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The contest for the tall forests of south-western Australia and the discourses of advocates

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Abstract. After over 50 000 years of interaction between Aboriginal people and changing climates, south-western Australia's tall forests were first logged less than 200 years ago, initiating persistent conflict. Recent conservation advocacy has resulted in the protection of 49% of these tall forests in statutory reserves, providing an opportunity to implement and benefit from a growing moral consensus on the valuing of these globally significant, tall forest ecosystems. We analysed a cross-section of literature (63 papers, 118 statements) published on these forests over 187 years to identify values framing advocacy. We differentiated four resource-oriented discourses and three discourses giving primacy to social and environmental values over seven eras. Invasion sparked initial uncontrolled exploitation, with the *Forests Act 1918* managing competing agricultural and timber advocacy. Following the *Colonial* and *Country Life* eras, industrial-scale exploitation of the karri forest region resulted in reaction by increasingly broad sectors of society. Warming and drying in the 21st Century emphasises the importance of intact tall forest and the *Indigenous Renaissance* discourse. Vesting for a more comprehensive set of values would acknowledge a new moral consensus.

Additional keywords: conservation policy, culture, environmental management, environmental sustainability, forestry, human impact, natural resource management, world heritage area

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Introduction

Nearly a century ago, Charles Lane Poole, Western Australia's Conservator of Forests, advocated:

> … *when the people develop a forest conscienceness* [sic] … *and they themselves will see to it that the forest policy is maintained and the forests are used for the benefit of the community as a whole, forever, and not for the benefit of the few sawmillers, timber hewers, and timber merchants of to-day* [sic] (Lane Poole 1920*a*, p. 34)

Lane Poole's plea to move beyond narrow exploitation in the forests of south-western Australia (SWA) was not for protectionism or exclusion of production. Rather, he advocated regulation and orderly management, with retention of aesthetic values. He recognised that a transition to 'cultivated' forest would result in significant change:

> *When the State's forests have become cultivated, trees will be cut when they reach maturity. Sentiment may dictate the preservation of a few for a period far beyond that of maturity, as reminders of the giants of former days, but whole forests of giant trees will no longer be seen.* (Lane Poole 1920*b*, p. 130)

Since these remarks, formal management of State-owned forests has been put into practice in the two major forest types of

SWA: jarrah (*Eucalyptus marginata*) and karri (*Eucalyptus diversicolor*). Lane Poole's prescience of a loss of 'giants' (but not 'cultivation') has occurred in the jarrah forests (Wardell-Johnson *et al.* 2015). However, in the karri (or tall eucalypt) forests, advocacy for the 'giants of former days' has resulted in substantial areas of forest being protected with national park status. This protected forest, together with stands of 'cultivated' trees within a matrix of regeneration in State forest provides an insight into the consequences of advocacy in the global context.

Forests regulate planetary processes and are extraordinarily biodiverse (FAO 2016; Watson *et al.* 2018). They capture primeval imagination (Schama 1995), reflecting and inspiring a complex interconnectedness of feelings and attitudes, representing symbolic and material values (Hay 2002). These values are derived through historical associations, contemporary use and future expectations, and coevolve and converge through landscape connections (Wardell-Johnson 2011; Ernoul and Wardell-Johnson 2015). As these values are important to people, they are often contested (Thirgood 1981; Gellman 2008).

High levels of contestation provide particular challenges for environmental management and governance (Rittel and Webber 1973; Reed and Massie 2013; Kanowski 2017) and often instigates advocacy. Advocacy is an expression of social values that define political imperatives, manifesting as a range of behaviours and interactions in relation to the *status quo*. Advocacy plays a role, both in maintaining (e.g. Underwood *et al.* 1991) and in challenging (e.g. South-West Forests Defence Foundation Inc. 1986) the *status quo*. Advocacy galvanises moral and ethical positions to defend environmental management (Batavia and Nelson 2016) and generates waves of consequences. The contested values in forest management (Thirgood 1981; Kanowski 2017) are evident in the tall forests of SWA:

> *It is an intense, even violent debate, and one which has become deeply political as proponents for one philosophy or the other seek the power to decide how the karri is to be managed. This is the social context in which foresters are attempting to produce responsible and workable management plans for the karri forest.* (Underwood *et al.* 1991, p. 22)

As values determine forms of advocacy (see Boon 2018) and are inseparable from politics, they manifest themselves in a diversity of human positions (Maser 1994; O'Laughlin 1996; Wardell-Johnson *et al.* 2018). Advocacy reflects sectoral values, identified through types of conflict (Duane 1997), informed by discrete knowledge systems (Wardell-Johnson and Selvaratnam 2011) that draw on different types of capital (Flora and Flora 1996), framing distinct discourses (Dryzek 1997; Wardell-Johnson 2005). Thus discourses can be identified through statements differentiated by: (1) the *conflicts* that people generate and to which they respond, (2) the *capitals* that drive human behaviours, (3) the *environmental discourses* that define values, and (4) the *knowledge systems* that inform these values.

In this contribution to the special issue on advocacy, we outline a contest for the tall forests of SWA. We first introduce the study area, encompassing the tall forest region of SWA. We then draw on theory from sociology to define and categorise statements to characterise discourses in the history of management of these forests. We examine these discourses through numerical taxonomic approaches with explicit attention to the discourses, conflicts, capitals and knowledge systems embedded within the statements. We then include selected statements within eras to provide a historical context for advocacy under three management rationales: *Deep Time*, *Resources* and *Conservation*. Finally, we discuss discourses in relation to the future of these forests under the rapid warming and drying now experienced in the region. We ask: what discourses enable policy and management to best maintain the values inherent in these tall forests? We conclude by advocating protection of a wider range of values under circumstances of changed social values and climate. This is because, we argue, World Heritage listing better protects the values provided by intact tall forests than any approach based on narrow sectoral interests.

Methods

Solutions to environmental issues involve evidence-based approaches drawing on transdisciplinary methods integrating the biophysical, ecological and social sciences. These methods have clear standards and transparent processes to achieve technical and scientific credibility (Brennan 2004). This research is framed by conceptual frameworks that allow integration of these disciplines (Mylopoulos 1992). These frameworks should include underpinning assumptions, and serve in the interpretation of positions (Kung and Solvberg 1986). We thus apply a discourse framework to analyse statements that reflect the inherent values of positions (Dryzek 1997; Wardell-Johnson 2005; Ernoul and Wardell-Johnson 2015) in the history of management of the tall forests of SWA.

Study area: SWAs tall eucalypt forests in context

The tall eucalypt forests of Australia include the world's tallest angiosperms, with volume and mass of vegetation that are amongst the greatest in terrestrial ecosystems (Keith *et al.* 2009). Although they occupy only 0.75% of Australia's landcover (4.9 million ha: Wardell-Johnson *et al.* 2017*a*), their environmental, economic and cultural values represent significance beyond their distributional area (Wardell-Johnson *et al.* 2017*a*). Tall eucalypt forests occur discontinuously in a zone of high rainfall (at least 1000 mm per year) from north-eastern Queensland to southern Tasmania, with an outlier over 2000 km to the west in SWA (Wardell-Johnson *et al.* 2017*a*). These forests share globally significant structural features and also provide habitat for unique biotic assemblages (Wardell-Johnson *et al.* 2017*a*):

> *With their associated understorey, the giant Karris of south Western Australia constitute a unique and ancient forest; one of the great botanical associations of the world* (CTRC 1974, pp. 2–16)

The tall eucalypt forests of SWA occur in the highest rainfall, most fertile and freely drained habitat in the south-western corner of the continent (Churchill 1968; Wardell-Johnson *et al.* 1997) (Fig. 1). These distinctive tall, open, and wet sclerophyll forests coincide with the distribution of the dominant tree species, karri (Wardell-Johnson *et al.* 2017*a*), which also defines the boundary of the Warren Bioregion (Thackway and Cresswell 1995) (Fig. 1).

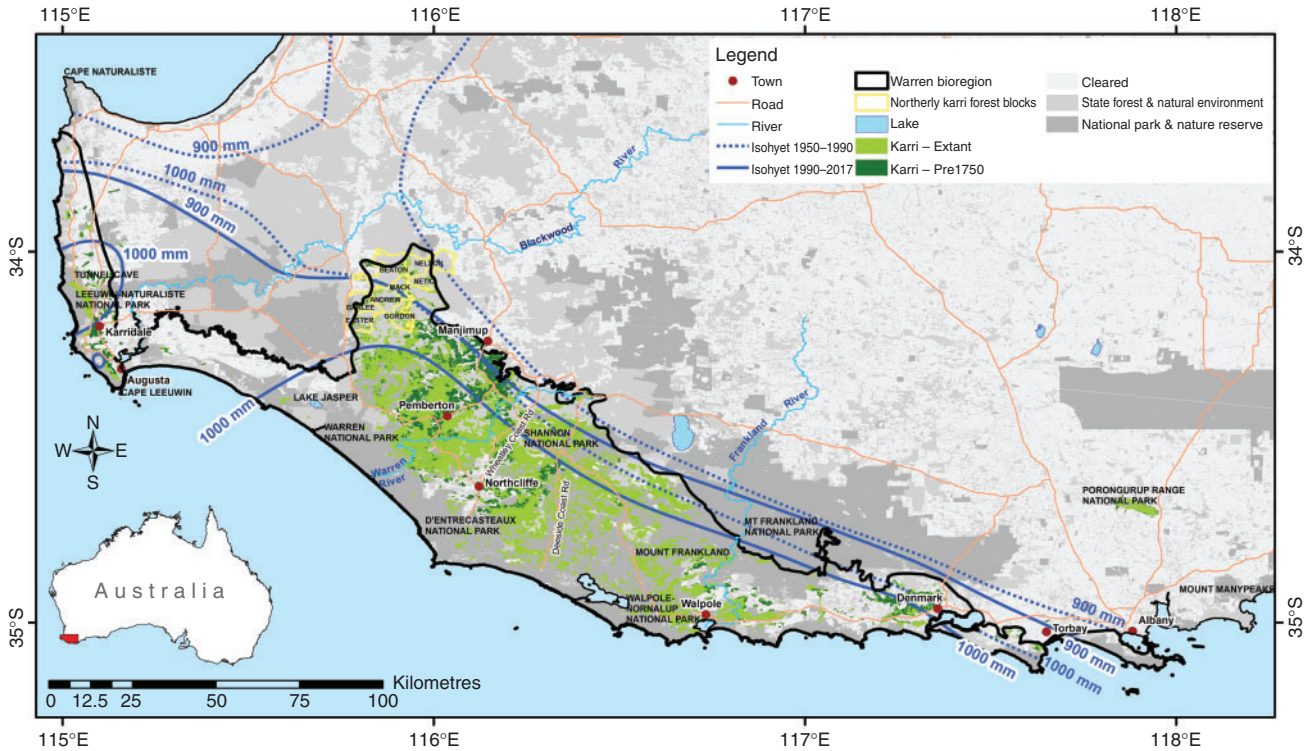

Fig. 1. The tall forest region of south-western Australia showing the distribution of karri (also tall forest); boundary of the Warren Bioregion, roads, northern karri forest blocks, and place names mentioned in the text. Historical mean isohyets (1950–90) and current isohyets (1990–2017) are also shown. The 900-mm isohyet is now approximately where the 1000-mm isohyet was during the eras of *Modern Rurality* and *Sustainability*, with drying and warming expected to continue and intensify.

Several other tall forest eucalypts (viz. red tingle (*E. jacksonii*), rates tingle (*E. brevistylis*), and yellow tingle (*E. guilfoylei*)) also occur within this region. These are the only tall eucalypt forests where there are no associated rainforest flora (*Podocarpus drouynianus* is exceptional, see Box 1; Fig. 2). Regardless, this forested ecosystem is notable for a high diversity of phylogenetic endemism (Hopper *et al.* 1992):

> *Recurring climatic changes, periodic isolation of hilltops during marine transgressions, and complex edaphic patterns in this wettest zone of an ancient, nutrient poor landscape has led to a rich biota of phylogenetic relics, other than* Spicospina, *in an area of limited topographic variation* (Roberts *et al.* 1997, p. 379)

Individual karri trees can live for hundreds of years (Rayner 1992; Wardell-Johnson and Coates 1996) and are now often found beyond current climatic suitability (Wardell-Johnson *et al.* 2017*a*, 2017*b*). Climate, especially rainfall, is the overriding factor explaining distribution of tall eucalypt forests in general, and karri in particular (Wardell-Johnson *et al.* 2017*a*). Thus karri usually occurs where rainfall is over 1000 mm at sites with an average summer rainfall of at least 25 mm per month (Churchill 1968) and summer evaporation less than 500 mm (Gentilli 1989). However, karri also occurs where rainfall runoff supplements groundwater (e.g. at outliers at the Porongurup Range and Mt Manypeaks).

Aboriginal peoples have continuously occupied SWA for at least 50 000 years (Turney et al. 2001). Deep time originally described geological time, as conceptualised by the Scottish geologist James Hutton (1726–97) (Kubicek 2008). However, it is increasingly applied to separate the time before humans had a global impact, from what is now called the 'Anthropocene' (A. Wardell-Johnson *et al.* 2011). We use 'deep time' here to describe the period of human occupation in Australia prior to 1788. SWA is country, or *booja,* for the Noongar/Nyungar People, within which the Warren Bioregion includes Pibbulmun/Bibbulmun and Minang peoples. The region is recognised for outstanding environmental, cultural and landscape values (Fig. 3) linking deep time Gondwanan values through cultural and ecological associations:

> *Nyungar* [Noongar] *oral histories will continue ad infinitum and they will continue to be recorded by Nyungar, Indigenous people and non-Indigenous people alike. Nyungar oral histories will keep on having a profound influence on our future generations. They will be the eternal link to Nyungar identity, heritage and culture.* (Collard 2009, p. 23)

Society, people and values

European colonisation of SWA, like the rest of Australia, amounted to invasion (Reynolds 1982; Feilberg 2015). Thus the dominant symbolic and material values of forests recognised by

Box 1. Outstanding Universal Value, World Heritage and the future of south-western Australia's tall forest region

To be included on the World Heritage List, sites must be of Outstanding Universal Value and meet at least one of 10 selection criteria. Tall eucalypt forests are represented in four World Heritage sites in Australia, in both of Australia's global biodiversity hotspots, and in several national hotspots. Tall forest of karri is represented in one of Australia's 15 national biodiversity hotspots (Augusta–Margaret River).

The broader environment in which karri is a major component (i.e. the Warren Biogeographic Region) is significant at a global scale for several values. These forests and adjacent land and seascapes have been long recognised as *containing superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance* (*Criterion vii*: Fig. 2). Several areas in the region are likely to meet this criterion (e.g. Porongurups, Augusta–Margaret River coastline, Warren River Valley, south coast Albany to Augusta: Fig. 2).

The tall forest region also includes species of outstanding universal value based on their *containing the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation*. (*Criterion x*). This bioregion, and nearby areas such as the Porongurup Range, is the most important centre of endemism for conservative, relictual, high-rainfall plant taxa in the State (Hopper *et al.* 1992). Outstanding examples of extraordinary monotypic and/or endemic universally recognised plants include *Eucalyptus jacksonii* (Fig. 3*i*), *Anthocercis sylvicola* (Fig. 3*g*) and *Cephalotus follicularis* (Fig. 3*c*). It is also notable for numerous Gondwanan fauna relicts, making it a globally significant phylogenetic hotspot, with numerous charismatic local endemics (Wardell-Johnson and Horwitz 1996; Roberts *et al.* 1997) (Fig. 3). These include the endemic Gondwanan monotypic sunset frog (*Spicospina flammocaeulea*) (Fig. 3*d*) and the quokka (*Setonix brachyurus*) (Fig. 3*h*).

The Warren Bioregion also includes outstanding examples representing *significant on-going ecological and biological processes in the evolution and development of terrestrial, freshwater, coastal and marine ecosystems and communities of plants and animals* (*Criterion ix*). These include the most significant organic-rich peat substrates and associated endemic biota in the western three-quarters of the Australian continent (Wardell-Johnson and Horwitz 1996). These peat swamps include the *Reedia* threatened ecological community (Fig. 3*f*), numerous Gondwanan relicts and species of relictual plant taxa.

Further, the Warren Bioregion contains outstanding examples representing major *stages of Earth's history, including the record of life, significant on-going geological processes in development of landforms, and significant geomorphic or physiographic features* (*Criteron viii*). These include the most significant pollen records in SWA (Boggy Lake, near Walpole), a globally significant fossil limestone cave fauna record (e.g. Mammoth Cave, Devils Lair, Tight Entrance Cave and others: Dortch and Wright 2010; Prideaux *et al.* 2010), and numerous locally endemic ironstone and limestone ecological communities (e.g. the threatened Tufa ecological community: Fig. 3*a*), adjacent to the Leeuwin–Naturaliste Ridge. The Tingle Mosaic (Wardell-Johnson and Williams 1996), a subset of this bioregion, includes the highest-biomass forests, and hence highest ecosystem carbon stores on the western three-quarters of the continent.

Culturally, the southern part of forested SWA is also significant. This significance includes *Criterion ii* of *exhibiting an important interchange of human values, over a span of time or within a cultural area of the world, on developments in architecture or technology, monumental arts, town-planning or landscape design*. Examples of potential outstanding universal value associated with this criterion include the large, widely spaced coastal peppermint trees signifying deep time fire management by Noongar people. Other tangible signs of deep time connections include long occupation records in caves (e.g. Fig. 2*e*) and sand dunes (e.g. Fig. 2*d*), fish traps designed for both past and present estuary configurations (e.g. Fig. 2*g*), oral histories recounting geologically recorded events, and the late Quaternary persistence of abundant coastal resources (see text for details). However, a continuing connection remains through more recent coastal cattle runs following Noongar routes to the coast, the timber industry, and, more recently still, the increasingly diversified cultural environment of the region exemplified by the integration of wine regions into the dairy and Group Settlement schemes, which consolidated the evolution of human values in the region that has been ongoing for 50 000 years.

postinvasion Australian society have their origins in Tudor English society (Schama 1995). Here, the Crown was the custodian of the old, free greenwood, while realising its economic assets – a dichotomy clearly revealed in the 1543 *Act for the Preservation of Woods*, which aimed to ensure the long-term provision of timber, especially oak for ships (Moorhouse 2005). By the year 1600 both conservationists and developers had invoked the fundamental interests of the realm to support their respective positions (Schama 1995). The ideas of conflict, capital, discourse and knowledge associated with forests today have long European tradition. However, Australia has other approaches and histories that are very different from those of Europe (Hopper 2009; Mucina and Wardell-Johnson 2011).

Conflict may occur when people (or communities) disagree about the desirability of implementing specific policy, planning, or management actions (Duane 1997). Advocacy may be differentiated through four types of conflict in forest management (Duane 1997): (1) *cognitive* conflict – people have different understandings or judgements as to the facts of a situation; (2) *values* conflict – a dispute over goals; (3) *interest* conflict – costs and benefits resulting from an action are in dispute; and (4) *relationship* conflict – winners and losers in the interaction of

Fig. 2. Outstanding Universal Value for exceptional natural beauty (Criterion vii), and for an important interchange of human values, over a span of time or within a cultural area of the world (Criterion ii) arguably recognisable in the tall forest region of south-western Australia. (*a*) Porongurup Range from Devils Slide looking east in October 2016; (*b*) Ellen Brook near Gracetown, a site chosen for a homestead by early European settlers on what is at least 6000 years of continuous occupation by Aboriginal peoples; (*c*) karri in the Woolbales, Walpole; (*d*) Quininup Brook, archaeological site of early occupation by Aboriginal people; (*e*) Tunnel Cave, archaeological site in Limestone of the Leeuwin-Naturaliste Ridge; (*f*) Tree Top Walk, Walpole; (*g*) Aboriginal fish trap at Oyster Harbour; (*h*) the 80.5-m-high Stewart Tree near Manjimup, now the tallest karri in south-western Australia. Photograph credits: photo 2*b*, M. de Jong; photos 2*a*, *c*, *f*, *h*, Grant Wardell-Johnson; photos 2*d*, *e*, *g*, Joe Dortch.

Fig. 3. Outstanding Universal Value for science or conservation (Criterion x), ongoing ecological and biological processes (Criterion ix) and ongoing geological processes (Criterion vii) in the tall forest region of south-western Australia. (*a*) Tufa threatened ecological community, Cape Leeuwen; (*b*) *Podocarpus drouynianus*; (*c*) *Cephalotus follicularis*; (*d*) *Spicospina flammo-caeulea*; (*e*) *Descolea* aff. *maculata*; (*f*) peat swamp habitat of *c* and *d*; (*g*) *Anthocercis sylvicola*; (*h*) *Setonix brachyurus*; (*i*) *Eucalyptus jacksonii*. Photograph credits: photo 3*a*, Kim Williams; photos 3*b–i*, Grant Wardell-Johnson.

power. These conflicts define implementation of ecosystem management in real places (i.e. the tall forests of SWA) as social catchments that influence decision-making in context (Ernoul and Wardell-Johnson 2013), including communities of place, identity and interest (Duane 1997).

Values that influence decisions about these tall forests can be distilled through seven capitals: social capital – *cultural*, *social*, *human*; economic capital – *financial* and *physical*; and ecological capital – *environmental* and *natural* (Bourdieu 1986; Flora and Flora 1996; Wardell-Johnson 2011). Within social dimensions of capital, *cultural capital* develops within the family sphere and is a non-economic means of acquisition (Bourdieu 1986). *Human capital* relates to individual human attributes generated through acquisition of education consolidated through *social* and *cultural capital*. Consolidation of the networks of trust and reciprocity between people develops into *social capital* (Portes 1998) that can have a multiplier effect on other forms of capital (Siisiäinen 2003).

Within the economic dimension, *financial capital* is convertible to money and is institutionalised as property rights. *Physical capital* includes infrastructure and material assets, and may also result as an outcome of *social capital*. Within the ecological dimension, *environmental capital* encompasses the ecosystem services generated through soil, water and forests, potentially as asset value in the private domain. *Natural capital* represents values from the natural world, such as intrinsic values of biodiversity, that hold symbolic value as a partial public good, which rarely holds market value. *Natural capital* is also a multiplier capital with value for all other capitals (Wardell-Johnson 2011). This framework of capitals reflects both symbolic and material values.

Different values of individuals and societies are reflected by the relative emphasis on the value of these capitals. Identifying these relative values provides a means of locating environmental discourses along a continuum (Dryzek 1997; Wardell-Johnson 2005). We apply this values framework to define binaries between radicalism and reformism on the one hand, and prosaic (business-as-usual where political positions and practice are reproduced) and imaginative (innovative approaches to intractable issues) discourses that challenge (or do not challenge)

status quo positions on the other (Dryzek 1997). Thus six discourses have been defined (Dryzek 1997; Wardell-Johnson 2005; Ernoul and Wardell-Johnson 2015). These include: (1) *Environmental Rationalism* (ER), which privileges *environmental* and *natural capital* for the use and service of people as a resource holding economic value; and (2) *Environmental Problem Solving* (EPS), operating within existing governance frameworks (the *status quo*), to position humans as central to solving environmental problems by drawing on scientific resources. In this prosaic position, discourses are premised on the assumption that forests regenerate timber as economic assets following exploitation (Underwood *et al.* 1991).

An intermediate group on this continuum includes: (3) *Survivalism* (SV), a radical position coined by Dryzek (1997) to represent the notion that the Earth's resources are finite and that solutions to environmental issues revolve around limiting consumption and human populations, as advocated by Paul Ehrlich (Scott *et al.* 2007); and (4) *Sustainability* (SY), which frames environmental solutions as an interaction between social, ecological and economic values, with the needs of future generations in mind, after the Brundtland Commission 1987 (WCED 1987). This position particularly locates people as stewards of the Earth, drawing on older notions of Arcadia. These perspectives assume that forests can be managed to achieve a wide range of desired ends.

Imaginative discourses include (5) *Green Rationalism* (GRA), a reformist position, that locates humans as part of nature. This discourse acknowledges humans (and science) as significant problems, requiring the framing of solutions using scientific techniques. The ecological end of the continuum is a radical position: (6) *Green Romanticism* (GRO), which may be recognised as ecocentrism (e.g. Batavia and Nelson 2016). Nature is central and people's needs are not given primacy over any other part of nature. These somewhat artificial dichotomies provide a means of differentiating values embedded in, and underpinning, decisions.

The practice of environmental management is mediated by different voices and values, with literature showing diverse paradigms. Advocacy positions are consolidated and reinforced within knowledge systems, at the expense of building capacity through additional voices and values (Rydin 2006). When the tenets of social justice and peace are applied, expression for all contributors in the process is made explicit (Wardell-Johnson and Selvaratnam 2011) by dint of actor and agency (Steiner 2008). We have selected this knowledge framework to render 'cultural blindspots' visible (Mühlhäuserler 1995; in Maffi and Woodley 2010). Thus we consider three knowledge systems as contributors to environmental management. The collective knowledge of Indigenous peoples, generated over deep time (*Indigenous knowledge*) is differentiated from *local* and *scientific knowledge. Local knowledge* is derived through experience in context in decentralised cultural communities, while *scientific knowledge* is generated through formal and abstract training (Wardell-Johnson and Selvaratnam 2011). This differentiates knowledge frameworks from the interests of sectors.

The literature, statements and analysis

The key rationales and eras in tall forest management covered in this study provide data in the form of statements. Our collation spans the period 1831–2018 (187 years) and includes 63 documents (Table S1 available as Supplementary Material to this paper) and 118 statements reflecting the history of tall forest management in the region. These statements represent the six discourses defined by Dryzek (1997) and Wardell-Johnson (2005) for identifying advocacy positions. For this component we sought clarity and succinctness within statements, and contrast between statements to encompass the diverse history of advocacy.

The many influences on advocacy include the four *conflicts*, seven *capital-values*, three *knowledge systems* and six *environmental discourses* and provide a rich context to describe embedded values. To operationalise these values, we integrated 20 'presence/absence variables' to characterise a range of 'discourses' framing advocacy positions. Note that 'presence' may be in multiple variables from any one group (e.g. one statement may embed each of several capitals, conflicts, knowledge systems and discourses). It is also recognised that these statements do not imply an inviolate position by the authors. Further, multiple perspectives can occur within any one document, and positions by authors may vary from document to document, and over time. Nevertheless, statements have meaning, and influence (or are influenced by) policy and management decisions, particularly when delivered from positions of power (Foucault 1991). Each statement in the text that follows is accompanied by its derived discourse and statement number in bold (e. g. **SY1** refers to the derived '*Sustainability* discourse', Statement 1, as listed in the two-way table – Fig. S1, Supplementary Material).

The presence (or absence) of each of the 20 variables based on interpretation of each of the 118 statements provided a 118 statement × 20 variable matrix. We then applied numerical taxonomic approaches (Belbin 1990), using PATN 3.2 (Belbin 2013) to derive patterns to show relationships between value variables, and the descriptive context variables. Cluster analysis (Bray–Curtis Metric, UPGMA, Beta = −0.1) was used to derive groups, and ordination (SSH MDS) and network analysis (MST) to determine congruence of the approach. A two-way table displayed relationships between statement and variable groups (Fig. S1). We also determined whether the derived discourses differed, based on the scored variables (ANOSIM).

To characterise advocacy positions, we also scored the 118 statements against 15 extrinsic variables associated with the context of these statements. This context included the *era* in which the statement was made, the *sector* to which the author belonged, and the *gender* of the (first) author. Six *eras* of rural policy discourses have been recognised in Australia (Wardell-Johnson 2008*a*, 2008*b*) and are used as the basis for identifying eras in the history of forest management (see also Dargavel 1995; Davison 2005; Kanowski 2017). The era of *Deep Time* is also recognised. The post-invasion period to 1900 can be referred to as *Colonial*, between 1900 and 1939 as *Country Life*, 1939–1966 as *Reconstruction*, 1966–1985 as *Modern Rurality*, 1985–2008 *Sustainability*, and post-2008 *Resilience* (Wardell-Johnson 2008*a*, 2008*b*). *Gender* character may be linked to environmental attitude (Dunlap *et al.* 2000).

Statements were also allocated according to sectoral representation, whereby the employer of the first-named author provided the basis for allocation of sector. These sectors were:

(1) Professional–NGO, (2) Activist–NGO, (3) Professional–business, (4) Private–research, (5) Professional–public sector, (6) Research–government, (7) Research–academic, or (8) Tourism. These 15 variables (i.e. six *eras*, eight *sectors* and *gender*) were recorded and used as extrinsic variables to provide descriptive capacity for the discourse value frames identified in the numerical taxonomic analysis of the 118 statements × 20 variable matrix.

Numerical taxonomic analysis to identify discrete value frames was followed up with close textual analysis in each after Wardell-Johnson *et al.* (2018). We aimed to identify forest-value positions by reducing the indeterminacy of subjective impression and review (Belsey 2013). This form of critical discourse analysis identifies the power dynamics in discursive elements, particularly in relation to broad aspects of society through the positioning of self with others (Fairclough 2010).

The results of our survey of advocacy in the history of tall forest management in SWA are presented in two parts: (1) discourses derived from a numerical taxonomic analysis of statements and characterisation of these discourses based on a textual analysis; and (2) a history of advocacy in relation to seven eras within each of three rationales for forest management (i.e. *Deep Time*, *Resources*, *Conservation*).

Results: numerical taxonomic and textual analysis; discourses in tall forest management

The analysis was congruent (i.e. cluster analysis, network analysis and ordination results were consistent) at the seven-group level (Figs 4, S1), providing seven ($P < 0.0001$, ANOSIM) discourses. Six of these discourses correspond with those defined by Dryzek (1997) and Wardell-Johnson (2005) and introduced in 'Methods'. On the basis of our analysis, we have identified a seventh discourse, which we call *Indigenous Renaissance*. These seven discourses can be broadly grouped into: (A) *Resource positions* and (B) *Environmental positions*, reflected in the cut-off at the two-group level in the row dendrogram (Fig. 4*b*). The resource positions are all prosaic, and include (1) *Environmental Rationalism* (**ER**, 27 statements – 23%), (2) *Environmental Problem Solving* (**EPS**, 25 statements – 21%), (3) *Survivalism* (**SV**, 12 statements – 10%), and (4) *Sustainability* (**SY**, 21 statements – 18%). The environmental positions are at the imaginative end of the discourse continuum and include (5) *Green Rationalism* (**GRA**, 16 statements – 14%), (6) *Green Romanticism* (**GRO**, 5 statements – 4%), and (7) *Indigenous Renaissance* (**IR**, 8 statements – 7%).

Eighteen of the 20 intrinsic variables were significantly associated with the ordination axes (i.e. all but *Survivalism* and *local knowledge* – Fig. 4*c*). Six of 15 extrinsic variables were significantly correlated with these axes (Fig. 4*d*). *Academic researchers* was an extrinsic variable associated with both the GRA discourse in the environmental discourse group, and the SV discourse in the resource group. The directions of these biplots in Fig. 4*c* (intrinsic variables) and Fig. 4*d* (extrinsic variables) and in the two-way table (Fig. S1) are used to interpret the seven discourses that we derived.

The four resource discourses (ER, EPS, SY and SV) were driven by *financial*, *environmental* and *physical capitals*, and (with the exception of SV) associated with *conflicts of interest* and *relations*. *Professional public sector staff*, *Gender* (i.e. Males), and the *Country Life* era *(1900–1939)* were most associated with the resource discourses. The first two were especially associated with the SV and ER discourses. ER emphasises *environmental*, *physical*, and *financial capitals* and is not associated with *natural* or any of the social capitals. *Scientific* and *local knowledge* are associated variables, as are *conflicts of interest*, *values* and of *relations*. This discourse is exemplified by Kessell (1922) calling for increased allocation of forests for timber production in the face of agricultural advocacy:

> *The areas of our prime forests have been very largely overestimated, and the position to-day is such as to render advisable the immediate dedication of all belts of pure karri forest as soon as located.* (Kessell 1922, p. 7; **ER22**)

The EPS discourse emphasises *environmental* and *physical capitals* and *local* and *scientific knowledge* systems. *Conflicts of values* and of *interest* feature in this position. Underwood *et al.* (1991) exemplified this discourse in mentioning multiple use while emphasising timber production:

> *The karri forest region supports a substantial timber industry. Hardwood production from the karri and associated southern forests exceeds one million cubic metres annually. Detailed planning and control of the activities associated with this industry is needed to maintain high standards of utilisation and to protect environmental values* (Underwood *et al.* 1991, p. 25; **EPS17**).

The SV discourse is notable for *environmental* and *natural capital*, *cognitive conflict* and both *local* and *scientific knowledge* systems (Fig. 4). Wardell-Johnson and Nichols (1991) exemplified the SV discourse by advising that current management in sites marginal for karri is not environmentally sustainable:

> *The establishment of karri in sites where it had not previously been a dominant component … may lead to stress during dry climatic periods and hence outbreaks of the borer* Tryphocaria acanthocera … (Wardell-Johnson and Nichols 1991, p. 78; **SV6**)

The SY discourse is associated with *environmental* and *financial capitals*, with *conflict of values*, and with *scientific knowledge* systems. Lane Poole (1920*a*) exemplified this discourse by suggesting that careful forest management will allow long-term sustained yield:

> *With proper forest management and sound sylvicultural* [sic] *treatment there is no reason why there should not be built up on the wreckage of the once splendid forests of Western Australia tended forests which will yield for all-time 100 cubic feet of timber per acre per year* (Lane Poole 1920*a*, p. 31; **SY2**)

There are three environmental discourses, GRO, GRA and IR, at the imaginative end of the discourse continuum. These positions were especially associated with *natural capital* (Fig. 4*c*). The GRA and GRO discourses allocate less value to the social capitals. Rather, they are driven by moral values and aesthetics of the natural environment (GRO) and by science (GRA). By contrast, the IR discourse identifies people as integral to the natural world and is associated with all three social capitals. Each of these groups was associated with *values conflict*. Of the

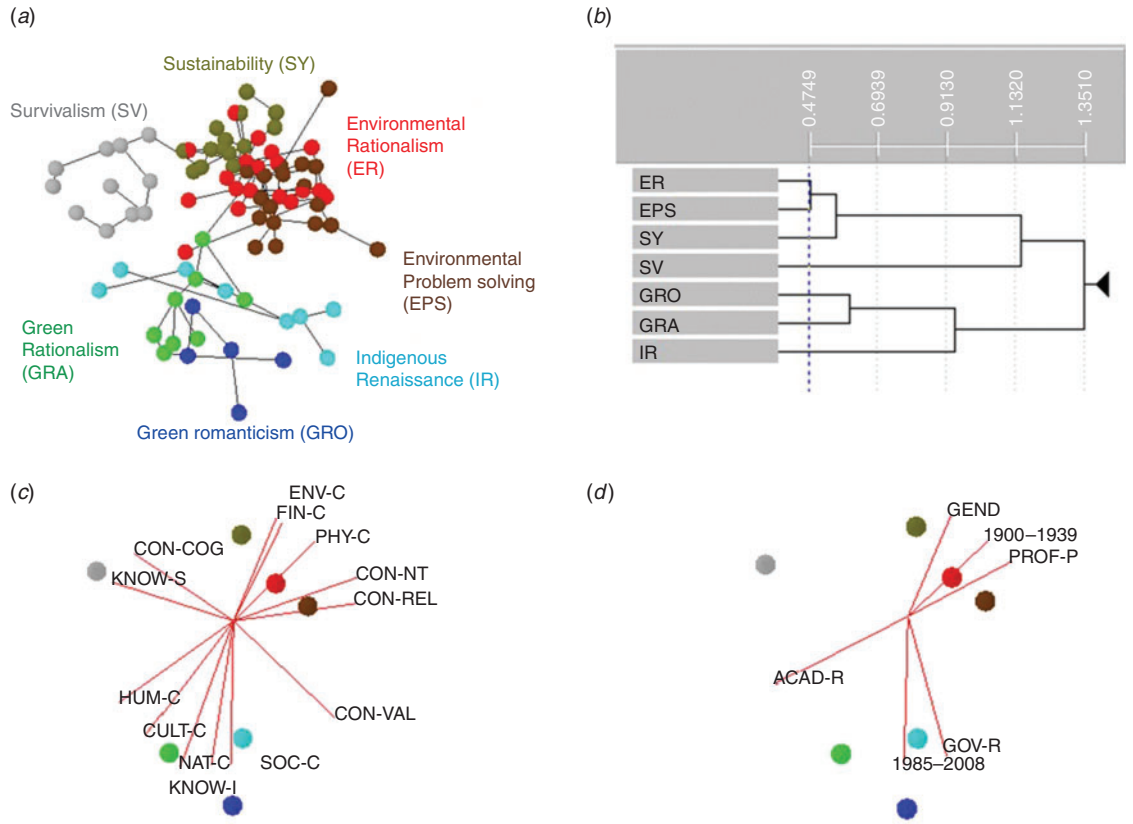

Fig. 4. Discourses based on 118 statements associated with the tall forests of south-western Australia. Statement relatedness is based on presence/absence of 20 variables (conflict: four variables; capitals: seven variables; discourses: six variables; and knowledge systems: three variables). Seven congruent (MST, MDS, UPGMA) discourse positions were derived by hierarchical polythetic agglomerative clustering using unweighted pair group arithmetic averaging (UPGMA). (*a*) 2D ordination (SSH MDS, dissimilarity cut at 0.9, stress 0.20) showing trends among statements based on variables, and network analysis (Minimal Spanning Tree) showing minimum distance joining all statements with one another. (*b*) Dendrogram classification of discourses based on 118 statements and 20 variables (UPGMA, Beta = −0.01) with cut-off at the seven group level defining seven discourses. The two group cut-off reveals two major groups of discourses (resources and environment – see text for details). (*c*) Overlays of 13 intrinsic variables significantly ($P < 0.05$) correlated against the ordination (MCAO, PCC) axes. There were 20 total intrinsic variables, 18 significantly correlated with ordination axes. Centroids of discourses are shown for clarity, while vectors for discourses are not shown. (*d*) Overlays of six extrinsic variables (15 total extrinsic variables) significantly ($P < 0.05$) correlated against the ordination (MCAO, PCC) axes. Centroids of discourses are shown for clarity. Key to vectors in (*c*) and (*d*): Significant intrinsic vectors shown include: Cognitive conflict (CON-COG), Relations conflict (CON-REL), Interest conflict (CON-INT), Values conflict (CON-VAL), Cultural capital (CULT-C), Human capital (HUM-C), Social capital (SOC-C), Financial capital (FIN-C), Physical capital (PHY-C), Environmental capital (ENV-C), Natural capital (NAT-C), Indigenous knowledge (KNOW-I), Scientific knowledge (KNOW-S). Significant extrinsic vectors shown are: Gender (GEND), Academic research (ACAD-R), Government researcher (GOV-R), Professional public sector (PROF-P), Sustainability (1985–2008), Country life (1900–1939).

extrinsic variables, *Government researchers* and the era of *Sustainability (1985–2008)* were both associated with these three discourses (Fig. 4*d*).

The GRA discourse has strong representation in *natural* and *environmental capitals*, and in *scientific* and *local* knowledge systems. *Conflict of values* is a key differentiation. This group is not associated with any of the social capitals. Hopper *et al.* (1992) exemplified this position by emphasising phylogenetic endemism of plants in the Warren Bioregion:

> *It [the Warren Bioregion] is the most important centre of endemism for conservative relictual high rainfall taxa in the State* (Hopper *et al.* 1992, p. 1; **GRA10**)

The GRO discourse is also at the imaginative end of the discourse continuum and has strong representation in *natural* and *environmental capitals*, *local knowledge* systems and *conflicts of values*. Wilson (in 1920), reported in Fernie and Fernie (1989), exemplified this position by emphasising the landscapes and aesthetics of the region:

> *You have got everything here* [what is now the Walpole-Nornalup National Park], *wonderful forest scenery, mountains, landscapes, seascapes, boating, fishing. It is one of the most beautiful single sights I ever saw in all my life. It is a fascinating place, I don't know of any other that affected me in the same way* (Wilson 1920, in Fernie and Fernie (1989), p. 47; **GRO1**)

We define IR as a seventh discourse. This discourse includes all knowledge systems and an array of social capitals. The combination of *natural*, *environmental* and *physical capitals* forms key associations but this position did not emphasise *financial capital*.

Wooltorton *et al.* (2015) exemplified this position by integrating deep time with *social* and *natural capitals* in land management:

> *The natural, living capital of Elaap Karlaboodjar is older, more diverse and more responsive than the built capital of Europe. The old trees and ecosystems … are reminders of people who experience and story our place very differently* (Wooltorton *et al.* 2015, p. 3; **IR3**)

On the basis of numerical taxonomy (Fig. 4), the IR discourse is characterised by a greater inclusion of knowledge systems and social capitals than other discourses. The combination of *natural*, *environmental* and social capitals is conspicuous. This analysis reveals a reassertion of the Indigenous in culture and nature. This discourse has affiliations with the GRO and GRA discourse in that it recognises *natural capital* as a key driver. However, unlike these two groups, the IR position includes specific inclusion of people within these landscapes. For the IR discourse, people neither are removed from nature, nor do they have it imposed upon them. This position represents the renaissance of Indigenous deep time cultural values facilitating an active reconnection with nature, acknowledging rights of people to belong to an environment, and being connected culturally. The name of this discourse does not imply that Indigenous peoples are limited to or by this discourse, that non-Indigenous people don't relate to it, or that it is new. Further, renaissance is used as a descriptor to indicate resurgence rather than conception.

Results: historical analysis

Deep Time – Aboriginal peoples and the tall eucalypt forest region

Advocacy in the era of Deep Time

Noongar oral histories include accounts of rising postglacial sea levels (~18 000 to 6 000 years ago), testimony to long occupation (Stocker *et al.* 2016). There is abundant evidence of Noongar land management before European invasion, particularly through the use of fire (Hallam 1979; Lullfitz *et al.* 2017). For example, Noongar people managed coastal *Agonis* as a woodland with the use of fire, which it is claimed later settlers maintained (Christensen 1992). The historical structure of this woodland is, in many areas, still discernible as a cultural landscape.

Several sources suggest management of tall forest resources by small Noongar populations with correspondingly subtle impacts. Historical evidence suggests that the tall forests of the wetter south coast were burnt at their margins or generally less frequently than surrounding vegetation (Hallam 1979). Oral histories indicate that Aboriginal people regulated their burning in the tall forest region to allow prey animal habitats to mature, notably 'tammar thicket'. Tammar (*Macropus eugenii*, the brush wallaby) were hunted from mature thickets by driving or firing (Kelly 1999; cf. Hallam 2002). Archaeological evidence of Aboriginal activity in and around karri forest includes the Northcliffe silcrete quarry, where outcrops were quarried for tool-stone, implying that either the forest was burnt, or pathways were maintained for access (Dortch 2005). Evidence from cave sites shows that sites were occupied less often, or less intensively, as tall forest encroached around sites, but they were not completely abandoned (Dortch 2004).

Some hundreds of archaeological sites have been reported from the tall forest region, including occupation sites in caves (Dortch and Wright 2010) (Fig. 2*e*) and in the open air (Ferguson 1981, 1985) (Fig. 2*b*, *d*); fish traps (Dortch 1997) (Fig. 2*g*); rock art sites (Gunn *et al.* 2011); and numerous modified natural features from 'burley holes' (for grinding burley for fishing) in coastal rock platforms, to trees notched for climbing to catch possums (Meagher 1974). The waters of Lake Jasper, near Northcliffe, on the southern edge of the tall forests, rose to their present levels some 4000 years ago, and inundated occupation sites and forest trees (including karri), creating Australia's only underwater Aboriginal sites (Dortch 1997).

Long archaeological sequences have been reported from the calcarenite Leeuwin Ridge between Capes Leeuwin and Naturaliste (Dortch and Wright 2010). The rich vertebrate remains from the two oldest cave sites, Devil's Lair and Tunnel Cave (Fig. 2*e*), overlap with the last glacial maximum 30 000 to 19 000 years ago (Lambeck *et al.* 2014), when sea levels were 130 m lower than those of today and there was an extensive coastal plain west of the present rugged coastline. The southern Australian Pleistocene climate was cooler and more arid than the climate today. Analyses of faunal remains and charcoal reveal an arid-adapted fauna and woodland/open-forest woody plants during this time, changing to closed habitats and karri from ~11 000 years ago (Dortch and Wright 2010). Considerable climatic fluctuations over tens of millennia of occupation imply changes in ecosystem management by people throughout this time, although evaluation of deep time changes in fire regime is a considerable challenge (Lullfitz *et al.* 2017):

> *'The Land is the Law': This means that the land is sacred and the basis of meaning. The relationship between people and the land determines our humanity and is the pattern for social relations.* (Graham 1999, p. 106, in Stocker *et al.* 2016, p. 845; **IR2**)

Advocacy in the eras since European invasion

SWA's historic record chronicles early 19th century Noongar economic and settlement patterns (e.g. Meagher 1974). Several key adaptations by Aboriginal people in the tall forest region are evident. Use of tall forests included the right to burn vegetation following traditional controls within a system of inherited land connections and kinship rights (Dortch 2002; Hallam 2002). These were tied to religious and spiritual beliefs (Lullfitz *et al.* 2017). Although tall forests may have been less often visited, they possibly played a similar role in Noongar cosmology as that of remote or inaccessible places in many cultures (Maffi and Woodley 2010).

To travel these tall forests, Noongar pathways followed stream valleys and crossed at campsites near sources of permanent water (Hallam 1979). Noongar paths traversing the tall forest region appear to have been followed by early European colonists and cattle-farmers, often with Noongar

guides, and eventually formed roads such as Deeside and Wheatley Coast Roads (Crawford and Crawford 2003). For much of the late 19th and early 20th centuries, drovers and farmers burnt the forest at a scale that perhaps resembled pre-European Noongar burning. Nevertheless, given that new arrivals strove to make the country much more open, it is possible that their burning was more frequent even before the incoming Forests Department's prescribed burning program was introduced in 1952 (Peet undated).

Nevertheless continuous occupation for at least 6000 years and into the 20th Century is recorded from areas claimed as homesteads by pioneering European settlers (Fig. 2*b*). Further, deep time land uses have not been forgotten, nor voices of the original inhabitants silenced (Collard 2009; Wooltorton *et al.* 2015):

> *The colonial enterprise has been instrumental in attempting to silence and destroy Indigenous expressions of spirituality. At the same time there has been much reliance upon Indigenous forms of knowing, Indigenous men and women of high degree, and the labour and guidance of young people* (Collard and Palmer 2015, p. 875; **IR4**)

Resources – managing tall eucalypt forests for timber production

Advocacy in the Colonial and Country life eras

The *Colonial* and *Country Life* eras spanned a period representing the frontier and the pioneer through to idealism and the imposition of order on the natural world. The tall forests (karri in particular) are more remote with a smaller distribution than the jarrah forests. Hence they were 'discovered' by the new colonists and exploited much later than the jarrah forests, for which sawmills had already become established by 1834 (Calver and Wardell-Johnson 2004). However, early colonial explorers and botanists noted the significance of the tall forests (e.g. Bannister 1831):

> [The Porongurups] *furnish a soil which is covered with gigantic gum trees many of them 100 feet high, without a branch – by far the finest timber I have ever seen in any country* (Drummond 1849, p. 234; **ER24**)

The tall eucalypt forests of Boranup, near the early settlement of Augusta (1830), and those around Denmark near the early settlement of Albany (1826), were exploited relatively early (Goodacre 2005). M. C. Davies established his first sawmill at Cooldardup (now Kudardup) in 1883, based on his 168 000-acre timber concession (Goodacre 2005). The Millar Brothers established a mill at Torbay, west of Albany, in 1884 (Christensen 1992).

Initial exploitation of karri in the tall forests was largely uncontrolled until the *Forests Act 1918* brought the SWA forests under active State management. In the main karri belt, clear-felling with regeneration was adopted with the passing of the *Forests Act 1918*. Approximately 8 680 ha of karri forest were logged and regenerated before 1939, when selective logging replaced clear-felling. Large areas of tall forest, particularly near Denmark, and subsequently (1920s) Northcliffe and Augusta, were released for agriculture and cleared. At that time the Western Australian Minister for Agriculture, James Mitchell, was an advocate for the release of tall forests as agricultural land through the Group Settlement Scheme (1921 to ~1936), expressing views often conflicting with those of Conservator of Forests, Lane Poole:

> *Herein lies the great strength. To get the last acre selected and the whole of the cultivable land put to its fullest use is the aim of my party.* (Mitchell 1930, quoted in Bolton 1992, p. 92; **EPS10**)

> *I never had my own way in anything, and that today the feud between the Lands and Forests Departments was more intense than it had ever been. … I could see the fight must go on until all the forestland was finally and permanently reserved for growing timber; that the fight to date has been a losing one all along …* (Lane Poole 1921, in Dargavel 2008, p. 71; **ER25**)

However, the Group Settlement Scheme caused considerable hardship for those involved, including returned soldiers and their families. Expectations that the size of the trees reflected agricultural productivity were not borne out. The low rates of essential trace elements in these soils and their importance in agriculture were only discovered much later (Gartrell 1968). Because the land was deemed unsuitable for agriculture, and governments recognised the need to retain forests to supply timber, most tall forests of the region (excepting desirable agricultural lands along river valleys), were dedicated as State forest from the 1920s to the early 1950s (Calver and Wardell-Johnson 2004).

Advocacy in the Reconstruction and Modern Rurality eras

The eras from *Reconstruction* (commencing in ~1939) through *Modern Rurality* (commencing in ~1966) represented the broad-scale industrialisation of forestry in the tall forests of SWA. In 1939 selective logging of karri replaced clear-felling, resulting in two-tiered forest that is a mixture of old-growth and regrowth trees. By 1967 alienation for agriculture was no longer seen as a threat to State forest, and a wood chipping industry based on the tall forests was planned. This resulted in the reintroduction of clear-felling of tall forest in 1967, and the wood chipping industry commenced in 1976 (Conacher 1975).

The return of clear-felling coincided with changes in technology and the introduction of chainsaws and heavy machinery. At the stand level, use of the axe before 1939 meant that despite clear-felling, stands retained many standing dead and unmerchantable trees. At the forest level, with increased mechanisation, more soil was compacted, fewer trees were retained, access increased disturbance, and a greater overall level of cut was achieved. In addition, larger sawmills and the 'marri woodchip industry' demanded substantial volumes of karri to meet contracted volumes and quality requirements.

The reintroduction of clear-felling was justified through claims of simulation of natural processes and regimes (Stoneman 2007). It was claimed that large areas of fire-damaged tall forest required rehabilitation through clear-felling and regeneration (e.g. Attiwill 1982). Further, it was recognised that veteran trees suppress karri regeneration (Rotheram 1983). Claims of

fire sensitivity justified clear-felling to regenerate karri forest in an industrial context:

> *… the clear-felling necessary to regenerate this forest type is essential whether there is a wood chip salvage operation or not* (Woodchip Enquiry, Senate Standing Committee on Science and the Environment 1977, p. 2209; **ER6**)

All tall forest eucalypts regenerate following disturbance, although the extent of disturbance required varies among species. For karri, this disturbance can range from tree-fall, soil disturbance, channelling by rivers and streams, through to intense fire. Stands therefore consist of multiple cohorts associated with disturbance events (Wardell-Johnson 2000). Unsurprisingly, primary karri forest (i.e. forest generated and regenerated only through natural processes – see Dean and Wardell-Johnson 2010) predominately occurs in mixed-aged stands at the sub-hectare scale (Bradshaw and Rayner 1997; Bradshaw 2015).

Response to clear-felling and wood chipping in Australia was intense (e.g. Routley and Routley 1973), including in SWA (Conacher 1975). Advocacy to 'save native forests' began with the formation of several conservation groups (Conacher 1983). The agency responsible for forest management on public lands (Forests Department, CALM, FPC, DEC, DPAW, DBCA) recognised the conflict with alternative advocacy in public involvement:

> *CALM fosters and gives support to 'Friends of the Park' and 'coastal access' groups and provides the local press with positive articles on what is being done. At this level, personal contacts are face to face and this facilitates mutual respect and understanding.* (Underwood *et al.* 1991, p. 22; **EPS20**)

However, these approaches to management planning were controversial and alternative advocacy called for an increase in the conservation reserve system (see next section: *Conservation – management and the protected area network*):

> *The WA public has once again been presented with a DFMP* [Draft Forest Management Plan] *that does not provide crucial information, ignores key scientific studies and the findings of official reviews of the previous FMP implementation, and fails completely to establish the sustainability of what is proposed.* (Western Australian Forest Alliance 2012 – not assessed)

Advocacy in the era of Sustainability

The era of *Sustainability* (commencing ~1985) was reflected in rhetoric associated with an increased array of values – but continued promotion of earlier government policy on forest management. Thus clear-felling was promoted as 'ecologically sustainable forest management' (ESFM) (Lindenmayer *et al.* 2000) and 'ecological forestry' (Stoneman 2007), and used to justify management operations:

> *Within the limitations of the data and analysis, the management of both jarrah and karri forest appears to be in accordance with the principles of 'ecological forestry' … The main strength of the model is that it aligns with the decision-making framework for silvicultural and harvest planning, and so is readily understood and can be applied by those undertaking such roles.* (Stoneman 2007, p. 564; **EPS4**)

Approaches to the monitoring of impacts also followed this line:

> *… there is no routine monitoring of a broad spectrum of biodiversity associated with timber harvesting in karri forest. Current silvicultural prescriptions are designed to align with ESFM principles and with regard to biodiversity conservation, are based on knowledge gained from research and experience, and on first principles* (Burrows *et al.* 2011, p. 29; **EPS5**)

The terms ESFM and ecological forestry have proved controversial in tall forest management with their usefulness determined by definition and caveats:

> *We argued that a conceptually complex worldview has not been duly supported by a clear normative or ethical framework, leaving ambiguities that allow a broad spectrum of different and potentially conflicting management actions to be called 'ecological forestry'* (Batavia and Nelson 2016, p. 8; **GRO5**)

High-profile advocacy by numerous groups and individuals resulted in a reduction of forest clear-felled during the 1980s, and then substantial reduction from 2001 with the election of the Gallop Labor State Government. Advocacy promoted by the Labor Party's platform reduced logging of old-growth forest and established many national parks. In addition, the dwindling supply of sawlogs undoubtedly contributed to this change in focus:

> *Current rates of cutting in the original forest cannot be sustained until a sufficient proportion of regrowth stands reach millable size. Cutting must, therefore, be progressively reduced for a period of 60–70 years.* (McNamara 1984, p. 10; **ER27**)

Advocacy in the Resilience era

The *Resilience* era, commencing in ~2008, coincided with the implications of anthropogenic climate change for forest management receiving attention in advocacy (Dean and Wardell-Johnson 2010; G. Wardell-Johnson *et al.* 2011). Thus advocacy focussed on environmental capital by engaging with the resource rationale. Warming and drying trends and projections (Bates *et al.* 2008; Wardell-Johnson *et al.* 2015, 2017*a*, 2017*b*) indicated a greater impact on SWA than for any other region in Australia (Delworth and Zeng 2014). Stand collapse associated with a rapid decline in ground water in the northern jarrah forest (200 km to the north of the karri forests) was recognised as trending southwards (Wardell-Johnson *et al.* 2015). Impacts of clear-felling on carbon stocks and the structural integrity of forests were quantified from local to global scales (Dean *et al.* 2012, 2017). In addition, effects of warming and drying were assessed (Dean and Wardell-Johnson 2010) and retention of old- growth characteristics advocated:

> *Careful management of old-growth TOFs* [tall open-forests] *in these two hotspots, to help reduce carbon emissions and change in biodiversity, entails adopting approaches to forest, wood product and fire management which conserve old-growth characteristics in forest stands.* (Dean and Wardell-Johnson 2010, p. 180; **GRA5)**

Alternative viewpoints have down-played the significance of stocks of carbon in tall forest (e.g. Bradshaw 2015), advocated use of wood products, or suggested exploitative approaches to managing carbon stocks:

> *… forests are best managed for C* [carbon] *storage by maintaining a mosaic of forests of different ages, maintaining access for fire control, and utilising harvested timber for long-life timber products and through using wood for construction …* (McIntosh and Moroni 2016, p. 10; **EPS24**)

The volume of the standing stock of timber in SWA has long been calculated by an inventory group, and annual projections concerning timber yields reported (Williamson 2015). Nevertheless, forecasts of timber from the karri forest include predictions (e.g. Conservation Commission of Western Australia 2013) involving lengthy periods for yield calculation (i.e. up to 220 years), seemingly without accounting for changed climatic circumstances. The trend in warming and drying also suggests increased complexity for fire management. A locally warming and drying climate prompted advocacy for management reflecting heterogeneity in the landscape (e.g. Wardell-Johnson and Horwitz 1996, 2000). An alternative perspective was to treat the tall forests as a homogenous entity (Abbott and Christensen 1994, 1996):

> *I can see no scientific sense, however … to suggest that there is something inherently wrong or dangerous in managing the karri forest primarily for karri* (Attiwill 1982, p. 28; **EPS26**)

Like mature karri trees, young karri are also able to coppice, or to resprout from epicormic buds. However, karri is relatively more fire sensitive up to ~25 years of age (McCaw *et al.* 1994; Bradshaw 2015). As juveniles, karri are therefore damaged more than mature trees in canopy fires (McCaw *et al.* 1994). This has led to debate about the development and impact of landscape and ecological traps (Lindenmayer *et al.* 2011; Attiwill *et al.* 2013). This is because, by the year 2000, large areas of fire-sensitive karri regrowth with dense understorey predominated in what was previously tall forest in State forest. This may render tall forest more prone to damage under severe or catastrophic fire situations than if the forest were retained unburnt and unlogged:

> *Our results suggested that the removal of mature trees since European settlement may have triggered tree and shrub regeneration, resulting in higher mid-storey cover and fire fuel hazard. Thus, managing stands for the persistence and replacement of mature trees may contribute to long-term fuel reduction in Australian forests and woodlands*. (Wilson *et al.* 2018, p. 353; **SV12**)

Given relatively slower than expected growth rates in regenerating karri (Prior *et al.* 2011; Wood *et al.* 2015), the presence of *Armillaria* fungus (Robinson *et al.* 2003) and reduced wood quality (Davison and Tay 2008; Donnelly and Davison 2008), the two-tiered forest available for logging may be fully exploited before regrowth, becoming suitable as saw-logs (Fig. 5):

> *On these projections there will be a gap of some 25 years (2042 to 2067) when there will be no karri forest aged 100 years and ready for clear-felling on the planned 100-year rotation. However, regrowth is growing much more slowly than anticipated.* (Schultz 2015, p. 1; **SY23**)

This indicates the potential for regrowth forest under 50 years of age to have reduced capacity to regain the former height or biomass of the forest it replaced even if it were not logged again (Dean *et al.* 2017). Alternative viewpoints assumed reduced rainfall as adequate to sustain karri forest (e.g. Conservation Commission of Western Australia 2013):

> *Unlike the jarrah and wandoo forests, the vulnerability of the karri forest to climate change is lower. This is because the area of karri forest predicted to fall below the threshold of 900 mm annual rainfall from climate models for 2030 ranges from 70 to 7160 ha depending on the climate scenarios used* (Burrows *et al.* 2011, pp. 32–33; **EPS11**)

Given that the threshold for karri forest is not 900 mm but 1000 mm annual rainfall, the vulnerability of the karri forest to warming and drying may equal, or be greater than, jarrah or wandoo forests. Despite recent moves to restore pre-logging tree species composition, replacement with 'pure' karri regeneration has been adopted throughout 'karri forest' managed for wood production, including current or scheduled sites already below the 900-mm isohyet (i.e. at least 16 forest blocks such as Andrew, Barlee, Beaton and Easter: Fig. 1). This has implications for sustainability and growth of karri on clear-felled sites that are unsuitable for the growth of karri (Wardell-Johnson and Nichols 1991; Farr *et al.* 2000; Bradshaw 2015).

Implications of a reduction in rainfall or change in dominant species in stands under climate change may be masked by thinning or salvage logging (Jackson *et al.* 2008; Burrows *et al.* 2011). However, impacts of climate change may be exacerbated by thinning or salvage logging:

> *The ecological impacts of salvage logging have the potential to substantially exceed those of green logging, even traditional high-intensity silvicultural systems such as clear cutting followed by even-aged stand management.* (Lindenmayer *et al.* 2008, p. 169; **SY18**)

Removal of thinned or salvage material from site may equate to mining under a warming and drying climate (Lindenmayer *et al.* 2008; Dean and Wardell-Johnson 2010; Dean *et al.* 2012), further reducing capacity for sustainability (Jackson *et al.* 2008). Alternatives to clear-felling these tall forests have been suggested, including transformation into a boutique high-value industry (Wardell-Johnson and Calver 2005), and relatively few workers are now engaged in what is now a highly technology-driven industry:

> *Native forestry employs relatively few people in WA, here estimated to be between 170 and 330 people. There are further jobs in sawmills processing FPC* [Forests Products Commission] *native sawlogs, estimated here at 130. For context, total employment in the State exceeds 1.3 million. Forestry employment has declined over the past 15 years, while state-wide employment is growing.* (Swann and Browne 2016, p. 2; not assessed)

Conservation – management and the protected area network

Advocacy in the early new settler eras: Colonial and Country life

The eras from *Colonial* to *Country Life* (to 1939) spanned a period representing conservation of aesthetic values. Thus

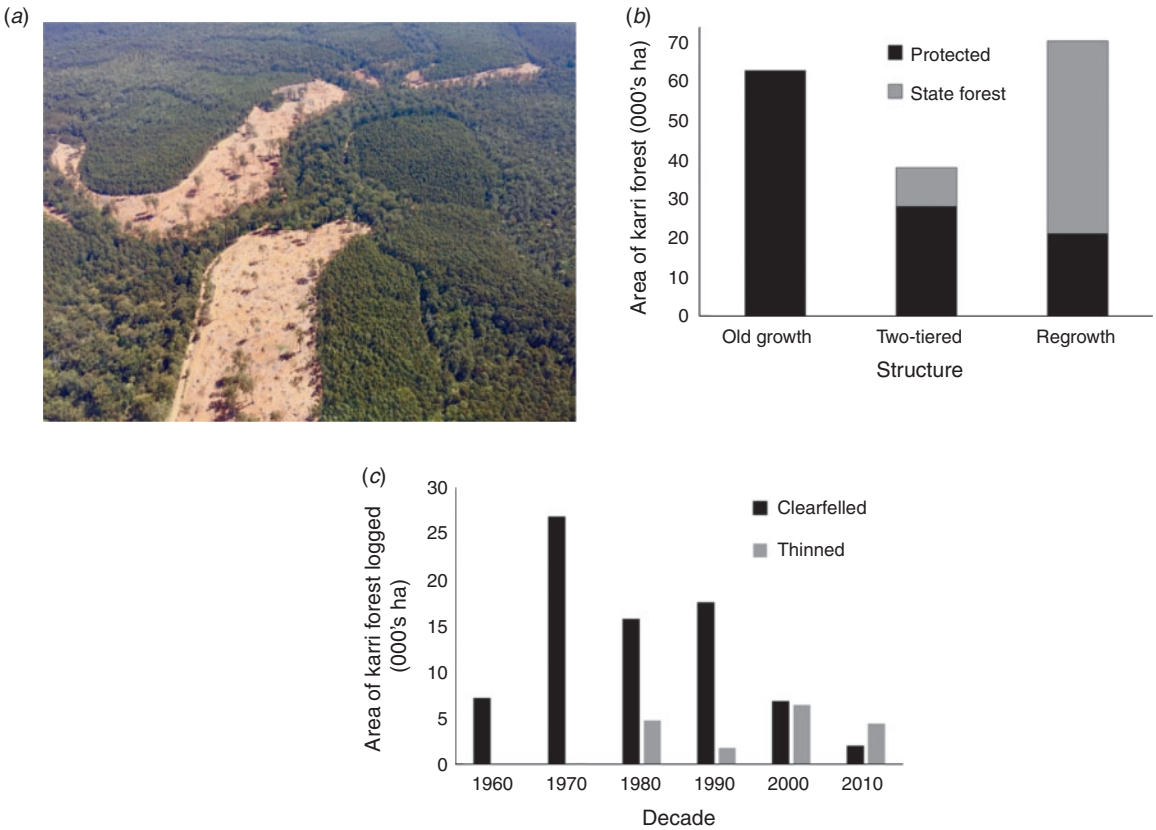

Fig. 5. Logging and structural change in the karri forest, south-western Australia. (*a*) Aerial view of State forest showing recent logging coupes, regenerating forest and mature forest in stream zones. (*b*) Area of old growth (primary forest), two-tiered and regrowth karri forest in State forest and the protected area network in 2016. (*c*) Classes of structure of the karri forest in relation to tenure in 2016. There is a 20-year gap (≈ 2050–70) in karri clear-felling on the originally planned rotation length of 100 years. However, growth rates have slowed rendering a 100-year rotation problematic. Photograph credit: 5*a*, Jess Beckerling.

European settlers advocated these values with the result that several small national parks were established to conserve scenic areas in the tall forest region (e.g. Walpole Nornalup, Porongurup Range, Beedelup Falls, Warren as initially gazetted: Fernie and Fernie 1989):

> *The 'virgin forest' is most usually thought of in terms like huge, magnificent, sombre, primeval, and even eternal – the best of the karri forest that we see, say, at Warren National Park.* (Attiwill 1982, p. 27; **GRO2**).

These early parks protected ~5% of tall forest as dominance of the exploitation ethic limited establishment of conservation reserves. However, inaccessibility and lack of knowledge of the importance of trace elements initially restricted wide-scale alienation for agriculture. Thus, at this time there was still flexibility concerning expansion of the protected area network.

Advocacy in the eras of Reconstruction and Modern rurality

The eras from *Reconstruction* (commencing in ~1939) through *Modern Rurality* (commencing in ~1966) represented a rise in alternative forms of advocacy concerning the protected area network. With the reintroduction of clear-felling (1967) and subsequently wood chipping (1976), several concessions were made by State Government to conservation interests. Thus, in the Forests Department's General Working Plan No. 86 of 1977 (Forests Department of Western Australia 1977), parts of State forest were designated as management priority areas (MPAs) for the conservation of flora, fauna and landscape. Many important conservation areas were thus established (Burrows and Christensen 2002), although conservation was not always the primary motivation in reserve choice:

> *Vegetation on steep slopes can … be difficult to extract for commercial use … It is reasonable for conservation to be allocated such areas with those of easier gradients and uniform type allocated for harvest. The Lower Shannon, O' Donnell, and Strickland M.P.As were selected partly for these reasons …* (White 1977, p. 21; **EPS11**).

Further, the Forests Department envisaged that these MPAs could eventually be logged:

> *Eventually … the regeneration process should be instigated by man. … The option to regenerate and to use the tools required (fire, wood harvest) must remain with the managing authority, within the constraints of the working plan … As the healthier, less over-mature virgin stands are selected for*

> *MPAs, the decision to regenerate or not has been postponed as far as possible into the future.* (White 1977, p. 21; **ER13**)

This approach was contested, with the conservation community condemning choice of areas being dictated by production demands rather than ecological or environmental considerations (South-West Forests Defence Foundation Inc. 1986). Thus, the conservation community advocated greater security of purpose for the conservation estate. The State Government established the Conservation Through Reserves Committee (CTRC) in 1972 to review existing parks and reserves, and to recommend new areas. In its report (1974), the CTRC recommended that clear-felling not be permitted in the Shannon River Basin (59 881 ha) during the first 15-year licence period of the Wood Chipping Industry Agreement (i.e. before 1991). It further recommended that towards the end of this period, a substantial area of the basin be set aside in perpetuity as natural forest and managed as if it were a national park. The conservation community then ran an eight-year campaign to 'save the Shannon Basin' (South-West Forests Defence Foundation Inc. 1986). The Australian Labor Party adopted this as policy, which was implemented following the 1983 State election. It was claimed that the karri forest in the Shannon River Basin was fire damaged and required rehabilitation (i.e. clear-felling):

> *The fire-damaged forests of the central Shannon having been rehabilitated, the suitability of the central Shannon for reservation should be reviewed at some time (perhaps one or two decades) in the future.* (Attiwill 1982, p. 35; **ER5**)

This pretext for logging in the Basin was rejected, and the Shannon Basin was gazetted as national park in 1988. Recognition as national parks or nature reserves of areas that had been listed as MPAs for flora, fauna and landscape also occurred following the 1983 State election. Meanwhile, a proposal to halve the width of road, river and stream reserves was met with disquiet. Some argued for greater recognition of the value of stream zones (Wardell-Johnson *et al.* 1991), while others suggested that environmental values would not be compromised by reduction in stream-zone width:

> *This study indicated that, if necessary, additional timber resource could be obtained by cutting in some stream buffers … by reducing the width of stream buffers to 50 metres, no significant impacts on water resources were evident.* (Underwood *et al.* 1991, p. 28; **EPS22**)

However, the State Government announced its intention to obtain 655 000 m^3 of sawlogs from road reserves, 320 000 m^3 from stream reserves and 100 000 m^3 from river reserves, to replace some of the claimed 1 705 000 m^3 of sawlogs (1 278 000 m^3 karri) withdrawn from timber production through the reservation of the Shannon River Basin (WA Parliament, Hansard, 17 September 1985, p. 1078). The conservation community saw this as evidence that these reserves were not protected from logging.

Advocacy in the eras of Sustainability and Resilience

The eras from *Sustainability* (commencing in ~1985) through to the era of *Resilience* (commencing in ~2008) coincided with a wide array of advocacy positions and increased scientific attention to the natural capital in what became recognised as the South West Australian Global Biodiversity Hotspot (Myers *et al.* 2000), owing to the high levels of endemism and increasing threats in the general region.

D'Entrecasteaux National Park was established in 1980 following recommendations by the CTRC for a south coast national park to preserve a large area free from human development. Together with the Shannon, these parks and adjacent reserves cover 171 778 ha. Following election of the Australian Labor Party to State government in 2001, there were further substantial increases in the protected area network. Forest blocks such as Jane and Sharpe, for which conservation groups and local communities ran successful campaigns, were gazetted as national parks.

Since 2001 there has been a substantial increase in reserved area, so that by 2018, 49% of tall eucalypt forests and 31% of the Warren Bioregion are within the statutory reserve system (Wardell-Johnson *et al.* 2016). This region (947 500 ha) now includes the highest level of reservation of the nine south-western Mediterranean-climate bioregions (Wardell-Johnson *et al.* 2016). It is also the least cleared of the SWA high-rainfall bioregions (18%) and contains the largest area in public ownership (i.e. State forest or similar) (Wardell-Johnson *et al.* 2016). Nevertheless, there remains disquiet as to the value to society of logging SWA's tall forests. Advocates draw attention to the loss in *natural*, *environmental* and *financial capital* through logging and to the financial benefits of maintaining tall forest stands:

> *Under the stewardship of the FPC, the real value of the forests has halved, the quality of the wood has declined, the amount of sawn timber recovered from sawlogs has fallen, and the volume of wood produced from each hectare logged is down. Current trends give no indication that native forestry is sustainable in the SW forests.* (Swann and Browne 2016, p. 33; **EPS13**)

Meanwhile, others have urged greater integration of knowledge systems for improved outcomes in forest management:

> *Opportunities for Indigenous and Western worldview exchanges* in *the bushfire management sector, through collaborative knowledge partnerships could assist the sector in both management practice and policy formulation.* (Ruane 2018, p. 1; **IR7**)

Discussion

Our survey of the history of management of the tall eucalypt forests of SWA reveals that there have been many millennia of interaction among people, climate change and tall forests, during which a broad range of land management options were practised. Significant environmental change occurred during this time – including possible influences from Aboriginal management (Hallam 1979; Sandom *et al.* 2014). However, the 150 years since commencement of industrial-scale exploitation for timber reveal a fundamental shift in interactions between people and the environment. Following European invasion, initial discourses from both the resource and environmental positions are suggestive of *terra nullius*, and rarely include a component of people, either Aboriginal or the new colonists. This recent period is notable for continued clashes between

advocates, as well as a reduction in land-use options in exploited forests. Statements from this period reveal a tendency (discourse position specific) to inflate the amount of exploitable resources, and to underestimate impacts of timber exploitation. This is especially in relation to what is now becoming a more rapid change in climate than that previously experienced. Thus there has been evolution in society's values concerning tall eucalypt forests, gradually shifting from a resource focus to integrate environmental and socio-cultural values in the way remaining intact forest is valued.

This follows the pattern of many recently exploited but globally significant forest environments.

Discourses, eras and advocacy in tall forest management

We have applied a framework of seven eras and seven discourses to outline a history of advocacy in the management of the tall forests of SWA. Our results have defined the *Indigenous Renaissance* (IR) discourse, which we identify as critical to achieving sustainability of these forest ecosystems. This discourse is associated with recognition that people are strongly linked to the landscape and the need to understand local-scale natural capital. The era of *Deep Time* saw significant climate change, including many tens of metres of change in sea level and in the distribution of forest types. Nevertheless, retention and building of culture were evident during deep time association and intrinsic connection to the land. Similarly, continuance and reassertion of the IR discourse reflects a broad connection of social, natural and environmental capitals, as well as a range of knowledge systems.

Of the seven discourses, only the three at the imaginative end of the continuum: *Green Romanticism* (GRO), *Green Rationalism* (GRA) and *Indigenous Renaissance* (IR) featured *natural capital* implicitly or explicitly within their frameworks. These discourses have consistently been marginal to the *status quo* throughout the recent 200-year history of the SWA tall forests (and forests more generally). This is reflected in the commonplace situation of both low resourcing and low political influence compared with resource-oriented positions (e.g. Crase *et al.* 2011). The extraordinary diversity and endemism within SWA's tall forest ecosystems impel greater consideration of natural capital in forest management.

However, two of these discourses (GRA and GRO) feature a low value of people in the landscape. Mainstreaming the natural and social capitals is necessary to build local connection to forests, and increase federal support and global interest. These forests are of global significance, similar to the Great Barrier Reef, and south-east forests, which have been recognised as globally significant and of World Heritage. Increased local and global support will require mainstreaming the IR discourse, engaging the three critical pillars of knowledge in environmental management.

At the other extreme, the prosaic perspectives of *Environmental Rationalism* (ER), *Environmental Problem Solving* (EPS), *Survivalism* (SV) and *Sustainability* (SY), encompassed *financial*, *environmental* and *physical capitals* and are resource focussed. These positions enabled vesting of forests, but did not link colonising people's needs to the landscape to which they were new. At this time, rationalist agricultural positions were more influential. However, this position became dominant following certainty of tenure of the tall forests as State forest. Thus the dominance of these discourses led to large-scale transformation during the *Reconstruction*, *Modern Rurality* and *Sustainability* eras of tall forest management in SWA. Visionary Conservators Lane Poole and Kessell were instrumental in the vesting of forests during the *Country Life* era. Their vision of cultivation preceded understanding of inherently low productivity in old, stable landscapes (Hopper 2009; Mucina and Wardell-Johnson 2011). Further, their vision reflected an era of invasion by European people and the notion of *terra nullius*, which did not include the inherent perspective of people's relationship to land. Thus subsequent forestry leaders promoted broad-scale exploitation of these public assets without acknowledging the impact on loss of *natural*, *environmental*, *physical* and *financial capital* (see Wardell-Johnson *et al.* 2015, 2016).

Maintaining a colonial approach to management allows experts to decide for the State and society. This approach may have suited the State for a time; as it was for the Crown in Tudor England, but did not result in the versatility required by democratisation of the forests, or capacity to respond to changing climatic circumstances. There is, for example, suggestion of a historically limited perspective within the Forests Department of Western Australia. Thus the *Forests Act 1918* was not amended until 1976 to allow graduates in professions other than forestry (graduated in the main from the University of Melbourne and the Australian National University) to occupy positions in that department. Contemporary governance recognises change as inherent in society with diverse values represented through public engagement (Williamson 2015; Kanowski 2017). The rapid warming and drying in the region require agile responses to engage solutions that prevent irreversible damage to natural and environmental capital. In an era of change, the future of these tall forests will require a greater role for advocacy that reflects society's broader values.

Resource use and the tall forests of SWA

Timber production and agriculture were pioneering industries in SWA's tall forest region. However, agriculture removed extensive areas of forest, while timber production structurally transformed much of the remaining tall forest from mixed-aged ecologically intact to even- aged regeneration less than 50 years of age (Fig. 5).

Logging of tall forests on publicly owned and managed lands is becoming less acceptable to society in SWA (Wardell-Johnson *et al.* 2017*a*). Low levels of acceptability are exacerbated where logging becomes a form of mining. This is because of the large and extensive impact on biodiversity, low value of products, high carbon footprint (Dean and Wardell-Johnson 2010; Dean *et al.* 2012), few beneficiaries, and opportunity cost of alternative land-uses. Relatively low fertility (globally) and rapid reduction in rainfall exacerbates these problems. Resistance by some sectors of society has hindered change (Harich 2010). Fortunately, much of the remaining intact tall forests of SWA is likely to meet a wide array of society's values (Watson *et al.* 2018).

Maintaining ecological integrity will increasingly require integration of sustainability values (i.e. social, ecological and

economic) and ethics (Batavia and Nelson 2016) into conservation practice (Wardell-Johnson 2011). This includes the sustainability values of the triple bottom line (environmental, social and economic: Du Pisani 2006) emphasised in this review. Historically, significant social changes have resulted from a growing moral consensus rather than a shift from utilitarianism (Batavia and Nelson 2016). This continuing shift would not preclude a timber industry. However, trends suggest that timber getting will become a boutique industry in public forests (see Wardell-Johnson and Calver 2005), with tree-based production increasingly on private land (Swann and Browne 2016). It is now evident that under rapid warming and drying in the region, this outcome will need to be expedited so that the timber resource is not 'mined' at the expense of *environmental*, *natural*, *physical* and *financial capital* (see Wardell-Johnson *et al.* 2016). In exploited public forests Lane Poole's observation is as true today as it was in 1920:

> *We have been mining our forests and have cut capital as well as interest* (Lane Poole 1920*a*, p. 32; **ER19**)

Almost all habitats worldwide have been degraded by exploitative value-frames (Halpern *et al.* 2008), and reviews of resource exploitation are bleak (Thirgood 1981; Ludwig *et al.* 1993). While tall forests of the Mediterranean basin have been impoverished by 10 000 years of exploitation (Wardell-Johnson 2018), those in SWA have been exploited for timber for less than 200 years (Calver and Wardell-Johnson 2004). Anthropogenic climate change now interacts with habitat transformation and other disturbances to amplify impacts of exploitation (G. Wardell-Johnson *et al.* 2011; Lindenmayer *et al.* 2012).

Retaining intact forests buffers the Earth against impacts of warming and drying. Intact forests have lower resource requirements and more moderating influence than regenerating forests at a time of rapidly declining rainfall (Macfarlane *et al.* 2010; Norris *et al.* 2012). Intact forests also provide a vibrant cultural environment that is highly attractive to new industries such as the emerging tourist industry (Williamson *et al.* 2012). This diversification is a re-emergence of multi-functionality shifting resource values from timber to tourism and environmental value that supports a wider range of capitals, including *physical*, *financial*, *environmental*, *natural* and *human capitals*.

Australia's south-west tourist industry uses the tall forests as a key element of its brand and generated AU$1530 million in 2016. This was up 27% from the previous year (Swann and Browne 2016). The tourist industry is increasingly reliant on intact forest to support a diverse cultural environment. Wine production and new rural industries such as truffle-growing reflect local nuances across the broader region, from Margaret River to Pemberton, Albany and Porongurup. The pathways of the first peoples of the region are now major roads connecting communities (Fig. 1). The future of the south-west forests may depend on the resurgence of the IR discourse that explicitly connects people with place.

Conclusion

Advocacy in the tall forests of south-western Australia has defended three value frames or rationales: *Deep Time*, *Resources* and *Conservation*. We have considered each of these rationales within seven eras: *Deep Time*, *Colonial*, *Country Life*, *Reconstruction*, *Modern Rurality*, *Sustainability*, and *Resilience*. This history recognises changing advocacy, which we have considered within seven discourses. Four are resource-oriented positions: *Environmental Rationalism*, *Environmental Problem Solving*, *Survivalism* and *Sustainability.* The three remaining positions give primacy to both social (*Indigenous Renaissance*) and environmental (*Green Rationalism* and *Green Romanticism*) values. In the era of *Deep Time*, people were intrinsic to landscapes, natural capital and forests. European invasion led to a period of largely uncontrolled exploitation, coinciding with the *Colonial* era. In the era of *Country Life* and following the *Forests Act 1918*, the role of people in forest management was replaced by the expert. This period preceded discovery of the importance of trace elements to agriculture, which limited conversion of tall forest to farmland. Early advocacy by Conservators Lane Poole and Kessell resulted in the establishment and gazettal of large areas as State forest at this time (Calver and Wardell-Johnson 2004; Williamson and Moore 2005; Dargavel 2008).

In the eras that followed, over-reach by the timber industry and its advocates resulted in industrial-scale exploitation of the karri forest and subsequent reaction by increasingly broad sectors of society (Williamson *et al.* 2012). The establishment of management priority areas for flora, fauna and landscape bought time for conservation regardless of longer-term intentions. Thus changing political circumstances enabled reassessment of vesting. During the *Resilience* era warming and drying in SWA became widely understood, if not acknowledged. Resource-driven advocacy associated with the 1990 20-year Regional Forest Agreement suggests that conflict has become increasingly polarised between the environmental and resource positions, often at the expense of the social positions. However, reassertion of the *Indigenous Renaissance* discourse suggests new possibilities for SWAs tall forest region.

The tall forest ecosystems of the Warren Bioregion and diverse socio-cultural values in landscapes of adjacent areas arguably meet no fewer than five criteria for World Heritage listing (Box 1). In the interim National Heritage and Queen's Canopy listing may be viable options. Many features of the region have been nationally recognised for their scientific, conservation, aesthetic and socio-cultural significance. There is now the opportunity to implement and benefit from a growing moral consensus on the valuing of these globally significant, tall forest ecosystems.

Conflicts of interest

MC is the Editor-in-Chief of *Pacific Conservation Biology*. He was blinded from the review process and had no editorial involvement with this paper, which was handled independently by other members of the Editorial Board. The authors declare no further conflicts of interest.

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