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Threatened Plant Translocation for Mitigation: Improving Data Accessibility Using Existing Legislative Frameworks. An Australian Case Study

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Translocation of plants is used globally as a conservation action to bolster existing or establish new populations of threatened species and is usually communicated in academic publications or case studies. Translocation is also used to mitigate or offset impacts of urbanization and development but is less often publicly published. Irrespective of the motivation, conservation or mitigation, on ground actions are driven by overriding global conservation goals, applied in local or national legislation. This paper deconstructs the legislative framework which guides the translocation process in Australia and provides a case study which may translate to other countries, grappling with similar complexities of how existing legislation can be used to improve accessibility of translocation records. Each year, across Australia, threatened plants are being translocated to mitigate development impacts, however, limited publicly accessible records of their performance are available. To improve transparency and opportunities to learn from the outcomes of previous mitigation translocations, we propose mandatory recording of threatened plant translocations in publicly accessible databases, implemented as part of development approval conditions of consent. The contribution to these need not be onerous, at a minimum including basic translocation information (who, what, when) at project commencement and providing monitoring data (outcome) at project completion. These records are currently already collected and prepared for translocation proposals and development compliance reporting. Possible repositories for this information include the existing national Australian Network for Plant Conservation translocation database and existing State and Territory databases (which already require contributions as a condition of licensing requirements) with new provisions to identify and search for translocation records. These databases could then be linked to the Atlas of Living

Australia and the Australian Threatened Plant Index. Once established, proposals for mitigation translocation could be evaluated using these databases to determine the viability of mitigation translocation as an offset measure and to build on the work of others to ensure better outcomes for plant conservation, where translocations occur.

Keywords: mitigation translocation, development offset, policy and legislation, conservation, data sharing, transparency, threatened plants

INTRODUCTION

Plant translocation is a tool that is increasingly used globally to complement conservation practice (Godefroid and Vanderborght, 2011; IUCN, 2013), as well as to mitigate or offset impacts of development (Silcock et al., 2019). Defined as the movement of whole plants or plant regenerative material from one area to another (Commander et al., 2018), the practice can be categorized based on source population and recipient site into: introduction, reintroduction, reinforcement/augmentation and assisted migration (Seddon, 2010; IUCN, 2013; Maschinski and Albrecht, 2017; Commander et al., 2018).

Although the motivations behind implementing a translocation are context specific, they can broadly be grouped into two categories; conservation or mitigation driven (Silcock et al., 2019). The primary objective of a conservation translocation is to preserve population, species or ecosystem diversity (IUCN, 2013) through the creation or bolstering of genetically diverse populations. Conservation translocations may be required in response to co-occurring pressures such as climate change (Vitt et al., 2010; Lunt et al., 2013), genetic and reproductive isolation (Weeks et al., 2011; Frankham, 2015) and habitat isolation and fragmentation (Monks and Coates, 2002; Dalrymple et al., 2012). One high profile, characteristic example of a conservation translocation is *Wollemia nobilis* (Wollemi Pine), which has been translocated to protect wild populations from threats of disease, climate, local population collapse and a single stochastic event, such as fire, impacting the entire population (Mackenzie et al., 2021). A video and podcast explaining this work can be found at https://www.plant-heroes.com/species/wollemipine. In contrast, the practice of mitigation (or salvage) translocation usually occurs as a condition of consent or a legislative requirement prior to development of land (e.g., clearing for subdivision, building, roads or resource extraction) with the purpose of reducing impacts to any threatened species on the development site (Germano et al., 2015; Commander et al., 2018). Like conservation translocations, it can include movement of whole plants, or collection of reproductive material which is then propagated *ex situ* and relocated to alternate locations. One species which has been a recipient of up to 20 translocations, for the purpose of allowing developments to proceed, is *Pimelea spinescens* subsp. *spinescens* (Spiny Rice-flower) (https://www.plant-heroes.com/species/spinyriceflower). Decision making frameworks for deciding whether or not translocations should go ahead are outlined in various best practice guidelines (Seddon et al., 2007; IUCN, 2013; Maschinski and Albrecht, 2017; Commander et al., 2018) and are therefore not discussed in this paper.

In many countries, protection of biodiversity is based on tiered commitments made globally under the UN Convention on Biological Diversity, which in 2010 developed the Aichi biodiversity targets (https://www.cbd.int/sp/targets/). This was then formulated at the regional level (e.g., Association of South-East Asian Nations Socio-Cultural Community [ASCC] Blueprint 2025; the European Union Biodiversity Strategy), and applied nationally through legislation (e.g., US Endangered Species Act (ESA), 1973). Commander (2021b) provides a good example of this tiered system. Translocation is one method to protect biodiversity but given that threatened species are protected by law (e.g., US Endangered Species Act (ESA), 1973), translocations often come under each nation's broader regulatory framework. Therefore, translocations of threatened species must comply with environmental protection/biodiversity conservation as well as development/planning legislation, the application of which is unsurprisingly varied and often complex (Germano et al., 2015). This complexity, where environmental legislation must work across borders sometimes in concert with development-based legislation, can make it difficult for governmental approval bodies or regulatory authorities to provide consistent interpretations. Complexity can also lead to numerous consent pathways and numerous potential repositories for translocation data and records, resulting at times in a confusing and "impenetrable" body of gray literature (Bradley et al., 2021), particularly for mitigation translocations which are rarely published in public or scientific literature (Silcock et al., 2019).

There are emerging discussions aimed at unifying practice with policy, both globally (e.g., Brodie et al., 2021) and at the national level (Berg, 1996; Shirey and Lamberti, 2010; Olson, 2021), where in the United States of America at least, regulatory language makes pathways for decisions, record keeping, and interrogation of success rate, unclear. As well, the IUCN Conservation Translocation Specialist Group provides impetus to include best practice guidelines within existing national policies (e.g., Scottish National Translocation Code) (IUCN, 2020) and offers open access case studies in the Global Reintroduction Perspective Series (Soorae, 2018, 2021, https://iucn-ctsg.org/resources/ctsg-books/). However, these generally emphasize conservation reintroductions or climate necessitated assisted migrations (although occasional mitigation translocations are included (e.g., Vistro and Das, 2011). Some countries have endeavored to generate plant specific translocation databases, such as Italy (IDPlanT, Abeli et al., 2021) and Australia (ANPC, 2018) and others have reviewed published literature of national plant translocations in China, Australia and France (Liu et al., 2015; Silcock et al., 2019).

While these resources provide an excellent baseline, sometimes including information on mitigation translocations, they do not provide a repository for valuable translocation data- both from either conservation or mitigation driven translocations. In fact, the recent study by Julien et al. (2022) focusing on mitigation translocations, demonstrated that in France records are often confidential, requiring consent to interrogate and the overall quality of mitigation translocation was poor with substantial gaps in data. These data are essential under existing legislative requirements, and important for analyzing to assess current and improve future translocation efforts.

In this commentary, we use Australia as a working example of how legislation guides, and is applied to, translocations, both for conservation and mitigation purposes, and how the body of unpublished information (or gray literature) generated may be used as a valuable data source to plan future conservation actions. As a continent which encompasses vegetation communities from desert to alpine, rainforest to woodland as well as nine legislative systems, Australia provides an excellent case study with relevance to political and ecological systems around the world. Within Australia's legislation, translocation is mostly interpreted as protection against harm to threatened species and an action that may harm threatened species (through collection, salvage, reintroduction). Under the *Commonwealth Environmental Protection and Biodiversity Conservation Act* (EPBC, 1999) it is an offense "to kill, injure, take, trade, keep or move" listed species without a permit. This restriction is mirrored at all levels of Government. Consequently Acts, Policies and Regulations occur which include permits and consent pathways aimed at environmental protection within a planning and development framework (a summary of relevant State and Commonwealth legislation is included in **Supplementary Material**). Attempting to access information about translocations from within the relevant State and Commonwealth Departments, which provide consent for these actions, is challenging however, because data are usually not publicly accessible and often embedded within **Supplementary Material**. The varied Departments often lack a centralized publicly accessible database, with basic information such as "who," "what," "where" and "outcome" not easily available to interrogate or analyze. This lack of information severely hampers the ability for current and future practitioners to research species-specific process, as well as success and failure, even if multiple translocations of a species may have already occurred. Consequently, practitioners attempting to translocate a species may allocate unnecessary resources to researching translocation techniques when a method for the particular species has already been developed, or they may repeat the same mistakes as prior translocations, resulting in sub-optimal outcomes or complete failure.

Globally the use of mitigation, or offsetting impacts to natural areas, as a legislative tool is increasing (Maron et al., 2016, 2018). Within Australia, although translocation as a mitigation action is "not generally an appropriate measure to mitigate the impacts of development" (DPIE, 2019), and proposals including translocation are "unlikely to be approved" (DSEWPC, 2013), mitigation translocations are increasing. Silcock et al. (2019) reported that 85% of all recorded mitigation actions have occurred since 2000. Of the many threats to protected plant species (e.g., climate change, disease and invasive species), habitat fragmentation from development is, we propose, associated with existing legislation that provides the best opportunities to learn from outcomes of previous translocation efforts, because the legislation governing approvals requires evidence of detailed planning and monitoring.

Mitigation translocations fall within the scope of this existing legislation and are subject to the conditions employed in development and planning approvals (generally referred to as "conditions of consent") (**Figure 1**). These conditions of consent are specified by various local, State, and Commonwealth consent authorities (**Supplementary Material**) and facilitate development via mitigation offsets. Mitigation offsets are designed so that impacts in one area one area are "offset" or "counterbalanced" through cash contributions or land acquisition under a goal of like for like conservation, net gain (where more new plants are planted or habitat is create than lost) or no net loss (e.g, DES, 2014; Maron et al., 2018). Ameliorant mechanisms used for offsetting include restoration, salvage, and translocation of threatened species (Maron et al., 2012; Evans et al., 2021). These ameliorant mechanisms can collectively be termed mitigation measures. However, the viability of translocation as a conservation action (as opposed to part of a mitigation action) is highly variable (Godefroid et al., 2011; Dalrymple et al., 2012; Guerrant, 2013; Silcock et al., 2019) and relies on sufficient resourcing and thorough planning, species' ecological knowledge and ongoing management, maintenance and monitoring (Commander et al., 2018). To improve translocation outcomes, it is time that the details of mitigation translocation were centralized and accessible. Accessing these data are a logical path to enable evaluation and adaptive management for translocations in Australia and may be adapted to suit applications in other jurisdictions around the world.

METHODS

Australia has a federal government which creates national legislation, in this commentary termed "Commonwealth." The country is divided into eight states and territories (excluding offshore and mainland military territories), each of which has their own government, within these there are numerous local government jurisdictions. Hence, actions must comply with both federal and state/territory legislation, and occasionally local government depending on the scale of the impacts.

To inform this commentary, all Australian legislation (excluding external and military territories) guiding actions to protect threatened flora were reviewed, including Acts, policies and statements (**Supplementary Material**). Some of these specifically refer to translocation actions (usually policies or position statements) but more commonly are the overarching instruments for protection of threatened entities directly (e.g., Commonwealth Environmental Protection and Biodiversity Act, 1999) or outline pathways to integrate environmental protection and development (e.g., Parliament W. A., 2005). The legislative mechanisms arising from these Acts and Policies, were then examined in detail. It is within these mechanisms

FIGURE 1 | Opportunities within the Development Application workflow for collating mitigation translocation data. Numbers represent sequence of DA process. DA, development Application; EMP/VMP, environmental/vegetation management plan; TP, Translocation Plan. For mitigation translocation the DA consent gives indirect approval for the translocation, via the acceptance of the Plans. Image credit; Dr Debbie Reynolds and Steve Mueck. *Opportunity for translocation data to be recorded in accessible public data base. #Usually different authority to those issuing DA conditions.

that requirements for recording, monitoring, or conserving threatened flora manifest. These mechanisms include:

- permits (usually to harm, damage or kill a threatened entity)-used in both mitigation and conservation translocations,
- reporting processes (where/how data or permit intended uses should be recorded)—used in both mitigation and conservation translocations,
- pathways for approval of developments (e.g., environmental impacts assessments, management plans required for mitigation translocations),
- public review portals (where development applications, including proposals impacts statements and management plans are made publicly accessible), and
- translocation plans (specifically required in some states such as Western Australia and New South Wales, for conservation).

We also considered "other platforms" where priority actions to conserve listed plant species occur (e.g., Recovery Plans or species management plans) and existing species data repositories (e.g., Queensland's WildNet or the National Atlas of Living Australia).

For pathways, be it permit, species profile, management plan, development application, public review portal or biodiversity database, we then asked; "Are these resources searchable for any direct or indirect translocation terms?" Searchable terms included; reintrod*, relocat*, transloc*, salvage, augment*, mitigat* and offset. We also interrogated all databases to determine if georeferenced species locations were accompanied by descriptive metadata detailing if the individuals were planted (restoration and translocation) or wild populations. Where we found terms or actions related to translocation, we recorded the repository as searchable or "partially" searchable. Under no instance did we locate a repository that was directly searchable, however some instances of "partially" searchable resources were identified. These repositories were classified as "partially" searchable because although they had means by which to potentially record a species as translocation, additional actions were required to access translocation specific information (e.g., methods such as number of plants/location and outcomes e.g., survival and reproduction). These additional actions included requesting/reading of extensive plans and contacting relevant government agencies to access species specific monitoring reports (assuming they were available).

In addition to our compilation of legislation (**Supplementary Material**), government employees from

planning/environment departments or experienced ecological consultants involved with mitigation translocations were enlisted to review our interpretations of the legislative requirements and repositories. All states and territories were reviewed, except for the Commonwealth and the Northern Territory. The reviewers are included in the Acknowledgments.

The observations and reports from individuals quoted in text arose from formal interviews conducted with 13 professionals involved in mitigation translocations (Doyle et al., in preparation[1]).

Our interrogation of the Australian Plant Translocation Database (APTD Database, ANPC, 2018) was based on raw data (as submitted by contributors). We did not filter or remove submitted records based on completion status; this varies slightly from data presented by Silcock et al. (2019) which referred mostly to "completed" projects. We elected to retain all records, and did not infer which were duplicates, because our primary focus was communication and/or publication of records (including pre-approval plans or monitoring reports), which is not contingent on completion. We only counted records as communicated or published where the information had been provided by the contributor.

RESULTS AND DISCUSSION

What Is the Objective of Translocation and Who Is Responsible?

The goal of translocation is to establish a self-sustaining population (Menges, 2008; IUCN, 2013), something that should ostensibly be the same irrespective of the conservation or mitigation motivator. Confirming how this has been achieved however depends on both species' ecology and timelines dedicated to monitoring. In practice, maintenance and monitoring of mitigation translocations has been the responsibility of the developer/proponent (or their engaged sub-contractor) but only for the project lifespan or an arbitrary time period selected by a consent authority (i.e., there is no standard time frame, it depends on the consent authority who may select 2, 3 or 5 years for instance). More recently, conditions of consent are being applied for up to 10 years post translocation (depending on the developer plans and agreeance by consent authority), at which point ongoing site management of the lands on which the translocation occurred is transferred to the landowner, most often to local government/s. For conservation translocations, the longevity of monitoring falls to the organization undertaken the translocation, and varies based on their research plan, funding, priorities and approved Translocation Plan (where required).

Do We Know if the Objectives Are Being Met?

Reviews of translocations to date indicate that performance evaluations are based on short-term outcomes of <3 years (Albrecht et al., 2019), and reporting is biased toward large scale successful conservation programs (Silcock et al., 2019), with most monitoring ceasing after four years (Godefroid et al., 2011). Most practitioners questioned in a direct survey by Godefroid et al. (2011) acknowledged longer timeframes are required and Hancock et al. (2014) in a review of Australian practitioners, identified strong support for over 10 year investments in monitoring. For many species, particularly long-lived woody species, a duration of decades may be required to determine if a population is self-sustaining (Monks et al., 2012; Albrecht et al., 2019) or indeed if any plants have survived. For example, revisitation of unmaintained conservation translocation sites by Drayton and Primack (2012), noted six of eight were completely absent of the translocated species after 15 years. These results indicate that maintenance and monitoring may be required to track species establishment and translocation outcomes past the immediate survival period, to determine outcomes and track success.

Within the mitigation sector translocation practices are not standardized and will necessarily vary based on the context, species and subsequent documents required under development condition of consent (e.g., Environmental Management Plans, Vegetation Management Plans or Translocation Plans). Consequently, monitoring frequency, duration, and data about the condition of translocated plants, plus the availability of the subsequent data, is at the discretion of the consent authority. Although not standardized, the monitoring data should record, at a minimum, information about outcomes such as—the number of plants used, their provenance/source and outcomes (survival and reproduction). However, once a project has been completed (or the period outlined in the management plan is exceeded) any continued monitoring is at the discretion of the land-manager and not required under legislative compliance. Instances of monitoring after the mandated period do occur, however; *Diuris tricolor* and *Prasophyllum petilum* translocations conducted by Glencore Coal Pty Ltd (Bell, 2020) have, for example, continued past their prescribed monitoring period.

Unfortunately, it is difficult to accurately gauge if translocation objectives are being met, because results of translocations are often not published (Silcock et al., 2019 finding only 109 of 1,001 translocation attempts were recorded in peer reviewed literature) meaning interrogating outcomes is a challenge. Where results of mitigation translocations are published, they are most common within the "gray literature" (Bradley et al., 2021) (i.e., reports prepared by proponents for the purposes of compliance, See Translocation Resources in Australia, **Table 1**) and protected by client confidentiality, even though technically the consent authorities can make all records publicly available. For instance, when the *Pimelea spinescens* Recovery Team (a group of experts tasked with advising on best actions to conserve a species) tried to access historical reports, they were met with a "black hole." Dr Debbie Reynolds describes the process of trying to gain access to monitoring reports, first starting with consultants (**Box 1**).

Consultants second the experience of Dr Reynolds. Geraldine Dalby-Ball (pers. comms. 27th Aug 2021) when commissioned to survey a threatened orchid impacted by road development noted

[1]Doyle, C., Yapp, S., Bragg, J., Rossetto, M., Orme, A. and Ooi, M. (in preparation). Mating system and population kinship as applied conservation tools of small populations in fragmented landscapes.

TABLE 1 | Summary of mitigation translocations recorded in the Translocation Database including records of all commenced translocations, regardless of completion.

State	Mitigation Translocations (1980–2018)	Number of unique species	Number of consultants (ex-records with no attributed contact)	Records with no attributed consultant	Records attributed to one consultant
NewSouth Wales	227	67	12	9	163*
Queensland	90	56	20	15	18∧
Tasmania	1	1	1	1	1
Victoria	42	11	11	7	9
Western Australia	29	13	8	1	12
Total	389	149	230#	33	201#

Table demonstrates many species have been translocated multiple times and also one individual consultant has contributed a large number of records in each state, particularly NSW.
**179 records associated with one project, the Pacific Highway upgrade, 163 of which led by one individual, who was also involved in the remaining 16.*
∧'22 records associated a single project, the Pacific Highway Upgrade, 18 of which led by one individual the remaining four by one other individual.
#Consultants associated with Pacific Highway Upgrade are duplicated across the NSW/QLD border, there for 2 records have been removed from the total.

BOX 1 | Dr. Debbie Reynolds, Pimelea spinescens recovery team member, reflecting on difficulties accessing data and reports from the Commonwealth Government and ecological consultants. Data which is important to inform species recovery actions and recovery team advice.

"The consultants say…"we write reports, and we send them to the compliance dept"…But because they're considered commercial in confidence, I think they're written for developers and given to the federal [Commonwealth] government as per the development conditions. I tried finding the reports that I knew were written, but no one seemed to know where in the government they went… this is an issue for all threatened species. What I don't understand is why report when you're not feeding back the lessons learnt to the Recovery Teams or people on the ground who are trying to save the species? The reports should be made public. Even if things have failed, at least you would know it was a failure, it definitely wasn't a waste of time. It is a learning opportunity, currently being denied to the threatened species network of stakeholders. With the information in these reports, protocols and procedures could be updated and the funds that are spent on future translocations will translate to a greater success" (Dr Debbie Reynolds, *Pimelea spinescens* recovery team member and co-author, pers comms 21st April 2021).

"I want to Google "Onion Orchid translocation," to find out who has moved it before, but I can't… a map of what species and where, just like in ALA [Atlas of Living Australia] is what I want."

A 2014 parliamentary report into environmental offsets (translocation often being a component of offsetting) found high levels of public concern about a lack of oversight and compliance auditing, and that annual reporting results were not publicly available (Parliment of Australia, 2014). For species with unique or specific ecological requirements (Abeli and Dixon, 2016; Maschinski and Albrecht, 2017; Commander et al., 2018), compliance is additionally important to ensure outcomes are being recorded, however involvement of specialists with knowledge of the target species' is uncommon. Instances of inclusion of species experts (such as Recovery Teams) in compliance or report evaluation are very rare. *Pimelea spinescens* subsp. *spinescens*, for example, has only recently had Threatened Species Recovery Team recommendations incorporated into the Commonwealth conditions of consent and compliance reporting (pers. comms. Dr Debbie Reynolds *Pimelea spinescens* Recovery Team, April 2021). This is despite it being one of Australia's most frequently translocated plants, with highly variable survival and limited recruitment (Biosis., 2014), plus a dedicated translocation protocol (Mueck and Reynolds, 2013). The *Pimelea spinescens* Recovery Team consequently can now review monitoring reports and can use data gleaned from these to inform future translocation plans (Mueck and Reynolds, 2013), adding provisions for ongoing replacement of dead individuals prior to project completion.

What or Who Governs Translocation?

The answer to this question is not simple. Globally there are a number of Best Practice Guidelines (IUCN, 2013; Maschinski and Albrecht, 2017; Commander et al., 2018), and efforts by the IUCN Conservation Translocation Specialist Group to include integrate best practice with policy (IUCN, 2020), but implementation relies on national governance. Within Australia, regardless of the motivation (conservation or mitigation), plant translocations are guided either/both by the *Commonwealth Environmental Protection and Biodiversity Conservation Act* (EPBC, 1999) and associated policy Statement ("Translocation of Listed Threatened Species—Assessment under Chapter 4 of the EPBC Act") and/or the equivalent State or Territory legislation (**Supplementary Material**), which may also include species specific Recovery Plans or Conservation Advice. State governments also address threatened plant translocation through specific procedural guidelines (e.g., DEPI, 2013; ACT., 2017; DPIE, 2019) or advice (DBCA, 2017). Commonwealth and State jurisdictions recommend that best practice (i.e., Commander et al., 2018), and in some cases species-specific methods (Mueck and Reynolds, 2013). Where translocations are being conducted for mitigation purposes, additional actions, such as a Feasibility Study or Translocation Plan, may append Environmental Management Plans (as well as Offset and Vegetation Management Plans) and be required under development conditions of consent (**Figure 1**). The degree to which these guidelines are enacted depends on the consent authority.

Where Is Information About Translocations Stored?

As noted, there are some databases of translocations (Abeli et al., 2021) or collections of case studies (Soorae, 2018, 2021),

however to the best of our knowledge no all-encompassing plant database exits, in any nation, despite calls for a global system (Godefroid and Vanderborght, 2011). This is at least in part likely due to the challenges navigating polices around mitigation and conservation translocations. Within Australia, interrogation of Commonwealth and State records for translocation information can be achieved through two main mechanisms (a detailed breakdown is included in **Supplementary Material**).

1. Review of all Permits Issued to Damage or Pick a Threatened Plant.
2. Review of Development Approvals, Associated Impact Assessments and Management Plans.

At the Commonwealth level, permits are required to pick, harm, or damage a threatened species which is: (a) listed under the EPBC Act 1999; and (b) occurs on Commonwealth land. These permits are required for undertaking both mitigation and conservation translocations and are publicly accessible and searchable back to 2007, during which time only three have been issued relating to translocation of a plant species (one of which was withdrawn). Developments which impact a nationally listed species may also be referred to the Commonwealth Department of Agriculture, Water and the Environment, for Ministerial decision about requirements for assessment under the EPBC Act. All projects nominated for referral are publicly listed, however not searchable on criteria (other than proponent details, referral title and reference number, see **Supplementary Material**).

At the State/Territory level, compliance pathways are more complicated, because the consent authorities vary based on the status of the development. In New South Wales (NSW), for example, threatened species protection falls under the NSW Biodiversity Conservation Act 2016 (BC Act) which for conservation translocations requires a license and a Translocation Plan. However, for mitigation translocations a Translocation Plan is not required because development is also governed by the NSW Environmental Planning and Assessment Act 1979 (EPA Act), which takes precedence over the BC Act with development consents. Under the EPA Act, practitioners (mostly consultants) are required to have a scientific license and follow the development specific Environment or Vegetation Management Plan (EMP/VMP). Where translocation is used as a mitigation measure, the process may be embedded in the EMP or VMP, and it may form an appendix or be a supplementary report. To the best of our knowledge, translocations conducted under VMPs or EMPs are not formally recorded in an accessible database, such as that used for the allocation of licenses under the BC Act, but rather are appended within consent documentation. Finally, while scientific licenses issued under the BC Act to "pick, damage, or harm a threatened species," require the species impacted during the licensing period to be reported, they do not require the action to be specified and do not include translocation as a potential action. Further, the database of these scientific licenses which gives permission to harm a threatened species is not accessible to the public. The inaccessibility of this database, lack of provision to include translocation as an action undertaken during the licensing period, as well as the lack of a requirement for a peer reviewed translocation plan (as is required for many conservation translocations), is a missed opportunity to document mitigation actions.

Each jurisdiction has a unique framework to govern development approvals (DAs) and consequently an array of possible consent authorities, with multiple repositories for application documentation. Due to the multiplicity of pathways, finding comprehensive repositories of all development applications is challenging. One national option, however, is private providers such as planning hubs (e.g., https://www.planningalerts.org.au), which aggregate applications across consent authorities, but again these do not present options to search using key terms or management actions. Although these records do not include data about translocation outcomes, they do provide evidence that a translocation occurred. Records of occurrence are a minimum first step in improving traceability, where the recorded data should at least include species, location (denatured if required) and proponent or contact details. The lack of transparent and easily accessible information is not limited to translocations. A recent review information flow in the Australian native seed industry highlighted the importance of data collection, record keeping and information transfer, and recommended the development of a National Seed Information Database (Commander, 2021a).

Translocation Resources in Australia: Where Can We Find Information?

The Australian Network for Plant Conservation has published the third edition of the Guidelines for the Translocation of Threatened Plants in Australia (Commander et al., 2018), and on their website hosts both a free download of these Guidelines and the Australian Plant Translocation Database (APT Database, ANPC, 2018), compiled in 2018 https://www.anpc.asn.au/australian-plant-translocation-database/. Reviews of this database have been published by Silcock et al. (2019). Although this database recorded information primarily from conservation-based translocations (67% of contributions), the most recent of which was added in 2018, it is the only searchable national database for plant translocation and is arguably more comprehensive than any other system. For example, of the 227 mitigation translocation records in NSW, only 15 were recorded in the same period under the (now superseded) NSW Government permit system (Pellow and Doyle, 2020), representing a large discrepancy between the number of traceable permits and the quantity of mitigation translocations which have occurred. In addition, permits are no longer publicly searchable, and it is unknown where records of translocations are now stored.

Unfortunately, the APT Database (ANPC, 2018) very likely represents a fraction of the total number of mitigation translocations occurring. Interrogation of the self-reported raw data [as distinct from the data presented in Silcock et al. (2019), where incomplete projects were removed] found that of the 389 mitigation translocation records, 227 were from NSW, of which 163 were attributed to one consultant (15 others contributing the remainder) and 67 unique species were represented (**Table 1**). If

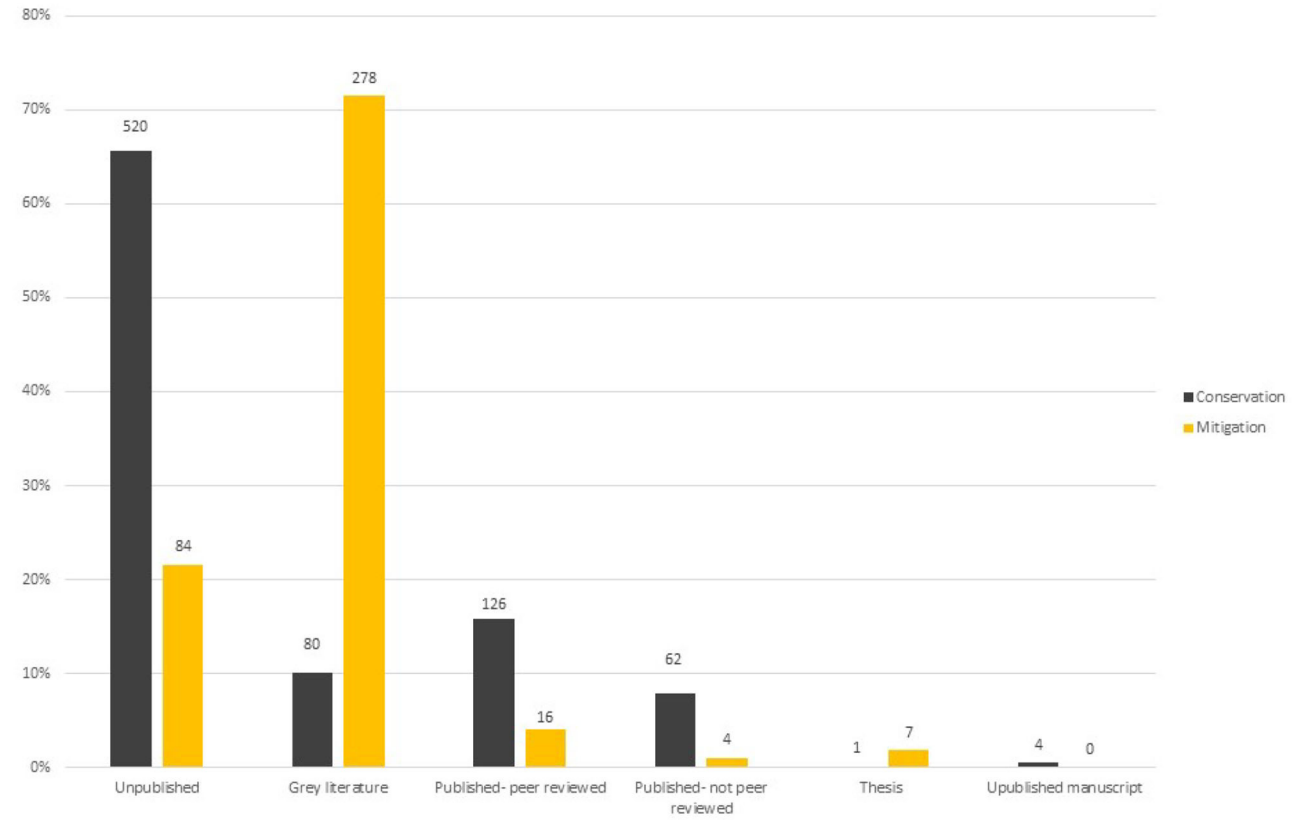

FIGURE 2 | Breakdown by self-reported publishing medium of mitigation and conservation translocations submitted to the Australasian Translocation Database. Columns represent percentage of total record type (conservation or mitigation) and numbers are total number of records. Raw data (as submitted) was used and varies slightly from data presented by Silcock et al. (2019) which referred mostly to "completed" projects.

one consultant elects to contribute 163 records (and contribution is not compulsory) it is plausible that tens or even hundreds of un-reported translocations were undertaken for mitigation purposes over the same time period in NSW (**Table 1**). Interrogation of the ATP Database (ANPC, 2018) found that of the 389 mitigation records submitted, 4.1% (17) self-reported publication in the peer reviewed literature (**Figure 2**) (references to conservation advice or recovery plans were excluded) and 1% (4) self-reported publication in public resources not peer-reviewed (most commonly an IUCN reintroduction case study or within the journal Australasian Plant Conservation). For comparison, 16 and 8% of conservation translocations studies were published (peer-reviewed literature and non-peer-reviewed respectively). Although mitigation translocations are less often published in public peer or non-peer reviewed literature, with the inclusion of gray literature (representing 71% (276) of total entries) only 22% of translocations were unpublished in any form. By comparison, 66% of conservation translocations remained unpublished in any form. This illustrates the quantity of valuable technical information about species translocations that, without the compilation of the 2018 Database, would have no central record. Unfortunately, because the contents of these reports are often owned by the clients (i.e., the consultants who prepared them are not legally able to distribute) it falls to the consent authorities to make them consistently publicly accessible. Although some reports are available on company websites (e.g., NSW Roads and Maritime Service, Whitehaven Mining) more commonly they are not directly traceable, and may require specific knowledge of the project, species, or access to relevant individuals within specific departments to actively trace records. This general lack of accessibility again presents a missed opportunity to learn from previous translocations, both successes and failures, particularly where mitigation translocation presents a wealth of detailed data about practices for important species.

At the State level there has been increasing references made in the legislation to translocation practice, and some jurisdictions have developed translocation specific policies and protocols (**Supplementary Material**). Tasmania for example has a provision to record translocation as an action when a threatened species permit is issued, and Victoria includes an option for uploading translocation data to the Victoria Biodiversity Atlas, which is (in theory) also searchable based on translocation terms. Victoria also has specific translocation and salvage protocols for three species in the Melbourne Growth Corridor (DELWP, 2018). In NSW, although a Translocation

Operational Policy was released (Godefroid et al., 2011; DPIE, 2019), it only applies to conservation translocation, experimental or emergency collection, but not mitigation or development conditions of consent. Summaries of the requirements at a State Government level are in included in **Supplementary Material**.

Why Should Mitigation Translocation Transparency Be Improved?

Translocations are far more complicated than putting a plant in the ground. Best practice procedures and guidelines caution that although translocation is a valuable tool it is not a "simple solution" (Commander et al., 2018) (nor is it a substitute for *in situ* conservation). Without considerable planning, resourcing, research and funding, risk of failure is high (Maschinski and Haskins, 2012). Cautions are compounded by low levels of documented success (Godefroid et al., 2011; Monks et al., 2012), assuming success is defined as the creation of a self-sustaining population (Griffith et al., 1989; Menges, 2008) and not just relocating the plant at risk from immediate damage by a development (Germano et al., 2015).

The Australian Threatened Species Index, for example, found decline in plant populations managed through translocation reduced on average 40% (NESP, 2020), compared to the average 72% decline of all threatened Australian flora in the Index. This outcome highlights that even in managed conservation translocations (NESP, 2020, 11 submitted species), populations did not increase, rather their downward trajectory was slowed. Even where short- and long-term goals are prescribed, as recommended by Monks et al. (2012), multidisciplinary teams (e.g., researchers, community, government agencies, developers, consultants) are required to conduct best practice threat assessments, research target species biology and horticulture, identify target sites and plan translocation maintenance and monitoring. The length of investment required to optimize the chances that the translocation will meet short-term goals, and longer-term self-sustaining population targets, is difficult to judge and varies between species and situations. In many cases it is species- and even context-specific, therefore detailed planning is required a priori.

Given the ongoing difficulties of translocation as a conservation technique (Albrecht et al., 2011; Godefroid et al., 2011), its use as a condition of consent should be employed with constraint, and the data generated by mandated monitoring should be publicly accessible for the purposes of informing and improving future endeavors. Limited transparency of the process, multiple consent authorities and limited to no public ability to access gray literature means that the ability to adaptively manage translocation practice, through critical assessment of outcomes and mistakes, is severely hampered.

Mitigation translocation is approved to ensure the survival of a known population of a threatened species, to conserve the genetic diversity of the affected population and to address public expectations that loss or reduction of a significant environmental asset will be offset. At the Commonwealth level and for most States, assessment based on the IUCN Listing Criteria (IUCN, 2019) (a system to assess the global extinction risk status of animal, fungus, plant species and communities) is used to determine the level of threat to a species in Australia. The level of threat translates to the species' listing on Schedules of each piece of legislation and the corresponding protective and management strategies to reduce risk of extinction. Translocation could work toward ameliorating the threats that a species faces and potentially extend its range or population size. But without knowledge of translocation outcomes, the role that it may play in threat status would remain unknown.

In summary, the lack of centralized, accessible State or Commonwealth databases that record translocations is of concern for the following reasons:

- reduced ability to effectively regulate or review the translocation process and amend future translocations as required
- limited ability to progressively improve conditions or translocation protocols as part of consent conditions
- limited knowledge building and adaptive management opportunities for practitioners and Recovery Plan managers, as there is no consistent way to locate information about translocation methods or outcomes
- poor record keeping of how many mitigation translocations are occurring in a location and for a particular species
- limited ability to, at a minimum, identify relevant contacts who may be experienced with a specific species or genera
- insufficient ability to determine (via documented monitoring) that translocation is a successful or worthwhile mitigation measure and
- no historical record of threatened plant placement in a location, meaning that future consultants, botanists, ecologists or surveyors may encounter populations with no knowledge of the plant provenance, and without expectation that the species could occur in the area (where for example State based predictive models/historical occurrence records are used to inform survey requirements; or where species area of occupancy and population size are required to assess risk of extinction).

Hence, we advocate for Australian State or Commonwealth database(s) which record the species, location and monitoring data, to inform the ability to regulate and review translocation applications and outcomes, keep track of where translocations are occurring and with which species, enable a contact database of expert practitioners undertaking the translocations, and inform estimates of extinction risk, recovery planning and contribute to initiatives such as the TSX. For the reasons described, we additionally recommend other jurisdictions across the world investigate the potential for a regional or national translocation database.

Recommendations

Anecdotal evidence suggests that many hundreds of plant translocations occur across Australia each year as part of attempts at mitigation for development impacts, and this is likely mirrored globally. Legislators need to develop a method for recording the outcomes from all threatened plant translocations so that the information can be accessed in a way that allows consultants,

practitioners, and ecologists to source knowledge on the location, success and failure of threatened plant translocations. We suggest the following steps, which build on existing legislation, be considered to ensure information on plant translocation is available to improve outcomes.

- Legislated compulsory registration of all plant translocations at a State level utilizing existing licensing arrangements and State databases (e.g., Victorian Biodiversity Atlas or WA's FloraBase) with a minimum data input of date, associated development, location (denatured), species, method (e.g., salvage, seed, whole soil), quantity of plants and contact details. Registration as part of the condition of consent for a development or the granting of a scientific license. Compulsory registration would require legislative and regulatory change.
- Mechanism by which data and reports documenting the success or failure of a mitigation translocation can be accessed to inform future translocations (e.g., reporting as part of renewal of scientific licenses) through a State or National Database and Herbarium records. Database options could include:
    - Expansion and annual updates of the public Australian Plant Translocation Database, managed by ANPC, as a national repository for the translocation information collected in each State.
    - State based biodiversity databases to feed into the Atlas of Living Australia which will include separate provisions to nominate records as translocation or restoration.
- Baseline and long-term monitoring data be contributed to the Australian Threatened Species Index, (TSX—Australian Threatened Species Index) for the purposes of tracking the status of translocated species populations and the impacts of different management regimes. This would likely require data preparation and submission, unique to TSX requirements, and is therefore a candidate for voluntary submissions.
- Encouragement of case study submission to the Global Reintroduction Perspectives (Soorae, 2021), with an emphasis on under-represented mitigation translocations. The filtering criteria on this database would benefit from discerning between conservation and mitigation translocations too, for ease of review.

Translocation is increasingly being used as an action to mitigate against impacts to threatened species. Overwhelmingly we need to ensure, as legislators, consultants, practitioners, and ecologists, that we focus on the use of translocation as a tool to protect plant populations from current and future threats. This can only be achieved by ensuring knowledge from past translocations is available to prepare future plans that are achievable and realistic, and to ensure accurate assessment of extinction risk for biodiversity planning. We cannot rely on translocation being a successful mitigation action without long term monitoring post translocation to ensure the mitigation actions have actually worked, and this requires planning for decades of investment.

AUTHOR CONTRIBUTIONS

BP and CD (early career) developed the concept and prepared the manuscript outline. MO undertook a supervisory role. DR and SB participated in extensive interviews. JS and LC are Australian translocation experts. All authors commented on and contributed to versions of the manuscript and conducted revisions of state legislation. All authors read and approved the final manuscript and contribution to the field.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fcosc.2021.789448/full#supplementary-material

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