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Estimating early contact-era populations for lutruwita (Tasmania)

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Abstract

While there have been many attempts to calculate pre-contact Aboriginal population sizes for Tasmania, estimates have varied from as little as 800 to as many as 20,000. We adapt a technique employed by Noel Butlin to model Australian continental populations in 1788 to the peculiar circumstances of Tasmania. We conclude that higher, rather than lower, pre-contact populations are likely. While the direct and indirect consequences of conflict were a serious contributor to the collapse in population, introduced disease played a significant role. This included sexually transmitted disease (a cause of declining fertility), as well as pulmonary disorders and crusted scabies.

KEYWORDS

carrying capacity, colonisation, frontier violence, indigenous population estimates, Tasmania

JEL CLASSIFICATION

N37, N47, N57

INTRODUCTION

Archaeological evidence suggests that lutruwita[1] (later renamed Van Diemen's Land and subsequently Tasmania by Europeans) was first occupied by the palawa at least 40,000 BP

[1]Note that proper nouns are not capitalised in palawa kani.

(O'Connell & Allen, 2012). The island was subsequently cut off from the Australian mainland by rising sea levels following the end of the last glacial maxima around 12,000 years ago. The next contact between palawa and outsiders occurred in 1642 when the Dutch East India Company commander, Abel Tasman, briefly landed on the east coast naming the island Van Diemen's Land (it was renamed Tasmania in 1856). The first European settlement dates from 1797 when sealing crews working out of Sydney occupied some of the offshore islands. Official settlement followed in 1803 when the British government sent landing parties to secure the main anchorages in the north and south (Johnson & McFarlane, 2008, pp. 62–86 and Boyce, 2010, pp. 15–19).

Convict labour catalysed the process of colonisation. For the first 50 years following its invasion Van Diemen's Land served as one of the principal penal colonies of the British Empire. During that time, it received at least 73,500 convicts—about 45% of all those despatched to the Australian colonies. At first the number of free and unfree colonisers remained low and settlement limited to the Derwent and Tamar estuaries and their immediate hinterland (see Figure 1). Settler numbers increased following the end of the Napoleonic Wars, a period which also witnessed the growth of capitalist pastoral production. Much of lutruwita had been adapted by generations of cool burning designed to increase carrying capacity for larger marsupials. These cultivated grasslands were expropriated by the British crown who reallocated them in the form of land grants to free settlers with capital. The latter were also supplied with cheap convict labour (Boyce, 2010; Panza & Williamson, 2019). In effect the British used the labour of thieves to catalyse the processes of alienation—an act of dispossession that was resisted by the palawa (Maxwell-Stewart & Quinlan, 2022, p. 44).

As violence between the European invaders and Indigenous Tasmanians escalated increasing numbers of troops and field police were deployed to the frontier. Martial Law was proclaimed in November 1828, military posts were established on known migratory routes and parties of soldiers and armed convict police placed in remote stock huts. A series of roving parties were also formed to track down palawa bands on the move. When these tactics failed to reduce the number of attacks, over 2200 soldiers and armed settlers and convicts were deployed between October and November 1830 to sweep the settled districts. At the same time George Augustus Robinson and a small party of Indigenous Tasmanians from his mission station on Bruny Island attempted to 'conciliate' the remaining palawa. Between 1830 and 1842 most of the survivors were persuaded to surrender. They were exiled first to a series of off-shore islands before being relocated to Wybalena—a mission station located on Flinders Island (Clements, 2014; McFarlane, 2008; Reynolds, 1995; Ryan, 2012a).

A plot of Tasmanian palawa population estimates over time provides a useful demonstration of long-term shifts in the politics of counting pre-contact population numbers (see Figure 2).[2] The first estimates provided by European colonists were by Hull and Kelly in 1815. Both thought that the size of the population was around 7000. Williamson estimated 10,000 in 1820 while George Augustus Robinson thought that there were between 6000 and 8000 remaining Indigenous Tasmanians, implying a considerably higher number at the point where the British colony was first established. In 1833 Henry Melville, owner of the *Colonial Times* and a leading critic of the Lieutenant Governor Arthur's administration estimated the pre-contact population to have been 20,000 (Boyce, 2010, p. 199). By contrast Jorgen Jorgenson who had led one of the roving parties put their numbers at 2–3000 (Plomley, 1991, p. 69).

Following the deportation of the palawa survivors to Flinders Island in the 1830s there was a substantial reduction in estimates. In 1843 the Quaker James Backhouse ventured that the

[2]We are indebted to Lyndall Ryan who first used this approach in a paper delivered to the history department at the University of Tasmania in 2006.

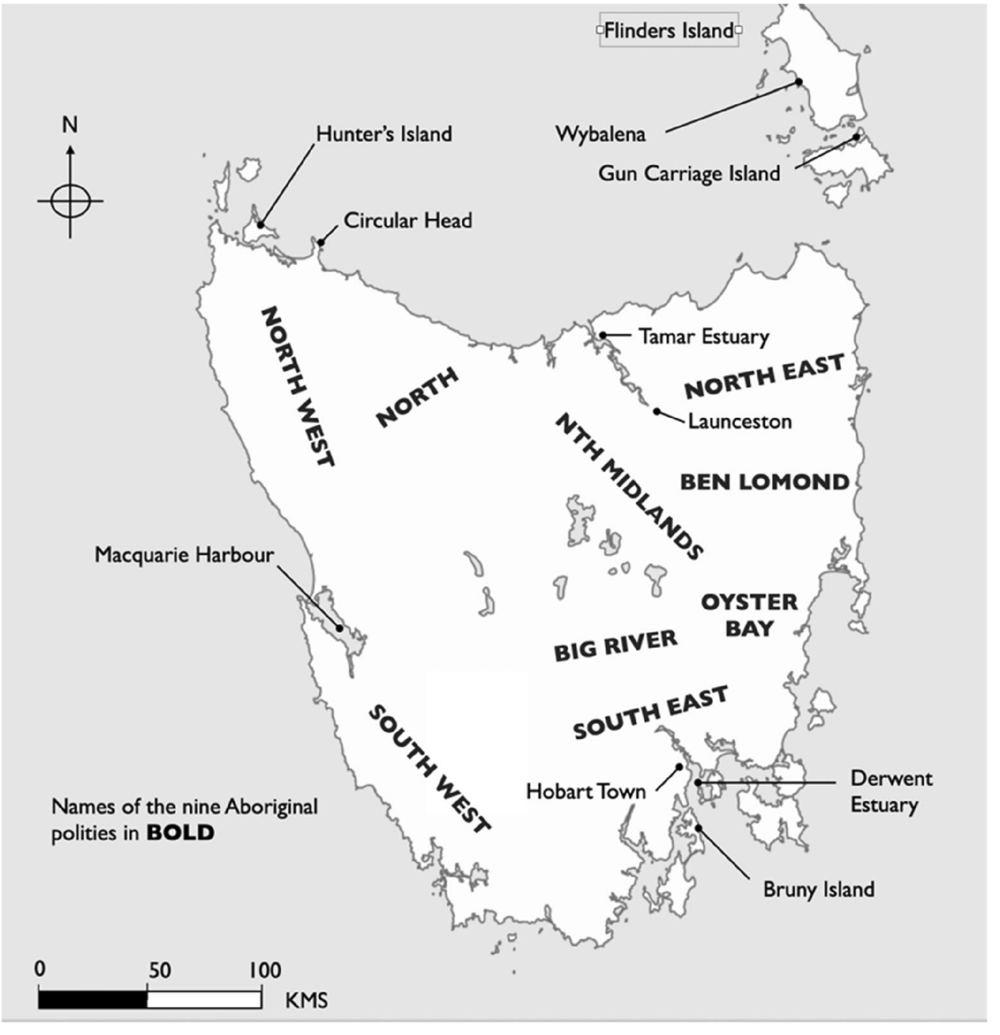

FIGURE 1 Lutruwita (Van Diemen's Land/Tasmania).

population had never numbered above 1000 and most other mid and late-nineteenth century estimates were similarly low (Backhouse, 1843). The notable exception was the surveyor James Calder who thought that the original inhabitants of the colony had numbered up to 7000 (Calder, 1972, p. 5). Early twentieth-century estimates remained low. In 1930 Radcliffe Brown put pre-contact numbers at between 2000 and 3000. Mean estimate size increased in the 1970s with the first attempts to reconstruct populations using information about band size and number. This trend has continued in more recent years (see Figure 2).

PREVIOUS ESTIMATES

Three techniques have been used to estimate pre-contact population levels: calculations based on band numbers; estimates derived from reconstructed carrying capacity; and back casts which utilise post-invasion-observed populations to model the likely impact of introduced disease,

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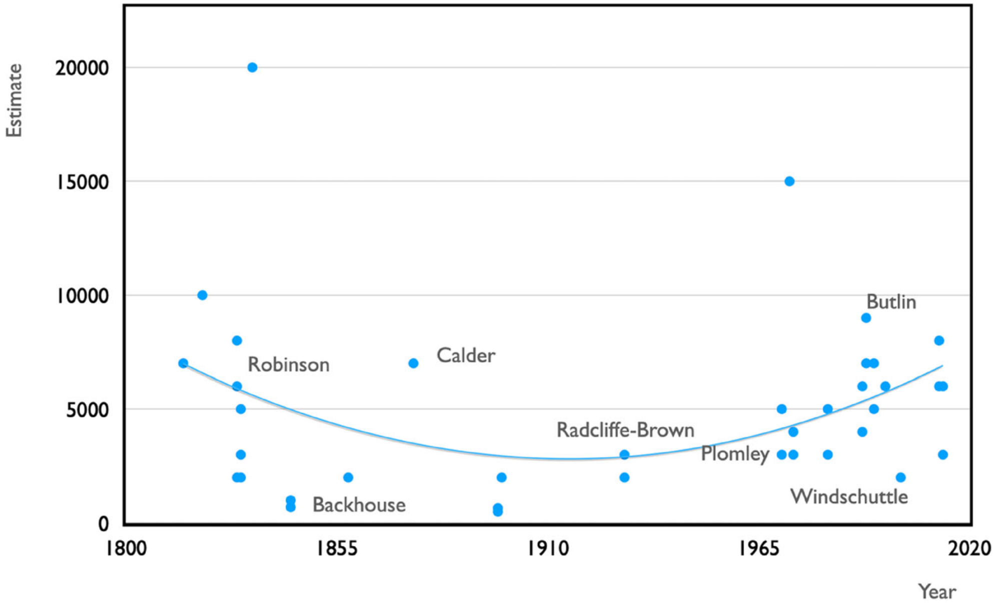

FIGURE 2 Tasmanian pre-contact population estimates. *Source*: Backhouse, 1843; Boyce, 2010, p. 199; Butlin, 1993, p. 126; Calder, 1972, p. 5; Hull, 1856; Jones, 1974, pp. 324–327; Plomley, 1991, p. 69; Plomley, 1992, pp. 3–38; Plomley, 2008, pp. 1003–1013; Radcliffe-Brown, 1930; Reynolds, 1995; Ryan, 2012a, p. 14; Walker, 1902; Windschuttle, 2003.

violence and loss of access to traditional resources. In the 1970s, two researchers N.J.B Plomley and Rhys Jones attempted to use estimates of hearth group size and bands to calculate pre-European contact population numbers. A hearth group can be defined as those who cooked together around the same fire, generally thought to have ranged in size from two to eight individuals. Several hearth groups make up a band consisting of perhaps 30 to 80 individuals. Both Plomley and Jones assumed that bands grouped together into larger associations of nations or peoples that were closely associated with a particular territory, although they moved seasonally. While bands referred to themselves by name there are few surviving palawa words for large groupings, which are generally referred to by European names. Nine such groupings are thought to have existed (see Figure 1).

Plomley (2008, pp. 1003–1013) attempted to enumerate the number of bands (which he confusingly referred to as tribes) in order to derive estimates for both regional populations and for Tasmania as a whole. At first, he identified 46 bands, although he reasoned that there may originally have been twice this number. He later revised his count to 57. On the assumption that each band averaged around 70 individuals he estimated the pre-contact population as 3990 (Plomley, 1992, pp. 3–38). Jones thought there was evidence for a minimum of 53 bands. He also noted that there was little information on the number of bands who occupied areas that were heavily colonised by Europeans in the early years of settlement and proposed that, as a conservative estimate, the total should be increased by 50%–70%. Based on the assumption that each band contained approximately 50 individuals he estimated the population for the whole of the island at between 3000 and 5000, divided between nine 'tribal' groupings (Jones, 1974, pp. 324–327).

TABLE 1 Carrying capacity estimates.

Nation	Estimated persons Per 100 km^2	Estimated population extrapolated to Tasmania (ex-King and Furneaux islands)
North-West Coast[a]	14.5	9460
South-West[b]	9.3	6068
Oyster-Bay[a]	8.0	5219
Big River[b]	4.3	2805
Tasmania low[c]	5.4	3500
Tasmania high[c]	9.5	6200

Source: [a] Binford (2001), [b] Kelly (2013), and [c]Tallavaara et al. (2017).

Existing carrying capacity estimates are available for four Tasmania regions, the areas traditionally thought to have been occupied by the South-West, Big River, Oyster Bay and North-West peoples (see Table 1). Calculating the size of territory over which each of these groupings ranged is problematic. The geographical boundaries associated with different groupings almost certainly reflect European desires to fix peoples to particular areas, rather than actual seasonal migration ranges. It is likely that the Big River people, for example, utilised highland areas in the warmer months and lowland and coastal in winter. The estimates are thus best treated as illustrative of the carrying capacity of particular environments.

The global estimates produced by Miikka Tallavaara, Jussi Eronen and Miska Luoto can also be applied to Tasmania. They modelled hunter-gatherer population size across a wide range of environments as a function of annual mean temperature and precipitation, biodiversity and the prevalence of known pathogens. As they outline, the interplay between factors can be complex. In high-productivity environments pathogen stress is more acute than in low for example. Their model predicts a population density for Tasmania in the range of 2–3.5 $\log_e$ per 100 km^2 or 5.4–9.5 people per 100 km^2 (Tallavaara et al., 2017).

We have extrapolated these estimates to Tasmania, excluding King Island and the Furneaux group which were not occupied by the palawa at the point of European contact (see Table 1). This provides a range extending from a low of 2941 (Kelly's estimate for Big River people extrapolated island wide) to a high of 9918 (Binford's North-West Coast estimate applied to the same area). Upper and lower carrying capacity ranges predicted by the Tallavaara et al model lie between these two (a low of around 3500 and a high of around 6200). An important caveat is the degree to which these models could be further adapted to take fuller account of the wholescale modification of the Tasmanian environment by anthropogenic cold burning—a form of land management which used controlled burning as a means of increasing carrying capacity. It is also possible that the storage of foods and other technologies may have averaged out population densities across different environments lifting carrying capacity in some areas thought to be sparsely populated. It should also be noted that the Tallavaara models are based on terrestrial resource variation. As marine resources formed a significant proportion of the palawa diet, these estimates are likely to be lower-bound.

The last technique, back casting, seeks to work from the known (or at least better observed) to the unknown. It uses information about Indigenous populations post-contact and estimates of the impact of introduced disease, frontier violence and loss of access to resources to model population decline over time. Such models can then be employed to predict pre-contact population levels given a variety of different historical scenarios. While the technique has not been applied specifically to Tasmania, Noel Butlin produced a set of back cast models for the Australian continent in his last work *Economics and the Dreamtime* (Butlin, 1993). This study included several observations that were specific to Tasmania.

Using Coale and Demeny's West Level 1 and 5 life tables for populations with a life expectancy at birth of 20 and 30 as a proxy for pre-contact Indigenous populations, Butlin modelled the likely impacts of colonisation on continental wide populations (Coale & Demeny, 1983). A notable feature of this exercise is that he did not attempt to provide an independent estimate of the number of Indigenous Australians who were killed as a direct result of settler aggression. Instead, he modelled the likely impact of small-pox, venereal disease, other introduced disorders, and resource loss on continental wide Indigenous populations. He argued that population decline as a result of violence was difficult to separate from the wider pressures encapsulated in the last of these factors. The progressive loss of access to hunting grounds and other resources would have resulted in starvation and population loss due to fertility decline as nutritional intake reduced. As well as deaths resulting from conflict with settlers, reduced access to traditional resources is likely to have also increased tensions between Indigenous peoples as groups displaced by the presence of Europeans were pushed into neighbouring territories. Under such circumstances it is likely that deaths due to internecine warfare increased too (Kelly, 2013, p. 158, Butlin, 1993, pp. 129–132).

A complication with any back-casting exercise is that population pressures rarely work in isolation. Reduction in access to resources, for example, is likely to have weakened immune systems which in turn would have increased Indigenous susceptibility to disease. While such interactions complicate population decline models, they also highlight the problem of emphasising a particular cause of population decline over another. There is an underlying assumption in some of the literature that some deaths can be directly attributed to settler violence, while others cannot (Windschuttle, 2003, p. 386). European invaders should be held accountable for deaths resulting from military operations, incursions and raids, but perhaps not those resulting from the introduction of new pathogens and other disorders. There is thus a risk that Indigenous bodies, or at least 'naive' immune systems, could be seen as the prime cause of New World population decline (Jones, 2003). This has led to an emphasis on deaths that can be directly attributed to settler violence. In Harris's words, 'the extent of violent death … has become a kind of battle for how history should be interpreted' (Harris, 2003, p. 83). The problem with this approach is that it ignores the manner in which dispossession and conflict can impact on immune responses. Thus, while immunity can be acquired as a result of a previous history of contact with a pathogen or inherited through placental transfer of antibodies or activated T-cells, nutrition remains a critical determinant of immune responses. In fact, malnutrition remains the most common cause of immunodeficiency (Chandra, 1997). In short, a process of colonisation that reduces access to resources will result in elevated mortality without a gun ever being fired.

Death rates are only one of two critical building blocks in any demographic model. There is thus a danger that an over emphasis on mortality will lead to an under appreciation of the role that birth rates play in determining population levels. Butlin's models attempt to account for both fluctuations in the birth rate over time as well as life expectancy. Indeed, he thought it likely that there was a partial recovery in continental wide Indigenous populations following the 1789 smallpox pandemic (Butlin, 1993, p. 127). Those regions most impacted by the presence of Europeans, however, are likely to have experienced sustained population reduction. In part this is because of the effects of resource loss. Reductions in fertility rates of around a quarter have been reported for famine effected populations—levels compounded by elevations in infant mortality by as much as a third. (Hernández-Julián et al., 2014; Kidane, 1989).

Butlin further reasoned that some Indigenous populations are likely to have experienced significant reductions in fertility as a result of the introduction of sexually transmitted disease. He thought that this was particularly likely in Van Diemen's Land, because of sealer interactions with Indigenous women from the late 1790s and the later impacts of European settlement. He estimated the likely precontact population of Van Diemen's Land at 9000, reasoning that George Augustus Robinson's 1820 estimate (the most reliable of the early of the early estimate's given Robinson's interactions with the palawa) needed to be inflated by 20% to account for reductions in fertility in the previous two decades resulting from introduced sexually transmitted disease (Butlin, 1993, pp. 125–126). In the remainder of this article we adapt Butlin's continental model to fit lutruwita. To do this we revisit the assumptions that he made about the likely impacts of introduced disease and resource loss on population numbers.

CONSTRUCTING BACK-CAST MODELS FOR TASMANIA

As Hunter and Carmody point out, Butlin's continental model relied heavily on smallpox to predict large precontact numbers for Australia as a whole. Their argument that the 1789 pandemic was caused by chickenpox (introduced via shingles) led them to downwardly revised Butlin's estimates. As they point out, their revised models are more closely aligned with the 'Mulvaney consensus'—the archaeological precontact population estimates calculated on the basis of carrying capacity (Hunter & Carmody, 2015). Their downward revision serves to highlight a Tasmanian paradox. There is no evidence for introduced smallpox or chickenpox infection in Tasmania—the most significant driver of population decline in both Butlin's models and the Hunter and Carmody variant. Despite this, all accounts agree that palawa populations were amongst the most severely impacted Australian Indigenous societies in the period to 1835. The alternative mechanisms that can explain this rapid population decline remain largely understood.

An advantage of applying back-cast models to Tasmania is that considerably more is known about the Indigenous population of lutruwita in the 1830s than is the case for other Australian regions. Indeed, it is possible to reconstruct the palawa population on Flinders Island from 1832 with some precision. George Augustus Robinson conducted two censuses at Wybalena. The first of these was in March 1832 and the second in January 1836. As Plomley notes, the March 1832 census appears to have some omissions. While Robinson recorded the names of 80 individuals, a total of 103 had arrived on Flinders Island by this date (Plomley, 1987, pp. 874–877). Of these eight can be accounted for by recorded deaths and two had absconded. It is likely that the undercount of 12 can be explained by unrecorded deaths that occurred prior to the March 1832 census. The alternative explanation is that the census is incomplete or that there were unrecorded departures.

Arrivals at the settlement after March 1832 are well documented. There is also a record of births and deaths although the latter appear to have been only systematically recorded after March 1833. A list of 22 deaths in Robinson's handwriting helps to fill in some of the remaining gaps. This notes, for example, that 'WY.MUR.RICK' died sometime around February 1832 and was cremated shortly afterwards along with the remains of eight others (Plomley, 1987, p. 910). After accounting for these there are still 17 individuals for whom there is no recorded death or departure who do not appear in the January 1836 census. We have assumed that these died in the period between March 1832 and March 1833 when no systematic death record was kept.

In the decade from 1832 to 1841 there were just seven recorded births for children who survived to their first birthday and 161 deaths. The average annual reduction in population was 17.4%. This ranged from a peak of 40.5% in 1833, a year which coincided with a large number of arrivals, and a low of 3.5% in 1836. This is the year that Robinson arrived to take personal charge of the settlement. In the following year there was a 37.5% decline in the population following the introduction of influenza (see Figure 3).

While these data enable the scale of the post-removal decline in the palawa population to be reconstructed, it can also be used to glimpse at the sex and age structure of those who survived the apocalypse on the frontier, to use Cassandra Pybus's phrase (Pybus, 2021). Following Butlin, we compare these to the age and sex distributions one might expect to see in a precontact population with a life expectance at birth of 30 (see Figure 4). Although there has been some speculation that the process of colonisation impacted disproportionately on men (a result of conflict) or women (kidnapping for sexual partners), survivor sex ratios are balanced (Calder, 1972, p. 15). Robinson's age estimates suggest that the men removed to Wybalena were on average younger than the women. The ravages of frontier warfare and disease impacted greatly on those aged over 40 and under 20, although survival rates for male children were greater than for female (see Figure 4). This might reflect increased rates of child abduction for girls as opposed to boys (Clements, 2014, pp. 193–194).

The high death rates observed at Wybalena, are in line with those recorded for palawa populations in a series of other locations in the late 1820s and early 1830s. There were 22 recorded deaths at Robinson's Bruny Island mission settlement between April 1829 and February 1830, 8 on Gun Carriage Island between April and August 1831, 5 on Hunter's Island between July and October 1832 and 13 at Macquarie Harbour between July and August 1833. As with any assessment of historic mortality determining an accurate cause of death is problematic. Deaths were not subject to rigorous recording and post-mortem examination of the deceased was rare although these were undertaken at Wybalena. These issues are exacerbated by changes in diagnostic terminology that has occurred over the past 200 years. Diagnoses such as 'visceral inflammation', 'catarrhal affections', 'loathsome disease' and 'anasurea' do not have clearly defined meanings (Plomley, 1987, pp. 915–947).

Plomley noted that a major post-contact cause of death was pneumonia (as was sometimes confirmed on autopsy examination), subsequently replaced by tuberculosis and influenza.

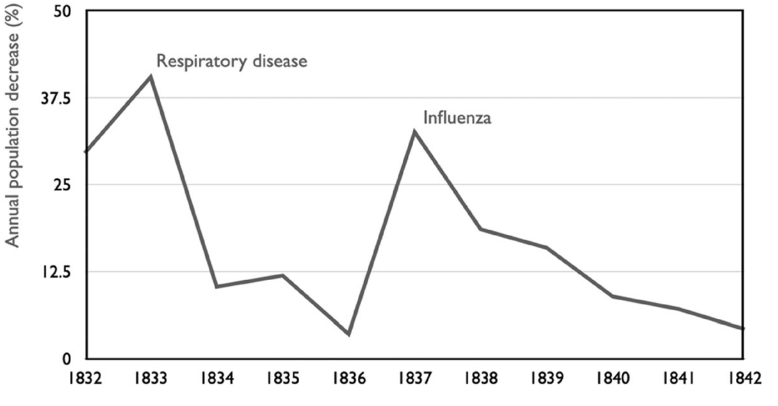

FIGURE 3 Annual aboriginal population decrease Wybalena. *Source*: (Plomley, 1987, pp. 791–947 and Plomley, 2008, pp. 1028–1029).

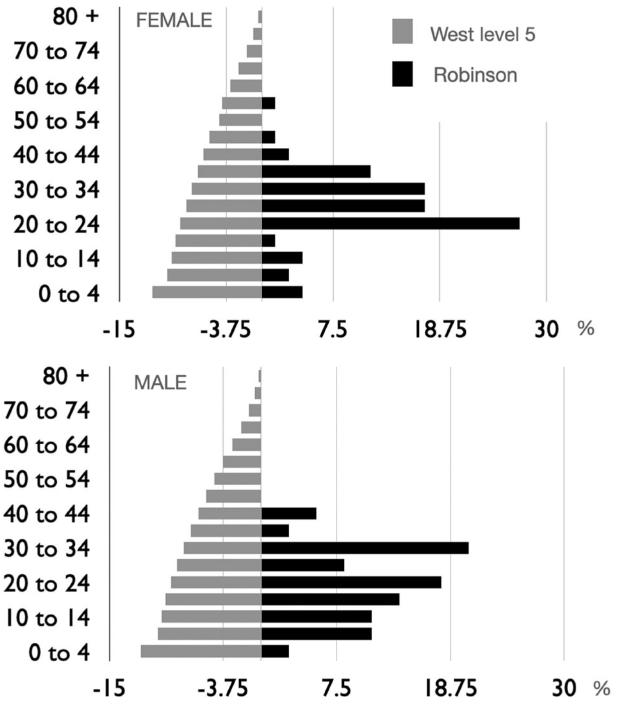

FIGURE 4 Age and sex structure coale and demeny west level 5 and G.A.R. Robinson observed 1831–38. *Source*: (Coale & Demeny, 1983, Plomley, 1987, pp. 791–947 and Plomley, 2008, pp. 1028–1029).

TABLE 2 Pulmonary disease mortality rates.

Place	Start	Finish	Deaths	Mortality rate (%)
Bruny Island	April 1829	Feb 1830	22	55
Gun Carriage Island	April 1831	Aug 1831	8	16
Hunter Island	July 1832	Oct 1832	5	19
Wybalenna	Jan 1833	Aug 1833	32	40
Macquarie Harbour	July 1833	Aug 1833	13	25

Source: Plomley (1987, pp. 791–947), Roberts-Thompson (2014), and Maxwell-Stewart (2009).

However, as manifestations of these conditions may be similar, with shortness of breath, cough and fever, employing an overarching term such as 'pulmonary disease' may be more useful—a term we apply to the five disease outbreaks documented in Table 2. Other causes of death that were identified at autopsy at Wybalenna include infections with peritonitis, empyema, pyelonephritis and meningitis (Plomley, 1987, pp. 915–947).

It is possible to calculate the size of the exposed population for each of the pulmonary disease events documented in Table 2. What is chilling about these mortality rates (they average 27.2%) is that they occurred in populations that had access to European supplied rations and medical care. These levels of population reduction are similar to Hunter and Carmody's estimates for the impacts of chickenpox (Hunter & Carmody, 2015). It should be noted that unlike chickenpox, or for that matter smallpox, which confer high levels of immunity on surviving populations, the palawa could be serially impacted by respiratory complaints leading to reductions that were conceivably higher than those experienced by mainland Indigenous populations in the wake of the 1789 outbreak.

Whereas it might be argued that close exposure to convict and settler populations put the populations in Table 2 at greater risk, the evidence suggests that the disorder or disorders responsible for these recorded episodes impacted upon the palawa more widely. In February 1830 Robinson came across the remains of a woman from Port Davey near the Huon. He was told by the palawa travelling with him that plenty of natives in the area had succumbed to disease. He concluded that 'the mortality with which the Brune (sic) natives had been attacked, appears to have been general among the tribes of aborigines' (Plomley, 2008, p. 143). A year later Robinson reported 'that the numerous tribes of aborigines once inhabiting that extensive country to the westward of the D'Entrecasteaux Channel and the Huon River were now extinct' (Plomley, 2008, p. 260, n. 7). Others too noticed a dramatic reduction in palawa numbers about this time. Gilbert Robertson reported in May 1829 that, whereas a few years ago the 'temporary villages' of the natives 'consisted sometimes of from 30 to 40 wigwams (sic) or huts (each containing on an average 4 or 5 inmates), [they] are now seldom found to consist of more than 4 or 5 huts (*Hobart Town Courier*, 23 May 1829).

The pulmonary disease that impacted upon the palawa at the Bruny Island mission and elsewhere appears to have effected Europeans too. A respiratory disorder variously described as catarrh or influenza, most probably the latter, spread throughout the settler population in the winter of 1827. By May the disease had become 'so general both in town and country', that scarcely an individual had escaped. By June death rates amongst the settler population had reached 'unprecedented' levels. As the *Colonial Times* put it: 'In former, times, it was rare to hear of a death, but now the bell is continually tolling'. A notable feature of this disorder is that it had a greater impact on those who had been in the colony for a long period of time, suggesting that more recent arrivals had higher levels of acquired immunity (*Colonial Times and Tasmanian Advertiser*, 8 May, 8 June, 3 August 1827). As the *Hobart Town Gazette* reported this catarrh 'affected the aboriginal natives exactly in the same way as the Europeans' (*Hobart Town Gazette*, 21 July 1827). As the *Courier* put it: 'They are seized with rheum, accompanied with severe pains in different parts of the body, and a purulent running at the nose' (*Hobart Town Courier*, 18 July 1829).

While the 'oldest hands in the Colony' could not recall a disorder of this severity, this does not mean that introduced disease did not impact upon palawa populations prior to 1827 (*Colonial Times and Tasmanian Advertiser*, 8 May 1827). When questioned by Commissioner Bigge in May 1820 the Hobart Town surgeon, Luttrell, named the disorders prevalent in the settlement as 'acute Prevalent and Chronic Rheumatism, Dysentery at some Parts of the year, catahrral Fevers, Diarrhaes, Hypatitis, and an obstinate species of Itch caught from the natives here.' (Watson, 1921, p. 501). Reference to the journals of surgeon superintendents on convict vessels confirms that, while the incidence of some infectious diseases, decreased over the course of the voyage to Australia, it was common for new cases to be diagnosed in the weeks before landing. This was especially the case for respiratory disorders. It is thus not surprising that by 1820 a building had been set aside in Hobart Town for the treatment of Indigenous patients (Kippen & Maxwell-Stewart, 2015 and Watson, 1921, p. 750).

A particular complaint was a 'cutaneous disorder' to which Indigenous Tasmanians were 'more or less liable' (Watson, 1921, p. 750). According to a report in the *Colonial Times* this 'loathsome cutaneous disease' first appeared around 1816—a period which coincided with an increase in convict arrivals (*Colonial Times and Tasmanian Advertiser*, 16 June 1826). While sometimes described as leprosy, this contagious skin complaint was more likely to have been scabies, a disorder routinely diagnosed on convict vessels. Passed from European to palawa populations and vice versa (Robinson was severely infected by an Indigenous man who crept into his tent to sleep one night), palawa Tasmanians appear to have been particularly susceptible (Plomley, 2008, pp. 170–1 and 184 and Roberts-Thompson, 2014, p. 133).

The prevalence of scabies in contemporary remote Indigenous Australian populations remains high (Gramp & Gramp, 2021). This includes 'crusted' or Norwegian scabies, a severe form of the disease associated with weakened immune systems. Descriptions of crusted scabies are consistent with settler accounts of Indigenous Tasmanians suffering from this affliction which was said to cover the body including the face (unusual in standard scabies presentations) to the extent that the sight was described as 'quite disgusting' (*Colonial Times and Tasmanian Advertiser*, 16 June 1826). The body of a palawa prisoner executed in 1826 was almost completely covered rendering movement difficult—he was restricted to crawling on his hands and knees (*Colonial Times and Tasmanian Advertiser*, 15 September 1826 and *Hobart Town Gazette*, 25 February 1826). Crusted scabies is a highly contagious, debilitating condition. The disorder can spread both by direct skin-to-skin contact and through contaminated items such as clothing and bedding as Robinson discovered.

The skin is an important barrier—a first line of defence against infection. Breaches in that barrier can have serious health consequences. It is for this reason that individuals suffering from scabies are at high risk of secondary infection including from staphylococcus aureus and group A streptococcus. These can produce serious sequelae such as rheumatic fever and post-streptococcal glomerulonephritis (Holt et al., 2010). Scabies sufferers are also at increased risk of chronic obstructive pulmonary disease which in turn can lead to acute respiratory failure, cardiopulmonary arrest and pneumonia (Chen et al., 2016). The current five-year mortality rate for untreated crusted scabies is 50% (Lokuge et al., 2014). There is thus abundant evidence that introduced disease severely compromised Tasmanian Indigenous health from at least the end of the Napoleonic Wars.

Butlin argued that Indigenous Tasmanian population decline was significantly exacerbated as a result of the European introduction of sexually transmitted disease and the resultant lowering of fertility rates. He estimated that in Van Diemen's Land the cumulative impact of gonorrhoea and chlamydia first introduced by sealer gangs in the late 1790s would be sufficient to reduce the overall palawa population by 29.85% by 1830 (Butlin, 1993, p. 126). As Grey argued, such a reduction would require 'massive and constant levels of exposure' to sexually transmitted disease, which in turn implies that rates of infection were high in initial European settler populations (Gray, 1985, pp. 138–139). Whereas massive and constant exposure is unlikely on a pre-1850 continental-wide scale it is certainly plausible for Van Diemen's Land.

Examination of diagnoses made by surgeon superintendents on convict vessels indicates that the incidence of sexually transmitted disease was particularly high amongst soldiers and crew (see Table 3). These two groups were also more likely to be diagnosed with genitourinary complaints than male convicts (although not female) a potential marker for otherwise undiagnosed sexually transmitted disease. Soldiers and sailors featured prominently in the initial phases of the British occupation of Van Diemen's Land, both informally as members of sealing gangs and formally as part of the initial bridgehead garrisons (Calder, 1972, p. 14). The risk of transmission of sexually transmitted disease to palawa populations was likely to have been high from point of first contact.

Infection risk almost certainly increased over time. There is abundant evidence that palawa women and children were absorbed (often forcibly) into European settler households and

TABLE 3 Diagnoses for sexually transmitted and genitourinary disease on convict voyages to Australia 1818–1853 (%).

	Number of diagnoses	STD	Genitourinary disease	STD (% of all)	Genitourinary (% of all)
Soldiers	2340	120	52	5.13	2.22
Sailors	739	39	17	5.28	2.30
Male Convicts	11,536	68	150	0.59	1.30
Female Convicts	4756	112	219	2.35	4.60

Source: Kippen and Maxwell-Stewart (2015).

whaling and sealing camps, particularly in the period prior to 1820. Stockmen traded bread and sugar with palawa women in exchange for sex and the many palawa who could speak English by the 1820s stands testimony to the frequency of movement between settler and palawa societies (Plomley, 1991, pp. 71, 78 and 95). Data from elsewhere supports Butlin's estimates for the impact of sexually transmitted disease in Van Diemen's Land as does the birth record at Wybalena (Butlin, 1993, p. 126; Bayliss-Smith, 2019; Harris, 2003).

In the decade from 1833 to 1842 there were just 15 births recorded at the mission settlement for 54 women who were aged between 15 and 44. (Plomley, 1987, pp. 946–947). This equates to a rate of 0.028 births per woman per year as opposed to the 0.108 required to keep a population with a life expectancy at birth of 30 in equilibrium (Coale & Demeny, 1983, p. 55, see also Gurven & Kaplan, 2007, pp.326-331). The number of births at Wybalena, described as ‘unnatural’ by members of the legislative council (*Colonial Times*, 25 July 1837), is likely to have resulted from multiple causes including the trauma of physical and cultural relocation. Not with-standing this, the level of fertility decline predicted by Butlin fits with the observed historical birth rate. The main point, however, is that a decline in fertility (no matter what the cause) played a substantial role in population reduction.

As well as accounting for the impact of introduced disease on Indigenous birth and death rates, it is also important assess the extent to which population decline was exacerbated by European occupation of palawa lands and the associated patterns of violence. Butlin argued that resource loss and frontier violence were ‘intimately related’. Indigenous peoples were targeted by settlers to gain both control over resources and reduce Indigenous access to hunting grounds and other economically important areas. The seizure of country could also lead to increased internecine violence as displaced peoples were forced onto territories traditionally controlled by neighbouring bands. Loss of access to resources exacerbated population decline through introduced disease as lower levels of nutrition compromised immune systems. As well as deaths from starvation, malnutrition rendered Indigenous peoples more vulnerable to settler attacks and less likely to recover from wounds inflicted by musket balls and swan and buckshot. Butlin estimated that by 1850, Europeans had rested control of 78% of pre-1788 Indigenous resources in New South Wales and 68% of Victorian (Butlin, 1993, pp. 129–133). The impact in Tasmania occurred earlier and was more or less complete by 1830.

The initial phases of colonisation were heavily concentrated on the Derwent and Tamar estuaries. Most early settler communication was by boat (Clements, 2014, p. 190; Wegman, 2020). Anchorages, especially if they were suitable for whaling and sealing were early targets. Even the west coast of Tasmania, often regarded as remote, was heavily impacted in the years following the formation of Macquarie Harbour penal station in 1822 (Maxwell-Stewart, 2009).

While terrestrial mammals formed an important source of protein for the palawa, marsupials, particularly macropods, have a low-fat content. Bracket fern is likely to have formed a significant source of carbohydrate, however, fat was principally sourced from marine and estuarine resources. Shearwaters, little penguins and swans (as well as their eggs) were all consumed, as were seals and stranded whales. Coastal foraging also gave access to abalone, oysters, mussels and other shellfish including rock lobster and crabs (Ranson, 2019, pp. 21–96). From the first sealing operations of the late 1790s, European occupation of coastal areas, particularly estuaries, is likely to have severely restricted shoreline harvesting.

The disruption in access to the coast was exacerbated by European inland penetration. There is now substantial evidence that the vegetation of pre-contact Tasmania was substantially altered by anthropogenic burning. The systematic burning of country was key to the maintenance of open *Eucalyptus* savanna and button grass moorland, both favoured habitats for marsupials (Jones, 1969; McWethy et al., 2013, McWethy et al., 2017; Gammage, 2011; Wegman, 2020). Regular firing also promotes new leaf growth in eucalypts bolstering body size and fat content in possum populations (Ranson, 2019, p. 45). A significant problem for Indigenous peoples was that the systematic burning of country also created optimal conditions for European settlement.

At first fire-stick farmed lands attracted European hunters. The early bridgehead settlements were difficult to supply and were therefore thrown back on resource-gathering. This included the harvesting of considerable quantities of macropods, an activity encouraged by government which purchased meat off settlers who in turn equipped their convict servants with dogs and guns to maximise hunting returns (Boyce, 2010; Fels, 1982). Hunting grounds were also sought out by European agriculturalists. Cleared land was valued by settlers since the labour costs associated with the removal of trees and their root systems were significant. Wheat, barley and other introduced crops were much more likely to be cultivated on pre-prepared hunting grounds, as these areas were easier to plough and as a result were targeted by colonists.

Initially, palawa loss of access to fire-adapted land was restricted to areas easily accessible from the Tamar and Derwent bridgeheads. As livestock numbers increased European settlement pushed inland. The legal footprint of settlement can be charted by plotting grants of land—the process by which colonists were allocated 'Crown Land' expropriated by the British state (Morgan, 1992, pp. 5–23). This is unlikely to accurately reflect competition for resources as grants often remained unoccupied after they had been made out. Conversely, it was common practice to squat on land before it had been officially privatised. Sheep and cattle were frequently grazed on Crown Land, particularly in the first two decades of European settlement. Since pastoralists invariably targeted hunting grounds adapted by palawa burning practices, increases in stock numbers provide an alternative method of measuring resource competition in non-coastal areas. The saturation density of the 'natural pastures' of the colony was reached in the 1840s, an indication of the extent to which former hunting grounds were expropriated for commercial gain (Hartwell, 1954, p. 115).

Figure 5 charts the rise in the number of introduced sheep against observed Tasmanian palawa resistance tactics. Prior to 1815 these primarily targeted kangaroo hunters and their dogs. After the end of the Napoleonic Wars, attacks on sheep became more common as pastoral expansion increased the pressures on traditional hunting grounds. A further shift occurred in the early 1820s reflecting a change in European focus from the rearing of mutton for local consumption to fine wool production destined for London markets. A dramatic rise in sheep numbers, a proliferation in stock huts, and the employment of armed shepherds to protect capital investments, was accompanied by increasing levels of violent conflict concentrated on stock

Asia-Pacific Economic History Review
A JOURNAL OF ECONOMIC, BUSINESS & SOCIAL HISTORY

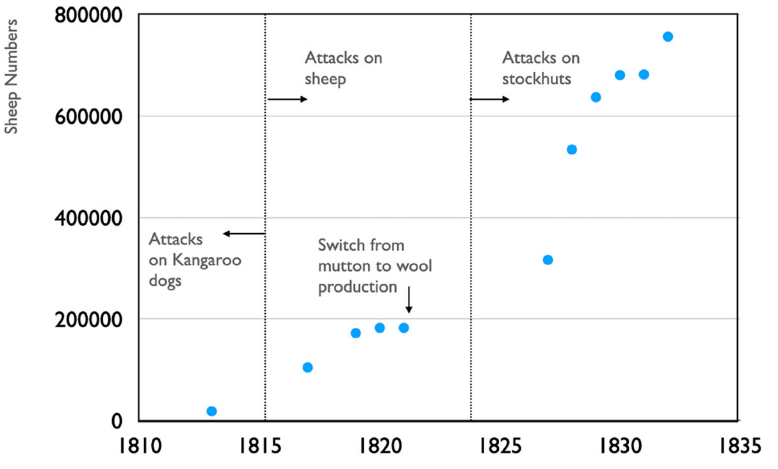

FIGURE 5 Sheep numbers and changing patterns of conflict. *Source*: (Watson, 1921, Boyce, 2010, Reynolds, 1995 and Hartwell, 1954, p. 118).

runs. As with agricultural production, these were invariably co-located on fire-stick adapted hunting grounds. After 1827 there was a marked rise in the number of huts plundered, particularly for flour—an indication of the extent to which pastoralism had disrupted traditional hunting and food gathering (Ryan, 2012a, pp. 93–100).

We have adapted Butlin's continental back-cast models to estimate the impact of introduced disease, resource competition and declining fertility as a result of the spread of sexually transmitted disease on palawa population numbers (see Table 4). Table 4, column 1 contains Butlin's estimates for the likely impact of sexually transmitted disease first introduced by sealers in the late 1790s on palawa fertility. Butlin derived these estimates by shocking Coale and Demeny's 'West Level 5' model for a population with a life expectancy at birth of 30. Column 2 assumes that the mean observed mortality rate of 27.2% for the five disease episodes observed between 1829 and 1833 was experienced by the palawa population as a whole. Column 3 adapts Butlin's estimates for the additional burden of resource loss in New South Wales to fit Van Diemen's Land. It is perhaps best seen as an estimate of excess mortality and related population decline directly attributable to frontier warfare and expropriation. It assumes that the loss of access to coastal resources was considerably exacerbated by the expansion of pastoral production in the period following the ending of the Napoleonic Wars as detailed in column 4.

To use Model 1 to calculate pre-contact populations it is necessary to first estimate the size of the surviving palawa population in January 1831. Between 1831 and 1842 the majority of the survivors of the frontier war were moved into detention on off-shore islands. The piecemeal way in which these removals occurred complicate estimates of population levels, but a reasonably accurate reconstruction is nevertheless possible. A total of 233 people born before 1831 are documented as arriving at Wybalena. To this should be added a further 31 deaths that occurred post-December 1830 but before arrival at the Flinders Island settlement. Another six captives never arrived on Flinder's Island. It is presumed that these also died before they could be removed but the deaths were never documented. At least 9 palawa never surrendered—three in the Upper Derwent Valley who were last sighted in 1839 and six in the North-West still at large in 1844 (*Launceston Advertiser*, 27 November 1839 and 30 August 1844, McFarlane, 2008, pp. 177–80). A further 15 palawa women were on Kangaroo Island in 1831 and at least another

TABLE 4 Estimated palawa Population Decline (Model 1), females WL5 Eo = 30.

	Infertility resulting from STDs[a]	STD + observed post 1827 disease mortality[b]	STD + post 1827 disease + resource loss[c]	Resource loss estimates[d]
1795	100.00	100.00	100.00	
1800	99.42	99.42	99.42	
1805	97.83	97.83	97.50	2%
1810	94.93	94.93	92.97	5%
1815	90.59	90.59	84.05	20%
1820	84.85	84.85	71.83	30%
1825	77.91	77.91	56.82	35%
1830	70.15	42.95	8.08	80%

Source: [a] Butlin (1993); [b] Plomley (1987), pp. 791–947), Roberts-Thompson (2014), Maxwell-Stewart (2009); [c] Butlin (1993); [d] We estimate that 40% of palawa resources were sourced from coastal regions and 60% from firestick adapted lands in the interior. We used the reported sheep population as a proportion of 1835 totals to estimate palawa loss of access to hunting grounds (Hartwell, 1954, p. 118). We estimated loss of access to coastal areas as 1% in 1805, 5% in 1810; 10% in 1815; 15% in 1820; 30% in 1825 and 80% in 1830.

10 living with other sealers in the Bass Strait. None of these appear to have been removed to Wybalena (Taylor, 2002, p. 35 and Plomley, 2008, pp. 1060–64). Several of these women had children although it is difficult to establish how many of these were born after 1831. In addition, there were a minimum of 7 further people of palawa descent in settler households (*Launceston Advertiser*, 25, July 1831, 7 August 1832, Colonial *Times*, 28 December 1831, 9 December 1837 and 10 February 1839, *Cornwall Chronicle*, 7 April 1838). The minimum size of the palawa population in January 1831 was thus 311. This is almost certainly an undercount. It does not, for example, take account of unrecorded deaths likely to have occurred between January 1831 and the point where various groups surrendered. A surviving population of 311 would suggest a pre-contact population of 3848 using the parameters in Model 1. A 10% increase in the surviving population to 342 would increase this estimate to 4232 and a 20% increase to 373 would deliver a pre-contact estimate of 4616.

Model 1 does not account for the additional burden of disease introduced prior to 1827 although, as we have shown, this is likely to have been significant. Crusted scabies, an infection commonly observed in palawa populations post-1815, significantly increases health risks especially from respiratory disorders. Increased risk of secondary infection and septic death following bacterial colonisation of the skin was also likely to be present prior to 1827, as were other sequelae including increased susceptibility to rheumatic fever, chronic obstructive pulmonary disease and pneumonia (Chen et al., 2016; Holt et al., 2010). To simulate the earlier impacts of introduced disease we have created a series of further models (see Table 5). Model 2 assumes a net reduction in population in the years 1816 to 1826 consistent with a 2.5% prevalence of crusted scabies, while Model 3 doubles this to 5%.

We use our estimates of the palawa population in January 1831 to populate these models (see Figure 6). Each predicts a range of pre-contact population sizes depending on the selected starting population. The lower bound curve assumes that all palawa people who survived to January 1831 were documented in the available archival sources. The mid and upper curves have starting populations inflated by 10% and 20% respectively reflecting the likelihood that the actual population was greater than that recorded in the surviving historical sources. The model outcomes vary significantly. The lowest (3848) lies within the carrying capacity range predicted by Tallavaara et al and is close to Plomley's, 1992 estimate of 3990. The highest (12,106) lies significantly beyond the upper limits of all the carrying capacity models and is considerably greater than Butlin's, 1993 estimate of 9000.

A precipitous drop in palawa population in the period 1825–1830 is a feature of all three models—a decline driven by the impact of post-1827 respiratory disease and the acceleration in resource loss. The slope is accentuated in models 2 and 3 as these predict higher pre-1825 population levels. These back cast projections fit with the qualitative evidence. This was a period that witnessed the introduction of martial law, the formation of roving parties and the 'Black Line'. As Ryan, Reynolds and Clements all argue–these were the years of concentrated frontier

TABLE 5 Estimated palawa population decline (models 1–3), females WL5 Eo = 30.

	Model 1 STD + Post-1827 disease + resource loss	Model 2 STD + Post-1827 disease +1816–26 @ 2.5% + resource loss	Model 3 STD + Post-1827 disease +1816–26 @ 5.0% + resource loss
1795	100.00	100.00	100.00
1800	99.42	99.42	99.42
1805	97.50	97.50	97.50
1810	92.97	92.97	92.97
1815	84.05	84.05	84.05
1820	71.83	70.83	69.83
1825	56.82	54.57	52.32
1830	8.08	4.58	3.08

Source: as per Table 5 with the addition of Lokuge et al. (2014).

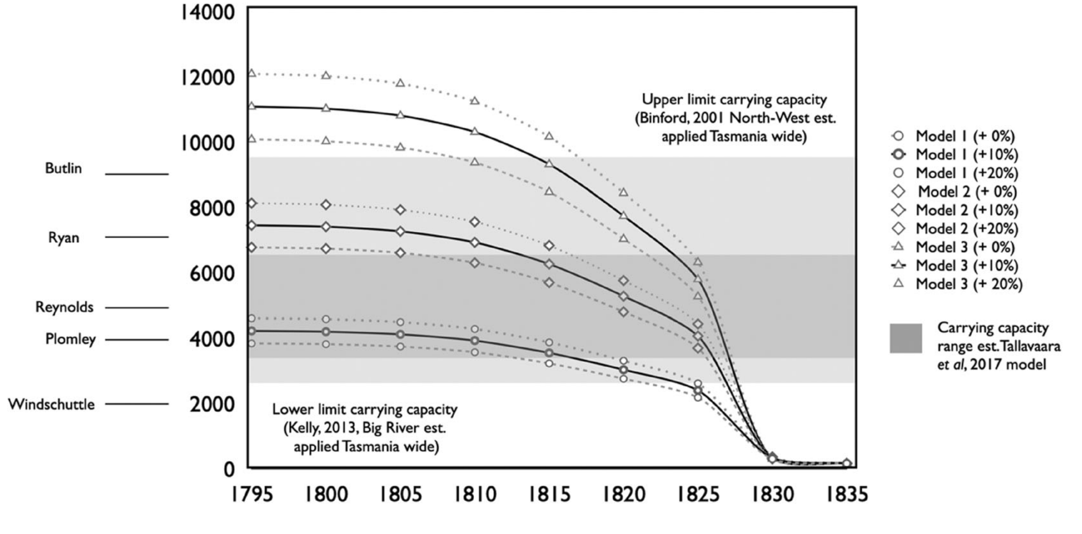

FIGURE 6 Back-cast early-contact population models. *Source*: Binford, 2001; Butlin, 1993; Kelly, 2013; Plomley, 1992; Ryan, 2012a; Reynolds, 1995; Tallavaara et al., 2017.

violence (Reynolds, 1995, Ryan, 2012a, Clements, 2015). Our back cast models also align with recorded settler observations. We plot all 137 settler estimates of the number of Indigenous people encountered in the years from 1825 to 1832 in Figure 7. The mean number reported per sighting dropped sharply after 1827, a finding consistent with our model predictions.

Disaggregating excess deaths attributed to resource loss, provides a further means of checking the integrity of our back cast estimates. It is a general rule of conflicts that a relatively small proportion of deaths are due to direct violence. The ratio of excess deaths not inflicted by weapons is highest in the least developed countries. Battle casualties made up between three and 29% of all war-related deaths in African conflicts between 1963 and 2002 (Garfield, 2008; Lacina & Gleditsch, 2005). War in the past was little different. Battle casualties account for only 27% of deaths recorded for soldiers serving in 13 conflicts in Europe and North America between 1620 and 1878—a figure further reduced with the inclusion of civilian war-related deaths (Landers, 2005, pp. 456–458). Frontier conflict in Van Diemen's Land is unlikely to have been different. War ensured total disruption of the palawa political-economy and thus the levels of excess mortality resulting from the wider effects of conflict are likely to have been substantial (Ryan, 2012 b: 107).

Loss of access to resources and the dangers associated with lighting fires to hunt, cook or for warmth in the face of increasing military and settler operations will have resulted in considerable levels of malnutrition. As well as starvation, declining levels of nutrition would have impacted fertility and lowered immune systems leading to increased morbidity and mortality. The resource loss component of a back cast model estimates the likely impacts of these effects, in addition to violent deaths. Independent estimates of frontier casualty rates are thus useful as they can be compared to levels of predicted population decline resulting from resource loss as a whole.

Broome argues that the ratio of Indigenous violent deaths to European in Van Diemen's Land was likely to have been 4:1 (Broome, 2003, pp. 89–90). As the European death toll was

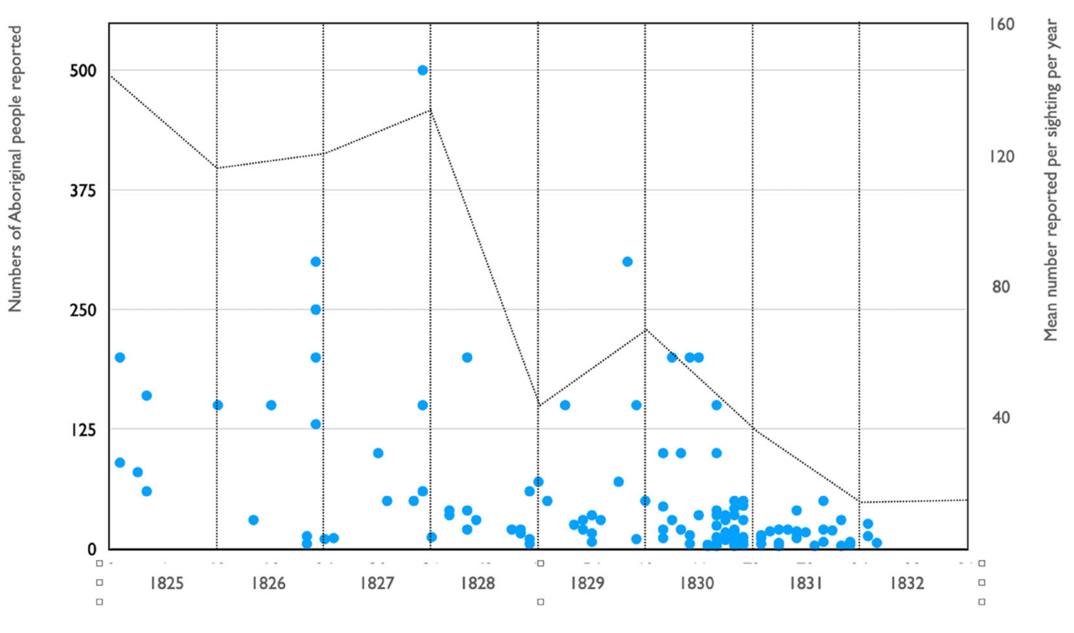

FIGURE 7 Reported Size of palawa Bands Sighted by Europeans. *Source*: (*Hobart Town Gazette, The Tasmanian and Port Dalrymple Advertiser, Colonial Times and Tasmanian Advertiser*, Hobart Town Courier, Colonial Advocate and Tasmanian Monthly Review and Register, Launceston Advertiser and Plomley (1992)).

Asia-Pacific Economic History Review
A JOURNAL OF ECONOMIC, BUSINESS & SOCIAL HISTORY

around 200, this suggest that 800 palawa deaths can be directly attributed to settler violence–a figure close to Ryan's estimate of 878 (Ryan, 2012a, p. 143). In which case frontier casualties would account for between 49% and 59% of the population decline attributed in Model 1 to resource loss (see Table 6). This is at least double the rate we might expect from historical experience. Models 2 and 3, are a better fit for the historical distribution of war-related excess mortality, suggesting a larger rather than smaller pre-contact population. Lower casualty estimates do not substantially alter the picture since they are usually predicated on smaller pre-contact population sizes. As Finnane points out, the record of violent palawa death in Van Diemen's Land will remain high compared to the casualty rate in other conflicts unless the base population was substantially greater than 5000 (Finnane, 2003).

TABLE 6 Conflict deaths as a percentage of resource loss estimates.

	Estimated pre-contact pop.	Resource loss mortality estimate	Conflict deaths % of resource loss (800)
Model 1 (0%)	3848	1356	59.02
Model 1 (10%)	4232	1491	53.67
Model 1 (30%)	4616	1626	49.21
Model 2 (0%)	6789	2370	33.76
Model 2 (10%)	7465	2606	30.07
Model 2 (30%)	8144	2958	27.04
Model 3 (0%)	10,093	3727	21.47
Model 3 (10%)	11,099	4098	19.52
Model 3 (30%)	12,106	4470	17.90

Source: See Tables 4 and 5 plus Broome (2003, pp. 89–90) and Ryan (2012a, p. 143).

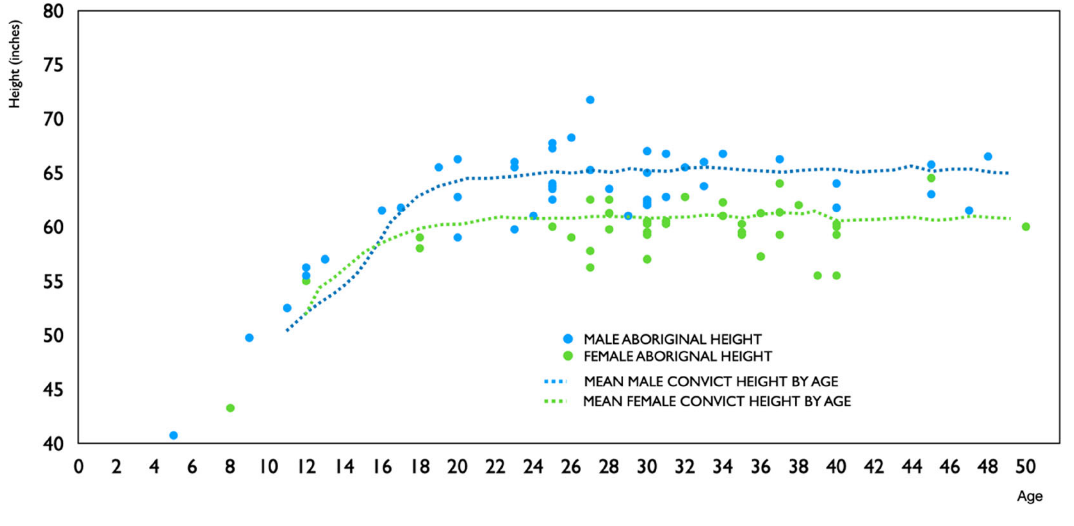

FIGURE 8 Comparing Convict and palawa Heights. *Source*: Tasmanian Archives: Con 18, 19, 23, 33, 41 and Plomley (1987, pp. 839–71).

While Models 2 and 3 are a better fit for recent estimates of palawa violent deaths they lie towards the top of existing carrying capacity models or, in the case of Model 3, beyond their upper limits (see Figure 6). As Tallavaara, Eronen and Miska argue, larger pre-contact population levels suggest higher levels of pathogen stress as well competition for resources (Tallavaara et al., 2017). If so, this should impact on growth patterns. Adult stature reflects levels of nutrition net of disease. Hunter-gatherer populations tend to be taller than farming communities reflecting higher levels of protein intake and a lower disease burden (Taylor, 2010 and Clark, 2007, pp. 59–62). As the stature of the palawa removed to Wybalena was recorded, it is possible to compare their heights to those of transported convicts (see Figure 8). While the number of observations for palawa peoples is small, they average the same stature as male and female prisoners convicted in industrialising Britain and Ireland (Plomley, 1987, pp. 836–871; Donald et al., 2023, p. 10). While it is possible that resource loss impacted on stature, all palawa adults were born in the period before 1815 when the effects of competition with European invaders were substantially less than in subsequent years. The comparatively short stature of the surviving palawa is suggestive of higher rather than lower pre-contact population levels.

CONCLUSION

While quantification can provide useful historical insights, it would be a mistake to assume that history can be fashioned from numbers alone. Not every aspect of the past can be counted, and not everything that can be counted matters. An argument for cultural autonomy, for example, should not depend on estimates of First Nation population size. This said, such estimates have long been used to lend weight to differing interpretations of the intent and nature of European invasion and dispossession and its consequences. Low population estimates can be used to imply that colonisation merely hastened an existing process of decline. Conversely, low numbers can imply bloody encounters. Even where estimates of frontier casualties are low, rates of violent death will be high if overall pre-contact populations are argued to have been smaller rather than larger. On the other hand, high counts imply that the arrival of Europeans had devastating impacts, although a by-product of high estimates is that they invariably give more weight to arguments that centre on the role that introduced disease played in the process of population decline (Smith et al., 2008, p. 533). All of this applies with force to the history of lutruwita.

To explore this in more detail we modify Butlin's continental Indigenous population back cast models in order to apply them to lutruwita. This enables us to produce a range of pre-contact population estimates. The lowest of these (Model 1) aligns closely with the estimates produced by Rhys Jones and N.J.B Plomley. It also falls within the range predicted by the most recent carrying capacity models. Model 1 utilises Butlin's calculations on the likely impacts of sexually transmitted disease and adjusts his modelling of other introduced European diseases to account for the effects of the pulmonary outbreak which impacted both settler and palawa populations in the years after 1827. It also adjusts Butlin's resource loss models to reflect European control of coastal areas and the spread of pastoral production.

Model 1 does not take the likely impact of scabies into account—a serious skin disorder first observed in palawa populations in the years immediately after the ending of the Napoleonic Wars. The description, symptoms (it was termed an 'itch') and ease of transmission match those associated with crusted or Norwegian scabies. This is a condition that is observed in some contemporary Indigenous Australian populations and is associated with an impaired immune system. If left untreated it has serious health consequences (a five-year mortality rate of 50%).

We produce two further models to estimate the effects of the introduction of scabies in the years after 1815. Model 2 assumes an infection rate of 2.5% and Model 3 5%. Model 2 produces a pre-contact population estimate that aligns closely with the 7000 provided by Lyndall Ryan, but lies at the top of the carrying capacity range calculations (Ryan, 2012a, p. 14). Model 3 estimates a much larger initial population in the order of 11,000. This last estimate lies significantly above the upper limits of the carrying capacity range.

We use estimates of the number of violent deaths to further interrogate the results of these modelling exercises. A general feature of conflicts is that battle casualties account for a relatively small proportion of all conflict related deaths. Butlin's attempt to model resource loss reflects the complex ways in which conflict impacts upon populations raising mortality and simultaneously reducing the birth rate. As a rule of thumb, one might expect around a quarter of all war-related excess mortality to directly result from armed confrontations. We note that the estimates produced by Model 1 are double this. We also argue that the recorded heights of the palawa survivors suggest higher, rather than lower, precontact population sizes.

We conclude that the pre-contact population of lutruwita was certainly greater than the 2000 estimated by Windschuttle (Windschuttle, 2003). It was also likely to have been higher than the estimates provided by Jones and Plomley. Our Model 2 lands close to Lyndall Ryan's estimate of 7000 although both of these lie above the carrying capacity window predicted by the Tallavaara et al. This is perhaps not surprising as their estimated do not take account of maritime resources which were significant in Tasmania. It is also possible that a fuller consideration of the impact of anthropogenic cool burning (also referred to as firestick farming) and other palawa technologies might lead to an upward revision of carrying capacity (Tallavaara et al., 2017).

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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