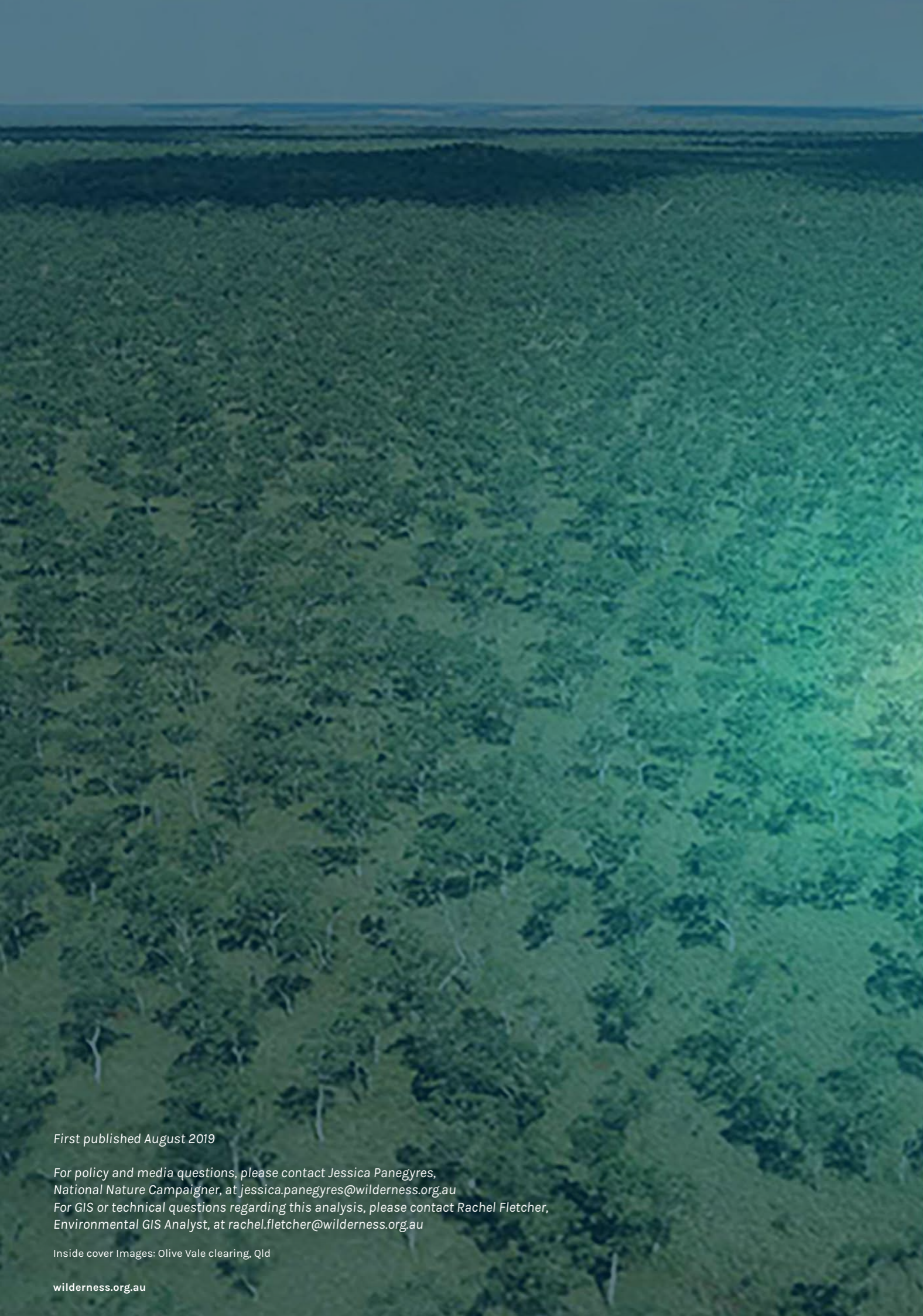AUGUST 2019

Drivers of Deforestation and land clearing in Queensland

Wilderness Society

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Executive summary

Deforestation in Australia has now reached globally significant levels, driven largely by land clearing in the state of Queensland. In the last five years, over 1.6 million hectares of forest and bushland has been cleared in Queensland alone, according to Queensland Government data.[1] Australia is now on a global list of deforestation "fronts", alongside the Amazon, the Congo and Borneo.[2] In Australia, deforestation (also known as tree clearing or land clearing) is a leading driver of biodiversity loss,[3] a significant source of greenhouse gas emissions,[4] and contributes to poor water quality running into the Great Barrier Reef.[5]

The Queensland Government's official reports consistently attribute over 90% of the state's forest and bushland destruction to replacement by 'pasture'.[6] For example, approximately 91% and 93% of the clearing mapped in 2016–17 and 2017–18, respectively, was assigned to the replacement land cover class of 'pasture'.[7] However, the Wilderness Society has undertaken fine-scaled GIS analysis to determine, for the first time, the specific sectors contributing to deforestation in Queensland. Our analysis is focused on Queensland for two key reasons. First, Queensland has the highest rates of deforestation and land clearing in the country, with more forest and bushland clearing than the rest of the country combined.[8] Second, Queensland has the nation's most accurate and publicly available dataset for measuring tree-cover change, the Statewide Landcover and Trees Study (SLATS).

Our analysis found that 73% of all deforestation and land clearing in Queensland is linked to beef production, a figure which is likely to be a significant underestimate.[9] The next largest land uses linked to deforestation and land clearing in order were sheep, crops, multiple mixed use, mining and other extractives, and rural housing. In the Great Barrier Reef catchments, over 93% of all deforestation and land clearing is attributed to beef as the primary land use, followed by relatively low levels of clearing for cropping, extractives, rural housing and fodder.

A key implication of these findings is that the sectors identified as key drivers of Queensland's deforestation and land clearing rates are currently exposed to deforestation risk. Deforestation risk—meaning the financial, reputation and brand damage that could flow from a company's activities being linked to deforestation—is increasingly being addressed at the global level by private sector and governmental deforestation-free sourcing policies. Our analysis suggests that the beef supply chain currently has the greatest exposure to deforestation risk in Queensland and that further action is urgently required to address this risk.

Summary Report

Deforestation in Australia

Deforestation—the reduction or complete removal of native forest and bushland—has escalated in Australia over recent years to reach globally significant levels.[10] Eastern Australia is now a designated global deforestation hotspot, alongside places including the Amazon, the Congo and Borneo.[11] On current rates, a football field-sized area of forest and bushland is being bulldozed in Australia every two minutes.[12] This is in a context where 50% of Australia's forest has now been completely cleared or severely modified since European colonisation.[13]

One recent study estimates that 50 million native animals, including the iconic koala, are being killed by land clearing in Queensland and NSW alone each year.[14] Carbon pollution from deforestation (excluding logging of native forests) is now equal to a third of all coal-fired power stations in Australia, or approximately 10% of Australia's overall domestic emissions.[15] In a survey of leading scientists conducted by the Ecological Society of Australia, clearing and land use change was ranked as the highest current threat to biodiversity in Australia.[16] A 2019 Scientists Declaration, signed by over 300 scientists, stated also that '*Large-scale clearing of woody native vegetation contributes to increased fire risk by exacerbating climate change through carbon emissions and increasing the severity and duration of droughts through changes in local and regional climates.*'[17]

Deforestation and land clearing in Great Barrier Reef catchments also leads to erosion and run-off of sediment into the Great Barrier Reef World Heritage Area.[18] This run-off reduces sunlight to seagrasses and smothers coral and other reef organisms. Agricultural activity often intensifies after land is cleared, driving additional chemical run-off into Reef waters on top of the existing chemical loads. The Great Barrier Reef Marine Park Authority has explained that '*The decline in coral cover and lack of recovery coincides with degraded water quality as a result of land clearing, land use changes and agricultural use of the catchment.*'[19] For this reason, the Australian and Queensland governments committed to a number of actions under the *Reef 2050 Plan* relevant to controlling deforestation and tree clearing in Reef catchments.[20] The *Reef 2050 Plan* was submitted to the UNESCO World Heritage Committee as part of Australia's bid to avoid having the Reef placed on the 'In Danger' list in 2015. One key action included was to '*Strengthen the Queensland Government's vegetation management legislation to protect remnant and high value regrowth native vegetation, including in riparian zones.*'[21]
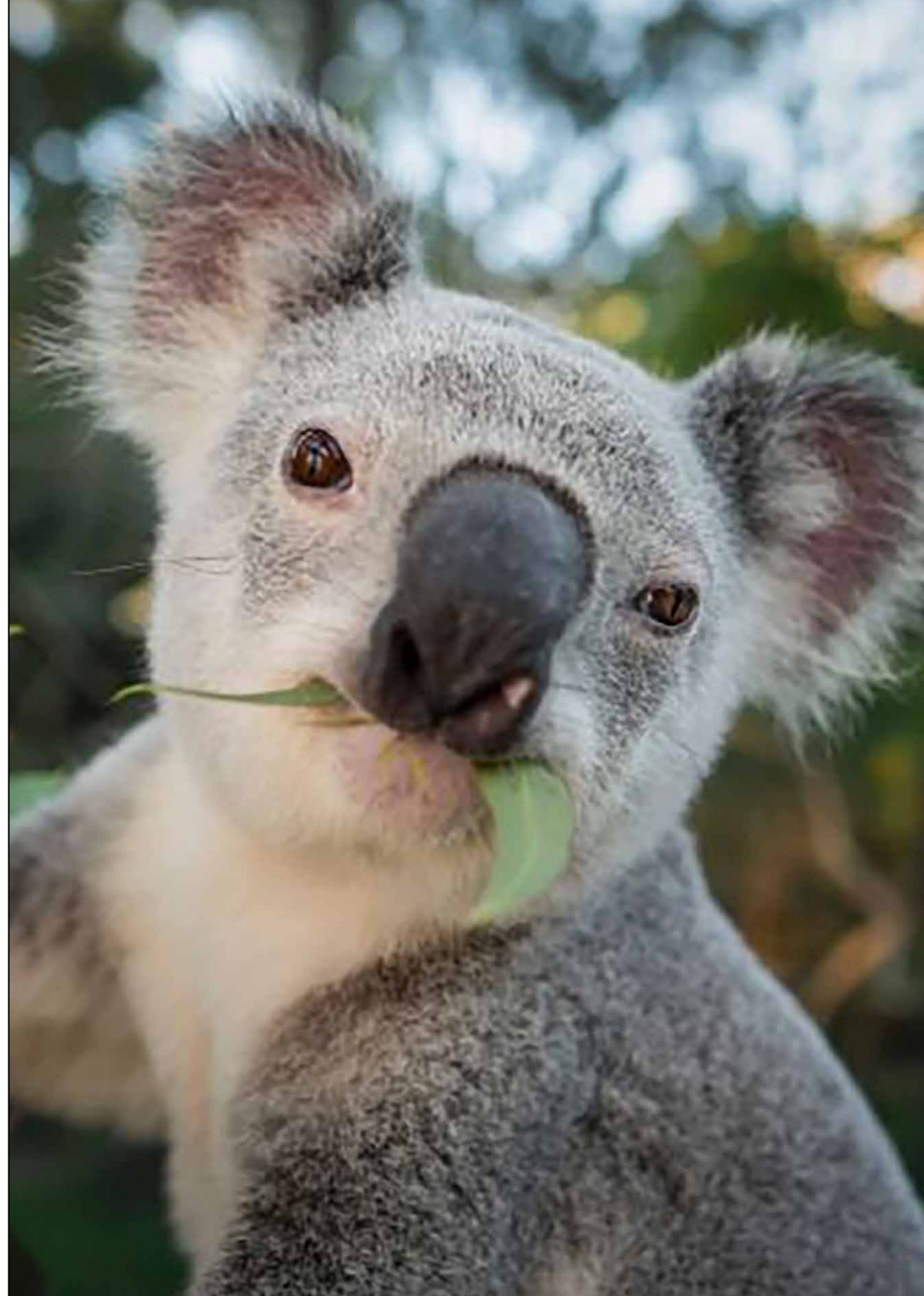
Summary findings

We quantified the contribution of various sectors to deforestation and land clearing using Queensland's vegetation change dataset, SLATS and the Queensland Valuation System (QVAS) data for land use. The analysis found that 73% of all detected deforestation and land clearing between 2013 and 2018 was attributed to beef production as the primary (65%) or secondary (7%) land use. In total, over 1 million hectares (1,174,634 hectares) of deforestation and land clearing over the last 5 years was linked to beef production. Of this total, 333,339 hectares was old growth or remnant vegetation. In Great Barrier Reef catchments, the proportion of forest and bushland clearing attributed to beef production as the primary land use was 94%. These figures are likely to be significant underestimates due to a number of conservative assumptions built into the analysis (see methods section for details).[22]

Table 1 **Clearing linked to beef production in Queensland 2013-2018**

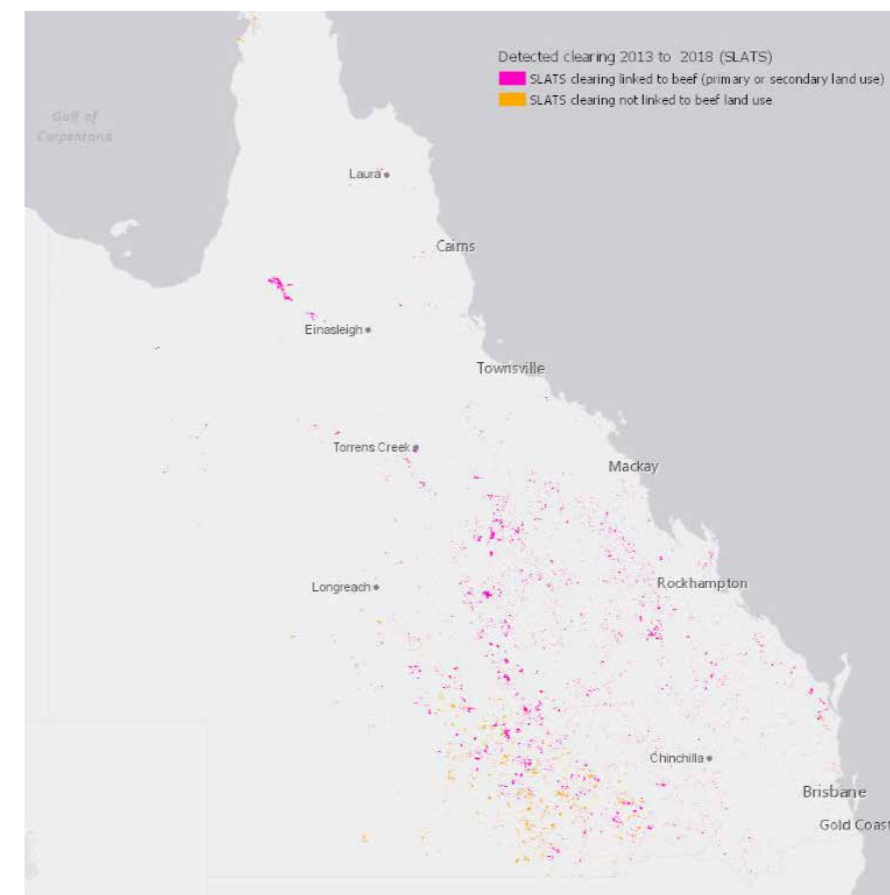| Beef land use types	Remnant (ha)	Non-remnant (ha)	Total (ha)	Proportion of clearing in Qld (%)
Primary beef cattle	295,005	740,460	1,035,465	64.6
Secondary beef cattle	27,839	80,670	108,508	6.8
Multiple tenures containing beef cattle	10,495	20,165	30,661	1.9
Total	**333,339**	**841,295**	**1,174,634**	**73.3**

The Queensland total (1,603,557ha) excludes parcels with no available land use data and excludes SLATS replacement land cover classes of "Timber plantation", "Natural tree death" and "Natural disaster damage". SLATS replacement land cover classes of "Mining" and "Settlement" occurring on cattle land uses were removed and added to "extractive" and "Rural housing" land use categories respectively

While beef production emerged as the overall number one driver of total deforestation and land clearing in Queensland on the primary land use listed (65%), this was followed by sheep (28%), cropping (2.2%) and extractives (1.3%). This was followed by small proportions of clearing for rural housing, other livestock, fodder, urban and recreational, industrial, defence force establishment, then reservoir, dams and bores.

In the Great Barrier Reef catchments, the analysis found that over 93% (or 575,291 hectares) of all deforestation and land clearing was attributed to properties where beef cattle was the primary land use. This is followed in order by cropping (2.03%), mining and other extractives (1.43%), rural housing (1.29%) and fodder (0.2%).
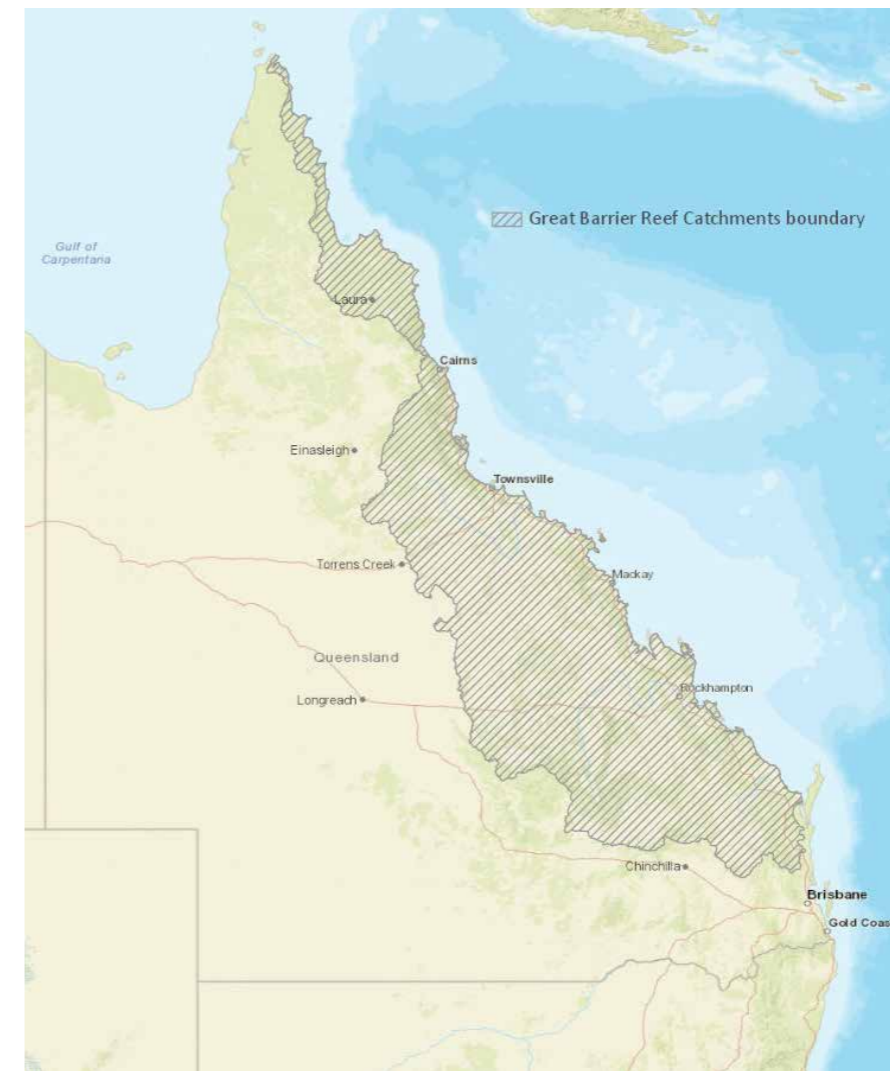

Great Barrier Reef catchments

Clearing linked to beef in Queensland

Primary land use group	Remnant (ha)	Non-remnant (ha)	Total (ha)	Proportion of clearing in GBR catchments (%)
Beef Cattle	119,120	456,171	575,291	93.5667
Cropping	2,392	10,120	12,512	2.0350
Extractives	3,264	5,498	8,762	1.4251
Rural housing	3,483	4,430	7,913	1.2870
Multiple tenure (multiple primary land use)	1,390	4,374	5,764	0.9375
Fodder	184	1,059	1,243	0.2022
Other govt use	556	616	1,172	0.1906
Industrial	341	504	845	0.1375
Urban and recreational	362	399	761	0.1238
Other livestock	70	488	558	0.0907
Sheep	0	25	25	0.0040
Grand Total	131,161	483,684	614,845	100

Excludes parcels with no available land use data. Excludes SLATS replacement land cover classes of "Timber plantation", "Natural tree death" and "Natural disaster damage". SLATS replacement land cover classes of "Mining" and "Settlement" occurring on sheep and cattle land uses were removed and added to "extractive" and "Rural housing" land use categories respectively. Totals may not equal the sum of the columns due to rounding of decimal places.

Clearing in Great Barrier Reef catchments by primary land use
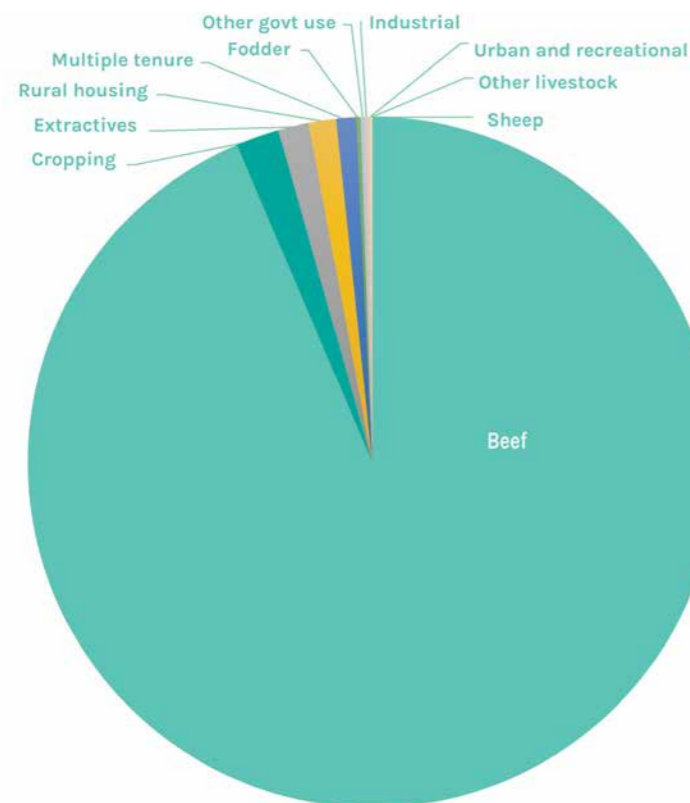
Implications: Deforestation risk in supply chains

This analysis suggests that deforestation risk exists in a number of Queensland-linked commodity supply chains, including beef and sheep production. Deforestation risk refers to the financial, reputation and brand damage that could flow from a company's activities being linked to deforestation. Public concern about deforestation, forest degradation (logging) and habitat destruction has sparked a growing wave of initiatives from the private sector to seek to eliminate deforestation and destruction of other native ecosystems from supply chains. As of mid-2018, there were about 760 such public commitments by 469 producers, processors, traders, manufacturers and retailers.[23]

The New York Declaration on Forests, launched at the 2014 New York Climate Summit, has to date been signed by over 40 national-level governments including the United States of America, the United Kingdom and the European Union, and over 50 multinational corporations.[24] Endorsers of the Declaration have committed under Goal 2 to: 'support and help meet the private-sector goal of eliminating deforestation from the production of agricultural commodities such as palm oil, soy, paper and beef products by no later than 2020, recognizing that many companies have even more ambitious targets.'[25]

The Accountability Framework Initiative (AFI), a group of International Non Government Organisations and technical organisations, has developed a general framework to help companies develop and implement these non-deforestation policies. Their draft guidance for new deforestation-free policies states that "a cut-off date no later than January 1 2020 would bring companies in line" with the global goals specified in the New York Declaration on Forests and the UN Sustainable Development Goals.[26]

Some corporations who have signed such deforestation statements are purchasers of Australian agricultural commodities. For example:

. McDonald's has a policy of "… eliminating deforestation from our global supply chains."[27] Their stated goal is to 'eliminate deforestation in our beef, chicken (including soy in feed), palm oil, coffee and the fiber used in customer packaging by 2020.' Beef from Australia has been identified by McDonald's as a top priority in implementing its Forests Commitment due to the high levels of deforestation present.[28]

. The China Meat Association recently signed the Chinese Sustainable Meat Declaration that commits to "… avoiding land degradation, deforestation and conversion of natural vegetation in the livestock production value feed chains".[29]

. Many of the companies who endorsed the New York Declaration on Forests are also part of the Consumer Goods Forum (CGF) that represents 400 companies across 70 countries and has committed to "achieving zero-net deforestation by 2020 through the sustainable sourcing of key commodities like soy, palm oil, cattle and paper and pulp."[30] In Australia, Woolworths has been a member of the CGF.

It is likely that over time, the proliferation of deforestation-free commitments will become a

market access risk issue for Australia's agricultural commodities still linked to land clearing.

Australian industry bodies appear to have recognised sustainability risk issues and taken steps towards sector-wide solutions. For example:

- The Australian dairy industry has committed to a goal of zero net deforestation by 2020.[31]
- The Australian Beef Sustainability Framework, which is an initiative of the Red Meat Advisory Council (RMAC), has released a set of indicators that measure what they refer to as 'the balance of tree and grass cover' in Australia.[32]
- There are multiple voluntary initiatives that encourage landholders to protect and restore biodiversity at the producer level, such as Landcare.[33]
- In 2019, a pilot program for a certification scheme for agricultural produce that meets key biodiversity measures was announced by the Australian Government.[34]
- The producer industry peak body Agforce Queensland was running a voluntary program, the Grazing Best Management Practices, 'to allow the grazing industry to demonstrate sound environmental and ethical practices to consumers and the community.'[35]

While these sorts of initiatives are positive first steps, the size and scale of deforestation risk demonstrates that there is more to be done to meet corporate sustainability commitments.

The trend towards deforestation-free commitments is premised on the recognition that the sustainability of commodity production is essential to its long-term viability. For example, the Global Roundtable on Sustainable Beef explains their Natural Resource principles as being 'based on the concept that ecosystem processes are managed through adoption of practices designed to sustain and restore ecosystem health throughout the beef production system.'[36] In other words, production and sustainability can co-exist, given the right management practices. It is important to note that beef and other livestock can be, and are, grown on already cleared land and can also co-exist with intact forests. A large proportion of Queensland is grassland or savannah where beef can be productive without removing forest and bushland. This suggests a viable pathway for production and sustainability to co-exist for Queensland.

Conclusion

By using Government datasets to attribute forest and bushland clearing to land use, our analysis found that 73% of all deforestation and land clearing in Queensland is linked to beef, of which 65% lists beef production as primary land use and an additional 7% lists beef as a secondary land use. The second largest driver is sheep (28%), followed by cropping (2.2%) and mining and other extractives (1.3%). In the Great Barrier Reef catchments, 94% of all forest and bushland clearing is attributed to beef as primary land use, followed by cropping, extractives and rural housing. While the data do not yet exist to conduct such an analysis at the national level, these are nationally significant results given Queensland leads the nation in deforestation and land clearing rates.

An important implication of these findings is that deforestation risk is present in several commodity supply chains linked to land clearing in Queensland. From this analysis, it is clear that beef has the largest exposure to deforestation of the sectors studied. Globally, new international agreements and corporate commitments to deforestation-free commodity supply chains will place increasing demand on Australia's soft commodity sectors to transition to sustainable practices.

Within Australia, while some industries with deforestation risk are taking positive steps

to address the problem, the size and scale of deforestation risk demonstrates that there is more to be done to meet corporate sustainability commitments. The Wilderness Society's view is that each sector with deforestation risk should adopt a sector-wide commitment to deforestation-free practices by 2020. In addition, individual companies with deforestation risk in their supply chains —producers, processors, retailers and fast food restaurants—should follow the growing trend in global corporate commitments and remove deforestation and land clearing from their supply chains. The removal of deforestation and land clearing from supply chains would have strong local, national and international benefits for the industry and consumers, as well as for the environment.

Detailed findings and methods

Detailed findings

The data

The contribution of different sectors to deforestation between 2013 and 2018 was quantified using Queensland's vegetation change detection dataset (Statewide Landcover and Trees Study—SLATS) and the Queensland Valuation System (QVAS) data for determining land use. The 2011 Remnant Extent was used to determine the split between remnant and non-remnant vegetation.

Analysis 1 *Analysis of clearing by primary land use*

The analysis showed that 65% of forest and other land clearing can be attributed to the primary land use of beef cattle - breeding, grazing or fattening (of this, 28% of clearing is of mature 'remnant', previously untouched forest and bushland). This is followed by sheep (28%), cropping (2.2%), mining and other extractives (1.3%) and rural housing (1%). The figure attributed to beef production is likely to be a significant underestimate given the lag in data of the transfer of primary use from sheep to cattle in QVAS, which has occurred extensively in recent years in places like the Mulga Lands in south-west Queensland.

Table 3 **Clearing in Queensland by primary land use 2013 - 2018**

Primary land use group	Remnant (ha)	Non-remnant (ha)	Total (ha)	Proportion of clearing in Qld (%)
Beef Cattle	295,005	740,460	1,035,465	64.573
Sheep	150,412	304,276	454,688	28.355
Cropping	5,372	30,224	35,596	2.22
Multiple tenure (multiple primary land use)	12,022	20,869	32,891	2.051
Extractives	11,292	9,038	20,330	1.268
Rural housing	6,691	8,999	15,690	0.978
Other livestock	452	2,218	2,670	0.167
Fodder	382	1,919	2,301	0.143
Urban and recreational	691	815	1,506	0.094
Industrial	410	614	1,024	0.064
Other uses	700	696	1,397	0.087
Total	**483,429**	**1,120,129**	**1,603,558**	**100**

Excludes parcels with no available land use data. Excludes SLATS replacement land cover classes of "Timber plantation", "Natural tree death" and "Natural disaster damage". SLATS replacement land cover classes of "Mining" and "Settlement" occurring on sheep and cattle land uses were removed and added to "extractive" and "Rural housing" land use categories respectively. Totals may not equal the sum of the columns due to rounding of decimal places.

Total clearing in Queensland by primary land use
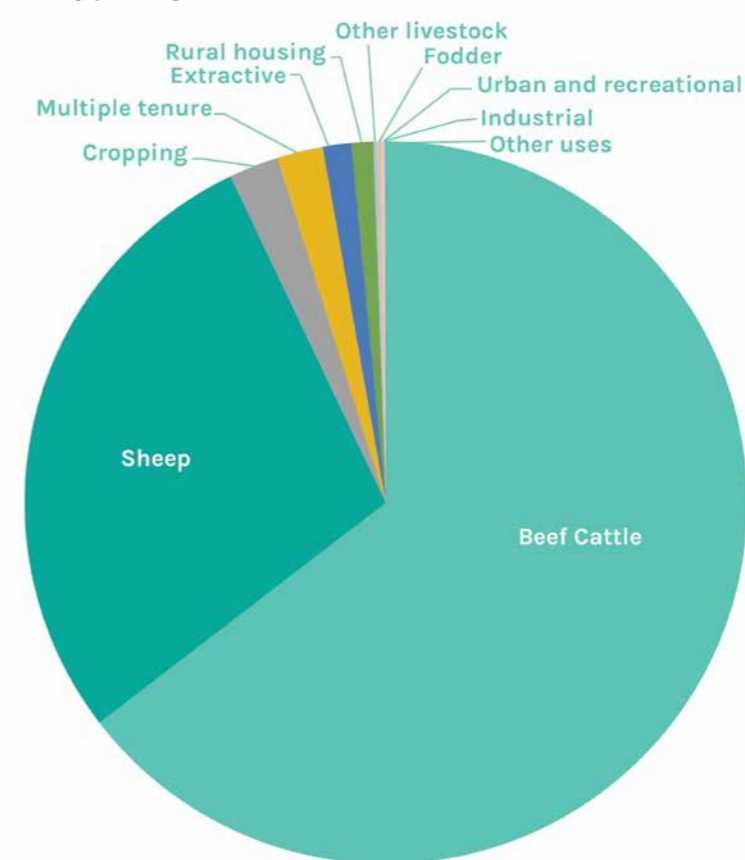
Analysis 2 *Total clearing linked to beef production*

The first analysis showed that beef production is linked to the majority of clearing. Given that beef production was the dominant land use represented in SLATS, the second stage in the analysis was to look at any additional land that had beef listed as a secondary land use. Parcels with more than one tenure in the legal parcel boundary were also investigated. It was possible to analyse the clearing polygons in these parcels more closely to ascertain whether they contained a beef cattle land use (breeding, grazing or fattening). By including these additional beef land uses, forest and bushland cleared linked to beef cattle increased to 1,174,634 hectares, or 73% of total clearing (refer to Table 1 on pages 6-7 of this report). As described above, this is likely to be a conservative figure given the time lag in transferring primary use data from sheep to cattle in QVAS.

Analysis 3 *Total clearing in the Great Barrier Reef catchments by land use*

In the Great Barrier Reef catchments, the analysis found that 94% of all forest and bushland clearing is attributed to beef cattle as a primary land use, or 575,291 hectares. This is followed by cropping (2.03%), mining and other extractives (1.43%) and rural housing (1.29%). Refer to Table 2 on pages 8-9 for detailed data.

It should be noted here that parcels smaller than 30 hectares and parcels with no land use data made up 2.8% of total clearing in the Great Barrier Reef catchments (17,838 hectares). This is a low percentage; however, it would be ranked second next to beef cattle if it was included in this analysis.

Analysis 4 *Technical 'forest' clearing linked to beef production*

The Australian Government has a technical definition of what constitutes a 'forest' (as opposed to other types of vegetation like bushland or sparse vegetation cover) which it uses for international reporting of carbon emissions. It is sometimes known as "Kyoto" forest because it is used for determining Australia's levels of technical forest cover and deforestation under the Kyoto Protocol reporting. 'Deforestation' therefore can have a specific technical meaning when used by the Australian Government. The formal definition of Kyoto forest is: "*Forests include all vegetation with a tree height of at least 2 metres and crown canopy cover of 20 per cent or more and lands with systems with a woody biomass vegetation structure that currently fall below but which, in situ, could potentially reach the threshold values of the definition of forest.*"[37] 'Land clearing' usually refers to all forest and bushland clearing. Forest, according to the forest definition, is a smaller subset of overall vegetation clearing in Queensland. It is important to note that many valuable natural ecosystems are not technically classed as a forest under the official Australian definition. Often the vegetation cleared in Queensland is referred to as "scrub", implying it is not valuable, and our analysis sought to understand how much total clearing in Queensland would formally be defined by the Australian Government as "forest" and therefore its removal as "deforestation."

This fourth analysis looked at the amount of technical deforestation (clearing of technical "Kyoto" forest) that was linked to beef production. The analysis found that 73% or 971,922 hectares of "Kyoto" forest clearing was linked to beef production. Of this, 241,316 hectares was remnant forest. In Great Barrier Reef catchments, 95% or 494,456 hectares of "Kyoto" forest clearing was linked to beef production.

Table 4 **Technical "Kyoto" forest clearing in Queensland linked to beef 2013-2018**

Vegetation	Primary land use beef cattle (ha)	Secondary land use beef cattle (ha)	Multiple tenures that contain beef cattle uses (ha)	Total linked to beef (ha)	Proportion of Qld total (%)	All Kyoto forest clearing in Qld (ha)
Remnant	213,286	21,942	6,088	241,316	68	353,704
Non-remnant	640,254	74,505	15,847	730,606	75	979,548
Total	853,540	96,447	21,935	971,922	73	1,333,252

Excludes parcels with no available land use data. Excludes SLATS replacement land cover classes of "Timber plantation", "Natural tree death" and "Natural disaster damage". SLATS replacement land cover classes of "Mining" and "Settlement" occurring on cattle land uses were removed and added to "extractive" and "Rural housing" land use categories respectively. Totals may not equal the sum of the columns due to rounding of decimal places.

Table 5 **Technical "Kyoto" forest clearing in Great Barrier Reef Catchments linked to beef 2013-2018**

Vegetation	Primary land use beef cattle (ha)	Secondary land use beef cattle (ha)	Multiple tenures that contain beef cattle uses (ha)	Total linked to beef (ha)	Proportion of GBR catchments total (%)	All Kyoto forest clearing in GBR catchments (ha)
Remnant	88,809	332	697	89,839	90	99,495
Non-remnant	397,615	3,050	3,953	404,618	96	423,061
Total	486,424	3,382	4,650	494,456	95	522,556

Excludes parcels with no available land use data. Excludes SLATS replacement land cover classes of "Timber plantation", "Natural tree death" and "Natural disaster damage". SLATS replacement land cover classes of "Mining" and "Settlement" occurring on cattle land uses were removed and added to "extractive" and "Rural housing" land use categories respectively. Totals may not equal the sum of the columns due to rounding of decimal places.

Methods

Data used

Spatial data

- Queensland cadastral data weekly—whole of State (downloaded 14/10/2018) © State of Queensland (Department of Natural Resources, Mines and Energy) 2018
- Statewide landcover and trees study 2013 to 2014 Queensland (12/11/2015) © State of Queensland
- Statewide landcover and trees study 2014 to 2015 Queensland (05/08/2016) © State of Queensland
- Statewide landcover and trees study 2015 to 2016 Queensland (05/10/2017) © State of Queensland
- Statewide landcover and trees study 2016 to 2017 Queensland (10/12/2018) © State of Queensland
- Statewide landcover and trees study 2017 to 2018 Queensland (10/12/2018) © State of Queensland
- Remnant Extent 2011—Queensland (acquired 12/09/2018) © State of Queensland (Department of Environment and Science) 2018
- Biodiversity status of pre-clearing regional ecosystems—Queensland—version 10.1 (01/03/2018) © State of Queensland (Department of Environment and Science) 2018 (accessed 13/06/2018)

Non-spatial related resources:

- Regional Ecosystem Description Database (REDD) © Environment and Science, Queensland Government, licensed under Creative Commons Attribution 4.0 Accessed on 15/10/2018
- Neldner, V.J., Wilson, B.A., Dillewaard, H.A., Ryan, T.S. and Butler, D.W. (2017) *Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland. Version 4.0.* p. 124. Updated May 2017. Queensland Herbarium, Queensland Department of Science, Information Technology and Innovation, Brisbane.
- Queensland Valuation System (QVAS), Office of the Valuer-General, State Valuation Service © State of Queensland (Department of Natural Resources, Mines and Energy) 2018. Sourced from Pricefinder 15/10/2018.

Basic analysis

The objective of this analysis was to determine which land use was the leading cause of deforestation and land clearing in Queensland.

Stage 1 *Identifying clearing in Queensland*

The Statewide landcover and trees study (SLATS) Queensland datasets for the period 2013 to 2018 were used to detect deforestation and land clearing. This analysis excludes repeat clearing. Where repeat clearing occurs, the first epoch of detected clearing is used. Australia Albers Equal Area projection was used to calculate area in hectares for the detected clearing polygons. The analysis excludes SLATS replacement categories of "Timber plantation", "Natural disaster damage" and "Natural tree death", totalling 4% of the total detected clearing (or 76,229 hectares). Beef-related and sheep-related clearing excludes SLATS replacement categories of "Settlement" and "Mine". The Remnant Extent 2011 dataset was used to determine if the vegetation being cleared between 2013 and 2018 was remnant or non-remnant. Further analysis was conducted to identify clearing of forest as defined under the Kyoto Protocol in stage 3.

Stage 2 *Property related land use data*

The Queensland Digital Cadastral Database (DCDB) November 2018 was used as a base for land use attribution on parcels > 30 hectares (102,227 parcels). Data from QVAS (sourced from Pricefinder, Nov 2018) was attributed to the DCDB data using the unique legal parcel number (lot number, plan type and plan number), including primary and secondary land uses of the parcel. Primary and secondary land uses in the QVAS data were categorised into land use groups as shown on the following page:

Table 6 Land use groups used in analysis

Primary and secondary land use in QVAS *	Primary land use - Group name	Secondary land use - Group name
CATTLE BREEDING & FATTENING CATTLE FATTENING CATTLE GRAZING & BREEDING	Beef cattle	Beef cattle
MILK—NO QUOTA MILK—QUOTA CREAM	Dairy	Dairy
ANIMALS-SPECIAL HORSES PIGS GOATS POULTRY	Other livestock/animals	Other livestock/animals
SHEEP BREEDING SHEEP GRAZING-DRY	Sheep	Sheep
SMALL CROPS & FODDER—IRRIGATED SMALL CROPS & FODDER—NON IRRIGATED	Fodder	Fodder
SUGAR CANE GRAINS PEANUTS ORCHARDS PINEAPPLES TROPICAL FRUITS TURF FARMS VINEYARDS COTTON TOBACCO OIL SEEDS	Cropping	Cropping
VACANT—LARGE HOUSE SITE VACANT RURAL LAND (EXCL 01 & 04) EXCLUSIVE USE AS SINGLE DWELLING OR FARMING DWELLING—LARGE HOUSE SITE SUBDIVIDED LAND—DISCOUNTED BY LG GROUP TITLE (PRIMARY USE ONLY) NOT ALLOCATED STRATUM	Rural housing related	Rural housing related or NONE
VACANT URBAN LAND OUTBUILDINGS TRANSPORT TERMINAL SPORTS CLUBS/FACILITIES OTHER CLUBS (NON BUSINESS) BUILDING UNITS (PRIMARY USE ONLY) CAR PARK CARAVAN PARKS CEMETERIES CHILD CARE—EX KINDERGARTEN COLD STORES-ICEWORKS COMMUNITY PROTECTION CENTRE DRIVE-IN SHOPPING CENTRE EDUCATIONAL—INCLUDING KINDERGARTEN FUNERAL PARLOUR GUEST HOUSE/PRIVATE HOTEL HOSPITALS, CONV. HOMES (MEDICAL CARE) PRIVATE HOTEL/TAVERN LICENSED CLUBS MARINA MOTEL MULTI UNIT DWELLING (FLATS) NURSERIES (PLANTS) PROFESSIONAL OFFICES PUBLIC HOSPITAL RELIGIOUS RESIDENTIAL INSTITUTIONS (NON-MEDICAL CARE) RESTAURANT SALES AREA OUTDOORS (DEALERS, CAR, BOATS, ETC.) SERVICE STATION SHOPPING GROUP (2 TO 6 SHOPS) SHOP-SINGLE SHOWGROUND, RACECOURSE, AIRFIELD SINGLE UNIT DWELLING WAREHOUSE & BULK STORES WELFARE HOMES/INSTITUTIONS WHARVES SPECIAL TOURIST ATTRACTION SHOPPING GROUP (MORE THAN 6 SHOPS) WALKWAY RETAIL WAREHOUSE	Urban and recreational	Urban and recreational
LIGHT INDUSTRY NOXIOUS/OFFENSIVE INDUSTRY (INCL ABATTOIR) GENERAL INDUSTRY BUILDERS YARD, CONTRACTORS YARD OIL DEPOT & REFINERY HARBOUR INDUSTRIES TRANSFORMERS	Industrial	Industrial (NONE)
STATE(SECONDARY LAND USE ONLY) LOCAL AUTHORITY (SECONDARY USE ONLY) COMMONWEALTH (SECONDARY USE ONLY)	N/A N/A N/A	State Local authority Commonwealth
FORESTRY & LOGS RESERVOIR, DAMS, BORES DEFENCE FORCE ESTABLISHMENT	Other government land uses	Other government land uses
EXTRACTIVE Not in QVAS	Extractive Not in QVAS	Extractive Not in QVAS

* There may be land uses associated with parcels < 30 hectares that are not included in this table.

It should be noted here that Primary land use "Fodder" was not treated as linked to beef as we are unable to identify which grazing animal the fodder is being used to feed. Clearing on parcels with a primary land use of fodder totalled 2,301 hectares, or 0.14% of clearing in Queensland.

QVAS data attributes a primary and secondary land use to parcels based on information provided to the Office of the Valuer General when a parcel is legally transferred from one entity to another. It has been noted that many gaziers on parcels in south west Queensland have converted from a primary land use of sheep to cattle prior to 2013, without a land transfer occurring (no sale occured) and that clearing on these parcels could be linked to beef. If this is the case, deforestation and land clearing linked to beef is likely to be underestimated in this analysis.

Parcels < 30 hectares: Financial cost restricted the number of parcels that were able to be extracted from Pricefinder. An initial analysis was conducted to ascertain which parcels contained the bulk of the clearing. Parcels > 30 hectares contained 98% of the SLATS detected clearing. The amount of clearing in parcels < 30 hectares was 2% of all detected SLATS clearing or 36,448 hectares over the five year study period. Therefore, clearing in parcels < 30 hectares, although still very important, was excluded when determining the land use that can be linked to the highest amount of clearing. Approximately 67% of the clearing in parcels < 30 hectares was attributed a SLATS replacement land cover class of "Pasture", implying that a significant amount of the clearing that is excluded in this analysis is likely to be linked to beef. This again suggests that the clearing attributed to beef has been underestimated in this report due to the conservative analytic approach that was employed.

Parcels where land use data was not returned: QVAS data from Pricefinder was not available for some parcels. These parcels were not able to be assigned with land use attributes. Of the 102,227 parcels within Pricefinder, 1,300 parcels were not assigned land use data. Unassigned land use accounted for 12,226 hectares of the total SLATS clearing (0.71%). Approximately 84% of the clearing in parcels that had no data returned from Pricefinder was attributed a SLATS replacement land cover class of "Pasture", again implying that a significant amount of the clearing that is excluded in this analysis is likely to be linked to beef.

Parcels returned with more than one tenure: Some parcels were returned from Pricefinder with more than one tenure. These parcels were excluded from the initial analysis because it was not possible to identify which land use was responsible for the clearing (the clearing in these parcels totaled 32,891 hectares). In the second phase of the analysis, these parcels were reassessed to determine the extent linked to the most commonly cleared land use, i.e. beef cattle. These parcels were assigned a mixed land use in relation to beef during the second phase analysis. Land use for each parcel with more than one tenure was allocated to one of the following categories:

Table 7 Land use categories related to beef used in the second phase analysis

GIS derived land use attribute for second phase beef cattle analysis	Description	Included in the second phase beef cattle analysis
No data from Pricefinder	The extract from the Pricefinder data was missing data for these parcels	No (excluded from all analysis phases and overall statistics)
Primary beef	Primary land use is beef cattle	Yes—Included in both initial and second phase analyses. Eighty-six percent of parcels linked to beef land uses have a primary land use of Beef cattle.
Secondary beef	Secondary land use is beef cattle	Omitted from initial analysis, but Included in the second phase analysis. Nine percent of parcels linked to beef land uses were allocated a secondary land use of Beef cattle.
Multiple tenures containing beef	There are different land uses associated with different tenures on the parcel, but at least one is beef cattle.	Omitted from initial analysis, but included in the second phase analysis. 1.8% of clearing is on parcels that have multiple tenures and are linked to beef
Not beef	Both the primary and secondary land uses are not beef cattle	Included in both initial and second phase as non-beef.
Multiple tenures containing no beef land uses	There are different land uses associated with different tenures on the parcel, and none of them are linked to beef cattle.	Omitted from initial analysis, but included in the second phase analysis as non-beef. 0.1% of clearing is on parcels that have multiple tenures and are not linked to beef

Stage 3 *Vegetation data that identifies deforestation*

Defining forest

The desktop analysis uses the following definition of forest as defined in Australian Government, Department of Environment and Energy, (2018) *National Inventory Report 2016 Volume 12*, p. 2. Commonwealth of Australia: Canberra.

"*Forests include all vegetation with a tree height of at least 2 metres and crown canopy cover of 20 per cent or more and lands with systems with a woody biomass vegetation structure that currently fall below but which, in situ, could potentially reach the threshold values of the definition of forest.*"

Vegetation stand/patch size area < 0.2 hectares

Polygons < 0.2 hectares were excluded from the forest statistics. This is considered a conservative method because these are not necessarily isolated polygons (some intact patches are split due to attributes included in the dataset, such as land uses or SLATS

epochs, and may be part of a forest patch that is > 0.2 hectares overall). This approach is also considered conservative because the minimum patch size in the definition refers to the patch size of the forest not the clearing event. The vegetation patch size is either equal to or greater than the event. Applying a minimum patch size of 0.2 hectares resulted in 5,449 hectares of clearing of forest regional ecosystems between 2013 to 2018 to be excluded from the forest analysis.

Determining Kyoto forest

Pre-clear Regional Ecosystem mapping v10.1, the Regional Ecosystem Description Database (REDD) and advice from the Queensland Herbarium on Regional Ecosystem (RE) structural classes were used to identify REs that met the definition of Kyoto forest. The Queensland Herbarium was approached

to assist in identifying which REs meet the definition of Kyoto forest. The Queensland Herbarium used structural class codes to determine which REs meet the Kyoto definition of forest (Table 10). Each RE has a structural class code that describes its typical vegetation structure. Table 11 provides a list of all the structural class codes and the Kyoto forest descriptor that each was assigned by the Queensland Herbarium (November 2018). There were three Kyoto forest descriptors identified by the Herbarium:

Kyoto Forest—These structure codes contain regional ecosystems that all meet the Australian Kyoto definition

Not Kyoto forest—These structure codes contain regional ecosystems that DO NOT meet the Australian Kyoto definition

Maybe Kyoto Forest—There are REs that contain both forest and non-forest in their reference state. Some vary at fine scales (REs are fundamentally 1:100k entities), while others might be forests in higher rainfall parts of their range but not in the drier

country. REs with both forest and non-forest are especially common in the arid bioregions, including Northwest Highlands, Mitchell Grass Downs, Channel Country and western Mulga Lands. The structural class codes that contain forest REs and non-forest REs are categorised as "Maybe forest". The Queensland Herbarium noted that assessing each RE individually instead of using structural classes would eradicate the need of the "Maybe forest" category. Refining the methods of identifying REs that meet the Kyoto forest definition (instead of structural codes) would lead to more REs being categorised as forest.

The "Maybe forest" classification was excluded from the stage three deforestation analysis. Again, this exclusion was done to ensure the deforestation analysis was conservative and potentially underestimated the detected forest clearing rather than over-estimated the forest cleared.

Table 8 Structural formation classes

Projective Foliage Cover	> 70%	> 30-70%	10-30%	<10%
Crown Class	Dense/Closed	Mid-dense	Sparse	Very sparse
Crown cover %[1]	> 80%	> 50-80%	20-50%	<20%
GROWTH FORM[2] ↓	Structural Formation Classes (qualified by height)			
Trees > 30m	tall closed forest TCF	tall open forest TOF	tall woodland TW	tall open woodland TOW
Trees 10 – 30m	closed forest CF	open forest OF	woodland W	open woodland OW
Trees 2-10m	low closed forest LCF	low open forest LOF	low woodland LW	low open woodland LOW
Shrubs 2 – 8m	closed scrub CSC	open scrub OSC	tall shrubland TS	tall open shrubland TOS
Shrubs 1 – 2m	closed heath CHT or closed shrubland CS	open heath OHT or shrubland S	shrubland S	open shrubland OS
Shrubs <1m	dwarf closed shrubland DCS	dwarf open heath DOHT or dwarf shrubland DS	dwarf shrubland DS	dwarf open shrubland DOS
Succulent shrub	NA	succulent shrubland SS	succulent shrubland SS	open succulent shrubland OSS
Hummock grasses	NA	NA	hummock grassland HG	open hummock grassland OHG
Tussock grasses	closed tussock grassland CTG	tussock grassland TG	open tussock grassland OTG	sparse tussock grassland STG
Herbs[3]	closed herbland CH	herbland H	open herbland OH	sparse herbland SH
Forbs	closed forbland CFB	forbland FB	open forbland OFB	sparse forbland SFB
Rush	closed rushland CR	rushland R	open rushland OR	sparse rushland SR
Vines	closed vineland CVI	vineland VI	open vineland OVI	sparse vineland SVI
Ferns	closed fernland CFN	fernland FN	open fernland OFN	sparse fernland SFN
Sedges	closed sedgeland CV	sedgeland V	open sedgeland OV	sparse sedgeland SV

[1] In this table the crown cover classes listed are used to allocate the modified Specht (1970) structural formation labels (after Walker and Hopkins 1998, page 68) and the relationship in Scarth *et al.* (2008) These approximate the Specht (1970) projective foliage cover (pfc) classes and derivation by converting crown cover to pfc using crown density types.

[3] Herbland refers to associations in which species composition and abundance is dependent on seasonal conditions and at any one time grasses or forbs may predominate.

[2] Growth form of the predominant layer (the ecologically dominant layer). See table 28 for definition of growth forms.

Source: after Specht (1970), Neldner (1984), and Walker and Hopkins (1998).

Neldner, V.J., Wilson, B.A., Dillewaard, H.A., Ryan, T.S. and Butler, D.W. (2017) *Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland.* Version 4.0. Updated May 2017. Queensland Herbarium, Queensland Department of Science, Information Technology and Innovation, Brisbane. P 91, Table 28 Structural formation classes

Structural class code	Queensland herbarium advice (Kyoto forest descriptors)	Structural class code	Queensland Herbarium advice (Kyoto forest descriptors)
bare	Not forest	OHT	Not forest
CF	Forest	OS	Not forest
CFN	Not forest	OSC	Forest
CH	Not forest	OSS	Not forest
CHT	Not forest	OTG	Not forest
CSC	Forest	OV	Not forest
CTG	Not forest	OVI	Not forest
CV	Not forest	OW	Maybe forest
CVI	Not forest	S	Not forest
DOHT	Not forest	SFB	Not forest
DOS	Not forest	SH	Not forest
DS	Not forest	SS	Not forest
FB	Not forest	STG	Not forest
H	Not forest	TCF	Forest
HG	Not forest	TG	Not forest
LCF	Forest	TOF	Forest
LOF	Forest	TOS	Not forest
LOW	Not forest	TOW	Maybe forest
LW	Forest	TS	Forest
OF	Forest	TW	Forest
OFB	Not forest	V	Not forest
OH	Not forest	VI	Not forest
OHG	Not forest	W	Forest

Regional Ecosystem Description Database (REDD) Environment and Science, Queensland Government, Regional ecosystems descriptions, licensed under Creative Commons Attribution 4.0 Accessed on 15/10/2018
Neldner, V.J., Wilson, B.A., Dillewaard, H.A., Ryan, T.S. and Butler, D.W. (2017) *Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland. Version 4.0.* Updated May 2017. Queensland Herbarium, Queensland Department of Science, Information Technology and Innovation, Brisbane.

Mixed polygons

Due to the scale of the regional ecosystem mapping, the mapping process can allocate up to five REs to a polygon, designating a percentage cover to each RE within the polygon. These are referred to as mixed polygons.

In the deforestation analysis, 10% of polygons were mixed, containing up to five REs each. Where mixed polygons occured, each RE was replaced with its structural class code and its corresponding Kyoto forest descriptor. The percentage cover for each RE was carried through to the Kyoto forest descriptor step. This meant that a percentage cover could be determined for each of the forest descriptors within each mixed polygon. Each mixed polygon had a maximum of three values (*forest, maybe forest* and *not forest*). Where the polygon was mixed, the clearing was attributed with one of the following:
1) Forest (100% Kyoto forest REs)
2) not forest (100% not Kyoto forest REs)
3) maybe forest (100% maybe Kyoto forest REs)
4) mixed containing 50% to 95% Kyoto forest REs
5) mixed containing 5% to 45% Kyoto forest REs
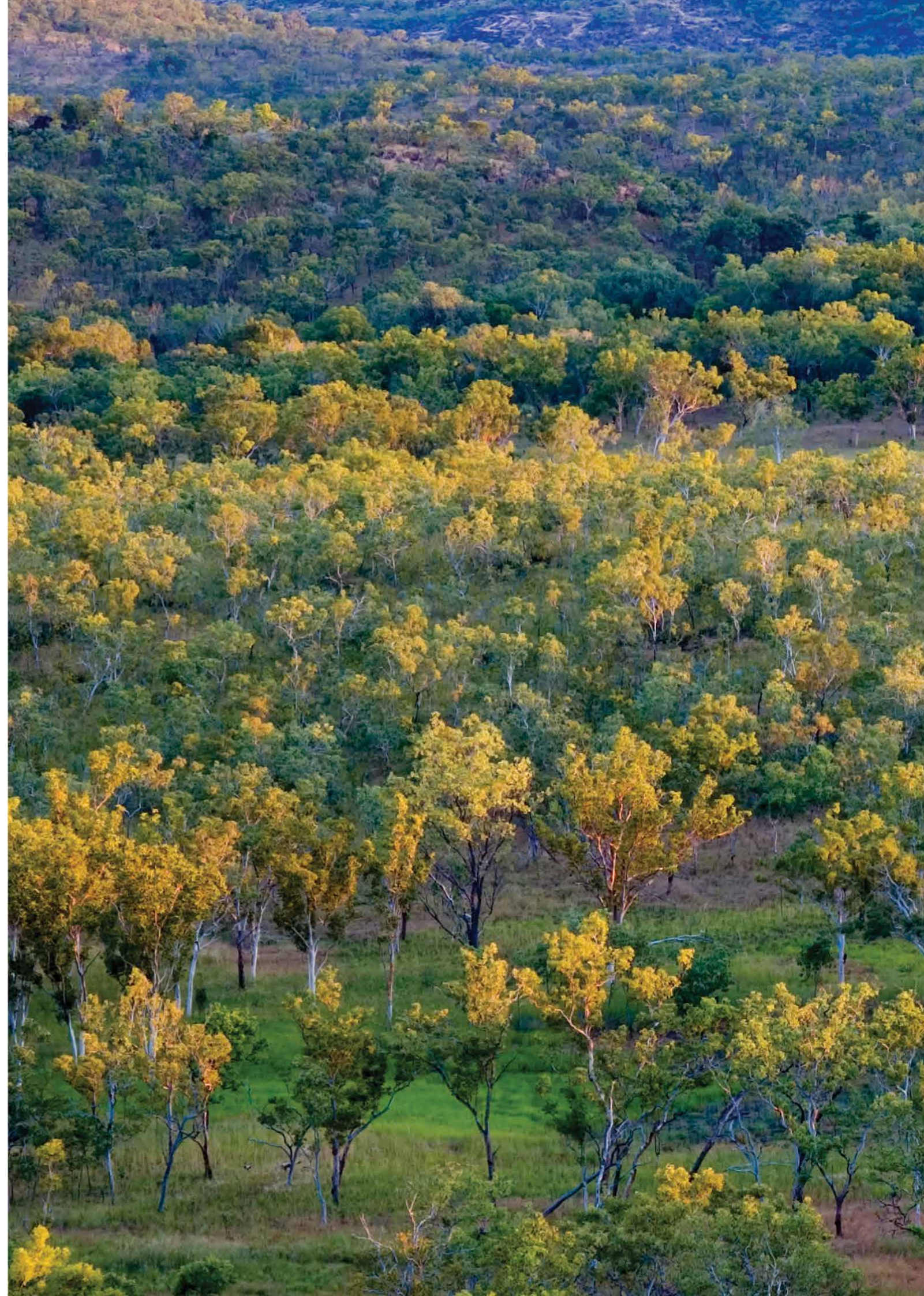6) mixed containing 5% to 95% maybe Kyoto forest REs

This analysis used 100% Kyoto forest REs and 50 - 95% Kyoto forest REs in the Kyoto forest analysis for deforestation. Polygons containing less than 50% Kyoto forest REs were omitted.

Data caveats and limitations

- There is 35,219 hectares of detected clearing in parcels < 30 hectares. This clearing is excluded from the analysis; 67% of this is identified as pasture in the SLATS replacement land cover class, and are likely to contain beef land uses. This analysis is a conservative calculation of deforestation and woody vegetation loss associated with beef.
- The forest structural class codes were used to identify forests that meet the definition used in Australia as defined in the National Inventory Report. The forest descriptors include "Maybe forest". This exists for structural class codes that contain regional ecosystems that are forest in certain bioregions, but not in others. Clearing in "Maybe forest" is not included in the deforestation numbers, meaning that when the forest structure assessments by RE become available, the deforestation areas will increase for this analysis.
- QVAS data uses economic assessments of land uses on a property, and where land has multiple uses, the primary land use reflects the highest economic activity. Area is not necessarily the basis for determining the primary land use. In cases where there are multiple land uses and the valuer determines that the primary land use is beef, it is likely that it is also the biggest area. It is likely that this caveat mostly impacts clearing attributed to small area productions such as vineyards and poultry. In these cases, the valuer would assign the primary land use of the vineyard, even if the land owner is using most of the land for beef production.
- QVAS data is usually updated if a property transfer occurs, such as when it is sold. The Office of the Valuer-General notes that a land holder could change the land use from one type of grazing to another and the department may not become aware of the change for some time. South west Queensland has seen a shift in grazing trends from sheep to beef in the last decade and this is not reflected in the QVAS data. This outdated QVAS data could significantly underestimate the impact on the clearing and deforestation rate associated with beef in this report.
- Mixed polygons containing forest structural codes < 50% were excluded from this analysis. Including these polygons in this analysis would have increased the deforestation figure, again showing that this analysis chose the conservative approach.
- "Timber plantation" replacement land cover class is defined by SLATS as timber harvesting in state or privately owned native or exotic forests or plantations. SLATS uses the Digital Cadastral Database and Agricultural Land Audit datasets to determine this replacement cover class. Some of these parcels have a beef primary land use. All "Timber plantation" in SLATS is excluded from this analysis as it is assumed to be a harvest. However, it has been ascertained that clearing with this replacement category may not be a harvest. In lots where the valuers office assigns a cattle primary land use, the clearing on these lots is excluded from the analysis. Further analysis of clearing in "Timber plantation" replacement categories could increase the clearing linked to beef.
- The Wilderness Society has chosen to be conservative in this analysis and refinement of the methods would result in a higher attribution of clearing to beef land uses.
- This is a desktop analysis only. Please refer to the data custodian metadata for further information on individual dataset limitations.

Endnotes

1   Queensland Department of Environment and Science (2011-2018), *Statewide Landcover and Trees Study (SLATS) reports, 2011-12 (2013); 2012-13 (2014); 2013-14 (2015); 2014-15 (2016); 2015-16 (2017), 2016-17 (2018); 2017-18 (2018)*. DES, Queensland Government: Brisbane, Queensland.

2   WWF International, (2018) *Living Planet Report* 'Deforestation Fronts', p. 28. Accessed online at: http://wwf.panda.org/knowledge_hub/all_publications/living_planet_report_2018/

3   Neldner, V.J., Laidlaw, M.J., McDonald,K.R., Mathieson, M.T., Melzer, R.I., Seaton, R., McDonald, W.J.F., Hobson, R., and Limpus, C.J. (2017). *Scientific review of the impacts of land clearing on threatened species in Queensland.* Queensland Government: Brisbane, Queensland.

4   Australian Government, Department of the Environment and Energy (2016) *Australia's emissions projections 2016 Chart data* Commonwealth of Australia: Canberra, ACT. Accessed online at: http://www.environment.gov.au/climate-change/publications/emissions-projections-2016 The projected deforestation emissions are: 49Mt in 2017, 53Mt in 2018, and 51Mt in 2019.

5   Waterhouse, J., Schaffelke, B., Bartley, B., , Eberhard, R., Jon Brodie, J., Star, M., Thorburn, P., Rolfe, J., Ronan, M., Taylor, B., and Kroon, F. (2017). *2017 Scientific Consensus Statement: Land use impacts on Great Barrier Reef water quality and ecosystem condition.* The State of Queensland: Queensland. Accessed online at http://www.reefplan.qld.gov.au/about/scientific-consensus-statement/

6   Queensland Department of Environment and Science (2011-2018), *Statewide Landcover and Trees Study (SLATS) reports, 2011-12 (2013); 2012-13 (2014); 2013-14 (2015); 2014-15 (2016); 2015-16 (2017); 2016-17 (2018); 2017-18 (2018)*. DES, Queensland Government: Brisbane, Queensland.

7   Queensland Department of Environment and Science. (2018.) *Land cover change in Queensland 2016–17 and 2017–18: a Statewide Landcover and Trees Study (SLATS) Summary Report.* DES: Brisbane, Queensland. Accessed online at https://www.qld.gov.au/__data/assets/pdf_file/0031/91876/landcover-change-in-queensland-2016-17-and-2017-18.pdf

8   Australian Government, Department of the Environment and Energy, (2018) *Quarterly Update of Australia's National Greenhouse Gas Inventory: March 2018*, p. 22. Commonwealth of Australia: Canberra, ACT.

9   This is explained in the methods section p. 10.

10   Megan C. Evans (2016) 'Deforestation in Australia: drivers, trends and policy responses' *Pacific Conservation Biology* 22(2) 130-150 https://doi.org/10.1071/PC15052 Published: 6 May 2016

11   WWF International, (2018) *Living Planet Report* 'Deforestation Fronts', p. 28. Accessed online at: http://wwf.panda.org/knowledge_hub/all_publications/living_planet_report_2018/

12   Calculations are based on national average of 600,000 hectares of deforestation and native forest logging per year, 1,643 hectares per day, 68 hectares per hour, 1.14 hectares per minute. 1.14 hectares x 2 minutes = 2.28 = well over the 1.77 hectare area of the MCG. So this is a technically a conservative figure.

13   Bradshaw C (2012)   Little left to lose: deforestation and forest degradation in Australia since European colonization   *Journal of Plant Ecology* 5 (1) p. 111.

14   Finn, H.C. & Stephens, N.S., (2017). The invisible harm: land clearing is an issue of animal welfare. *Wildlife Research (CSIRO Journal).* CSIRO Publishing. p.4.

15   Australian Government, Department of Environment and Energy, (2017). *Australia's emission projections 2017—chart data.* Commonwealth of Australia: Canberra, ACT. Accessed online at: http://www.environment.gov.au/climate-change/publications/emissions-projections-2017

16   Australian Government, Department of Environment and Energy, (2017). *Australia State of the Environment 2016—Biodiversity report*, p.11. Commonwealth of Australia: Canberra, ACT.

17   Ecological Society of Australia (2019) *Scientists' Declaration: Strong legislation needed to curb Australia's accelerating rate of land clearing* Published online at : https://www.ecolsoc.org.au/scientists-declaration-strong-legislation-needed-curb-australias-accelerating-rate-land-clearing

18   Great Barrier Reef Marine Park Authority (2014) *Great Barrier Reef Outlook Report 2014*, p.229. GBRMPA: Townsville, Queensland.

19   Great Barrier Reef Marine Park Authority (2014) *Great Barrier Reef Outlook Report 2014*, p.229. GBRMPA: Townsville, Queensland.

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21   Commonwealth of Australia (2015), *Reef 2050 Long-Term Sustainability Plan*, p. 36. https://www.environment.gov.au/system/files/resources/d98b3e53-146b-4b9c-a84a-2a22454b9a83/files/reef-2050-long-term-sustainability-plan.pdf

22   This is explained in the methods section, p. 18-24.

23   Donofrio S., Rothrock, P., and Leonard, J. (2018) *Zooming In: Companies, Commodities, & Traceability Commitments that Count*, Forest Trends: Washington, DC. See also: Stephen Donofrio, Philip Rothrock, and Jonathan Leonard (2017). *Supply Change: Tracking Corporate Commitments to Deforestation-free Supply Chains*, Forest Trends: Washington, DC. Available online at: https://www.forest-trends.org/wp-content/uploads/2018/04/2017SupplyChange_Trackin-Committments.pdf

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25   United Nations, (2015) *New York Declaration on Forests and Action Statement*, accessed online at: https://unfccc.int/news/new-york-declaration-on-forests

26   The Accountability Framework Draft Operational Guidance on Cutoff Dates, p. 2. *https://accountability-framework.org/wp-content/uploads/2019/02/Op-Guidance-on-Cutoff-Dates-DRAFT-2018-7-NEW-NOTE.pdf*

27   McDonald's Corporation (2015) *McDonald's Corporation Commitment on Forests*, updated February 2017, and *McDonald's Commitment on Forests Supporting Addendum* available online at: https://corporate.mcdonalds.com/content/dam/gwscorp/scale-for-good/McDonaldsCommitmentOnForests.pdf See also: http://corporate.mcdonalds.com/corpmcd/scale-for-good/our-planet/conserving-forests.html

28   McDonald's Corporation (2017–19) , 'Beef sustainability' Conserving Forests accessed online at: https://corporate.mcdonalds.com/corpmcd/scale-for-good/our-planet/conserving-forests.html#goals The priority section reads: *In order to better focus our efforts, we have mapped out and identified a list of countries that have a high deforestation risk, as defined in the WWF Living Forests report, and that we currently are sourcing from: Fiber – Argentina, Cambodia, China, Indonesia, Laos, Malaysia, Russia and Vietnam. Coffee – Honduras, Indonesia and Vietnam. Palm oil – Indonesia and Malaysia. Soy – Argentina, Bolivia, Brazil and Paraguay. Beef – Argentina, Australia, Bolivia, Brazil, Colombia and Paraguay.*

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31   Dairy Australia (2019), *Australian Dairy Industry Sustainability Report 2018*, p. 87.

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37   Australian Government, Department of Environment and Energy, (2018) '*National Inventory Report 2016 Volume 12*, p. 2. Commonwealth of Australia: Canberra

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