-ground survey data is available along with better satellite imagery. To better comprehend the distribution and conservation status of these unique wetland types and to assess the validity of some of these predicted area assessments a targeted mapping program was deemed necessary. Here using a combination of existing and new satellite imagery interpretation and verified on-ground data points, an attempt to map occurrences of bogs and assess its reservation status within the NETB was conducted. This mapping includes areas within south-eastern Queensland that is not part of the NSW threatened community listing, but is part of the NETB.

Figure 1: A button grass dominated bog north east of Tenterfield within New South Wales.

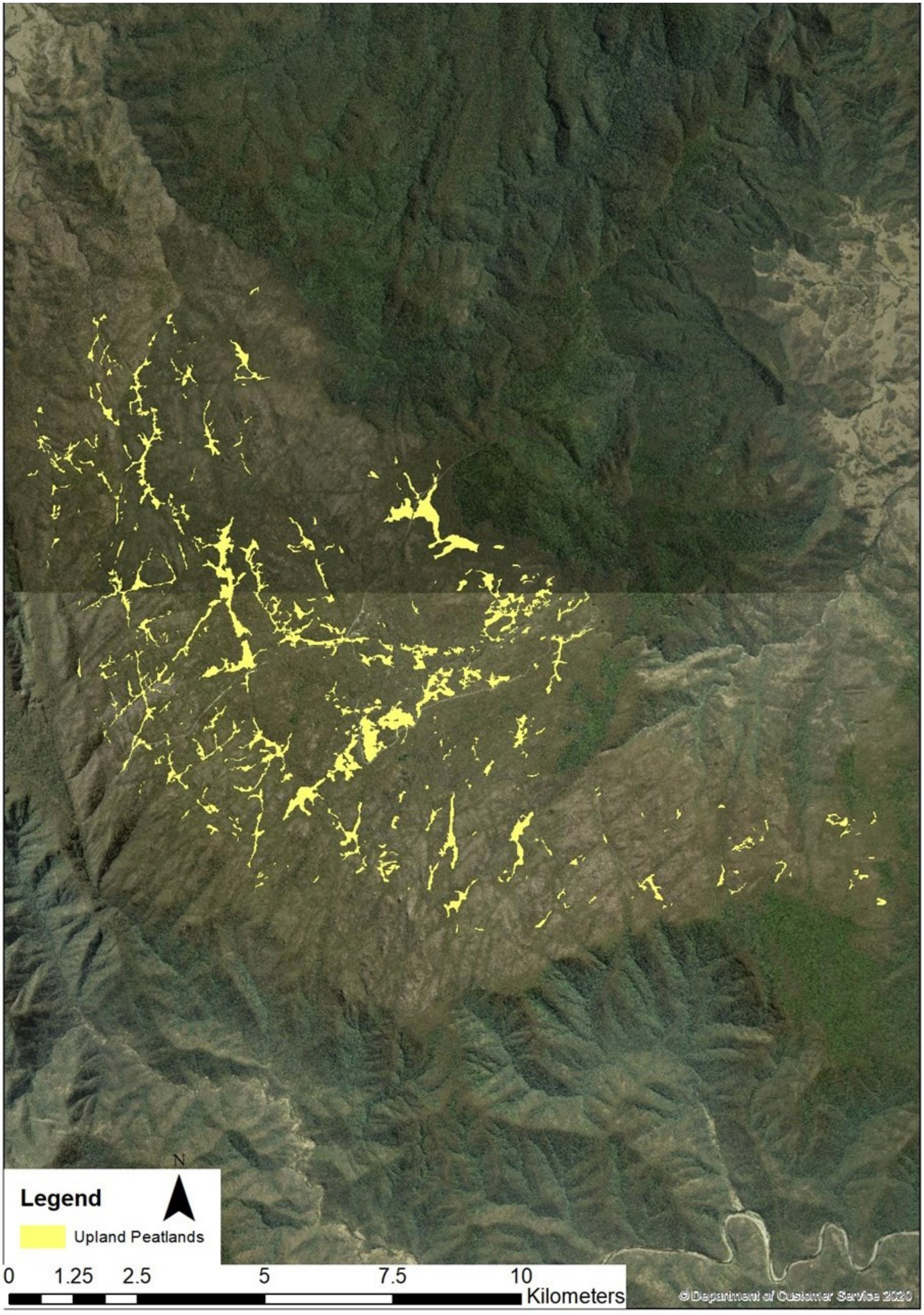

Figure 2: Detail of mapping of montane bogs within the Gibraltar Range and Washpool National Park region.

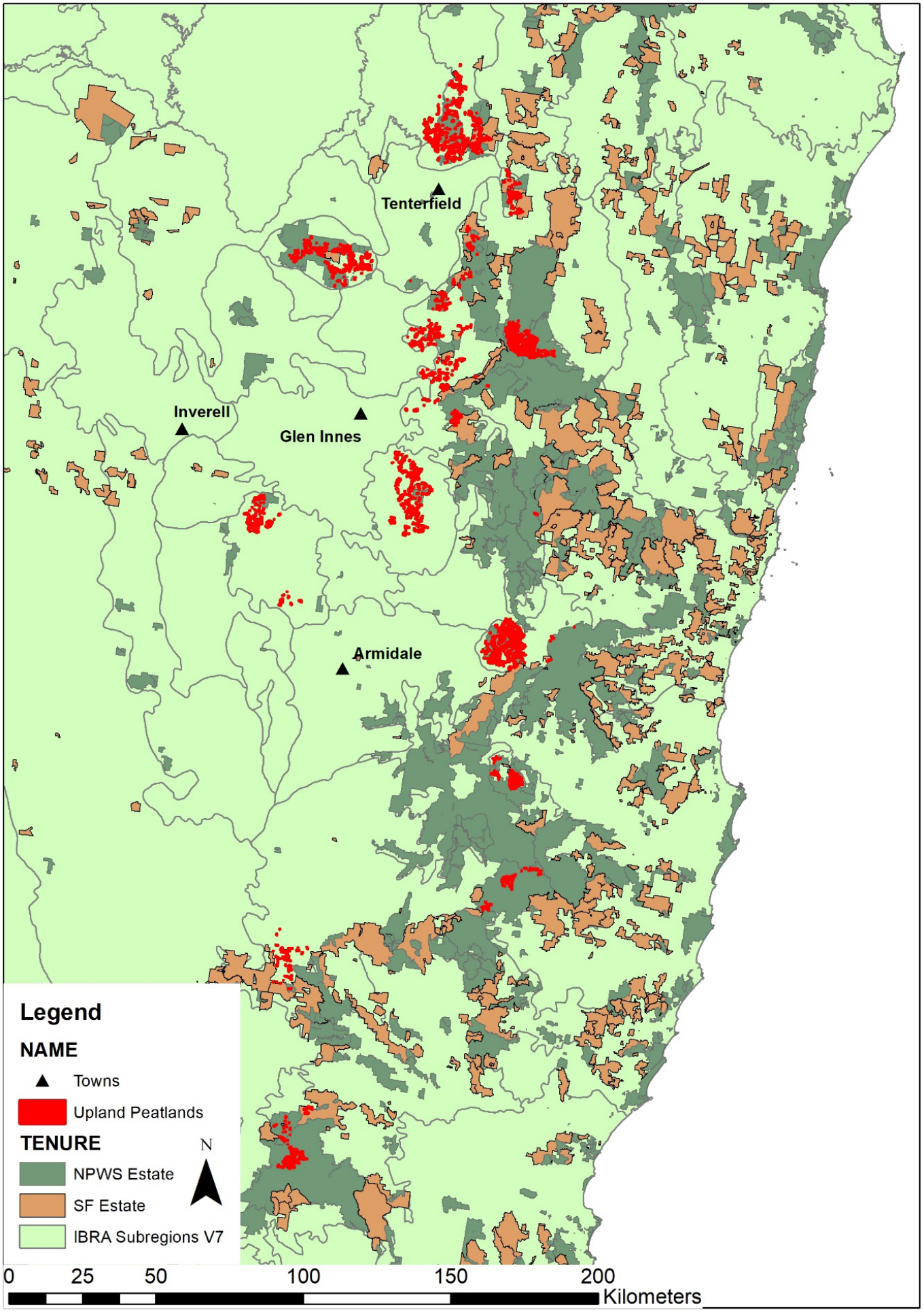

Figure 3: Mapped distribution of montane bogs (red) in northeast NSW and southeast Queensland.

Methods

Previous on-ground survey and mapping projects conducted by the author that included montane bogs (Clarke *et al*. 1999, Hunter 1998, 1999, 2000, 2002, 2004 a b, 2005, 2011a b, 2013, Hunter *et al*. 1999, Sheringham and Hunter 2002, Hunter and Bell 2007, Hunter *et al*. 2016, Lechner et al. 2016, Hunter and Hunter 2020) were referenced. This was followed up by additional on-ground surveys during 2024 and 2025. Previous mapping shape files were reviewed and used as a guide for an entirely new mapping program within ArcMAP 10.8.2 (Esri 1999-2021). Satellite imagery was used to locate and then map the boundaries of montane bogs within ArcMAP 10.8.2 (Esri 1999-2021). The NSW Imagery layer (SDT Explorer) was used though other available imagery was consulted from time to time to help in areas where the quality was not sufficient or where a different time series provided additional detail (e.g. World Imagery WGS84, https://wi.mapfiles.arcgis.com). The area of mapped polygons was calculated using the calculate geometry tool within ArcMAP 10.8.2 (Esri 1999-2021). The Interim Biogeographic Regionalisation for Australia version 7.0 shapefile was used to investigate the placement of bogs within biogeographic sub-bioregions. All bogs were also allocated to land tenure; public, private, private land conservation (in-perpetuity conservation property agreements registered with the *Biodiversity Conservation Trust* 2016), Indigenous Protected Area (IPA), National Parks and Wildlife Estate (NPWS), State Forest or Crown Land.

Results

A total of 3181 polygons were created totalling a combined area of 6152 ha. The largest single polygon was 148 ha (within Carrai National Park), the smallest 0.2 ha and the average being 2 ha. Most montane bogs were found within National Parks and Wildlife (NPWS) estate (52%) followed by unprotected private land (33%) (Figures 2 and 3, Table 1).

Montane bogs were found within 13 different NPWS reserves with Gibraltar Range NP (11.2%; 691.5 ha) and Cathedral Rock NP (9%; 556.3 ha) having the largest mapped occurrences (Table 2). Including NPWS estate, Indigenous Protected Area (IPA) and Private Land Conservation (PLC), 57% of the area of montane bogs were within some form of in-perpetuity protection (Table 1).

Approximately 87% of montane bogs were found within the NETB with the remaining within the adjacent NSW North Coast Bioregion (NCB). The North East Forest Lands (1531.5 ha) and the Stanthorpe Plateau (1312.4) sub-bioregions contained the largest area of montane bogs (Table 2). Sub-bioregions with the least area of montane bogs include (Rocky River Gorge (0.6 ha) and Deepwater Downs (1.8 ha)) (Table 2). While the sub-bioregions of Chaelundi and Comboyne Plateau have 100% of montane bogs within NPWS estate though only less than 10 ha occur in each region (Table 2). The sub-bioregions with the highest number of montane bogs in NPWS estate include Barrington Tops (70%), Round Mountain (70%), Binghi (65%), Walcha Plateau (63%), Carrai (62%) and North East Forests (61%) (Table 2). Though only 2.6% of montane bog area is found within NPWS estate in the Moredun Volcanics sub-bioregion 41.3% is found within an IPA (Table 2). Sub-bioregions with at least 10 ha of montane bogs and the lowest amount within in-perpetuity conservation include Washpool (3.7%), Ebor Basalts (20%), Nightcap (25%), Wongwibinda Plateau (25%) and Stanthorpe (27%) (Table 2, Figure 3).

Table 1 Area and distribution of montane bogs within northeastern NSW and southeastern Qld within different land tenures. NPWS – National Parks and Wildlife Service; IPA – Indigenous Protected Area; PLC – in-perpetuity private land conservation under the *Biodiversity Conservation Act* 2016.

Reservation status	Hectares	Percent of total area
Crown	384	6%
Indigenous Protected Area (IPA)	165	3%
National Parks and Wildlife Service	3194	51%
Private Land Conservation (PLC)	92	1%
Private	2039	33%
State Forest	311	5%
Total	**6216**	

Table 2 Area and distribution of upland peatlands within northeastern NSW and southeastern Qld within bioregion, sub-bioregion and reservation status. NPWS – National Parks and Wildlife Service; IPA – Indigenous Protected Area; PLC – in-perpetuity private land conservation under the Biodiversity Conservation Act 2016.

Bioregion - Sub-bioregion (Total Ha)	Conservation Status	Location	Hectares	Percent of Subregion	Percent of Total
New England Tablelands (5221.G)					
Binghi Plateau (350.0)	Crown		46.4	13.3	0.8
	NPWS	Torrington SCA	228.4	65.3	3.7
	PLC		7.0	2.0	0.1
	Private		56.4	16.1	0.9
	State Forest	Torrington SF	11.9	3.4	0.2
Deepwater Downs (1.8)	Crown		0.4	21.0	0.0
	Private		1.4	79.9	0.0
Ebor Basalts (52)	NPWS	Cathedral Rock NP	2.8	5.4	0.0
		New England NP	5.1	9.8	0.1
		Serpentine NR	2.3	4.4	0.0
	Private		41.8	80.4	0.7

Bioregion - Sub-bioregion (Total Ha)	Conservation Status	Location	Hectares	Percent of Subregion	Percent of Total
Moredun Volcanics (378.1)	IPA		156.1	41.3	2.5
	NPWS	Single NP	9.9	2.6	0.2
	Private		183.6	48.6	3.0
	State Forest	New Valley SF	28.6	7.6	0.5
Nightcap (615.5)	Crown		101.8	16.5	1.7
	IPA		9.8	1.6	0.2
	NPWS	Warra NP	155.5	25.3	2.5
	Private		338.1	54.9	5.5
	State Forest	Warra SF	10.2	1.7	0.2
Northeast Forest Lands (1531.5)	Crown		40.5	2.6	0.7
	NPWS	Barool NP	0.9	0.1	0.0
		Bolivia Hill NR	0.1	0.0	0.0
		Butterleaf NP	17.2	1.1	0.3
		Capoompeta NP	59.7	3.9	1.0
		Gibraltar Range NP	691.5	45.1	11.2
		Mann River NR	68.8	4.5	1.1
		Washpool NP	90.0	5.9	1.5
	PLC		76.7	5.0	1.2
	Private		427.1	27.9	6.9
	State Forest	Brother SF	28.9	1.9	0.5
		Butterleaf SF	1.1	0.1	0.0
		Glen Elgin SF	2.0	0.1	0.0
		Forest Land SF	27.1	1.8	0.4
Round Mountain (831.5)	Crown		20.0	2.4	0.3
	NPWS	Cathedral Rock NP	556.3	66.9	9.0
		Serpentine NR	22.0	2.6	0.4
	Private		233.3	28.1	3.8
Stanthorpe Plateau (1312.4)	Crown		125.9	9.6	2.0
	NPWS	Bald Rock NP	133.7	10.2	2.2
		Basket Swamp NP	170.1	13.0	2.8
		Boonoo Boonoo NP	41.3	3.2	0.7
		Demon NR	1.6	0.1	0.0
		Girraween NP	154.9	11.8	2.5
		Timbarra NP	3.4	0.3	0.1
	PLC		8.7	0.7	0.1
	Private		522.6	39.8	8.5
	State Forest	Boonoo SF	67.1	5.1	1.1
		Gerard SF	67.3	5.1	1.1
		Malara SF	6.2	0.5	0.1
		Wilsons Downfall SF	9.5	0.7	0.2
Walcha Plateau (209.7)	Crown		18.0	8.6	0.3
	NPWS	Tuggolo Creek NR	1.3	0.6	0.0
		Werrikimbe NP	61.5	29.3	1.0
	Private		118.2	56.4	1.9
	State Forest	Tuggalo SF	10.7	5.1	0.2
Wongwibinda Plateau (91.6)	Crown		55.6	60.7	0.9
	NPWS	Cathedral Rock NP	22.7	24.7	0.4
NSW North Coast (867.1)					
Barrington (428.3)	NPWS	Barrington Tops NP	301.4	70.4	4.8
		Barrington Tops SCA	63.1	14.7	1.0
	Private		13.2	3.2	0.2
	State Forest	Barrington Tops SF	50.6	11.8	0.8
Carrai Plateau (360.0)	Crown		56.5	15.7	0.9
	NPWS	Carrai NP	178.6	49.6	2.9
		Carrai SCA	44.3	12.3	0.7
	Private		80.6	22.4	1.3

Bioregion - Sub-bioregion (Total Ha)	Conservation Status	Location	Hectares	Percent of Subregion	Percent of Total
Chaelundi (6.0)	NPWS	Guy Fawkes River NP	6.0	100.0	0.1
Comboyne Plateau (10.4)	NPWS	Werrikimbe NP	10.4	100.0	0.2
Rocky River Gorge (0.6)	Crown		0.6	100.0	0.0
Upper Manning (61.5)	NPWS	Werrikimbe NP	48.1	98.2	0.8
Washpool (11.1)	NPWS	Nymboida NP	0.4	3.7	0.0
	Private		13.4	14.6	0.2

Discussion

Previous suggestions of the number of hectares of montane bogs in the northeast of NSW have been wildly speculative, ranging from all wetland types combined covering only 1970 ha (Wall 2000) to 10,000 ha for montane bogs alone (Hunter and Bell 2007). The predicted modelled area based on Plant Community Types (6412 ha) was very close to the total area mapped with this program (6153 ha).

Only 33% of mapped montane bogs were found within private land with no form of formal protection, with 57% occurring within 13 NPWS reserves and in other forms of protection such as private land conservation (IPA, PLC) (Table 1 and 2). Thus, from a bioregion perspective, montane bogs in northeast NSW are one of the better reserved vegetation types. Almost all sub-bioregions have good representation of bogs within conservation areas (i.e. > 30%) with only Wangwibinda Plateau (25%), Nightcap (25%), Ebor Basalts (20%), Washpool (3.7%) and Deepwater Downs (0%) having poorer conservation outcomes, though these areas largely have small occurrences.

Based on these results montane bogs (peatlands) can be considered adequately reserved within the NETB and NCB, though this study does not address issues of degradation across occurrences, nor the threat of changing climates, which are likely to cause some contraction in occurrences and loss of peat. Peat is a necessary component of these systems allowing moisture retention through dry periods, and persistence in less optimal climatic locations (Whinam and Chilcott 2002, Hunter and Bell 2007, Hunter and Bell 2013, Hunter 2016). Further research on montane bogs, particularly long-term monitoring in the NETB where this vegetation type is at its climatic and distributional limits, will be essential to understand its ability to persist with anthropogenic climatic change.

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