Considering biodiversity in natural product supply chains

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PREPARED BY:

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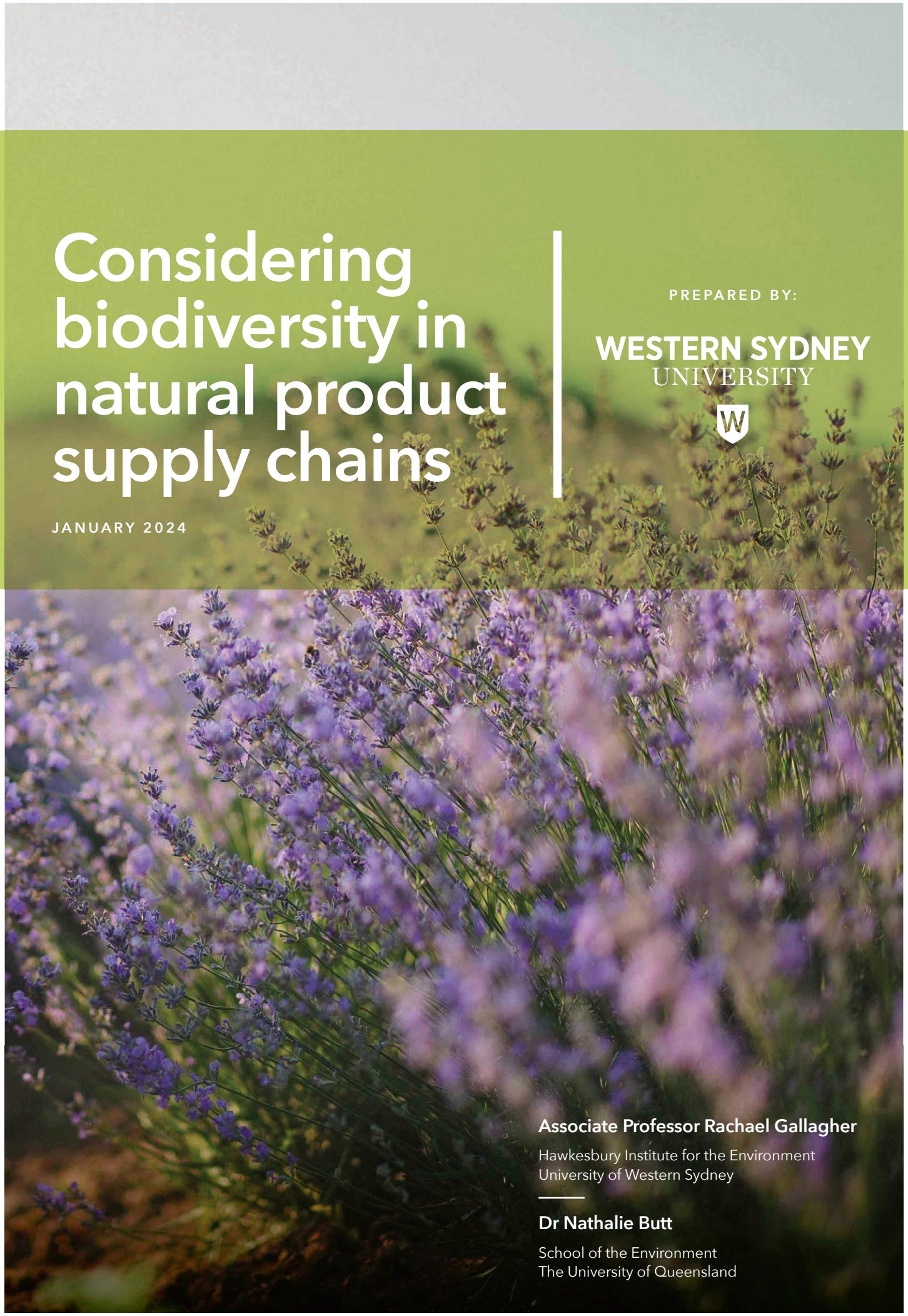

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Executive Summary

Biodiversity impacts present an escalating risk to businesses and their investors. Proactive companies are taking actions to understand their impacts on nature and mitigate these risks. The Taskforce on Nature-related Financial Disclosures (TNFD) is an emerging global initiative to create market-driven processes that identify how nature can be factored into global business decision-making and risk analysis. While disclosure is not itself action, it can drive action for companies, and engaging with the emerging TNFD process puts early adopters in a good position to shape policy.

Part 1 of this report introduces the global context surrounding TNFD, discusses Australian government moves to create a market in nature repair and explores reputational risks and motivations for corporations engaging in TNFD activities. In part 2, climate change related impacts on nature-related supply chains are explored, using a generalised case study example of a plantation-derived supply chain ingredient in the natural health products sector grown in southeastern Australia.

The key insights from this case study can be used to inform:

- Approaches to TNFD risks under climate change. Specifically, it provides a framework for guidance based on the concept of 'vulnerability' of nature-related supply chains under climate change. In this framework, vulnerability can be seen as the product of two components:
  (1) Exposure – projected changes in conditions across production areas
  (2) Sensitivity – the likely impacts of exposure on the biology of targeted species in supply
- Insights for Procurement to consider levers to influence nature risk assessments, and nature positive initiatives – for example contract clauses;
- The development of future collaborations especially with technical/scientific experts and across the natural health products sector;
- The development of deeper partnerships (especially across supply chains) for critical data/mitigation scenarios;
- The formulation of clear examples of nature-based solutions to build into business models;
- Future disclosures of supply chain risks and business opportunities.

The broader lessons from the project include that:

- Case studies that evaluate nature-based risks/dependencies are adaptable and transferable;
- Supplier/grower engagement is critical at all stages of a project to ensure risks and benefits of TNFD approaches are communicated;
- Expectations of buyers and suppliers should be transparent and discussed at the time of project commencement, including the preparation of site-specific risk assessments;
- Accurate information from the supplier is critical for site-specific risk assessment;
- Some ecosystem impacts from the extraction of supply chain ingredients can be assessed using existing accessible datasets;
- Diverse scientific expertise is required to inform risk assessments and nature positive actions;
- Barriers may include data gaps and the lack of skills across complex supply chains to interpret the available data and ensure credible insights are incorporated into business systems.

Blackmores is a leading company formulating, manufacturing and marketing natural healthcare products to consumers in Australia and Asia. In terms of co-benefits to Blackmores and nature, it is uncertain whether the TNFD or the Australian Government biodiversity credits scheme can result in nature-positive outcomes, but early adoption by Blackmores places the company in a strong position to guide more effective policy, and undertaking evidence-based efforts to reduce impacts on nature, will identify Blackmores as leaders in the field, resulting in reputational gains.

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Part 1 Global context of nature related risk

Taskforce on Nature-Related Financial Disclosures (TNFD)

Most of the global economy relies on nature and the services it provides. However, nature is at risk from both the economic drivers that have led to the increasing consumption of natural resources, and the fact that natural systems (their characteristics and functions) and their damage or destruction are not generally considered in any accounting (IPBES 2019). There is growing awareness across the business community of the importance of valuing nature as a business imperative, grounded in the knowledge that 50% of our global economy is under threat from biodiversity loss: Biodiversity loss and ecosystem collapse is in the top four global risks in the next decade (World Economic Forum 2023). Biodiversity-related risk can be dependency-related or impact-related. Dependency-related risk refers to when ecosystem services are reduced or changed, negatively affecting a company's production (e.g., a reduction in water available for growing or processing). Impact-related risk refers to when a company's actions negatively impact biodiversity (e.g., decreasing population sizes due to overharvesting, or loss of biodiversity/ecosystem health due to pollution). These two elements are referred to as 'double materiality', and they should be considered both separately and synergistically (Hawkins et al. 2023).

The Taskforce on Nature-Related Financial Disclosures (TNFD 2023) is a recent global initiative, following on from the Taskforce on Climate-Related Financial Disclosures (TCFD), and was created as a parallel, market-driven process to identify how nature can be factored into global business decision-making and risk analysis. The alignment of reporting standards to the recommendations of the TCFD and the development of the TNFD demonstrates the need for stronger governance for nature and climate impacts as a core business element. With increasing pressure on natural resources from a wide range of commercial value chain operations, TNFD aims to provide a framework for companies to understand the impact of their operations on nature, and of global environmental change on their commercial bottom line: biodiversity impacts present an escalating risk to businesses and their investors (Hawkins et al. 2023; White et al. 2023). The development of the TNFD framework has been an iterative and responsive process, with companies taking part in pilot projects, the results of which are informing its development. Final recommendations from the Taskforce were provided in December 2023 (https://tnfd.global/publication/recommendations-of-the-taskforce-on-nature-related-financial-disclosures/). It will be a transferable and widely applicable mechanism, and ensure that signatories to the scheme will be transparent in their processes, and be able to adjust/update/improve their industrial operations to reduce damage to biodiversity.

The state and trend of the environment of Australia is poor - and deteriorating – due to increasing pressures from climate change, habitat loss, invasive species, pollution and resource extraction (Australian State of Environment Report 2021). Habitat loss and degradation are the main threat to species in Australia, with nearly 70% of Australian threatened taxa impacted and 60% of listed threatened species seriously affected. In line with G7 support for TNFD (White et al. 2022), in March 2023 the Australian Government introduced the Nature Repair Market Bill to federal parliament as part of a suite of environmental reforms designed, in part, to improve regulation of activities that impact nature. The Bill was passed in early 2024, creating passage for the world's first market in biodiversity credits (DCCEEW 2023a) and signals the aspiration for better engagement with industry in approaches to protecting nature. Biodiversity projects, defined specifically in the Bill as those that aim to 'enhance' or 'protect' native biodiversity (including native vegetation restoration, planting, and fencing), would need to demonstrate that the methods used meet statutory Biodiversity Integrity Standards. These standards remain under development, but could include requirements for measurement and assessment of actions that seek to enhance or protect biodiversity. Projects meeting these standards could ultimately be awarded certificates, which can be traded in commercial contract agreements. Companies and organisations seeking to fulfill environmental social governance (ESG) commitments, such as those which are signatories to the TNFD, would make up the voluntary market for these certificates, or biodiversity credits. This proposed market structure aligns with the carbon credit market (developed under the Carbon Farming Initiative 2011, which was combined with the Emissions Reduction Fund (ERF) in 2014: Clean Energy Regulator, Australian Government), to promote the delivery of biodiversity co-benefits. There is considerable uncertainty surrounding the passage of the Nature Repair Market Bill following a Parliamentary Inquiry in June 2023. Broader environmental reform agenda, primarily legislating changes to the Environment Protection and Biodiversity Conservation Act, are being prioritised over the nature market regulation. Despite this, there remains a commitment from government to nature positive reforms as outlined in the Nature Positive Plan (DCCEEW 2022).

Aside from regulatory requirements, and informing supply chain risk, key drivers for companies in high-income nations to engage in TNFD are social licence and reputational risk. Companies want to avoid poor nature outcomes and commit to real change as opposed to engaging in 'greenwashing' to maintain their customer bases. While disclosure is not itself action, it can drive action for companies, and engaging with the emerging TNFD process puts early adopters in a good position to shape policy (which can also be of benefit to them). Widespread adoption of the TFND is anticipated, especially as regulation will require it in some places, creating an opportunity for pioneering businesses to demonstrate leadership through early implementation of its recommendations.

Part 1

Global context of nature related risk

Biodiversity markets and financing

The global nature market, including mechanisms such as biodiversity offsetting, is estimated to be currently worth A$7 billion, potentially increasing almost twenty-fold by mid-century (Chee 2023). However, while evidence-based guidance can in theory help companies reduce or avoid risks to biodiversity and promote nature benefits (White et al. 2023), the key difficulty will be transferring economic gains into tangible positive outcomes for biodiversity, in a measurable way. Most of the global biodiversity market is compliance-based (to compensate for biodiversity loss through development) with just a few examples of voluntary mechanisms in place (World Economic Forum 2022), and the level of demand for such a market is unproven (Cox 2023). Governance and regulation are critical for the success of such instruments, and it is unclear how private finance can deliver nature-positive outcomes without policy. Previously established markets for carbon, water, and biodiversity offsets in Australia have not worked in the way intended – indeed, land clearing in NSW has actually increased as a result of the carbon market (Hemming 2022), while the water market demonstrated "everything that can go wrong when our policy response to protecting a natural resource is to commodify it" (Hemming 2022). Evidence for market-based biodiversity mechanisms achieving their ecological goals remains very limited, and there has been little progress in the last few years: Global Fortune 100 companies reporting 'specific, measurable and time-bound biodiversity targets' increased from only five to ten between 2016 and 2021 (White et al. 2023).

The financing gap for biodiversity projects – how much is required compared with how much is spent - is large and growing (US$4.1 trillion in 2021: Mulder et al. 2021), and biodiversity credit markets are developing to address this by leveraging private finance. Regulation and governance must be strengthened and developed alongside market-based instruments (Taskforce on Nature Markets 2023). There is also moral argument that companies that have benefitted greatly from the commercialisation (and destruction of) nature should take on some of the responsibility of redressing the situation. While the stated objective of the TNFD is to "shift global financial flows away from nature-negative outcomes and towards nature-positive outcomes" (TFND 2023), it remains unclear that there is sufficient interest for private investment to match the scale of what will be needed; companies may be attracted by the idea of lucrative returns-on-investment associated with nature positive perceptions, but it remains unclear if sufficient investment will flow to support these aspirations.

The conundrum/internal contradiction

Humans are dependent on our capacity to continue to extract and use natural resources, and in theory TNFD can allow for the more transparent and equitable transfer of value from nature to commercial organisations' financial bottom line. However, the essential – perhaps unsolvable – problem is that potential drivers of negative impacts on nature (e.g., the exploitation of natural resources for profit via direct harvesting, supply chain activities that affects local environments, land use change that drives habitat loss/degradation) and market-based actions to 'repair' nature currently remain mutually exclusive. The gulf in knowledge and practices between economic markets and biodiversity science may be insurmountable. While voluntary mechanisms can be posited to allow for continued and increasing financial profits from using natural products, involving the same actors in the protection of nature is problematic. It is perhaps unreasonable to anticipate that companies and their shareholders will be willing to pay for what is needed to enhance and protect nature through avoided profits. In general, there is a lack of detail around how such a mechanism would work, from both business and political sectors (Chee 2023).

Potential benefits to Blackmores

However, businesses do have an opportunity to contribute to global measures to reduce or avoid declines in biodiversity driven by their activities, and only a minority of companies currently act to tackle their biodiversity impacts. Were a company such as Blackmores to commit to TNFD, accepting the financial consequences largely driven by dependency on natural ingredients, they could be leaders in the field and make an enormous positive difference. Changes that can positively influence nature outcomes may flow from supporting suppliers to improve risk and impact mitigation measures by raising awareness and/or supporting certification processes. These outcomes may be achieved through ensuring that their biodiversity risk assessments and reporting, as well as constructive engagement with suppliers, drive actions to protect/conserve/enhance nature affected by their supply chain activities, with proper monitoring, adaptive management, and a commitment (followed by tangible action) to discontinue products that are not possible to source sustainably or without irreversible damage to nature. The reputational benefits of these actions could increase interest from stakeholders and add great value to its social licence. Acknowledgment of the fact that the opportunities arising from biodiversity markets will not be directly financial, but rather societal and environmental, will be a critical first step. Other valuable opportunities and benefits relate to deeper involvement in the circular economy: principles of sustainability and minimal waste are embodied in Blackmores supply chain options.

Blackmores has already demonstrated commitment to sustainability goals around decarbonisation and ethics in its supply chain – for example, its Sustainability Linked Loan incorporates penalties for failing to meet targets and incentivises achievement of more ambitious goals (Blackmores Group 2022). With increasing public concern around threats to nature, including land clearing, extinction of native species, and climate change, and businesses as well as government cited as having key responsibility for the environment (Borg et al. 2023), the company is extremely well-poised to play a central role in delivering nature-positive outcomes.

Part 1

Global context of nature related risk

Regulation, monitoring, and evidence-informed practice

National environmental regulation that is properly implemented and where transgressors are penalised remains a cornerstone of effectively achieving nature-positive outcomes. Current or future governments may be unwilling to: a) invest the required amount of public money, and b) take responsibility for regulation and enforcement in the face of political and industrial opposition, creating a potential role for the private sector beyond that of philanthropy. A large body of scientific evidence is available to understand what is needed to repair nature (Balvanera 2019); the hierarchy of actions is to curb damaging actions such as land clearing, polluting industrial activities (including reducing greenhouse gas emissions), and unsustainable water extraction, before undertaking vegetation and waterway restoration, controlling or removing invasive species, and improving existing native habitat (IPBES 2019). Evidence-based management is critical for success (White et al. 2023). Another key factor in any success of nature-repair or nature-positive activities will be post hoc assessment – in general very few biodiversity conservation programs are monitored to measure the success of management actions (White et al. 2023). This is also the case with mitigation programmes under offset schemes. Analysis of these programs demonstrates a lack of success such that 'no net loss' (of biodiversity, the aim of offset schemes) has not been achieved (zu Ermgassen 2023). Companies are not currently held accountable, and this is difficult to do without robust and scientifically informed biodiversity targets and the baselines against which impacts are measured.

Using evidence to inform practice is essential for businesses to engage effectively with the conservation sector, however, this is not generally happening, and there are several trends emerging from research on this topic. These are that: commonly used mitigation measures are not actually effective; ineffective (or unassessed) mitigation measures are still being applied; information or documents being used as guidance are not based on evidence; proof of the success of proposed actions is generally lacking, and; monitoring and assessment of outcomes after mitigation is very limited (White et al. 2023). Further, across-the-board standardisation of metrics, or agreement on what to use for risk assessment, and mitigation opportunities are lacking (Hawkins et al. 2023). To enable companies to learn from their actions, and to pre-empt charges of greenwashing, or criticism around poor implementation, transparent and regular reporting is essential. Implementing best practice has challenges, however, including a lack of operational control in the supply chain and limited capacity to influence transparent reporting from partners.

Recommendations for best evidence-based practice (derived from White et al. 2023; see Figure 1):

1. The use of evidence should be central to business practice and environmental management such that evidence-based practice is the norm. An organisational cultural shift may be required to address some of the barriers to this.
2. Evidence should be assessed and used appropriately to guide actions, which will vary according to the biodiversity component, the threat, and the point of the supply chain where the impacts occur. Where there is no evidence that an action will be effective, the practicability of the mitigation should be examined.
3. Type and source of evidence is important. Mitigation actions within complex socio-ecological systems, for example, may rely on Indigenous or expert knowledge, and stakeholder values should be integrated into planning. For other types of evidence, quality control should be applied. The variability of evidence/information should be considered when making decisions.
4. Documentation of evidence use should be standard practice so that the decision-making process is clear (i.e., what information was used to guide the decision).
5. Baselines, actions, and impacts should be reported.
6. Monitoring of biodiversity outcomes is critical for evidence-based practice, and should take place throughout the mitigation process so that any problems or failures can be addressed as soon as possible.
7. Sharing biodiversity information will improve the evidence base, especially with regard to baseline and monitoring data, and these can be contributed to biodiversity databases.

Part 1

Global context of nature related risk

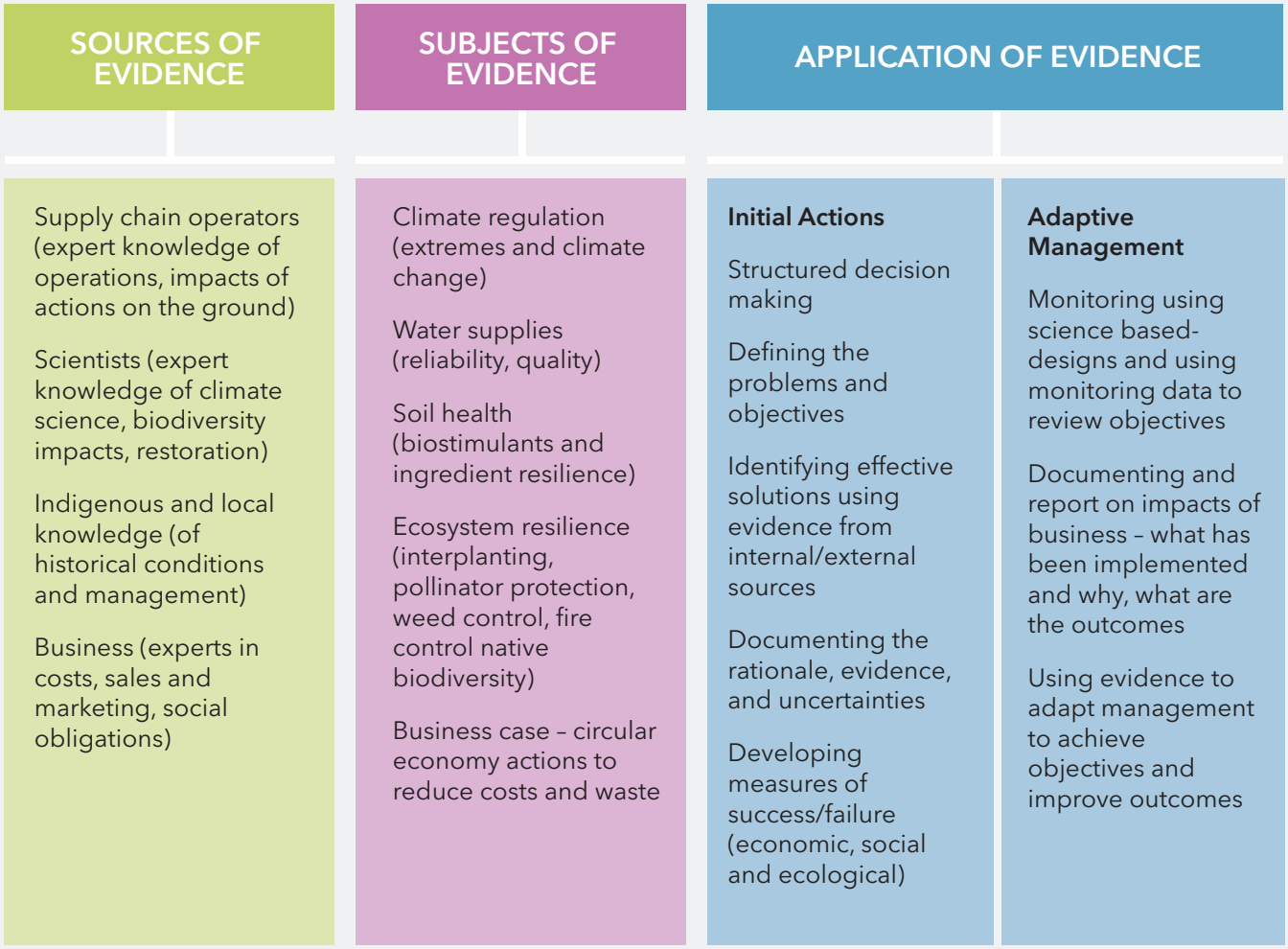


Figure 1: Overview of evidence use in mitigation action planning; for a plantation-based example for panels 1 and 2.

It is also worth noting that when the above recommendations are followed to guide planning, evidence may improve the outcomes of specific actions but not actually address the underlying causes of biodiversity decline. Political action and wide-reaching policy implementation will be necessary to achieve that.

The LEAP approach

The TNFD assessment process uses the LEAP approach, an integrated approach that follows a preliminary business prioritisation (i.e., consideration of the scope of an assessment), and aims to support internal science-based assessments of nature-related risks and opportunities (TNFD 2023). The four parts of the approach are: Locate the interface with nature; Evaluate the dependencies and impacts; Assess the material risks and opportunities, and; Prepare to respond and report. Biodiversity impact mitigation by companies is not always evidence-based (White et al. 2022), and the data collected may not have been appropriate, so it is important that a transparent, transferable, fit-for-purpose method is used. A core characteristic of the LEAP approach is that is it iterative, thus allowing for review of findings that can then inform repetition of the process. Importantly, because the approach has clear separate steps, stakeholders can be consulted at each point, to provide insight and guidance. Thus far there are few LEAP assessments – Blackmores carried out four pilot assessments on existing Australian facilities and key ingredients in 2022 and 2023; one of the few companies to participate to this level.

Part 2 Climate change impacts on nature: case study of potential supply chain issues

Climate change is already driving impacts on nature across all biomes and ecosystems globally, from marine to tundra. For example, shifts in species' distributions (primarily pole-wards in the northern hemisphere, and also laterally in the southern hemisphere; Vanderwaal et al. 2013), changes in the timings of life history events, such as flowering and fruiting, which then also affects the availability of food resources for dependent animals (Butt et al. 2015), and changes in plant community composition and species diversity (Gallagher et al. 2013). These impacts drive changes at different levels (Figure 2).

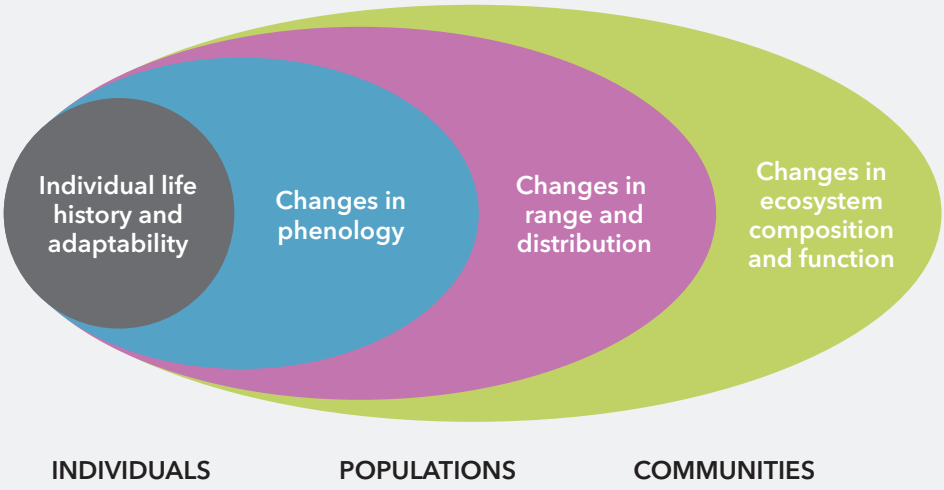


Figure 2: Climate change impacts on biodiversity across ecological scales. Individual plants or animals, populations of individuals, and communities of different populations can all be affected, with impacts interacting across scales.

Climate change can manifest as gradual mean change (constant change, Figure 3), as regular annual events which may be extremes (e.g., higher than average summer temperatures), and as more complex irregular events, or extreme climate events (e.g., drought events).

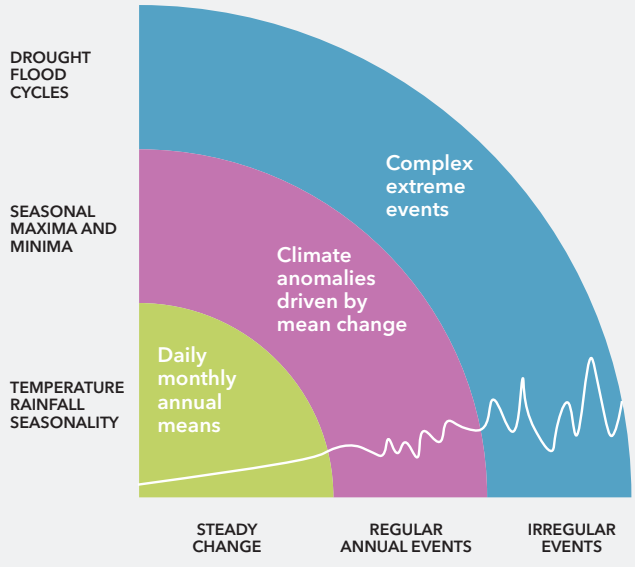


Figure 3: Climate change factors. Daily, monthly and annual mean temperatures, for example, are constantly changing (steadily increasing), and these can drive extremes such as hotter-than-average summer temperatures. Extreme climate events are less consistent and predictable, and include cyclones and floods.

Part 2

Climate change impacts on nature: case study of potential supply chain issues

BACKGROUND

Local ecosystems

It is important to identify the local native vegetation of the areas surrounding the locations of the source material; some of these ecological communities will be listed as threatened under the EPBC Act (DCCEEW). Many agricultural landscapes are largely non-native (cleared/planted) agricultural land (NVIS; Keith and Pellow, 2015).

Local climate

Southern and Eastern Australia was the region explored to inform Blackmores' nature risk assessment approach, and we considered those broad temperate areas for exposure factors and dependencies, risks and opportunities. For plants, temperature is an important factor in productivity: minimum, maximum, nighttime, and seasonal temperature data should be collated. In Australia, water availability is critical for plants and crops, and mean, maximum, and minimum rainfall data should be collated. Rainfall in La Niña years is more than average, and due to increased cold cover nights can be warmer and the number of frost days reduced, whereas El Niño typically suppresses rainfall in eastern Australia during the winter and spring months.

KEY EXPOSURE FACTORS FOR PRODUCTION OF SUPPLY CHAIN INGREDIENTS

1. Dependencies on nature under current conditions

Four key dependency indicators: climate stability, water supply, soil quality, and ecosystem resilience (including flood protection and erosion control) have location-specific risks and significance to natural product supply chains.

The following ecosystem services are important:

- Climate regulation, through biosphere-atmosphere feedbacks (terrestrial vegetation modulates energy fluxes and water fluxes to the atmosphere, affecting local climate conditions) that mitigate climate extremes, e.g., ensuring a suitable temperature range for growing; Green et al. 2017)
- Fresh and consistent water supply (Murray-Darling Basin)
- Soil (soil organic matter (SOM) physical characteristics relating to stability, drainage, and nutrient content relating to fertility; Campbell and Paustian 2015)
- Ecosystem resilience – local native vegetation ecosystem (stable species composition, genetic diversity, disease/pathogen resistance, storm/flood protection).

2. Nature-related impacts under current conditions

- Some threats to local natural systems are presented by all agricultural activity, and are not specific to the production of specific products/components; land clearing for planting and pesticide/fertiliser input, for example.
- Likely threats to other species/ecosystems from ingredient production
  - Australian Government Key Threatening Processes (DCCEEW 2): Land clearance (for agriculture); Novel biota and their impact on biodiversity (EPBC threatened ecological communities; DCCEEW 3)
  - Invasive species – linked to reductions in native species richness and changes in soil nutrient dynamics (Gallagher et al. 2010).
- Pesticides and fertiliser use – changes to insect populations and communities, and to soil health through changes in nutrient composition.

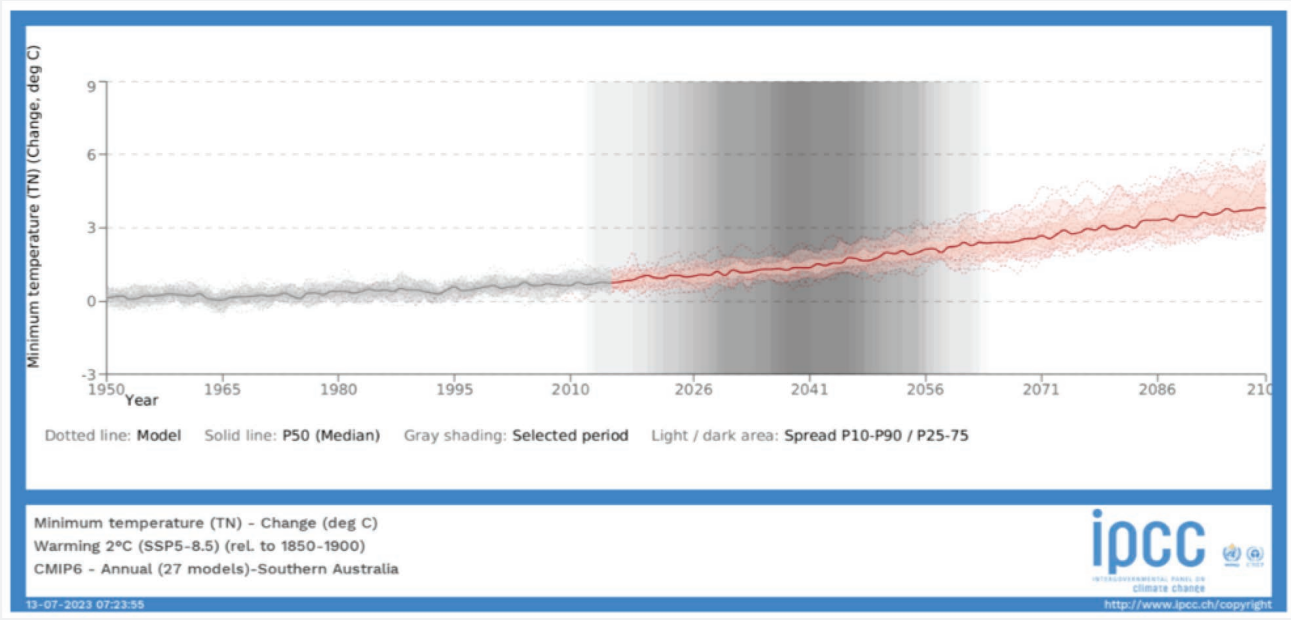
3. Nature-related impact and risks under climate change/future conditions

The risk to the supply chains from potential climate change impacts on biodiversity. Most risks occur at the growing site.

- Climate regulation – extreme events (increased risk of ecological and agricultural drought, more intense short-duration rainfall, less frequent but more intense tropical cyclones, intensifying heatwaves, and an increase in the intensity, frequency and duration of fire weather; Pitman et al. 2021).
- Seasonal water stress is likely to increase, which could provide an ecological tipping point for native vegetation ecosystem persistence (Butt et al. 2013). Resultant changes in ecosystem composition and tree cover could also impact on local hydrology and climate, further exacerbating environmental stress by affecting climate regulation.
- IPCC (sixth assessment report) projections for Southern Australia (Lee et al. 2021):
  - Decrease in mean rainfall, especially in the cool season;
  - Increase in aridity and agricultural and ecological droughts;
  - Cool temperature extremes have become rarer since 1950; hot extremes have increased in frequency and intensity; the number of warm days and nights have increased (Figure 4).

Part 2

Climate change impacts on nature: case study of potential supply chain issues



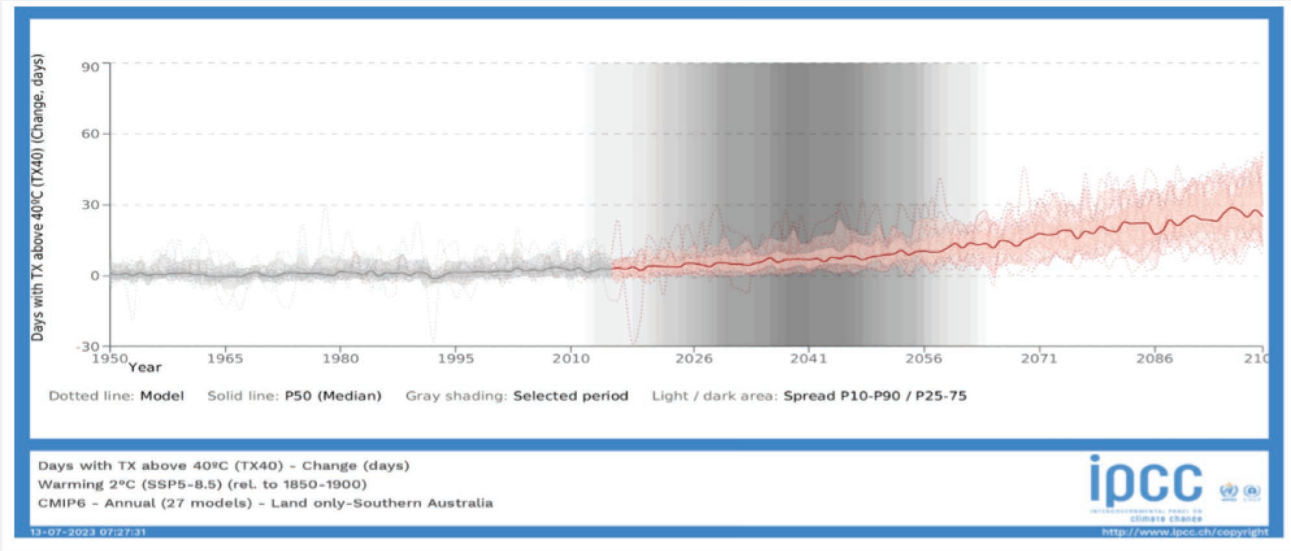


Figure 4: IPCC projections for minimum (night-time) temperatures (top), and extreme heat days (bottom).

Part 2

Climate change impacts on nature: case study of potential supply chain issues

KEY CLIMATE CHANGE SENSITIVITY FACTORS FOR SUPPLY CHAIN INGREDIENT PRODUCTION

Temperature

Under climate change, the physical climate hazards related to temperature that may affect temperate production areas are: heat stress, temperature variability, frost, and storms. These all have a high level of likelihood and are rated as significant or high as risks. Insufficient rainfall/drought has a relatively high level of likelihood, and the risk is significant (Figure 5).

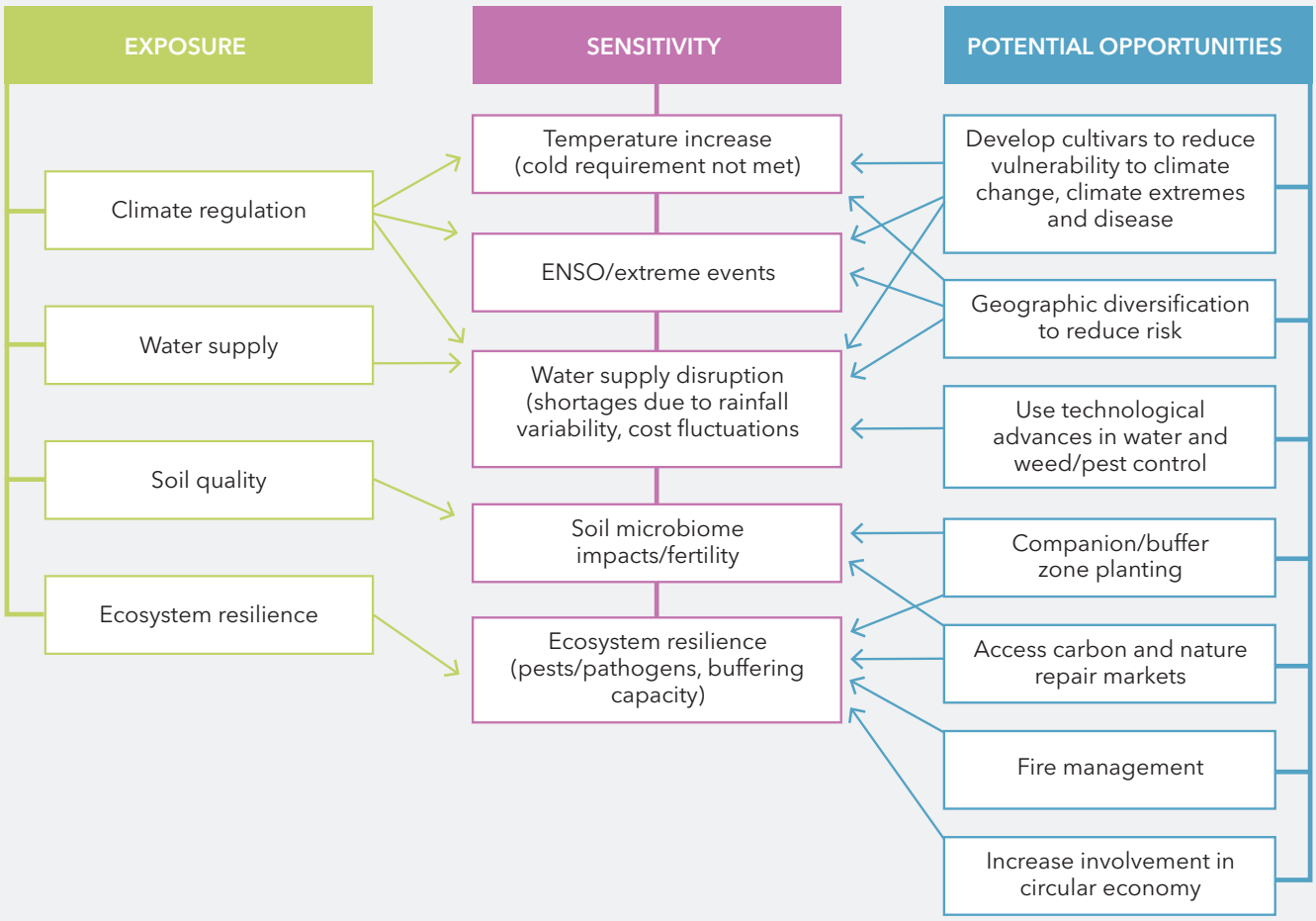


Figure 5: Summary of exposure, sensitivity and opportunities: a summary of potential impacts on a supply chain due to climate change.

Part 2

Climate change impacts on nature: case study of potential supply chain issues

El Niño–Southern Oscillation (ENSO)

In Australia, the El Niño–Southern Oscillation (ENSO) climate system has three phases: neutral, El Niño, which brings hot and dry conditions, and La Niña, which brings increased rainfall over northern and eastern Australia. Most climate models predict an increase in both El Niño and La Niña events. Extreme El Niño events result in the conditions for an extreme La Niña to develop – suggesting frequent swings between extreme events of each, between drought and floods. La Niña events are predicted to happen almost twice as frequently this century (Cai et al. 2021), which may lead to extended wet periods, while droughts are becoming faster in their onset ('flash droughts'; Yuan et al. 2023), and are also intensifying more rapidly – plants that are otherwise adapted to dry conditions will be vulnerable to these extremes.

Natural resource use

Water shortages. The Murray-Darling Basin, an area of 1 million square km in the southeast of Australia is a critical resource for a large proportion of national agricultural production, and 40% of all farms are located here (Murray-Darling Basin Authority – MBDA). The southern Murray-Darling Basin is already receiving less rainfall than the long-term average, and rainfall is projected to decrease further (BoM; MBDA). This will affect water storage capacity and lead to higher demand from irrigators and communities. Variability is likely to increase (increases in drought frequency and severity, and also in heavy rainfall). Further, water use links to consumer preferences as there is widespread awareness of environmental/biodiversity damage from historic water abstraction and irrigation in the region, and concern around current and future use for agriculture. Almond farming, for example, which has greatly expanded along the Murray River in recent years, is extremely water-intensive, and a proposed South Australian almond farm just 40 km from the Victorian border will demand up to 30 gigalitres of water from the Murray-Darling Basin, with impacts on water supply for agricultural and other uses (Chan 2023). Changes in water availability due to climate change impacts on the reliability of supply may lead to fluctuations in cost to the company.

There is also pressure on the federal government to buy back water/water entitlements from irrigators, as part of the Murray-Darling Basin plan, in order to restore environmental flows to the rivers and wetlands in the area. A new report Victorian Government report found that 140 threatened species, 48 animals and 92 plants, depend on these environmental flows, and are at risk of extinction if they are not restored (Environment Victoria 2023). Reduced water entitlements may also lead to price increases or variation in water availability for irrigation in some locations.

Extreme climate events

Floods – in late 2022 there was a disastrous flood across areas of Victoria, NSW, and South Australia, with hundreds of thousands of hectares inundated, causing enormous agricultural losses.

Fire – Droughts can provide suitable conditions for bushfires by decreasing soil and fuel moisture content, causing plant mortality and die-back leading to higher fuel loads. In growing areas surrounded by cleared/agricultural land or low native bush (e.g., Mallee), the potential fuel load is low. Increases in the severity of fire conditions, which have been increasing in frequency since 2000, are likely to occur (Canadell et al. 2021), and some fire regimes have been identified as a threat to more than 800 native species and 65 ecological communities listed as threatened (DAWE, 2022). Such fire regimes are one of the most significant threats to Australia's biodiversity: existing firebreaks and landscape barriers may not be effective in future.

Other flood or fire-related risks include the possibility of soil seedbanks, and weed species may appear in large numbers, requiring intensive management. Floods, droughts, and fires can all cause damage to growing locations, resulting in yield loss.

Soil

Soil physical and nutrient properties, as well as the soil microbiome, will likely be affected by climate change. Soil temperature, moisture, and soil organic matter (SOM) will be altered, likely resulting in a lowering of soil fertility (Rosenzweig and Hillel 2000). Maintaining suitable levels of soil fertility may therefore require more fertiliser input. In addition to becoming more costly, this can also increase the ecosystem impacts of adding nutrients. There is also an interaction with local hydrology – in times of drought the water table can be lowered, which increases soil salinity, also reducing fertility. In addition, warming soils and concomitant alterations to the soil biome can facilitate an increase in soil-borne pathogens (also potentially requiring more expensive soil management treatment). Cation exchange capacity (CEC) is important for soil fertility as it determines how effectively nutrients can be held in the soil and buffers sol acidification.

Ecosystem resilience

Potential invasion of site(s) from invasive species expanding their ranges under climate change. Pest species expanding or shifting their distribution range under climate change or climate change-driven changes in phenology can affect both managed/farmed land and natural vegetation communities. Changes to native vegetation can reduce its resilience to other threats, and its capacity to buffer managed areas from abiotic and biotic threatening processes. Growing sites located within a matrix of land uses (primarily agricultural) may diminish resilience relative to contiguous areas of native vegetation. This could result in reduced productivity/increased management costs around pesticides, weed clearing, etc. Also, changes in invertebrate

herbivore composition resulting from ecosystem changes may risk unsustainable levels of herbivore leaf predation/damage, which could affect the chemical or nutritional quality of supply chain ingredients, and pose a risk to the supply chain.

Pathogens and pests

Most supply chain ingredients are at risk from species-specific pests or pathogens at growing and production sites. More generally, pests and pathogens expanding outside their historical ranges as the climate becomes more suitable for them will also be problematic.

4. Opportunities

Enhance ecosystem/site resilience

Species composition/planting – focus on understorey or companion planting – inter-row planting. Could follow an agroforestry approach of multiple vegetation layers using commercially attractive or high-value native species. Including herb layer nitrogen fixers would enhance soil fertility, shrub layer species that stabilise the soil and prevent/reduce erosion, species that enhance water transport and soil drainage.

Companion planting can repel insect pests, attract beneficial insects, and fix nitrogen. Native ground cover nitrogen fixers include running postman (Kennedia prostrata), coral creeper (K. coccinea) and native wisteria (Hardenbergia comptoniana). Bindweed (Convolvulus spp.) and Myoporum species are also effective native ground cover species.

Buffer zone planting could increase pollinator and insect habitat in general, which could promote/support regulation of insect populations by competitors and predators, reducing the risk of over-predation of leaves by herbivores.

Fire management

New fire break strategies, such as landscape protection breaks and asset protection breaks (Forest Fire Management Victoria), and future-proof fire management planning would also enhance ecosystem resilience.

Enhance plant resilience to climate extremes and extreme climate events

Biostimulants (seaweeds, protein hydrolysates, humic substances and microorganisms, and recently nanoparticles or nanomaterials) have been tested on crop species elsewhere, and research is underway into their potential benefits (in Europe) (Dias et al. 2022). The idea is that pesticide, fertiliser, and water use is reduced, thus reducing costs. Biostimulants can also be used to control pathogens. Successful development of this approach could also provide another income stream, from on-selling of the technology to other growers and producers facing the same pests – extending to other crops/agricultural systems.

Access to carbon and nature repair markets

Mixed planting, using marginal land, and a range of species for better integration with local native fauna and flora (vegetation communities), as well as benefitting nature in itself and promoting ecosystem resilience, could be financially beneficial through market mechanisms such as the DCCEEW's Nature Repair Program through government investment in projects related to vegetation restoration, management, and protection (DCCEEW 1). Blackmores could partner with supply partners to develop a methodology for enhancing biodiversity under that scheme, and then sell the credits to the international market, if the outcomes are well tracked. Control of feral animals on the property (e.g. rabbits) may also be eligible if it can be connected to the recovery of native plants (especially threatened plants) at the site.

Similarly, through the Emissions Reduction Fund (ERF) Blackmores could earn Australian Carbon Credit Units (ACCUs) through emissions avoidance or storage of carbon dioxide in vegetation and soil. As processing and product production energy use contribute to emissions (and thus climate change), a transition to renewable energy such as solar could offer revenue potential (Clean Energy Regulator, Australian Government). Sourcing future climate resistant provenances for vegetation planting/restoration would also increase ecosystem resilience.

Geographic diversification

Locating growing sites in different, more diverse locations, to mitigate some of the potential climate change impacts. Avoidance of flood zones, or areas where the minimum temperatures are set to increase above plant tolerance levels, or where rainfall seasonality (droughts/floods) is projected to greatly increase, would reduce the risk of crop loss/damage due to adverse climate conditions.

Technological advances

Targeted systems for water use and for delivering herbicides and pesticides and fertiliser with improved precision would reduce unintended impacts on non-target vegetation and soils, and could also reduce costs through smaller quantities needed. An LiDAR (Light Detection and Ranging) system could be used to detect changes in water content of leaves, or soils, or to closely track growth in challenging climate conditions.

Circular economy actions

Growing residues can be managed and returned to the soil to retain nutrients and maintain/improve soil fertility. Processing and using organic waste as a fuel source for local energy needs would reduce waste as well as energy use.

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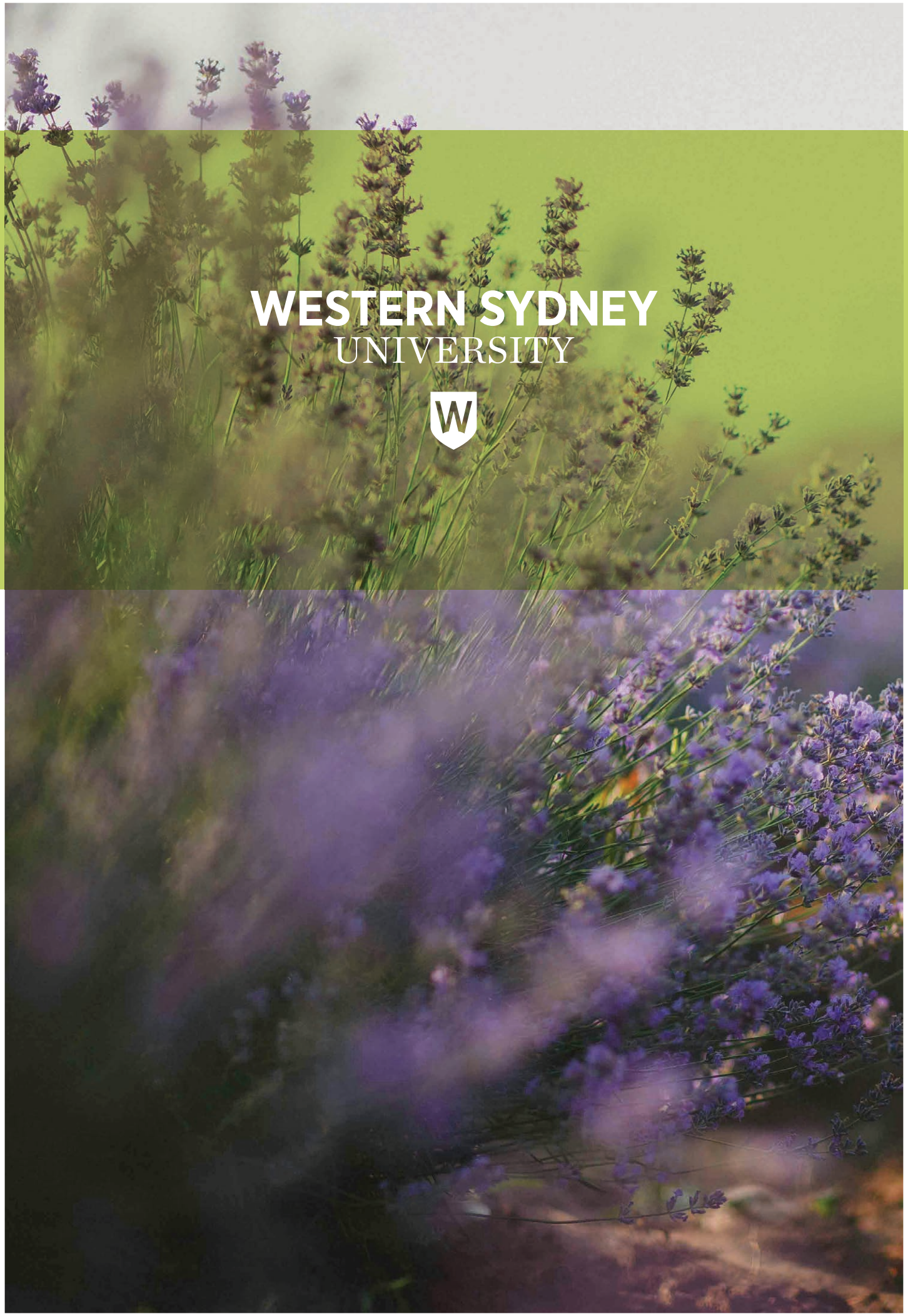
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