

1 **Title:** *Drivers of seedling establishment success in dryland restoration efforts*

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138 **Running title:** *Global dryland restoration*
139 **Number of Tables:** 0
140 **Number of Figures:** 3

141 **Abstract:**

142 *Restoration of degraded drylands is urgently needed to mitigate climate change, reverse*
143 *desertification, and secure livelihoods for the two billion people who live in these areas. Bold*
144 *global targets have been set for dryland restoration to restore millions of hectares of degraded*
145 *land. These targets have been questioned as overly ambitious, but without a global evaluation of*
146 *successes and failures, it is impossible to gauge feasibility. Here, we examine restoration seeding*
147 *outcomes across 174 sites on six continents, encompassing 594,065 observations of 671 plant*
148 *species. Our findings suggest reason for optimism. Seeding had a positive impact on species*
149 *presence: in almost a third of all treatments, 100% of species seeded were growing at first*
150 *monitoring. However, dryland restoration is risky: 17% of projects failed, with no establishment*
151 *of any seeded species, and consistent declines were found in seeded species as projects matured.*
152 *Across projects, higher seeding rates and larger seed sizes resulted in a greater probability of*
153 *recruitment, with further influences of site aridity, taxonomic identity, and species lifeform on*
154 *species success. Our findings suggest that investigations examining these predictive factors will*
155 *yield more effective and informed restoration decision-making.*

156 **Main text:**

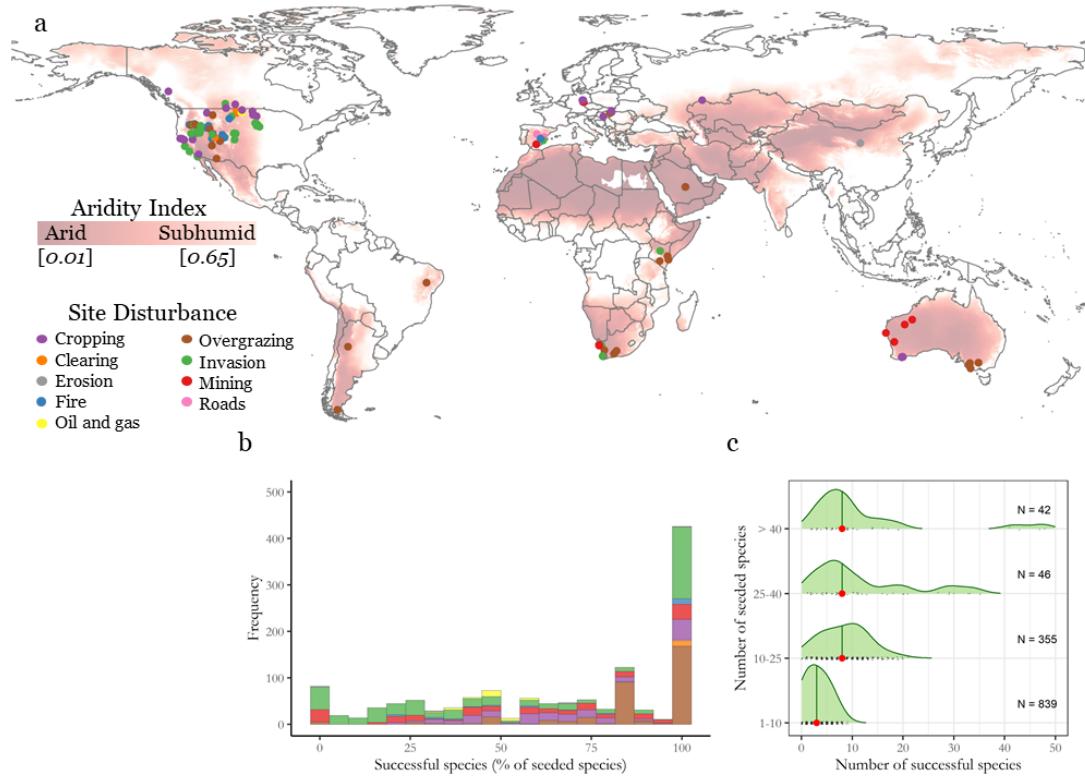
157 Restoration ecology is rapidly advancing in response to the ever-expanding global decline in
158 ecosystem integrity and its associated socio-economic repercussions^{1–4}. Nowhere are these
159 dynamics more evident than in drylands, which help sustain 39% of the world's human
160 population⁵ but remain some of the most difficult areas to restore^{6,7}. Restoration of degraded
161 dryland ecosystems is frequently constrained by low and variable precipitation, extreme
162 temperatures, relatively low soil fertility, seed quality and availability, and a prevalence of
163 invasive species^{8–11}. As a result, successful establishment of seeded species in dryland restoration
164 projects may be as low as 1%^{12,13}. Despite these challenges, only a small fraction of terrestrial
165 ecology (6%)¹⁴ and restoration studies (<5%)¹⁵ are conducted in drylands.

166 Dryland ecosystems are ecologically distinct^{16,17}, increasing in global extent under shifting
167 climates^{18–20}, and have been recognized as degraded in over 50% of their range²¹. Depending on
168 the severity of degradation, vegetation recovery of depleted and denuded dryland landscapes
169 through natural succession processes is very slow, if not impossible²². Passive restoration
170 methods (e.g. reducing livestock and wildlife grazing) alone are often ineffective, as degraded
171 dryland environments can show stability and resilience in undesired states¹¹. Resource-intensive
172 methods such as seedling transplants or prescribed fire can be used for dryland restoration, but
173 often logistical challenges or expense limits the widespread application of these techniques^{23–25}.
174 Consequently, seeding is a widely used approach for dryland restoration^{26,27}, likely because it is
175 an intuitive and spatially feasible strategy to reintroduce desired species²⁸. It is clear that seeding
176 in dryland ecosystems is challenging, with most projects exhibiting low germination and
177 establishment success²⁹, and high mortality in the development from seedling to adult plant¹³.
178 Yet, seeding remains one of the only viable methods of reintroducing or enhancing populations
179 of native species at large scales in natural settings. Thus, it is essential to understand what
180 elements contribute to overall seeding success.

181 Here, we present a large-scale assessment of restoration seeding in drylands. Well-documented
182 restoration seeding trials and controlled experiments allowed us to compare restoration outcomes
183 over a range of biotic and abiotic conditions³⁰. This is important because restoration trajectories
184 are driven by a series of ecological assembly filters³¹ – processes that sort and narrow the pool of
185 potentially establishing species based on the intersection of site conditions, exogenous factors,
186 and species' traits³². In restoration, filter models have most commonly focused on abiotic
187 constraints, such as resource availability; external factors, such as disturbance type or limitations
188 in propagule sources; and biotic constraints, such as priority effects and competition from
189 resident species. Large data synthesis allows many of these factors to be assessed in a single
190 framework over wide ranges of each potential variable. We sought to elucidate general drivers in
191 dryland restoration seeding efforts, as well as identify whether there are key sources of
192 unexplained variability. While the ultimate goals of restoration vary among projects (increasing
193 habitat value, reducing erosion, reducing fire risk, *etc.*), we focused here on a response variable
194 common to all types of seed-based restoration efforts: whether projects were able to establish
195 target species. A small number of restoration trials included seeding exotic species, either as
196 desired species for key ecological functions or as experimental treatments to understand effective
197 control methods. Our analysis included any seeded species, and we assessed species success
198 without distinction based on origin in order to understand general drivers of species-level
199 outcomes. We measured species-level seeding success based on species occurrence (density or
200 cover > 0) at the sampling unit level, so that our final response variable was the probability that a
201 species was present in an individual replicate, also referred to here as “species success” or, more
202 generally, “success”. It is important to note that as with any synthesis effort, some biases exist in
203 the database. The most influential for this analysis are likely caused by the geographic
204 prevalence of western regions, specifically North America, and the predominance of
205 experimental studies at relatively small scales.

206 Results and Discussion

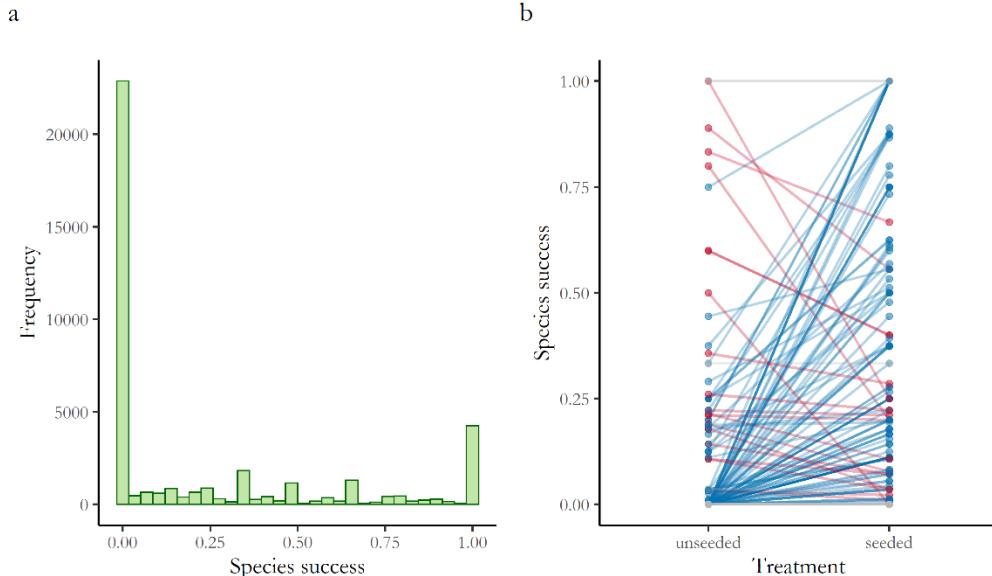
207 Our database reflected widespread patterns of dryland degradation (**Fig 1a**), where restoration
208 seeding projects were implemented in response to a variety of disturbances from mining and road
209 construction to erosion and fire. Overall, plant invasion was the most reported disturbance, and it
210 often accompanied cropping, grazing, and fire, which likely led to positive feedbacks between
211 degradation pressures^{33,34}. In almost a third of projects, all seeded species had some individuals
212 that established (**Fig 1b**). The inherent risk of seeding in drylands was also apparent: in a distinct
213 set of projects (17%), seeded species were not detected during the monitoring period. Most
214 projects seeded fewer than 10 species, and the number of species present did not consistently
215 increase with the number of seeded species (**Fig 1c**); only rarely (12%) were more than 10
216 seeded species present during the first sampling period in a given treatment.



217

Figure 1: a,b, The distribution of restoration sites spans drylands globally, with restoration seeding triggered by a variety of anthropogenic disturbances (as shown in b). Note that a single point in a covers a diameter of >250 km due to the mapping scale; if project sites are closer than that distance, a single point represents more than one project. b, We found evidence that a portion of projects had a high proportion of successfully seeded species. For instance, in 30% of projects, all seeded species were recorded during monitoring. We also found that dryland restoration seeding is somewhat of a gamble, with none of the seeded species recorded in 17% of projects. c, While seeding more species would be expected to lead to greater species richness, there was a limit to this increase. Rarely did a project record more than 10–15 successful species, regardless of the number of species seeded.

218 As a result, the success of an individual species was low, aligning with other studies of dryland
 219 seedling recruitment^{12,13}. In 57% of the individual species records, the species failed to recruit in
 220 any surveyed replicate across time (Fig 2a), and on average, species were successful, i.e.
 221 recorded, in only 24% of replicates within a treatment. Seeding was key for a successful
 222 outcome: the majority of targeted species were more common after seeding, with almost a
 223 doubling of overall species success (Fig 2b). There were a small number of instances where the
 224 seeded species was more likely to be found in unseeded controls than in seeded treatments (6%
 225 of studies). This could be due to seed sourcing, for example if the provenance of seed used for
 226 treatments was not appropriate for the region³⁵ while unseeded controls may have had an *in situ*
 227 seed bank of locally-adapted seed that allows for passive recovery. Alternatively, incorporation
 228 of highly competitive species in seeded areas may reduce the success of competitively inferior
 229 species, and could lead to greater success of these species in unseeded controls³⁶.



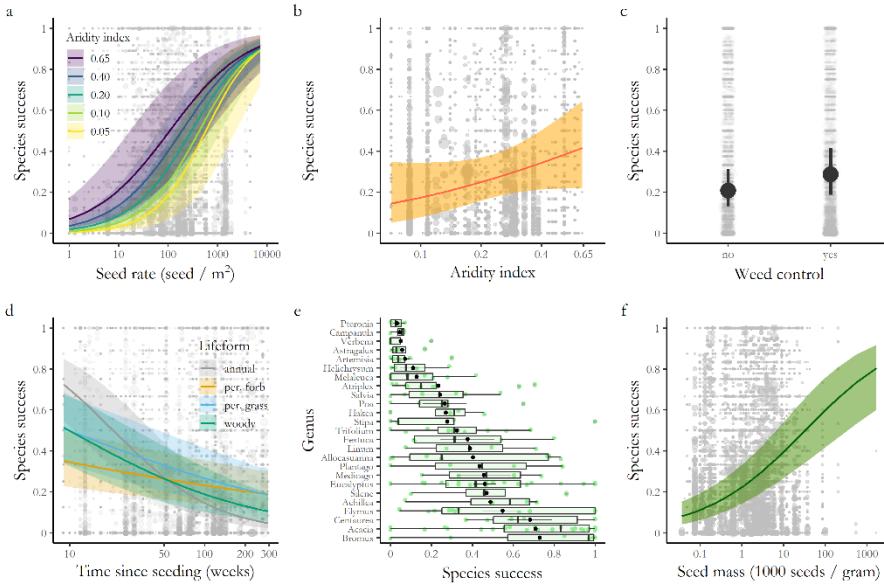
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Figure 2: a, Within a restoration treatment, individual species success (defined as the probability of a species being present during monitoring) was relatively low, with 57% of species failing to recruit when seeded. *b*, Seeding did, however, clearly increase success in seeded treatments compared with unseeded controls, with each line in *b* representing the difference in success of one species in an unseeded and seeded treatment pair. Blue lines indicate greater success in seeded treatments and red lines indicate greater success in unseeded controls. The prevalence of lower success of target species in control treatments emphasizes the role of propagule limitation in these systems. The same methods were used for measuring success in unseeded controls and seeded treatments.

231 Given these overall patterns, we then explored the most generalizable predictors that could
 232 characterize the presence of a target species after seeding efforts. We focused our analysis on
 233 three factors that could be critical determinants of successful dryland restoration seeding
 234 projects, reflecting different aspects of potential ecological filters. First, the rate of seeding is the
 235 primary method of overcoming propagule limitations, and seeding rate varied in these projects
 236 from 1 seed m⁻² to over 7,000 seeds m⁻². Second, abiotic filters in drylands are most closely
 237 linked to water limitation, captured in our data using the global aridity index (annual
 238 precipitation / annual potential evapotranspiration)³⁷. Third, a prominent biotic filter was
 239 considered: the competitive effects of other species. Management of competitive effects in
 240 restoration commonly focuses on controlling weed invasion, *i.e.* reducing the abundance of
 241 species viewed as barriers to restoration goals. This was reflected in our database; weed control
 242 was the most commonly used management tool in drylands, occurring in 46% of treatments.
 243 Thus, controlling weed invasion was used to assess the role of biotic filter management (*i.e.*
 244 reducing competition) in restoration outcomes. We considered three factors that may affect how
 245 seeded species respond to these ecological filters. First, the influence of species characteristics
 246 that drive seedling growth patterns and longevity, here captured as a factor combining lifeform
 247 and life span; second, seed size, which can interact with the environment to influence restoration
 248 success³⁸; third, taxonomic identity, which likely represents unmeasured phenotypic traits.

249 As would be predicted in the dynamics of seed-limited populations, adding greater numbers of
 250 seed was an important predictor of success (Fig 3a). On average, the predicted probability of
 251 success increased sharply with increasing seeding rate. This high seeding rate is likely to be well

252 outside the resources available for most restoration seeding projects, as seed is an expensive
 253 component of restoration projects. Thus, while increasing seeding rates may lead to higher
 254 success rates, it can be limited by financial and biological resources³¹.



255

Figure 3: a, Success is influenced by ecological filters and species characteristics including propagule limitation, where increasing seed rates lead to dramatically higher rates of species success. This relationship was mediated by site aridity, with more mesic sites benefiting less from additional seed inputs. The main effect of aridity emphasizes the importance of abiotic filters (b), where aridity (that is, values close to zero) depresses the probability of restored species success. c, Managing competitive effects with weed control led to modest gains in species success. d–f, Intrinsic species characteristics such as plant functional type (d), taxonomic grouping (e) and seed mass (f) affect species success, with the strategies that characterize annual species leading to initially high success followed by more rapid declines over the first six years of monitoring; some genera have higher probabilities of success than others and seed size has an overall positive influence on species success. Solid lines (a,b,d,f) and dots (c) indicate population-level predictions (that is, marginal means) conditioned on the fixed effects. Confidence bands and error bars represent 95% confidence intervals (CI).

256 It would be tempting to increase seeding rates by increasing application of less expensive seed,
 257 but it is important to note that our study assessed seeding rates on a *per species* basis. That is, the
 258 likelihood of a given species recruiting at a site increased only when its own seeding rate was
 259 elevated, and we did not analyze effects of seeding rates of other species. Mixes are often
 260 dominated by species that have less expensive seed and higher overall likelihood of
 261 recruitment³⁹. Increasing seeding rates uniformly over such a mix would likely increase
 262 competitive pressure on less competitive species⁴⁰. This common seeding practice may influence
 263 our results through a form of sampling bias, as many of the species with the highest seeding rates
 264 are also likely to be species that are more financially and biologically available and may
 265 therefore also be easier to recruit. We note, however, that although the optimal seeding rate may
 266 be difficult to implement, our data suggest that for seeding rates below the optimum, any
 267 additional seed inputs should have strong and immediate impacts on restoration seeding success.

268 Influence of seed rate was mediated by site-level aridity. Overall, arid sites showed much lower
 269 probabilities of a species being present under similar seed rates (i.e., 32% lower success in drier
 270 sites with 100 seeds m^{-2}). However, the benefits of adding additional seeds led to more rapid

increases in success in arid sites (**Fig 3a**), up to the extremely high seed rates where success was high regardless of climate. On more mesic sites, fewer seeds may be needed to enhance species success because of the increased success of individual seeds in wetter regions. Though this is an important finding for planning project-level seed rates in the most arid sites, it is important to recognize the generally depressed rates of species success at the majority of seeding rates in arid sites (**Fig 3b**), emphasizing the strength of abiotic constraints in these systems. As sites become increasingly arid, the predicted success rate fell from about 42% [CI 22-64] to 14% [CI 5-35], with the decline being strongest at the dry end of the gradient. These patterns were slightly different when considering North America only, where, notably, the most arid sites benefited from the addition of more seeds, but never quite reached the levels of success observed in the full database (see **Supplementary note 3** for the full North American results). Thus, the expense of increasing seed rates in arid sites comes with an increasing cost of unsuccessful seed inputs. This finding quantifies the well-established fact that water availability is a key constraint for seedling establishment and survival⁴¹. While we assessed average long-term site aridity here, it is likely that other factors such as extreme weather events following seeding, or the site-level pattern of rainfall received within the first season after seeding²⁹, and landscape and soil characteristics likely also play a role in influencing restoration seeding success in arid sites^{42,43}. Indeed, nearly a third of the variance in success metrics was due to site-level random effects that were unmeasured in our study, emphasizing the need to incorporate factors such as other sources of environmental variation (e.g. topographic and edaphic factors) in assessing restoration seeding outcomes.

While weed control positively influenced the probability of restoration seeding success over time, the effect size was surprisingly small: weed control only resulted in an 8% increase in probability of species success over time (**Fig 3c**). Since many disturbance types in arid environments typically promote the proliferation of weed species, we expected that weed control would be an important action to reduce competition and enhance the probability of species success⁴⁵. Within our database, however, invasion was most common in specific regions (North America and Europe) or after particular disturbance types (cropping, grazing, and fire). Thus, many projects that did not apply weed control were in regions that were not reporting invasion as a problem, or in disturbances like mining or erosion, where abiotic factors outweigh biotic competition. As our database continues to develop, these patterns of management outcomes may be more comprehensively assessed. In our analysis of North America only, for example, where invasion is a commonly cited restoration motivator, there was a slightly greater positive impact of weed control, with a positive increase of 9% as opposed to 8% in the full database.

Probability of species success decreased significantly over time, contingent on plant functional type. Seeded annual species had the highest predicted initial success (*c.* 72%) relative to other plant functional types, with a non-linear decline through time to reach a probability of *c.* 5% after six years (**Fig 3d**). Though they were not frequently seeded and sometimes represented seedings of non-native species, patterns of recruitment and decline in annual species are consistent with their life history strategy⁴⁴. Disturbance-oriented native annuals have shown promise as competitors with invasive species in drylands^{45,46}, and these results highlight that annual plants could play an important role in initial site stabilization. While initially high, annuals had the

313 lowest predicted success at the end of our time window, and though their seeds can remain
314 dormant for decades and may return years after initial establishment^{47,48}, their life history
315 strategies may represent a barrier to long-term retention in restoration projects. Perennial forbs
316 had the lowest initial success of the four plant functional types analyzed, but increased to have
317 probabilities of species success similar to those of perennial grasses after six years. Perennial
318 forbs are known to have a diversity of dormancy characteristics and germination requirements⁴⁹
319 that could delay germination, possibly contributing to low initial presence but increased species
320 success over time.

321 By its nature, our database contains many unidentified variables that differ among studies but
322 almost certainly contribute to species success in projects, resulting in high variation despite
323 overall trends (**Fig 3**). For example, we cannot identify species that are particularly effective for
324 use in restoration seeding projects, as they would differ by region and project. However, we note
325 that in our models, species identity accounted for 50% of explained variance of random effects
326 and 30% of all variation in success. This might reflect differential success of species belonging
327 to taxonomic groups which share traits that influence plant growth and survival in arid
328 ecosystems (*i.e.* reduce water loss or increase resource acquisition). For example, in our
329 database, species from the genus *Bromus* (Poaceae), *Acacia* (Fabaceae), and *Centaurea*
330 (Asteraceae) showed high average success across species (**Fig 3e**). This result highlights that
331 careful species selection is a key step to increase success of seed-based restoration projects⁵⁰.
332 Finally, we found that seed mass had an overall positive influence on the presence of individual
333 species (**Fig 3f**), though again, there was high variation surrounding this overall trend (see
334 **Supporting note 4** for further details on the database taxonomic composition). Thus, our results
335 indicate that dryland restoration trials that test the efficacy of seeding multiple species at
336 different seeding rates, as well as efforts to understand barriers to establishment for genera with
337 lower average success, and further investigating the role of seed size on successful
338 establishment, would be excellent areas of research.

339 To our knowledge, our database is the largest collation and analysis of restoration projects from
340 any ecosystem type, and we aim to increase participation and contributions as we move the vast
341 majority of the database into the public domain. The database has continued to grow since the
342 analysis began, and we welcome any additions (www.drylandrestore.com). In particular, we have
343 few datasets from arid regions in Asia, the Eurasian dry grassland belt and adjacent desert and
344 semi-desert regions, and dryland areas of North Africa. Thus, our results under-report restoration
345 efforts from these regions, and results may be biased by areas with larger samples, such as
346 western North America. Additionally, other factors, such as the amount and timing of
347 precipitation in the year of seeding, seeding timing and seeding methods, are all known to affect
348 outcomes in some species, and almost certainly contribute to the variation observed among
349 studies; the variation observed among our datasets indicates many possible explanatory factors
350 that have yet to be explored. Increasing the breadth and depth of this resource will allow deeper
351 assessment of predictor and response metrics, as well as the ability to study interactions among
352 causal factors; such additions would help translate our observations of overall trends into specific
353 recommendations for restoration practice. Finally, future restoration needs to account for
354 possible climate change scenarios and land-use policies, carefully selecting species that can
355 persist in a changing world. The need is great for restoration science to make rapid advances in

356 the next decade, especially in global drylands, and we can only meet that need by synthesizing
357 our shared knowledge to provide guidelines and recommendations for practitioners and land
358 managers.

359 **Data Availability**

360 Data housed in the GAZP database is a compilation of primary research data from active projects
361 worldwide. The database is being launched as a publicly available tool, with some datasets requiring
362 authorization by the individual contributor for full release due to internal data use agreements. To make it
363 findable, accessible, interoperable and reusable (FAIR), the database requires extensive documentation
364 and clear curation, which will be an ongoing effort as the project develops. The data used for this analysis
365 that have been approved for release will be available, with clear metadata included, through github
366 (https://github.com/paternogbc/ms_global_dryland-restoration, <https://doi.org/10.5281/zenodo.5062861>).
367 For the full subset of data used for this analysis, including the restricted data, please contact the
368 corresponding author.

369 **Code Availability**

370 Code for all statistical models and plots is available on github
371 (https://github.com/paternogbc/ms_global_dryland-restoration, <https://doi.org/10.5281/zenodo.5062861>).
372 Note that the data housed publicly are not the full data set used in this analysis. To execute the code
373 exactly as conducted here, please contact the corresponding author for the dataset used in the analysis.

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531 **Competing Interests Statement:** The authors declare no competing interests.

532 **Figure Legends:**

533 **Fig 1. Restoration seeding in drylands globally showed limited but promising success.** **a)**
534 The distribution of restoration sites spans drylands globally, with restoration seeding triggered by
535 a variety of anthropogenic disturbances (point color, and fill for bars in **panel b**). Note that a
536 single point covers a diameter of >250km due to the mapping scale; if project sites are closer
537 than that distance, a single point represents more than one project. **b)** We found evidence that a
538 portion of projects had a high proportion of successfully seeded species. For instance, in 30% of
539 projects, all seeded species were recorded during monitoring. We also found that dryland
540 restoration seeding is somewhat of a gamble, with none of the seeded species recorded in 17% of
541 projects. **c)** While seeding more species would be expected to lead to greater species richness,
542 there was a limit to this increase. Rarely did a project record more than 10-15 successful species,
543 regardless of the number of species seeded.

544 **Fig 2. Within a restoration treatment, individual species success (defined as the probability**
545 **of a species being present during monitoring) was relatively low,** **a)** with 57% of species
546 failing to recruit when seeded. **b)** Seeding did, however, clearly increase success in seeded
547 treatments compared to unseeded controls, with each line in **panel b** representing the difference
548 in success of one species in an unseeded and seeded treatment pair. Blue lines indicate greater
549 success in seeded treatments, and red lines indicate greater success in unseeded controls. The
550 prevalence of lower success of target species in control treatments emphasizes the role of
551 propagule limitation in these systems. The same methods were used for measuring success in
552 unseeded controls and seeded treatments.

553 **Fig 3. Success is influenced by ecological filters and species characteristics** including **a)**
554 propagule limitation, where increasing seed rates lead to dramatically higher rates of species
555 success. This relationship was mediated by site aridity, with more mesic sites benefitting less
556 from additional seed inputs. The main effect of aridity emphasizes the importance of **b)** abiotic
557 filters, where aridity (*i.e.* values close to zero) depresses the probability of restored species
558 success. Managing **c)** competitive effects with weed control led to modest gains in species
559 success. Intrinsic species characteristics such as **d)** plant functional type, **e)** taxonomic grouping,
560 and **f)** seed mass affect species success, with the strategies that characterize annual species
561 leading to initially high success followed by more rapid declines over the first six years of
562 monitoring, some genera have higher probabilities of success than others, and seed size has an
563 overall positive influence on species success. Solid lines (a, b, d, f) and dots (c) indicate
564 population-level predictions (*i.e.* marginal means) conditioned on the fixed effects. Confidence
565 bands and error bars represent 95% confidence intervals.

566 **Methods:**

567 **GAZP Database.** The Global Arid Zone Project (GAZP) is an international collaboration aimed
568 at developing a spatially extensive, long-term, and continually expanding database. The curated
569 primary datasets included in GAZP meet the following criteria: they describe a restoration
570 project (*i.e.* a project aimed at “assisting the recovery of an ecosystem that has been degraded,
571 damaged, or destroyed”⁵¹), located in drylands (*i.e.* an area receiving less than 600 mm of
572 precipitation per year, with an aridity index at or below 0.65), and included seeding a minimum
573 of three species. Single-species monoculture treatments were accepted where multiple
574 monocultures were implemented in the same project.

575 All data were collected directly from researchers or practitioners and then processed into a set
576 database structure. Data collection began in January 2018 and is ongoing. For the purposes of
577 this analysis, we used data collected up until August 2019, reflecting a total of 20 months of
578 active collection and processing time. As of this analysis, the database encompassed 89
579 independent studies covering 174 individual sites, 1,632 treatments and 594,065 observations
580 from 671 species (see S1 for details). Seeded species represent a wide range of taxonomic groups
581 and phylogenetic lineages, including plant species from 29 orders, 66 families and 339 genera
582 (see S4 for a breakdown of the database phylogeny). The data include species outcomes for any
583 seeded species, regardless of whether they were native or exotic to the restoration site.

584 Species terminology and measurement units were standardized across data sets. Plant names
585 were standardized after The Plant List v1.1 database⁵² (see S1 for full protocol details). All
586 spatial measurements were converted to m or m², all coordinates were converted to decimal
587 degrees, volumetric measurements were converted to mL and temperature to °C, and all seeding
588 rates were transformed to estimated seeds per m². Many data sets were provided in weight of
589 seeds per area, and these were transformed using seed weight averages from the Seed
590 Information Database⁵³. This allowed all data sets to include the same treatment structure of
591 seeds/area, which could be linked to at least a subset of the response data in plants/area.

592 We acquired site-level data for each project to evaluate environmental drivers of restoration
593 success. Data included coarse topography, historical climate, and land cover class information.
594 We also collected species-level trait data, primarily from the TRY database⁵⁴ (see
595 **Supplementary note 1** for the full methods and details of the database). Site preparation data
596 were noted where available in our database, but few studies conducted site preparation work, and
597 as such, we were limited in how it could be incorporated into our analyses. Similarly, soil
598 information was infrequently available for studies in our database, and at present, there are no
599 consistent soil classification maps available at a global scale that matches the site-level scale of
600 the database. Similarly, a global dataset on ecologically relevant climatic and weather pattern
601 data is currently unavailable, though efforts to create such databases are currently underway
602 (SoilTemp, <https://soiltemp.weebly.com/>).

603 **Restoration success.** We measured success based on occurrence (density or cover > 0), a
604 criterion that meets the most minimal requirement for restoration seeding success. For each
605 sampling unit within a treatment, we recorded a target species as either present or absent. Thus,

the final response variable was the probability that a species was present in a single sample point across a whole treatment, referred to throughout the text as the ‘probability of species success’ or just ‘success’. We assessed the influence that seeding had on success in the first monitoring point for each project that contained an unseeded control. The same metrics were used to quantify unseeded controls and seeded treatments. Additionally, we assessed trends through time for all projects in the database, with or without unseeded controls, by modeling success across all time points up to six years, with the number of weeks since seeding as an additional predictor. While a simple presence score may seem like a low bar for success, and may not work for categorizing restoration outcomes in regions with more favorable conditions, we found that there was considerable spread and many failures using this response variable, indicating that it can be a meaningful measure of restoration outcomes in dryland systems.

Predictor variables. We focused on three external predictors of species success. These included biotic and abiotic filters including species inputs (seeding rate, dispersal filter), site conditions (site aridity, abiotic) and site treatments (weed control, biotic). We also considered three factors that may affect how seeded species respond to these ecological filters. First, the influence of species characteristics that drive seedling growth patterns and longevity, here captured as a factor combining lifeform and life span; second, seed size, which can interact with environment to influence restoration success; third, taxonomic identity, which likely represents unmeasured phenotypic traits. Seeding rate was included as seeds/m², and was log-transformed then centered and standardized with a z-score transformation⁵⁰. In order to maintain a relatively continuous distribution of seeding rate, we excluded any data that seeded at rates higher than 10,000 seed/m² (see S2 for detailed statistical protocols). This resulted in exclusion of 0.03% of the total dataset.

Lifeform was included as a categorical predictor. This was determined for each species as each data set was processed, and was assigned as either annual, perennial graminoid, perennial forb, or woody species. The assignment per species combined data from TRY on lifespan and Raunkiaer life-form, from the contributor’s data if included, and from online sources such as the USDA Plants Database⁵⁵ and the Western Australian Florabase⁵⁶. Seed mass was extracted on a per species basis from the Seed Information Database⁵³ and was log-transformed, centered and standardized with a z-score transformation. Species identity was included as a random predictor, and then residuals were explored against species, genus, and family classifications. We calculated an aridity index for each site by dividing the site-level mean annual precipitation⁵⁷ by mean annual potential evapotranspiration^{37,58,59}. Here, increasing positive values of the aridity index correspond to increasing site moisture. This value was log-transformed, centered and standardized with a z-score transformation. Last, we included a binary variable for whether the treatment included weed control efforts. We were able to include this variable because application of some form of weed control was the most common treatment across the database and had global spatial coverage. Other management treatments were not possible to include in analysis due to uneven spatial coverage but, nonetheless, general trends are discussed in the results section.

Model structure and validation. To model the probability of success, we used zero-inflated generalized linear mixed effect models (ZIGLMM) implemented using the R package

647 "glmmTMB" v1.01⁶⁰ in R version 4.0.2⁶¹. We created models for two types of responses: initial
648 success comparing unseeded controls and seeded treatments, and trends through time excluding
649 records for unseeded controls. For both model types, we assumed a binomial distribution with a
650 logit link function, and the number of replicates (*i.e.*, binomial denominator) was included as a
651 weighting variable in each model⁶². To control for the excess of zeros in the data, both models
652 were fitted with zero-inflation⁶³ (see **Supplementary note 2** for full statistical protocol details).

653 The first model, testing the role of seeding on success in initial recruitment, included only one
654 predictor – a yes / no treatment factor for whether a species was seeded. We modeled initial
655 recruitment across all species using only the first monitoring time point in each study, and we
656 used only those data that had both an unseeded and seeded treatment for direct comparison. We
657 initially used a nested random intercept structure of treatment within site, within project and a
658 crossed random variable for species ID, because some species were seeded in multiple studies.
659 However, likely because the data set was limited to one time point per treatment, the random
660 treatment variable prevented model convergence and was dropped. During model checking
661 protocols (see **S2** for protocols, and **S3** for diagnostic plots), the inclusion of species ID in the
662 random structure of this reduced data set was found to cause outliers and was also removed.
663 Thus, the final model had a random structure of site within project.

664 To determine the stability of success trends through time, we analyzed all time points in each
665 study but restricted data to a minimum of two months post-seeding and a maximum of six years
666 post-seeding. Although restoration trajectories can be longer than six years, long-term restoration
667 monitoring is rare⁵⁷ and this was reflected in the GAZP database. We included time since
668 seeding (weeks) as an additional predictor, log-transformed and standardized using a z-
669 transformation. Given the differences in temporal patterns of different life forms, we also
670 included the interaction between time since seeding and life-form. We included the nested
671 random structure of treatment within site, within project and a crossed random variable for
672 species ID. Less than a third of the treatments (28.9%) had more than three sampling times, so
673 temporal autocorrelation was not incorporated within individual treatments beyond the fixed
674 effect of time and the nested random structure.

675 We used QQ-plots of random effects to visually check for clear patterns in residuals.
676 Additionally, we visually checked residuals for deviations in uniformity, zero-inflation and
677 model overdispersion (see **Supplementary note 3** for details on model validation, results, and
678 extended results). We acknowledge that modeled relationships with time are log-linear, with
679 interaction terms that alter only the rate and intercept of the relationship based on lifeform. This
680 likely misses important non-linearities that may vary uniquely with each lifeform. There is
681 inherent computational complexity in modeling a database of this kind, and though there are
682 important signals in the consistent declines in success through time and the differences between
683 lifeforms, there is still much to explore as the database continues to grow.

Supplementary information

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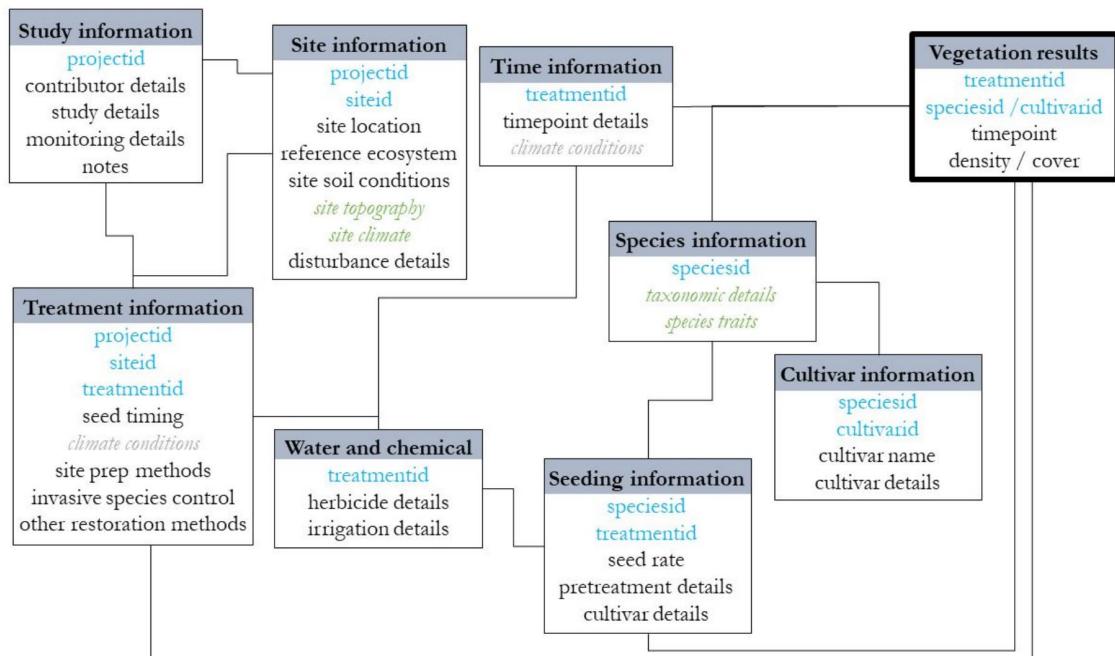
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Supplementary note 1 - Database overview

Database Structure

The GAZP database is a relational database with unique identifiers linking different components of each data set (Figure S1.1). The current (2020) storage status of the database is a series of Microsoft Excel Open XML Spreadsheet (.xlsx) files privately hosted on GitHub. The next stage of development will involve launching a publicly accessible online version of the database, planned to occur before the end of 2020. Each contributor has provided information on the accessibility of their data, which will guide the components of the database that will be released.



Supplementary Figure 1. Conceptual outline of the database structure. Relational identifiers are shown in light blue. Data that is fully or partially sourced from other global databases are shown in green. Additions that are currently under development are shown in grey.

List of variables

Supplementary Table 1. Variables collected and curated in the GAZP database, with a general description as well as units or defined categories. Relational identifiers are shown in blue; data sourced outside of contributor information is shown in green. Value options for categorical variables are underlined.

Database location	Variable	Description	Values
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Study information	<i>projectid</i>	project identifier	
Study information	studytype	study design type	<p><u>Artificial plots</u> = mimicking restoration site conditions rather than on actual restoration site</p> <p><u>Experimental restoration</u> = controlled restoration design to test experimental question</p> <p><u>Landscape restoration</u> = observational study of restoration outcomes</p>
Study information	contributor	GAZP contributing participant	
Study information	email	GAZP contributor contact	
Study information	location	country of study or state within USA	
Study information	region	region of study	<u>Africa, Australia, Europe, Middle East and Asia, North America, South America</u>
Study information	vegmetric	monitoring method	<p><u>cover</u> = estimated by contributor with no restriction on survey and estimate methodologies</p> <p><u>density</u> = estimated by contributor; generally converted to plants/m² except in instances where linear densities were provided, conversion impacted data quality, or original units were unclear</p>
Study information	viability	whether seed viability was considered in estimated seed rates	<p><u>PLS</u> = seed rates were provided in pure live seed</p> <p><u>lab</u> = seed rates were estimated using lab-tested viability</p>
Study information	spatialmetric	monitoring method	<u>plot</u> or <u>transect</u>
Study information	surveyunit	unit of area that vegetation data was provided by contributor; can be used to back transform density vegetation results to original data contribution	numeric in m for transects, m ² for plots
Study information	tsrfirst	first monitoring time point	numeric in weeks since restoration action
Study information	tsrlast	last monitoring time point	numeric in weeks since restoration action

Study information	timepoints	number of monitoring timepoints	numeric
Study information	community	whether vegetation monitoring was community-data rather than data on focal species only	<u>yes</u> = community data was provided and processed
Study information	refdata	whether reference data was provided	<u>yes</u> = reference data was provided but is unprocessed <u>not provided</u> = reference data was collected by contributor but not provided for database
Study information	availability	level of public availability	<u>public</u> = no restrictions; <u>no spatial information</u> = no site names or coordinates <u>delayed public</u> = waiting on publication before release <u>by request</u> = request to primary author required <u>private</u> = no access outside GAZP publications
Study information	notes	study details important for use	
Site information	<i>siteid</i>	site identifier	
Site information	<i>projectid</i>	project identifier	
Site information	sitename	contributor site identifier	
Site information	latitude		in decimal degrees
Site information	longitude		in decimal degrees
Site information	refecosystem	target or historical plant community as provided by contributor	
Site information	<i>landcover</i>	global land cover 2000 (source UNEP [1]): the main data set used for the Global Land Cover 2000 project is the "VEGA 2000" data set. This is essentially composed of 14 months of daily 1-km resolution satellite data acquired over the whole globe by the VEGETATION	<u>tel</u> = "tree cover, broadleaved, evergreen" <u>tc2</u> = "tree cover, broadleaved, deciduous, closed" <u>tc3</u> = "tree cover, broadleaved, deciduous, open" <u>tc4</u> = "tree cover, needle-leaved, evergreen" <u>tc5</u> = "tree cover, needle-leaved, deciduous" <u>tc6</u> = "tree cover, mixed leaf type"

		<p>instrument on-board the SPOT 4 satellite and delivered as multi-channel daily mosaics ("SI" format). The period covered is 1 Nov. 1999 - 31 Dec. 2000. The data set is made of global mosaics (from 75°N to 56°S and from 180° W to 180° E) at 1 km resolution. For each day of the period all channels are available, i. e. 4 spectral channels (blue, red, near infrared and short wave in fared), the NDVI, 4 angle channels, 1 status map, 1 time grid file. Data are top of canopy reflectances re-mapped to a lat-long grid. Each pixel is 1/112 degree in size. The project was carried out to provide accurate baseline landcover information to the International Conventions on Climate Change, the Convention to Combat Desertification, the Ramsar Convention and the Kyoto Protocol. This means in particular that the GLC2000 dataset is a main input dataset to define the boundaries between ecosystems such as forest, grassland, and cultivated systems. In contrast to former global mapping initiatives the GLC2000 project is a bottom up approach to global mapping. In this project more than 30 research teams have been involved, contributing to 19 regional windows. Each defined region was mapped by local experts, which guaranteed an accurate classification, based on local knowledge.</p>	<u>tcfw</u> = "tree cover, regularly flooded, fresh water" <u>tcsw</u> = "tree cover, regularly flooded, saline water" <u>tco</u> = "mosaic: tree cover / other natural vegetation" <u>tcb</u> = "tree cover, burnt" <u>sc1</u> = "shrub cover, closed-open, evergreen" <u>sc2</u> = "shrub cover, closed-open, deciduous" <u>h</u> = "herbaceous cover, closed-open" <u>sp</u> = "sparse herbaceous or sparse shrub cover" <u>shw</u> = "regularly flooded shrub and/or herbaceous cover" <u>c</u> = "cultivated and managed areas" <u>ctco</u> = "mosaic: cropland / tree cover / other natural vegetation" <u>csgo</u> = "mosaic: cropland / shrub and/or grass cover" <u>b</u> = "bare areas" <u>s</u> = "snow and ice" <u>a</u> = "artificial surfaces and associated areas"
Site information	sand	site-level particle-size as provided by contributor	percent; if range was provided, center value was taken
Site information	silt	site-level particle-size as provided by contributor	percent; if range was provided, center value was taken
Site information	clay	site-level particle-size as provided by contributor	percent; if range was provided, center value was taken

Site information	<i>soildescription</i>	categorical description of soil type as provided by contributor	approximates traditional soil texture classes where possible ; otherwise verbatim from contributor
Site information	<i>soildepth</i>	categorical description of soil depth as provided by contributor	
Site information	<i>elevation</i>	as provided by SRTM layers [2]	meters
Site information	<i>aspect</i>	as calculated from SRTM layers [2]	°, calculated as per [3]
Site information	<i>slope</i>	as calculated from SRTM layers [2]	°
Site information	<i>precipc</i>	average annual rainfall as provided by contributor	mm
Site information	<i>tempc</i>	average annual temperature as provided by contributor	°C
Site information	<i>aridity</i>	average annual precipitation / potential evapotranspiration; data sourced from CGIAR-CSI [4]	above 0; lower numbers mean more arid
Site information	<i>temp</i>	annual mean temperature [5]	°C
Site information	<i>drange</i>	mean diurnal range (mean of monthly (max temp - min temp)) [5]	°C
Site information	<i>iso</i>	isothermality (drange / trange) (* 100)[5]	°C
Site information	<i>tseason</i>	temperature seasonality (standard deviation *100) [5]	°C
Site information	<i>mtwarm</i>	max temperature of warmest month [5]	°C
Site information	<i>mtcold</i>	min temperature of coldest month [5]	°C
Site information	<i>trange</i>	temperature annual range (mtwarm - mtcold) [5]	°C
Site information	<i>twetq</i>	mean temperature of wettest quarter [5]	°C
Site information	<i>td,yq</i>	mean temperature of driest quarter [5]	°C

Site information	<i>twarmq</i>	mean temperature of warmest quarter [5]	°C
Site information	<i>tcoldq</i>	mean temperature of coldest quarter [5]	°C
Site information	<i>precip</i>	annual precipitation [5]	mm
Site information	<i>pwet</i>	precipitation of wettest month [5]	mm
Site information	<i>pdry</i>	precipitation of driest month [5]	mm
Site information	<i>pseason</i>	precipitation seasonality (coefficient of variation) [5]	mm
Site information	<i>pwetq</i>	precipitation of wettest quarter [5]	mm
Site information	<i>pdryq</i>	precipitation of driest quarter [5]	mm
Site information	<i>pwarmq</i>	precipitation of warmest quarter [5]	mm
Site information	<i>pcoldq</i>	precipitation of coldest quarter [5]	mm
Site information	disturbance	disturbance type that led to restoration treatment	<u>agriculture</u> = actively planted and harvested <u>clearing</u> = cleared with no subsequent long term use <u>erosion</u> = wind- or water-caused erosion <u>fire</u> = wild or prescribed fire <u>gas</u> = oil and gas development <u>grazing</u> = over-grazing <u>invasion</u> = invasive species dominance <u>mining</u> = mineral mining <u>roads</u> = clearing, paving, grading, or driving as per road use
Site information	minetype		<u>salt</u> , <u>coal</u> , <u>gold</u> , <u>gypsum</u> , <u>iron ore</u> , <u>lignite</u> , <u>diamond</u>
Site information	ogtype		<u>pipeline</u> , <u>well pad</u> , <u>sump</u>
Site information	invasivespe	invasive species of primary concern; if invasion was treated, this was (one of) focal species for treatment	

Site information	<code>invasiveform</code>	broad lifeform of invasive species of primary concern	<code>shrub</code> , <code>pgrass</code> , <code>agrass</code> , <code>pforb</code> , <code>aforb</code> where 'p' and 'a' represent 'perennial' and 'annual' respectively
Treatment information	<code>treatmentid</code>	treatment identifier	
Treatment information	<code>projectid</code>	project identifier	
Treatment information	<code>siteid</code>	site identifier	
Treatment information	<code>seedinglear</code>	year of seeding	
Treatment information	<code>seedlingmonth</code>	month of seeding	
Treatment information	<code>seedlingday</code>	day of seeding	
Treatment information	<code>applicationmethod</code>	seed application method	<u>broadcast</u> = mechanically spread onto soil surface <u>drill</u> = drill-seeded below soil surface <u>hand</u> = hand spread onto soil surface <u>hydro</u> = hydroseeded
Treatment information	<code>seedinglear</code>	year of planting if tubestock was used	
Treatment information	<code>seedlingmonth</code>	month of planting	
Treatment information	<code>seedlingday</code>	day of planting	
Treatment information	<code>growthmedium</code>	substrate applied as seedbed	<u>fines</u> , <u>gypsum</u> <u>spoil</u> , <u>byproduct</u> , <u>mixed</u> , <u>topsoil</u> , <u>waste</u> , <u>haul</u> , <u>scoria</u> , <u>spoil</u>
Treatment information	<code>topsoilage</code>	length of time topsoil was stored between collection and application	in years

Treatment information	irrigation	whether irrigation was applied; more details of each irrigation treatment can be found 'waterandchemicals'; when rain-out shelters were used, this is considered "negative irrigation" and is listed as reduced; the amount of reduction will be listed in 'waterandchemicals' as reduced proportion of ambient rainfall	<u>yes, no, reduced</u>
Treatment information	invasioncontrol	control of invasive species	<u>fire</u> = prescribed burn <u>mowing</u> = cutting or mowing surface vegetation <u>pulling</u> = hand or hoe pulling; herbaceous species <u>herbicide</u> = chemical control <u>thinning</u> = mechanical or hand pulling ; woody species <u>natural</u> = natural mortality event <u>scalping</u> = removing topsoil layer
Treatment information	fertilization	whether fertilizer was applied or nutrients removed	<u>yes</u> = if yes, details in waterandchemicals removed
Treatment information	grading	reformation of substrate	<u>yes, no</u>
Treatment information	bedmaterial	addition of material on surface of substrate	<u>mulch</u> = organic-based chipped medium, excluding woodchips <u>biochar</u> <u>straw</u> = dried hay with no potential seed source <u>hay</u> = hay collected from natural systems; likely contains native seed sources <u>woodchips</u> = chipped wood, often created from local shrub/tree removal <u>kelp</u> = dried seaweed <u>organicmaterial</u> = any other organic addition such as compost <u>gravel</u> <u>brushpile</u> <u>manure</u>
Treatment information	bedprep	reformation of upper bed material	<u>tilling</u> (includes ploughing), <u>fire</u> , <u>raking</u> , <u>ripping</u> , <u>pitting</u> , <u>discing</u> , <u>harrowing</u> , <u>scarification</u> , <u>packing</u> (includes cultipacking)

Treatment information	erosioncontrol		<u>rolling</u> <u>blanket</u> = surface cover of straw or other material
Treatment information	grazermamp		<u>allowed</u> , <u>added</u> , <u>removed</u>
Treatment information	shelter		<u>natural</u> = brush or other natural material <u>artificial</u> = created shelter, including cardboard boxes, metal caging, etc. <u>living</u> = nurse plant
Treatment information	othertreatments		
Treatment information	overlaptreatments	whether additional treatments are included in the overlap treatment sheet	<u>yes</u> , <u>no</u>
Overlap treatment information	<i>treatmentid</i>	treatment identifier	
Overlap treatment information	treatmentcategory	column name in treatment document	
Overlap treatment information	description	value of extra treatment matching treatmentcategory	see treatment variable descriptions
Water and Chemicals	<i>treatmentid</i>	treatment identifier	
Water and Chemicals	tsr	time since restoration that treatment was applied	in weeks
Water and Chemicals	irrigation	amount of irrigation applied per treatment OR amount of reduction in rainfall	in mm OR in proportion of ambient
Water and Chemicals	herbicidetype		
Water and Chemicals	herbicideamount		
Water and Chemicals	fertilizertype		
Water and Chemicals	fertilizeramount		

Time information	<i>treatmentid</i>	treatment identifier	
Time information	tsr	time since restoration of monitoring point	in weeks
Time information	year	year of monitoring point	
Time information	month	month of monitoring point	
Time information	day	day of monitoring point	
Species information	<i>speciesid</i>	unique species code	
Species information	<i>group</i>	taxonomic [6]	
Species information	<i>order</i>	taxonomic [6]	
Species information	<i>family</i>	taxonomic [6]	
Species information	<i>genus</i>	taxonomic [6]	
Species information	<i>species</i>	taxonomic [6]	
Species information	<i>sub_type</i>	taxonomic [6]	
Species information	<i>name</i>	taxonomic [6]	
Species information	lifeform	basic lifeform	
Species information	<i>seedmass</i>	1000 seed weight [7]	
Species information	<i>path</i>	photosynthetic pathway [8,9]	
Species information	<i>raunkiaer</i>	Raunkiaer lifeform [8]	
Species information	<i>woodiness</i>	woodiness [8]	

Species information	<i>nfix</i>	nitrogen fixing capacity [8, 10]	
Species information	<i>lifespan</i>	lifespan [8, 10]	
Cultivar information	<i>speciesid</i>	unique species code	
Cultivar information	<i>cultivarid</i>	numeric	
Cultivar information	cultivar	cultivar name	
Cultivar information	cultivarorigin	cultivar origin location	
Cultivar information	seedlat	cultivar origin coordinates	
Cultivar information	seedlong	cultivar origin coordinates	
Seeding information	<i>treatmentid</i>	treatment identifier	
Seeding information	<i>speciesid</i>	unique species code	matches species sheet except in the case of a cultivar, at which point an underscore and cultivar number are added to the end of the code (e.g. Agr_cri_l). The cultivar number and name combination comes from two columns in the cultivars sheet.
Seeding information	seededrate	seeds/m ²	
Seeding information	seedpretreatment		<u>acid</u> = acid bath <u>boiled</u> = boiling or soaking in hot water <u>coated</u> = seed coating, without hormonal or fungicide treatment <u>moddus</u> <u>scarification</u> = mechanically breaking seed surface <u>cleaned</u> = outer layers removed to pure seed <u>soaked</u> = immersed in water, not near boiling <u>smoke</u> = smoke treatment or use of Karrikinolide <u>GA</u> = Gibberellic acid

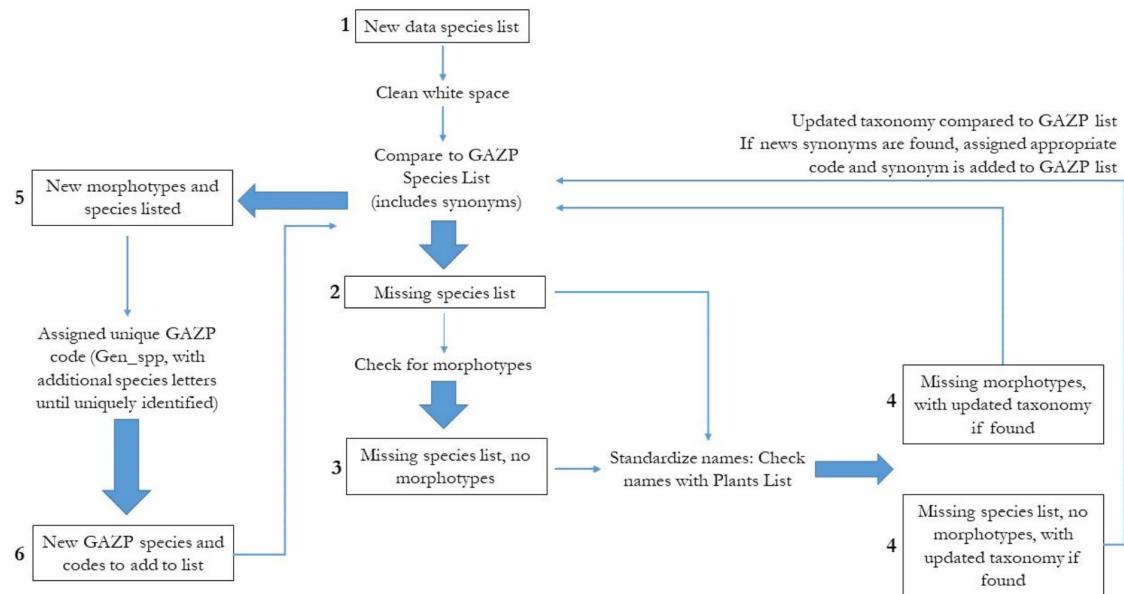
Seeding information	origin	origin for species within project	<u>native</u> , <u>exotic</u>
Seeding information	seedsource		<u>farmed</u> = agronomic growout by practitioners <u>commercial</u> = purchased from commercial provider <u>wild</u> = wild harvested
Seeding information	seeddist	origin of seed source population	in km
Seeding information	cultivar	cultivar name	
Seeding information	cultivarorigin	location of cultivar source population	
Seeding information	seedlat	coordinates of seed source population	
Seeding information	seedlong	coordinates of seed source population	
Vegetation results	<i>treatmentid</i>	treatment identifier	
Vegetation results	tsr	time since restoration of monitoring point	in weeks
Vegetation results	replication	replicate within treatment	assigned by GAZP; does not align with original data
Vegetation results	<i>speciesid</i>	unique species code	
Vegetation results	density	plant density split by treatment, replicate, timepoint, and species where possible	estimated by contributor; generally converted to plants/m ² except in instances where linear densities were provided, conversion impacted data quality, or original units were unclear
Vegetation results	cover	plant cover split by treatment, replicate, timepoint, and species where possible	estimated by contributor with no restriction on survey and estimate methodologies

List of protocols

A number of protocols were developed to create consistency in the database and comparability between data sets.

Taxonomy

To compare species between data sets collected in different regions, and at different times, is a taxonomic challenge. In order to achieve consistency in species naming assignments, the GAZP database utilizes a multistep process (Supplementary Figure 2) that ends with a unique code assigned to each species within the database, including all synonyms and relevant subspecies or variants.



Supplementary Figure 2. Protocol to move from species list in new data set to GAZP species ID code. The process involves checking a new species list against the existing GAZP list, which contains the GAZP unique code with both the most updated taxonomic name and any known synonyms or prior names. New species are then checked against the Plants List to update any taxonomic issues, and then compared again to the GAZP list. If a species is updated and the updated name matches a species in GAZP, the old name is recorded as a new synonym in the GAZP list. Otherwise, a new code is assigned and the species is incorporated into the GAZP list. The code is Gen_spp, with as many letters as needed in the species to achieve a unique identifier. Sub-species and variants are handled by adding numeric codes to the end of the species ID. These are also stored in the GAZP list and checked in new data sets.

Species traits

Species traits were drawn primarily from the Kew Gardens Seed Information Database [7], the TRY Plant Trait database [8], and the USDA Plants Database [10]. Data on each trait was downloaded in full from each database, cleaned, and run through the same taxonomic protocol as the data sets. This resulted in updated taxonomic names assigned to each trait (as of 2019), which are then matched against updated names of any new species incorporated into the database. Some traits required higher level decision protocols (Supplementary Table 2).

Supplementary Table 2. Species traits (left) and the higher level decisions made to standardize values across species (right).

Photosynthetic pathway	Data had multiple versions of each variable that were all standardized. If a species had multiple entries in a single cell, cell value designated as "Multi".
Raunkiaer lifeform	There are multiple sources of formal Raunkiaer categories. The GAZP categories follow Ellenberg and Mueller-Dombois [11]. If single TRY entries had multiple values, we standardized to: <ul style="list-style-type: none"> • The longer-lived category • The terrestrial category • Either the category with the most shoot reduction or (if there were three values), the middle reduction category
Woodiness	Data had multiple versions of each variable that were all standardized. If multiple values within single cell, standardized to semi-woody.
Nitrogen fixing capacity	Data had a variety of values that were standardized to yes or no for the GAZP trait data set.
Lifespan	If single entries had multiple values, all were kept.

Site descriptors

Spatial coordinates were required for all sites in all data sets. These were standardized to decimal degrees. Using a combination of direct access to online databases (WorldClim [5] and SRTM tiles [2]) and downloaded global rasters (land cover [1] and CGIAR aridity [4]), coordinates were then used to calculate site-level values for abiotic variables.

Standardization

Individual studies were all standardized to uniform units (see Supplementary Table 1 for details on most variables). The most standardization error is likely to have arisen in transforming all seed rate values to estimated seeds per m^2 . If data was provided in weight per unit area, it was transformed to weight per m^2 . SID KEW [7] average seed weights were then used to estimate seeds per m^2 . If data was provided in seeds per unit area, it was transformed to seeds per m^2 .

List of studies

Though GAZP has continued to grow, this manuscript was analyzed around 89 separate datasets

Supplementary Table 3. Contributor and data information for all studies used in the first GAZP analysis.

Contributor	Publication (or study name)
Ali Abdullahi	Rangelands Restoration for Hirola, The World's Most Endangered Antelope, Kenya
Andrea Kramer	Pine Ridge fire: Native winner seeding trials
Anita Kirmer	Kirmer, A., Baasch, A. and Tischew, S., 2012. Sowing of low and high diversity seed mixtures in ecological restoration of surface mined-land. <i>Applied Vegetation Science</i> , 15(2), pp. 198-207.

Anita Kirmer	Kirmer, A. and Tischew, S., 2014. Conversion of arable land to lowland hay meadows: What influences restoration success. <i>Guidelines for Native Seed Production and Grassland Restoration</i> , p. 118.
Anita Kirmer	Kirmer, A., Pfau, M., Mann, S., Schrödter, M. and Tischew, S., 2016. Zeitschrift für Naturschutz und Landschaftspflege.
Anita Kirmer	Baasch, A., Kirmer, A. and Tischew, S., 2012. Nine years of vegetation development in a postmining site: Effects of spontaneous and assisted site recovery. <i>Journal of Applied Ecology</i> , 49(1), pp. 251-260.
Anita Kirmer	Kirmer, A., Rydgren, K. and Tischew, S., 2018. Smart management is key for successful diversification of field margins in highly productive farmland. <i>Agriculture, Ecosystems & Environment</i> , 251, pp. 88-98.
Arlee Montalvo	Montalvo, A.M., McMillan, P.A. and Allen, E.B., 2002. The relative importance of seeding method, soil ripping, and soil variables on seeding success. <i>Restoration Ecology</i> , 10(1), pp. 52-67.
Balázs Deák	Large-scale grassland restoration on former croplands by sowing low-diversity grass seed mixtures
Balázs Deák	Seed sowing of grassland plants on historical sites
Barry Heydenrych	Greening Australia decadal summary
Carina Becker	South Africa shelter boxes, Renosterveld and Hardeveld
Carla and Phil Burton	Burton, C.M., Burton, P.J., Hebda, R. and Turner, N.J., 2006. Determining the optimal sowing density for a mixture of native plants used to revegetate degraded ecosystems. <i>Restoration Ecology</i> , 14(3), pp. 379-390.
Chad Boyd	Boyd, C.S. and Davies, K.W., 2012. Differential seedling performance and environmental correlates in shrub canopy vs. interspace microsites. <i>Journal of Arid Environments</i> , 87, pp. 50-57.
Chad Boyd	Boyd, C.S. and Davies, K.W., 2012. Spatial variability in cost and success of revegetation in a Wyoming big sagebrush community. <i>Environmental Management</i> , 50(3), pp. 441-450.
Charlie Clements	Empire Burn
Charlie Clements	Gerlach weed control
Claire Wainwright	Wainwright, C.E., Wolkovich, E.M. and Cleland, E.E., 2012. Seasonal priority effects: implications for invasion and restoration in a semi-arid system. <i>Journal of Applied Ecology</i> , 49(1), pp. 234-241.
Darin Law	Law, D.J. and Kolb, P.F., 2007. The effects of forest residual debris disposal on perennial grass emergence, growth, and survival in a ponderosa pine ecotone. <i>Rangeland Ecology & Management</i> , 60(6), pp. 632-643.

Ellery Mayence	Mayence, C.E., Carrick, P.J., Van Beem, D., Broenland, E. and Dixon, K.W., 2017. Seed dormancy, soil type and protective shelters influence seedling emergence at Shark Bay, Western Australia: Insight into global dryland revegetation. <i>Ecological Management & Restoration</i> , 18(2), pp. 156-163.
Ellery Mayence	Mayence, C.E., Stevens, J.C., Courtney, P. and Dixon, K.W., 2017. Edaphic constraints on seed germination and emergence of three Acacia species for dryland restoration in Saudi Arabia. <i>Plant Ecology</i> , 218(1), pp. 55-66.
Ellery Mayence	Saudi seeding trials
Enrique Garcia	de la Riva, E.G., Casado, M.A., Jiménez, M.D., Mola, I., Costa-Tenorio, M. and Balaguer, L., 2011. Rates of local colonization and extinction reveal different plant community assembly mechanisms on road verges in central Spain. <i>Journal of Vegetation Science</i> , 22(2), pp. 292-302.
Eric Seabloom	Seabloom, E.W., 2011. Spatial and temporal variability in propagule limitation of California native grasses. <i>Oikos</i> , 120(2), pp. 291-301.
Erin Espeland	Espeland, E. and Richardson, L., 2015. The role of competition and seed production environment on the success of two perennial grass species in a roadside restoration. <i>Ecological Restoration</i> , 33(3), pp. 282-288.
Erin Espeland	Espeland, E.K., Hendrickson, J., Toledo, D., West, N.M. and Rand, T.A., 2017. Soils Determine Early Revegetation Establishment with and without Cover Crops in Northern Mixed Grass Prairie after Energy Development. <i>Ecological Restoration</i> , 35(4), pp. 311-319.
Erin Espeland	Espeland, E.K., Muscha, J.M., Scianna, J., Kilian, R., West, N.M. and Petersen, M.K., 2017. Secondary invasion and reinvasion after Russian-olive removal and revegetation. <i>Invasive Plant Science and Management</i> , 10(4), pp. 340-349.
Gustavo Paterno	Paterno, G.B., Siqueira Filho, J.A. and Ganade, G., 2016. Species-specific facilitation, ontogenetic shifts and consequences for plant community succession. <i>Journal of Vegetation Science</i> , 27(3), pp. 606-615.
Hannah Farrell	Pipeline restoration meta-analysis
J.A. Navarro-Cano	Barberá, G.G., Navarro-Cano, J.A. and Castillo, V.M., 2006. Seedling recruitment in a semi-arid steppe: the role of microsite and post-dispersal seed predation. <i>Journal of Arid Environments</i> , 67(4), pp. 701-714.
Jeremy James	BLM fire complex
Jeremy James	Bunchgrass demography
Jessica Drake	Drake, J.A., Carrucan, A., Jackson, W.R., Cavagnaro, T.R. and Patti, A.F., 2015. Biochar application during reforestation alters species present and soil chemistry. <i>Science of the Total Environment</i> , 514, pp. 359-365.

Joshua Eldridge	Eldridge, J.D., Redente, E.F. and Paschke, M., 2012. The use of seedbed modifications and wood chips to accelerate restoration of well pad sites in western Colorado, USA. <i>Restoration Ecology</i> , 20(4), pp. 524-531.
Juame Tormo	Tormo, J., Bochet, E. and García-Fayos, P., 2007. Roadfill revegetation in semiarid Mediterranean environments. Part II: Topsoiling, species selection, and hydroseeding. <i>Restoration Ecology</i> , 15(1), pp. 97-102.
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Kari Veblen	Restoration of native understory plants in degraded sagebrush steppe ecosystems
Kari Veblen	Restoration of native understory plants in degraded sagebrush steppe ecosystems
Katharine Stuble	Stuble, K.L., Fick, S.E. and Young, T.P., 2017. Every restoration is unique: testing year effects and site effects as drivers of initial restoration trajectories. <i>Journal of Applied Ecology</i> , 54(4), pp. 1051-1057.
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Kirk Davies	Davies, K.W. and Bates, J.D., 2014. Attempting to restore herbaceous understories in Wyoming big sagebrush communities with mowing and seeding. <i>Restoration Ecology</i> , 22(5), pp. 608-615
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Liz Ballenger	ConMod trial
Luis Merino-Martin	Merino-Martín, L., Commander, L., Mao, Z., Stevens, J.C., Miller, B.P., Golos, P.J., Mayence, C.E. and Dixon, K., 2017. Overcoming topsoil deficits in restoration of semiarid lands: designing hydrologically favourable soil covers for seedling emergence. <i>Ecological Engineering</i> , 105, pp. 102-117.
Manuel Esteban Lucas Borja	Natural regeneration after prescribed fires
Mark Paschke/Jayne Jonas	Herron, C.M., Jonas, J.L., Meiman, P.J. and Paschke, M.W., 2013. Using native annual plants to restore post-fire habitats in western North America. <i>International Journal of Wildland Fire</i> , 22(6), pp. 815-821.
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Matt Bahm	Bahm, M.A., Barnes, T.G. and Jensen, K.C., 2015. Native grass establishment using Journey® herbicide. <i>Natural Areas Journal</i> , 35(1), pp. 69-73.
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Megan Wong	Soils and Land Use in the Rochester and Echuca Districts, Victoria, including the Rochester Irrigation area, Campaspe Irrigation District, and Echuca East Irrigation Settlement
Merilynn Schantz	Schantz, M.C., Sheley, R.L. and James, J.J., 2015. Role of propagule pressure and priority effects on seedlings during invasion and restoration of shrub-steppe. <i>Biological Invasions</i> , 17(1), pp. 73-85.
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Nelmarie Saayman	Re-vegetation of old lands in the West Coast districts
Nelmarie Saayman	Restoration of bare patches on sand-clay-loam soils in the Nama Karoo

Nichole Barger	Ross, M.R., Castle, S.C. and Barger, N.N., 2012. Effects of fuels reductions on plant communities and soils in a piñon-juniper woodland. <i>Journal of Arid Environments</i> , 79, pp. 84-92.
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Patricia Holmes	Holmes, P.M., 2002. Renosterveld restoration on cultivated lands at Eerste River, Western Cape: preliminary findings of a pilot study. Unpublished report to Lafarge quarries, Cape Town, pp. 1-33.
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Peter Carrick	Restoration pack experiment - Koingnaas
Peter Golos	Telfer seeding
Péter Török	Seed sowing of grassland species in filled channels
Qinfeng Guo	Guo, Q., Shaffer, T. and Buhl, T., 2006. Community maturity, species saturation and the variant diversity-productivity relationships in grasslands. <i>Ecology Letters</i> , 9(12), pp. 1284-1292.
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Réka Kiss	Seed sowing of grassland plants in newly abandoned agricultural land
Sandra Dullau	John, H., Dullau, S., Baasch, A. and Tischew, S., 2016. Re-introduction of target species into degraded lowland hay meadows: How to manage the crucial first year?. <i>Ecological Engineering</i> , 86, pp. 223-230.
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Shauna Uselman	Uselman, S.M., Davison, J., Baughman, O.W., Sullivan, B.W., Miller, W.W. and Leger, E.A., 2018. Restoring dryland old fields with native shrubs and grasses: Does facilitation and seed source matter?. <i>PloS One</i> , 13(10).
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Sue Milton	South Africa Enterprise Network restoration
Tamás Miglécz	Testing species rich cover crop seed mixtures in vineyards of Tokaj wine region, Hungary
Tamás Miglécz	Testing species rich cover crop seed mixtures in vineyards of Szekszárd wine region, Hungary
Todd Erickson	Pilbara mining experiment
Tom Monaco	Newhall, R.L., Monaco, T.A., Horton, W.H., Harrison, R.D. and Page, R.J., 2004. Rehabilitating salt-desert ecosystems following wildfire and wind erosion. <i>Rangelands</i> , pp.3 -7.
Tom Monaco	Waldron, B.L., Monaco, T.A., Jensen, K.B., Harrison, R.D., Palazzo, A.J. and Kulbeth, J.D., 2005. Coexistence of native and introduced perennial grasses following simultaneous seeding. <i>Agronomy Journal</i> , 97(3), pp. 990-996.
Tom Monaco	Morris, C., Morris, L.R. and Monaco, T.A., 2019. Evaluating the effectiveness of low soil-disturbance treatments for improving native plant establishment in stable crested wheatgrass stands. <i>Rangeland Ecology & Management</i> , 72(2), pp. 237-248.
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Supplementary note 2 - Statistical protocols

Q2: Initial recruitment model

Data manipulation before analyses

- Missing data in any predictor or response variable were excluded from the dataset
- The dataset was cropped for the **earliest time point of each project**
- The dataset was cropped for **aridity index less or equal to 0.65**
- Data was filtered to seed rates between **0 and < 10.000 seeds** (four orders of magnitude)
- Data was filtered to time since restoration (post seeding) **below 3 years (tsr < 156 weeks)**
- Only treatments within sites **that had both an unseeded control and a seeded treatment** were included

Variables

Response variables

- **Probability of success (Ps)** was used as response variable.
 - We first calculated occurrence for each observation in the dataset.
 - occurrence = 1 when density or cover > 0
 - occurrence = 0 when density or cover < 0
 - **Ps** was calculated at the treatment level, by dividing the **number of occurrences** of a given species in a given treatment **by the number of replicates** in the same treatment:

$$PS = \frac{Nobs}{Nrep}$$

- **Ps** is a continuous variable bounded between **0 and 1** which reflects the probability of success of a given species in a given treatment.

Explanatory variables (predictors)

- **Seed treatment:** seeded vs unseeded

Modelling approach

- We used **zero-inflated generalized linear mixed effect models (ZIGLMM)** with *binomial distribution*
- The **number replicates (n)** was included as **weights** in the model.

Fixed effects

Models were fitted using Ps (probability of success) against one predictor

- Seed treatment (seeded vs unseeded)

Random effects

The model was fitted with a **nested random intercept structure** of site within project:

```
(1 | projectid / siteid )
```

Model formula:

```
model <-  
  glmmTMB(  
    Ps ~ seed +  
      (1 | projectid / siteid),  
    family = binomial(link = "logit"),  
    weights = n,  
    ziformula = ~ 1,  
    data = dc_clean  
)
```

Q3: Trends in vegetation development

Data manipulation before analyses

- Missing data in any predictor or response variable were excluded from the dataset
- The dataset was cropped for **aridity index less or equal to 0.65**
- Data included only seeded species (seed rate > 0)
 - Data was filtered to seed rates between **1 and < 10.000 seeds** (four orders of magnitude)
- Data was filtered to time since restoration (post seeding) **between two months and six years** (8 weeks < tsr < 312 weeks)

Variables

Response variables

- **Probability of success** (Ps) was used as response variable.
 - We first calculated occurrence for each observation in the dataset.
 - occurrence = 1 when density or cover > 0
 - occurrence = 0 when density or cover < 0
 - Ps was calculated at the treatment level, by dividing the **number of occurrences** of a given species in a given treatment **by the number of replicates** in the same treatment:

$$PS = \frac{Nobs}{Nrep}$$

- Ps is a continuous variable bounded between **0 and 1** which reflects the probability of success of a given species in a given treatment.

Explanatory variables (predictors)

- **Seeded rate**: number of seeds seeded per m² in a given treatment
 - Transformation: **log(x + 1)**
- **Seed mass**: weight in g of 1000 seeds for a given species. Based on Kew's Seed Information Database estimates
 - Transformation: **log(x + 1)**
 - After scaling (see below), was rounded to nearest one decimal place
- **Lifeform**: annual, perennial forbs, perennial grasses and woody
 - woody species included trees, shrubs and succulents
- **Aridity**: Site level aridity index
 - Transformation: **log(x)**
- **Weed control**: yes or no
 - Different control methods are grouped (e.g. herbicide, mowing, pulling, etc)
- **Time since seeding**: The number of weeks post seeding

Standardization

- All numerical **continuous predictors were scaled and centered** before analysis (z-score transformation):
 - Values were centred by subtracting the mean
 - Values were scaled by dividing the centered values by the standard deviation, by the formula:

$$X_z = \frac{X - \bar{X}}{SD_X}$$

Modelling approach

- We used **zero-inflated generalized linear mixed effect models (ZIGLMM)** with *binomial distribution*
- The **number replicates (n)** was included as **weights** in the model.

Fixed effects

Models were fitted using Ps (probability of success) against six key predictors and two interactions:

- Seeded rate (number of seeds seeded, $\log(x + 1)$)
- Seed mass (weight per 1000 seeds, $\log(x + 1)$)
- Aridity (site level, $\log(x)$)
- Lifeform (“annual”, “per. forb”, “per. grass” & “woody”)
- Weed control (yes or no)
- Time since seeding (number of weeks, $\log(x)$)
- **Interaction:** Lifeform : Time since seeding
- **Interaction:** Seeded rate : Aridity

Random effects

Models were fitted with a **nested random intercept structure** of treatment within site, within project and a **crossed random variable** for species ID:

```
(1 | projectid / siteid / treatmentid) + (1 | speciesid)
```

Model formula:

```
model <-  
  glmmTMB(  
    Ps ~ aridityLZ * seededrateLZ + weed_control + seedmassLZ + tsrlZ *  
    lifeform2 +  
      (1 | projectid / siteid / treatmentid) + (1 | speciesid),  
    family = binomial(link = "logit"),  
    ziformula = ~ 1,  
    weights = n,  
    data = dc  
)
```


Model validation & Prediction

Model diagnostic

1. We used QQ-plot of the random effects to check for any patterns or clear deviation in the residuals
2. We checked model residuals for clear deviation in uniformity, Zero-inflation and Overdispersion
3. We plotted model residuals against predictors to check for any clear correlation

Model predictions

1. Marginal effects for each predictor were calculated by holding the other covariates constant
2. Numeric covariates were set to their mean value
3. Factors were “averaged” to reflect the proportions of each factor’s category
4. Predicted values and confidence intervals were calculated accounting for uncertainty in random-effects

Packages used in the analyses

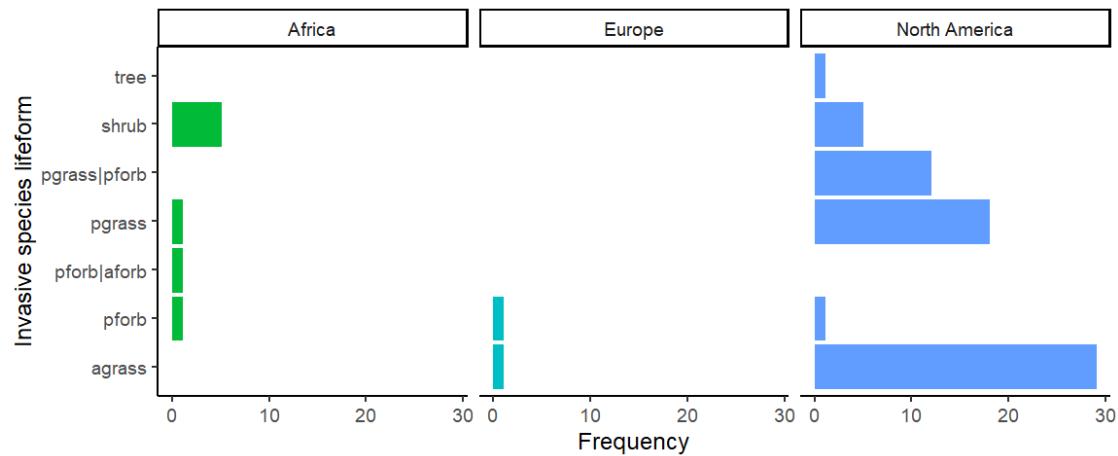
- Zero-inflated Generalized Linear Mixed Modeling was performed with the R package `glmmTMB` v1.01 (Brooks et al. 2017).
- QQ-plot for random effects was performed with the R package `sjPlot` v2.4.1 (Lüdecke, 2018)
- Residuals diagnostics were performed with the R package `DHARMa` v 0.3.0 (Hartig, 2020)
- Model predictions were plotted with the R package `ggeffects` v0.14.3 (Lüdecke, 2018) which uses the R package `effects` v 4.1.4 (Weisberg, 2019) to calculated marginal effects.

References

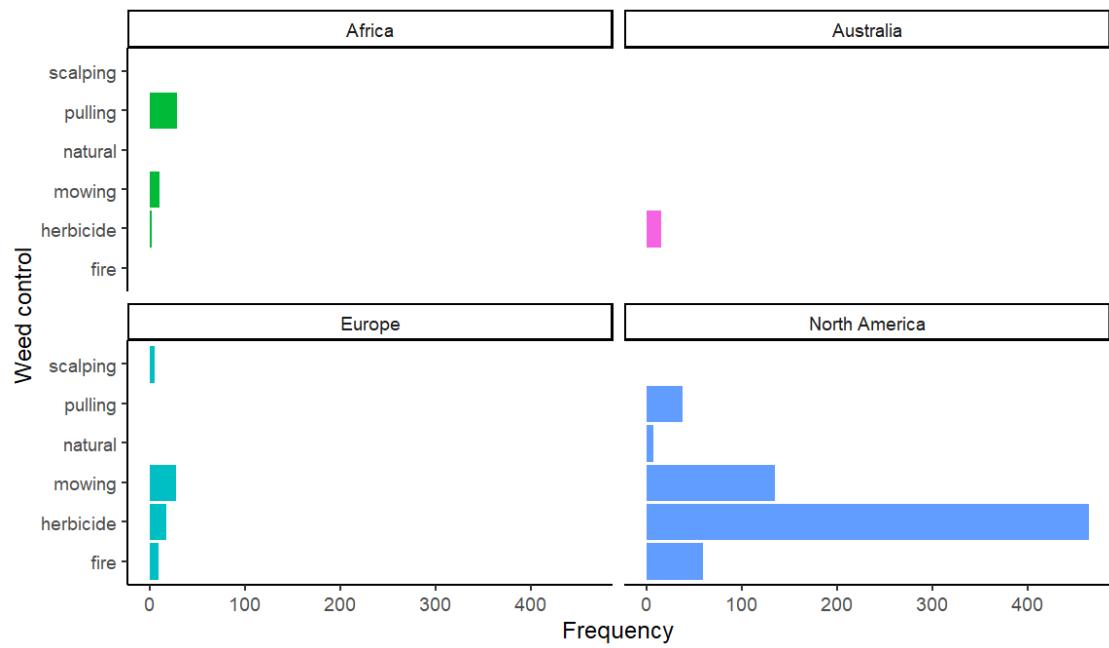
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Supplementary note 3 - Extended results

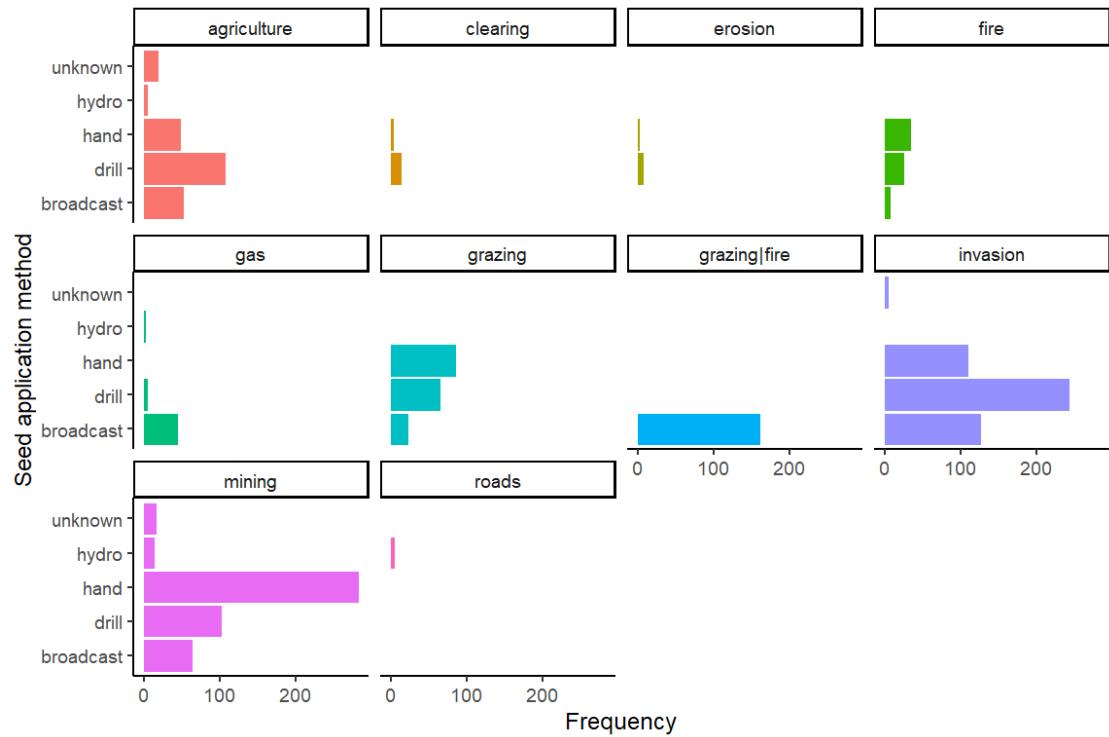
Treatment and site level variables



Supplementary Figure 3. Frequency distribution of invasive species life form across regions.



Supplementary Figure 4. Frequency distribution of weed control methods across regions.



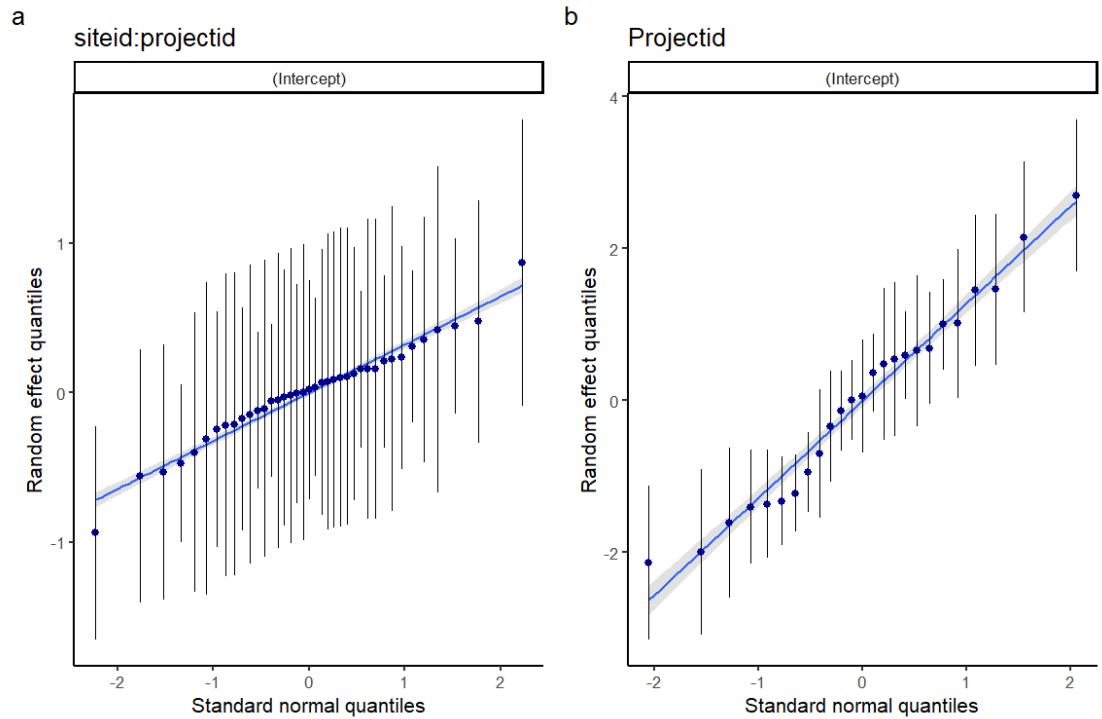
Supplementary Figure 5. Frequency distribution of weed control methods across disturbance types.

Model results and diagnostics

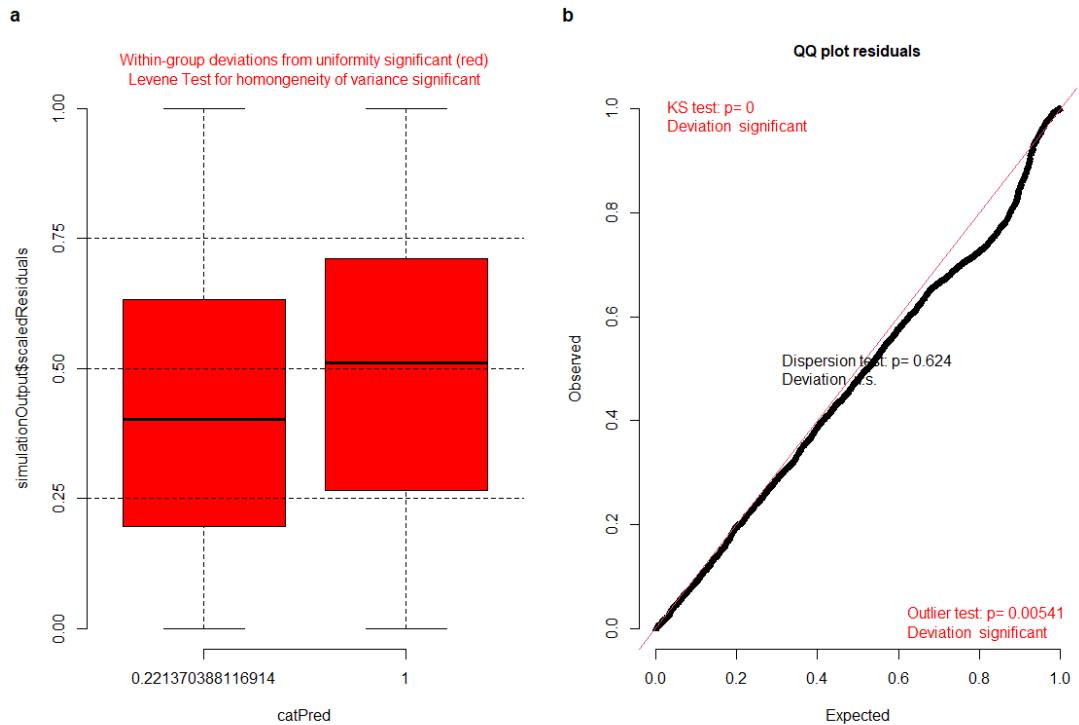
Q2 - Initial recruitment

Supplementary Table 4. Summary of linear mixed-effects model evaluating initial recruitment (Q2). See Supplementary note 2 for full details about model implementation.

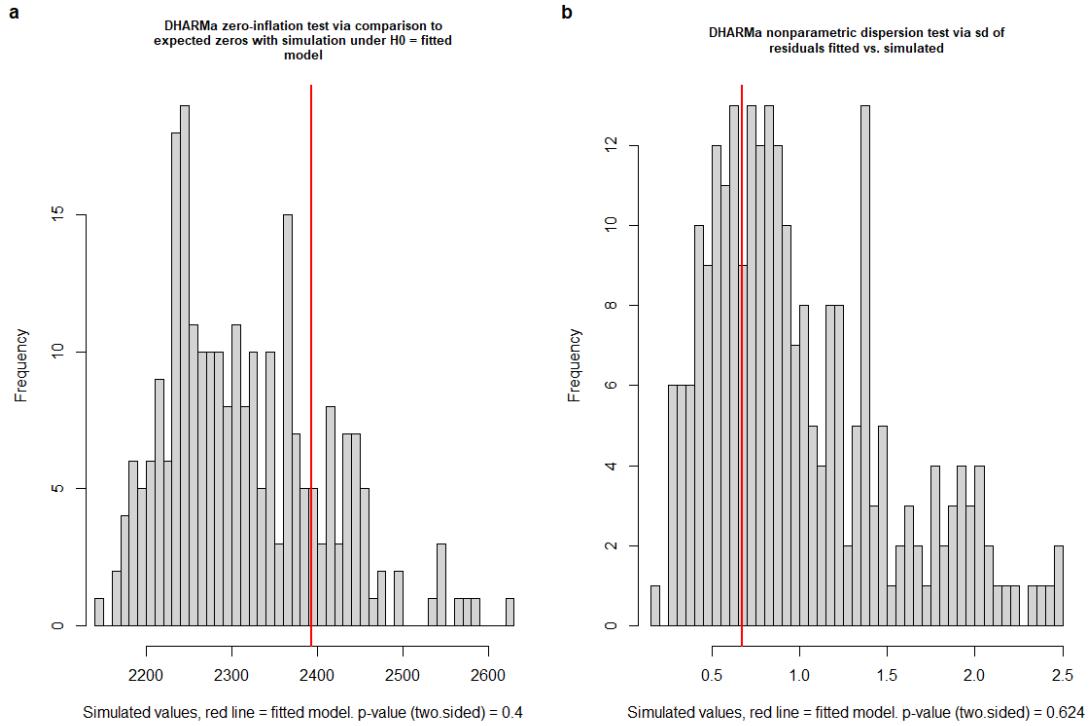
```
## Family: binomial ( logit )
## Formula: Ps ~ seed + (1 | projectid/siteid)
## Zero inflation: ~1
## Data: dc_clean
## Weights: n
##
##      AIC      BIC  logLik deviance df.resid
## 10010.9 10041.3 -5000.4 10000.9     3245
##
## Random effects:
##
## Conditional model:
## Groups           Name        Variance Std.Dev.
## siteid:projectid (Intercept) 0.2897   0.5382
## projectid         (Intercept) 1.8651   1.3657
## Number of obs: 3250, groups: siteid:projectid, 39; projectid, 25
##
## Conditional model:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept) -0.16791   0.29381 -0.571   0.568
## seedunseeded -1.38261   0.07163 -19.303  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Zero-inflation model:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept)  0.63424   0.04999 12.69   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```



Supplementary Figure 6. QQ-plot for random effects of linear mixed-effects model evaluating initial recruitment (Q2). See Supplementary note 2 for full details about model implementation.

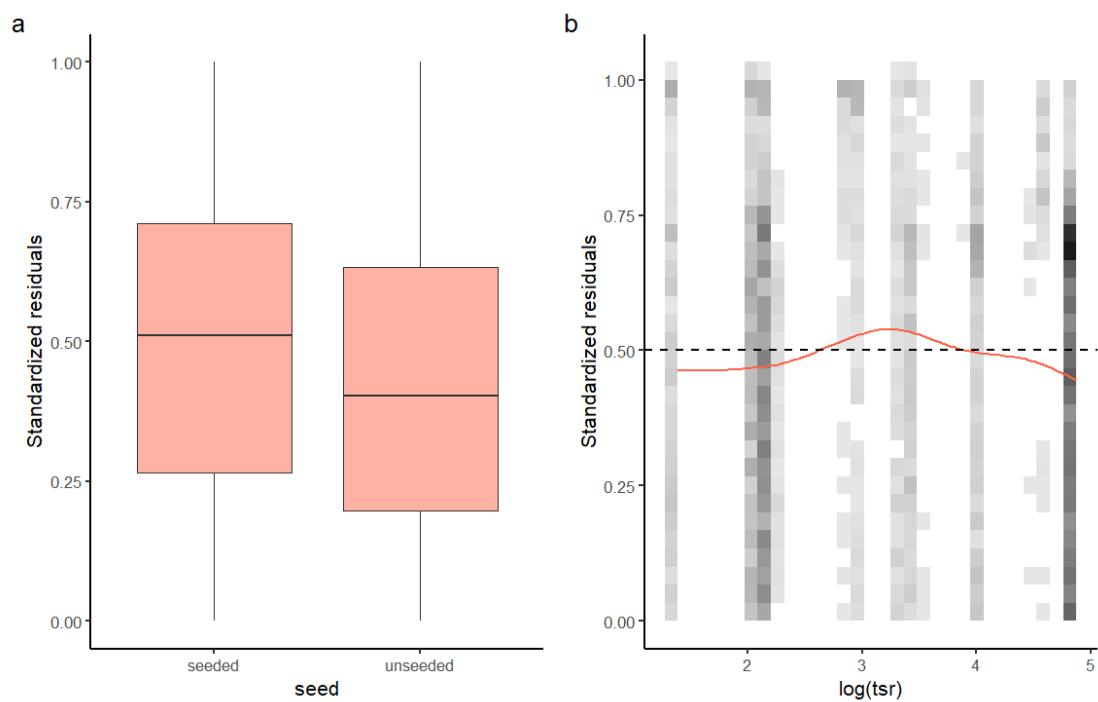


Supplementary Figure 7. Residuals uniformity of linear mixed-effects model evaluating initial recruitment (Q2). See Supplementary note 2 for full details about model implementation.



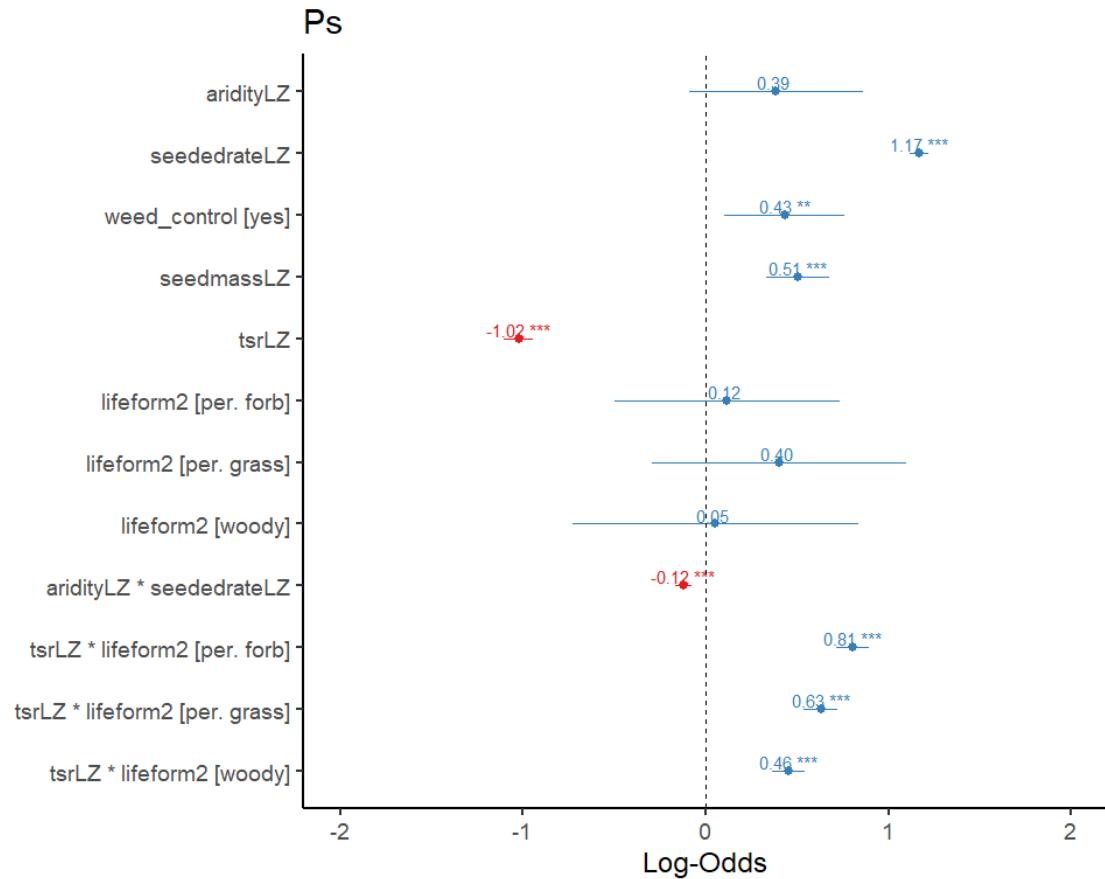
Supplementary Figure 8. Residuals dispersion and zero-inflation of linear mixed-effects model evaluating initial recruitment (Q2). See Supplementary note 2 for full details about model implementation.

Standardized residuals against predictors



Supplementary Figure 9. Standardized residuals against predictors of linear mixed-effects model evaluating initial recruitment (Q2). See Supplementary note 2 for full details about model implementation.

Q3 - Trends in vegetation development



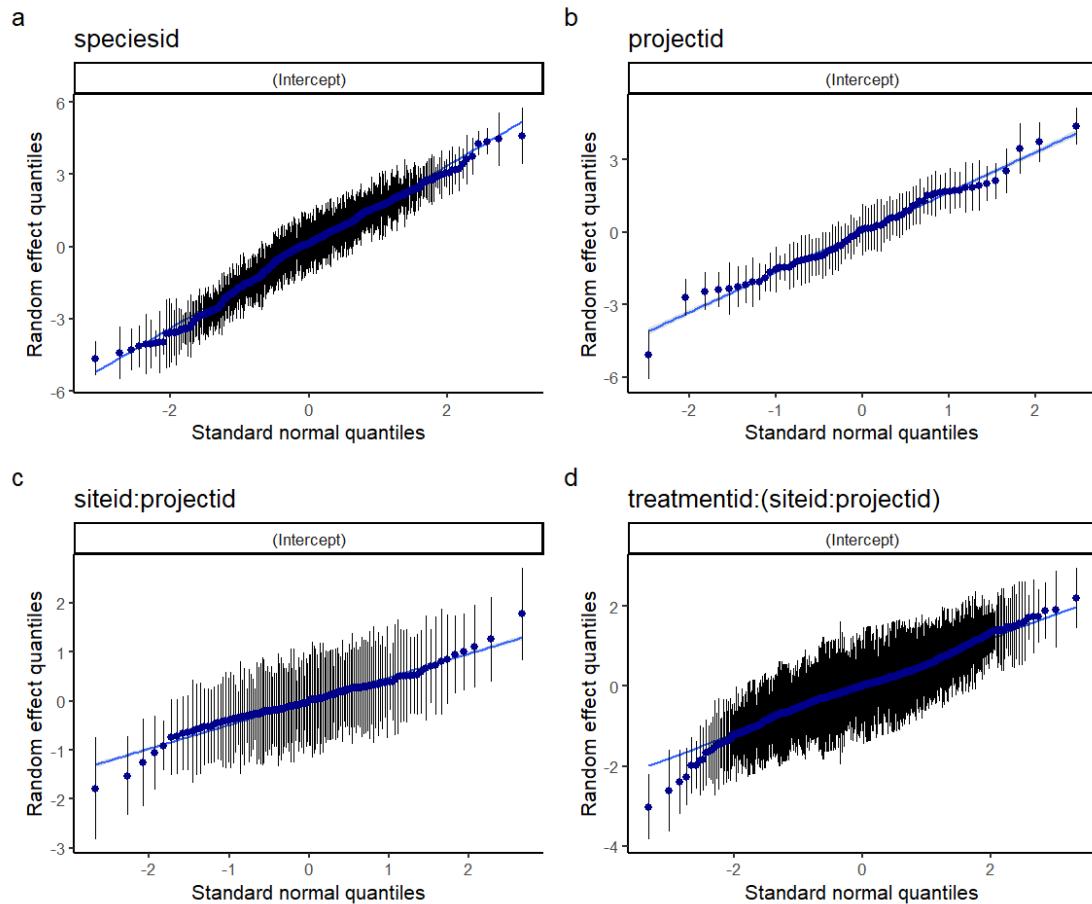
Supplementary Figure 10. Forest plot with model coefficients of linear mixed-effects model evaluating trends in vegetation development (Q3). See Supplementary note 2 for full details about model implementation.

Supplementary Table 5. Summary of linear mixed-effects model evaluating trends in vegetation development (Q3). See Supplementary note 2 for full details about model implementation.

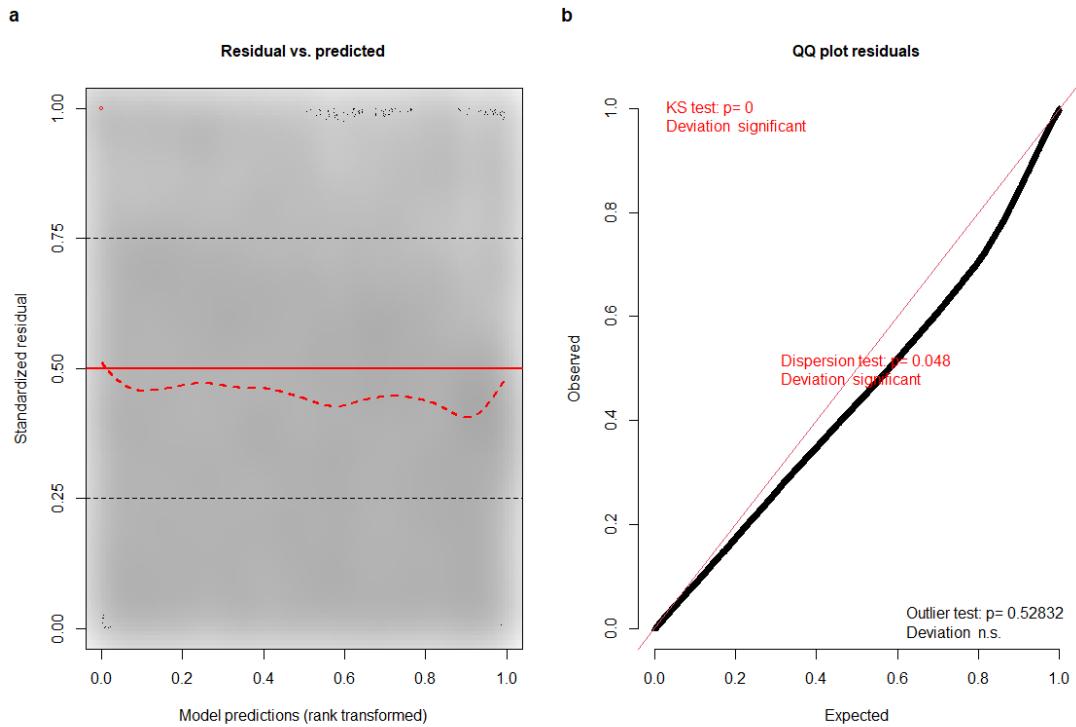
```

## Family: binomial ( logit )
## Formula:
## Ps ~ aridityLZ * seededrateLZ + weed_control + seedmassLZ + tsrLZ *
##      lifeform2 + (1 | projectid/siteid/treatmentid) + (1 | speciesid)
## Zero inflation: ~1
## Data: dc
## Weights: n
##
##      AIC      BIC   logLik deviance df.resid
## 79416.6 79567.2 -39690.3 79380.6     31797
##
## Random effects:
##
## Conditional model:
## Groups                  Name      Variance Std.Dev.
## treatmentid:(siteid:projectid) (Intercept) 0.5564  0.7459
## siteid:projectid           (Intercept) 0.6729  0.8203
## projectid                 (Intercept) 3.7597  1.9390
## speciesid                 (Intercept) 3.6625  1.9138
## Number of obs: 31815, groups:
## treatmentid:(siteid:projectid), 1178; siteid:projectid, 131; projectid,
## 73; speciesid, 488
##
## Conditional model:
##                               Estimate Std. Error z value Pr(>|z|)
## (Intercept)                -1.51778  0.38571  -3.94 8.32e-05 ***
## aridityLZ                   0.38595  0.24188   1.60  0.11058
## seededrateLZ                 1.17104  0.02648  44.22 < 2e-16 ***
## weed_controlyes              0.43299  0.16717   2.59  0.00959 **
## seedmassLZ                   0.50538  0.08766   5.77 8.14e-09 ***
## tsrLZ                      -1.02278  0.04126 -24.79 < 2e-16 ***
## lifeform2per. forb          0.11758  0.31405   0.37  0.70811
## lifeform2per. grass          0.40144  0.35500   1.13  0.25813
## lifeform2woody               0.05312  0.39876   0.13  0.89403
## aridityLZ:seededrateLZ      -0.11978  0.02269  -5.28 1.30e-07 ***
## tsrLZ:lifeform2per. forb     0.80578  0.04486  17.96 < 2e-16 ***
## tsrLZ:lifeform2per. grass    0.63097  0.04684  13.47 < 2e-16 ***
## tsrLZ:lifeform2woody        0.45521  0.04557   9.99 < 2e-16 ***
## ---
## Signif. codes: 0 '****' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Zero-inflation model:
##                               Estimate Std. Error z value Pr(>|z|)
## (Intercept) -1.07263  0.02341  -45.82 <2e-16 ***
## ---
## Signif. codes: 0 '****' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

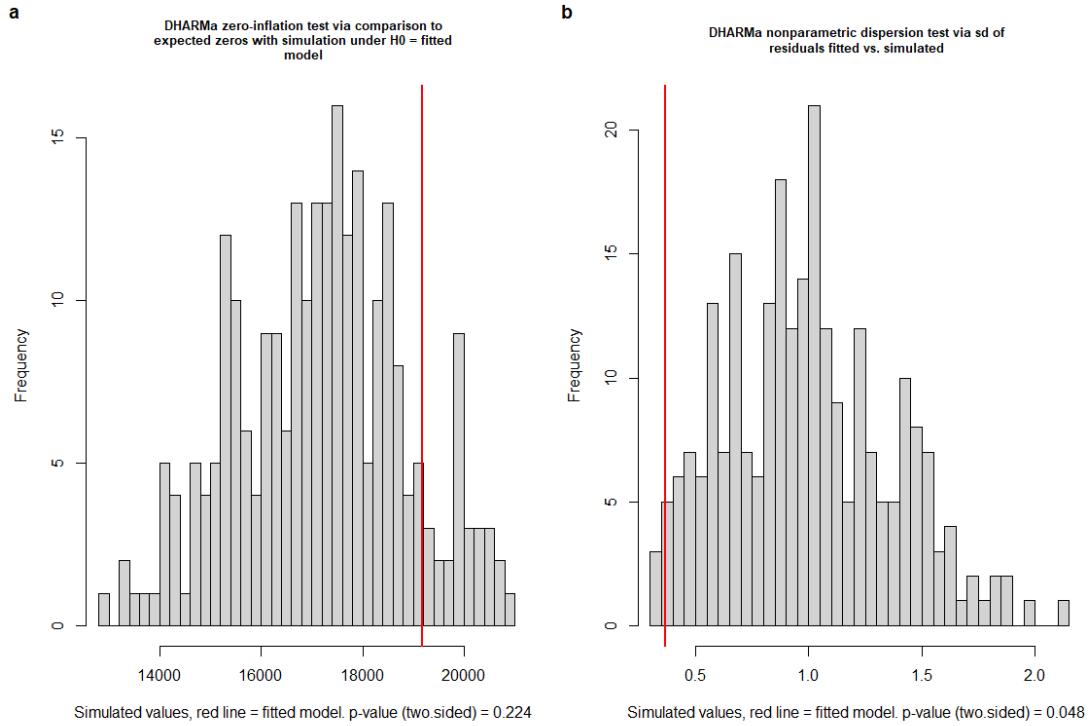
```

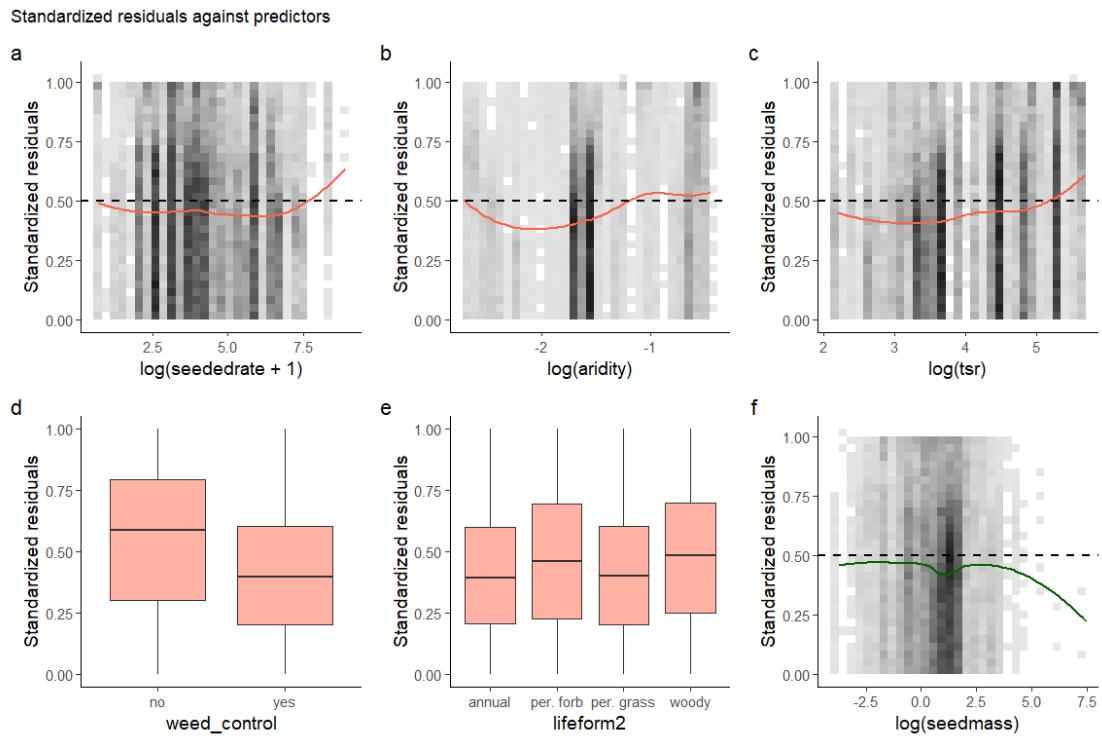
Supplementary Figure 11. QQ-plot for random effects of linear mixed-effects model evaluating trends in vegetation development (Q3). See Supplementary note 2 for full details about model implementation.



Supplementary Figure 12. Residuals uniformity of linear mixed-effects model evaluating trends in vegetation development (Q3). See Supplementary note 2 for full details about model implementation.

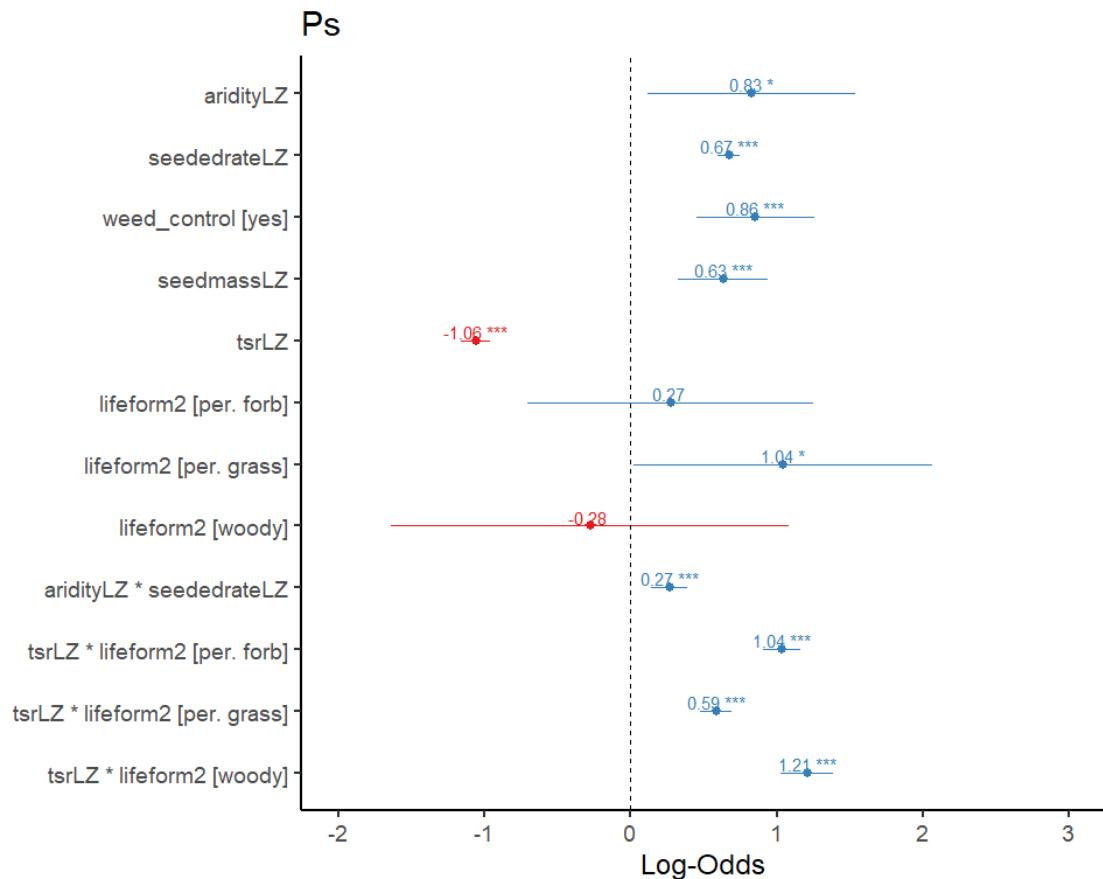


Supplementary Figure 13. Residuals dispersion and zero-inflation of linear mixed-effects model evaluating trends in vegetation development (Q3). See Supplementary note 2 for full details about model implementation.



Supplementary Figure 14. Standardized residuals against predictors of linear mixed-effects model evaluating trends in vegetation development (Q3). See Supplementary note 2 for full details about model implementation.

Q3 - Trends in vegetation development (North America)



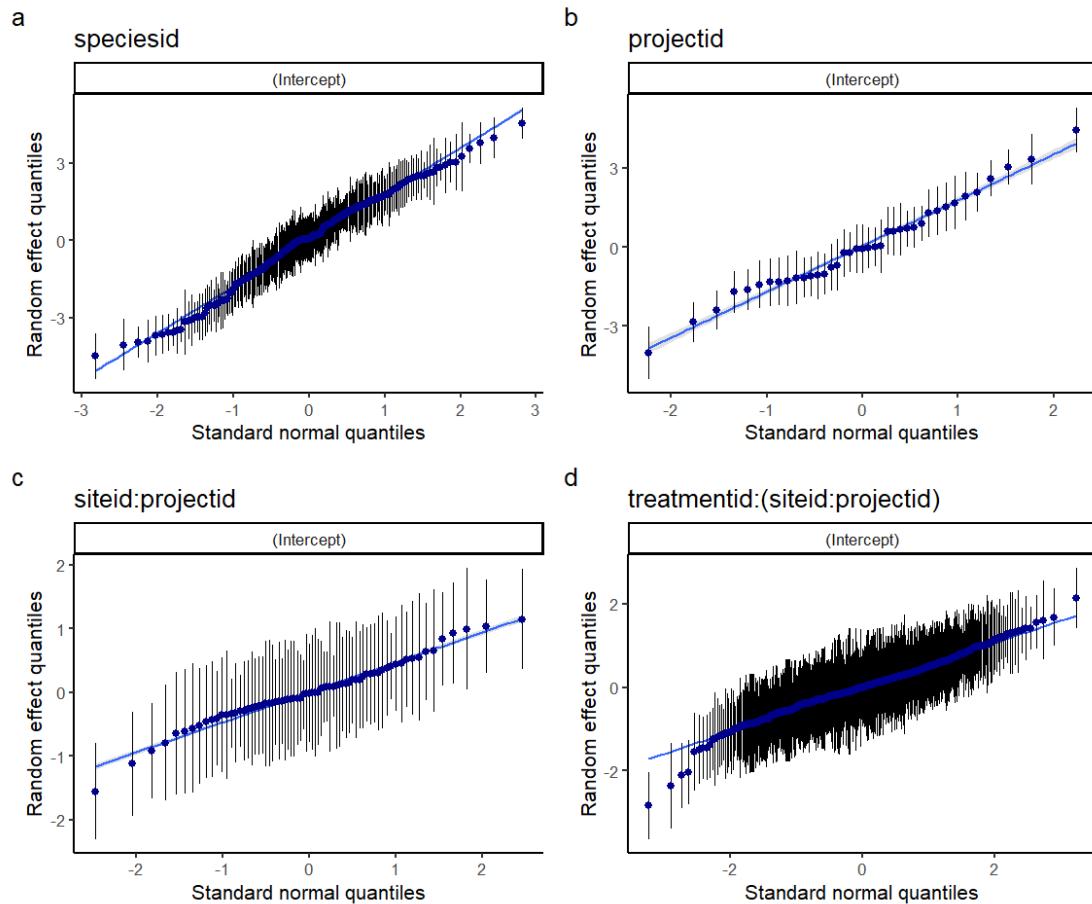
Supplementary Figure 15. Forest plot with model coefficients of linear mixed-effects model evaluating trends in vegetation development (Q3, North America only). See Supplementary note 2 for full details about model implementation.

Supplementary Table 6. Summary of linear mixed-effects model evaluating trends in vegetation development (Q3, North America only). See Supplementary note 2 for full details about model implementation.

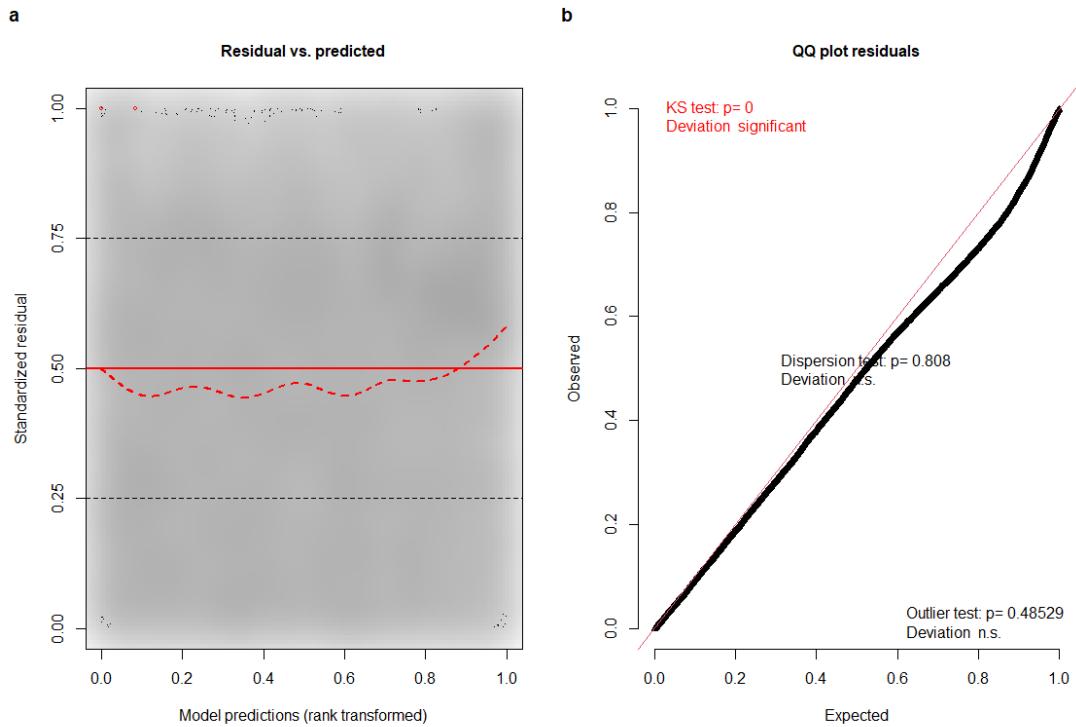
```

## Family: binomial ( logit )
## Formula:
## Ps ~ aridityLZ * seededrateLZ + weed_control + seedmassLZ + tsrLZ *
##      lifeform2 + (1 | projectid/siteid/treatmentid) + (1 | speciesid)
## Zero inflation: ~1
## Data: dc[dc$region == "North America", ]
## Weights: n
##
##      AIC      BIC  logLik deviance df.resid
## 39439.7 39582.9 -19701.8 39403.7     21047
##
## Random effects:
##
## Conditional model:
## Groups                  Name      Variance Std.Dev.
## treatmentid:(siteid:projectid) (Intercept) 0.4781   0.6915
## siteid:projectid           (Intercept) 0.5732   0.7571
## projectid                 (Intercept) 3.8678   1.9667
## speciesid                 (Intercept) 4.3604   2.0881
## Number of obs: 21065, groups:
## treatmentid:(siteid:projectid), 831; siteid:projectid, 73; projectid, 39;
## speciesid, 208
##
## Conditional model:
##                               Estimate Std. Error z value Pr(>|z|)
## (Intercept)                -2.81422  0.56560 -4.976 6.50e-07 ***
## aridityLZ                   0.83051  0.36217  2.293  0.0218 *
## seededrateLZ                 0.67311  0.03931 17.123 < 2e-16 ***
## weed_controlyes              0.85565  0.20576  4.158 3.20e-05 ***
## seedmassLZ                   0.63434  0.15697  4.041 5.32e-05 ***
## tsrLZ                      -1.05800  0.04949 -21.380 < 2e-16 ***
## lifeform2per. forb          0.27458  0.49848  0.551  0.5817
## lifeform2per. grass          1.04095  0.52085  1.999  0.0457 *
## lifeform2woody               -0.27696  0.69239 -0.400  0.6892
## aridityLZ:seededrateLZ       0.26774  0.06273  4.268 1.97e-05 ***
## tsrLZ:lifeform2per. forb     1.03623  0.06571 15.770 < 2e-16 ***
## tsrLZ:lifeform2per. grass    0.58624  0.05609 10.451 < 2e-16 ***
## tsrLZ:lifeform2woody        1.21021  0.09162 13.209 < 2e-16 ***
## ---
## Signif. codes:  0 '****' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Zero-inflation model:
##                               Estimate Std. Error z value Pr(>|z|)
## (Intercept) -0.55169    0.02833 -19.47   <2e-16 ***
## ---
## Signif. codes:  0 '****' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

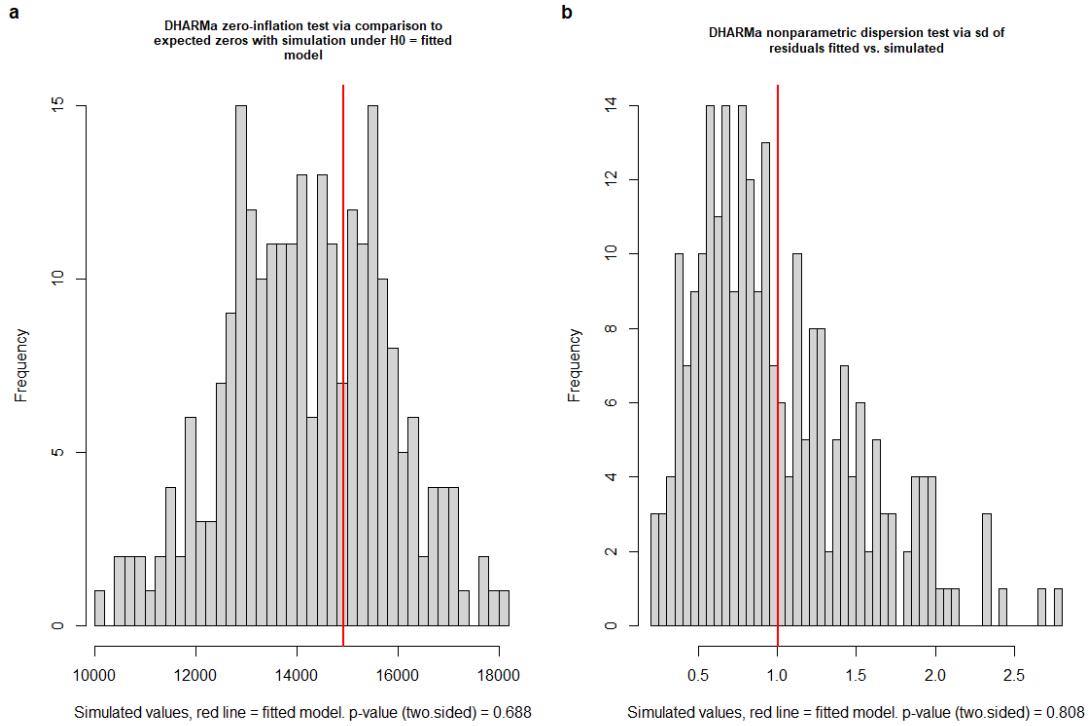
```

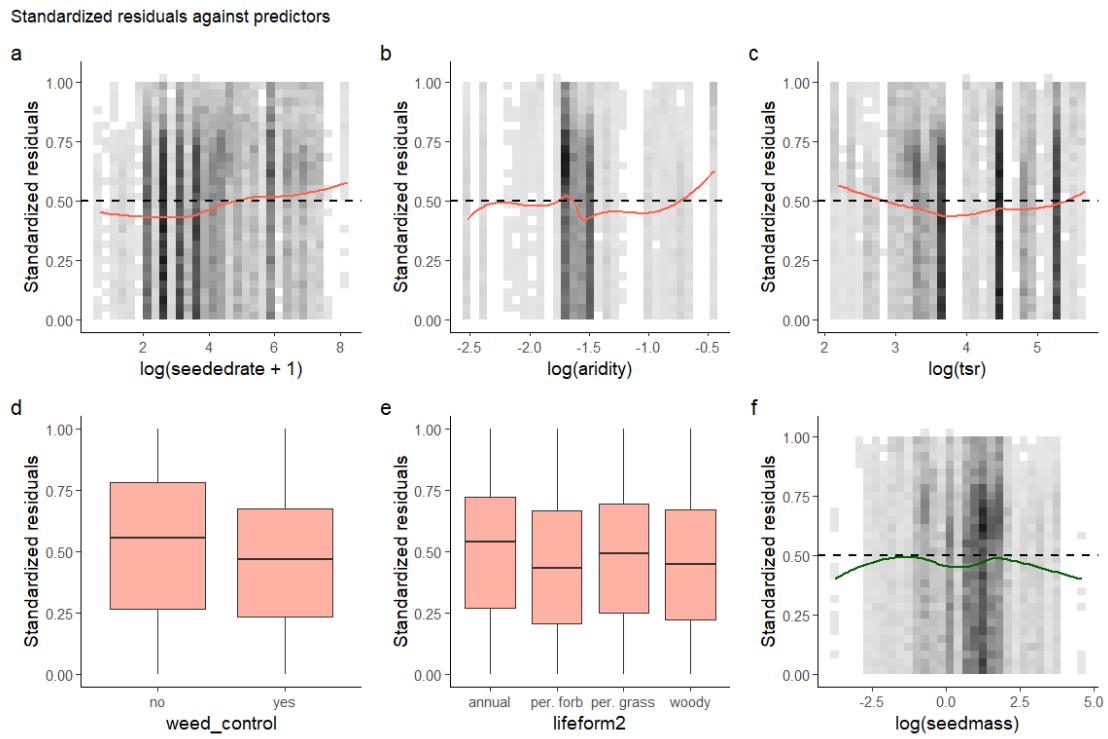
Supplementary Figure 16. QQ-plot for random effects of linear mixed-effects model evaluating trends in vegetation development (Q3, North America only). See Supplementary note 2 for full details about model implementation.



Supplementary Figure 17. Residuals uniformity of linear mixed-effects model evaluating trends in vegetation development (Q3, North America only). See Supplementary note 2 for full details about model implementation.



Supplementary Figure 18. Residuals dispersion and zero-inflation of linear mixed-effects model evaluating trends in vegetation development (Q3, North America only). See Supplementary note 2 for full details about model implementation.



Supplementary Figure 19. Standardized residuals against predictors of linear mixed-effects model evaluating trends in vegetation development (Q3, North America only). See Supplementary note 2 for full details about model implementation.

Exploratory trends

The following data displays are exploratory only. No statistical models have been fit, and these were not included in the formal analyses. Plots of species success were made by pooling all timepoints. Thus, they show the probability of finding a species in a sample unit at any monitoring time.

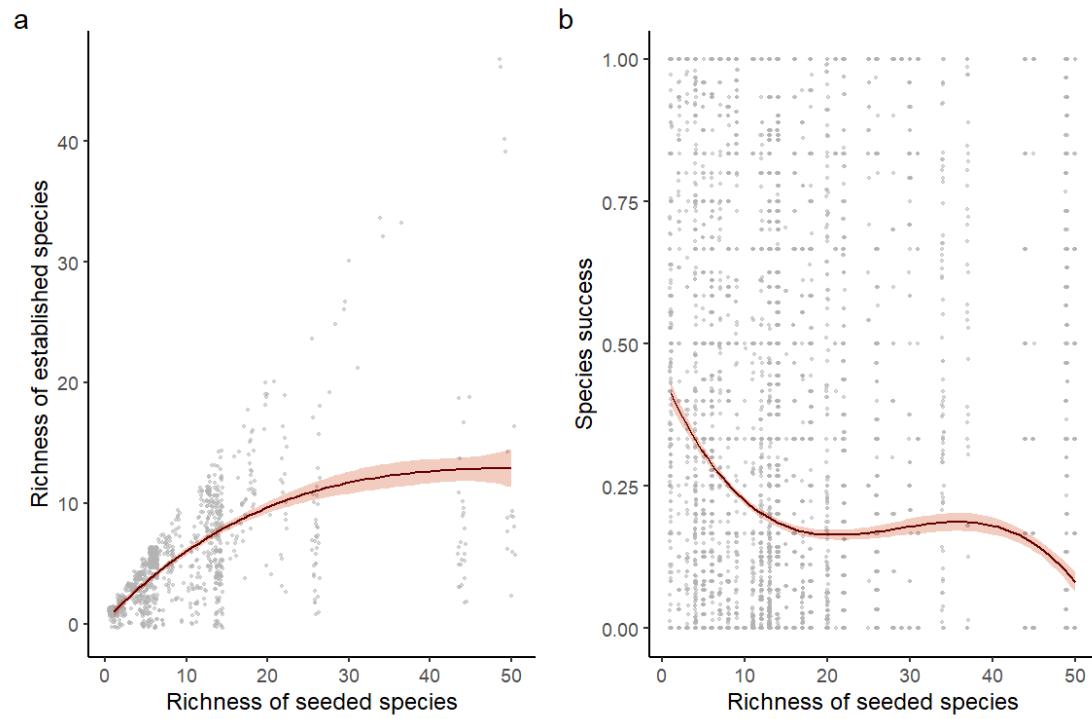
Taxonomic variation in species success

Supplementary Table 7. Average probability of presence (Success) for 30 species with the highest values across 405 angiosperm species. Species that occurred in less than 3 treatments are not shown. SE represents the standard error of the mean and N is the number of treatments the species occurred across the complete dataset. Species were arranged in descending order Success.

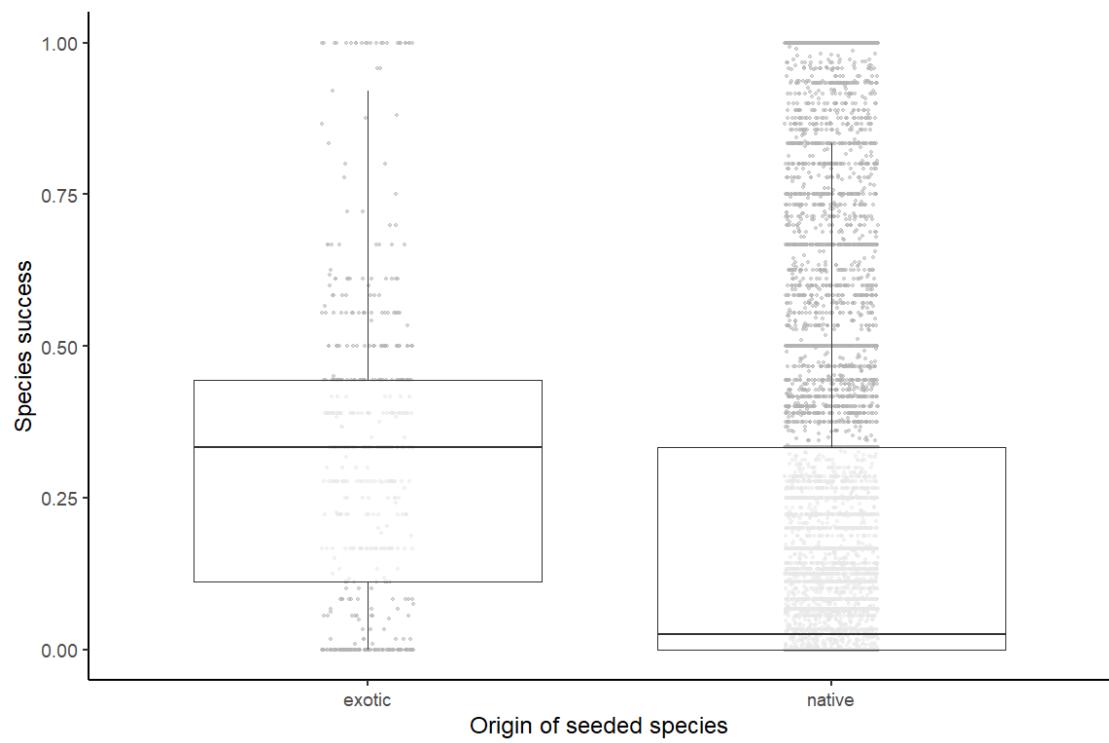
## # A tibble: 30 x 7	family	species	Projects	Treatments	N	Success
## # A tibble: 30 x 7	SE					
## <chr>	<dbl>	<chr>	<dbl>	<dbl>	<dbl>	<dbl>
## 1 Fabaceae	0	Acacia tetragonophylla	1	8	8	1
## 2 Poaceae	0	Bromus setifolius	1	6	6	1
## 3 Asteraceae	0	Centaurea jacea subsp. ~	1	3	18	1
## 4 Asteraceae	0	Centaurea stoebe	1	2	10	1
## 5 Lamiaceae	0	Leonurus cardiaca	1	1	6	1
## 6 Fabaceae	0.008	Senna glutinosa	1	8	8	0.992
## 7 Poaceae	0.008	Bromus inermis	2	4	12	0.989
## 8 Asteraceae	0.017	Leucanthemum ircutianum	1	2	12	0.983
## 9 Polygonaceae	0.011	Eriogonum fasciculatum	1	9	9	0.972
## 10 Fabaceae	0.012	Acacia paradoxa	1	4	24	0.972
## # ... with 20 more rows						

Supplementary Table 8. Average probability of presence (Success) for species with the lowest values across 405 angiosperm species.

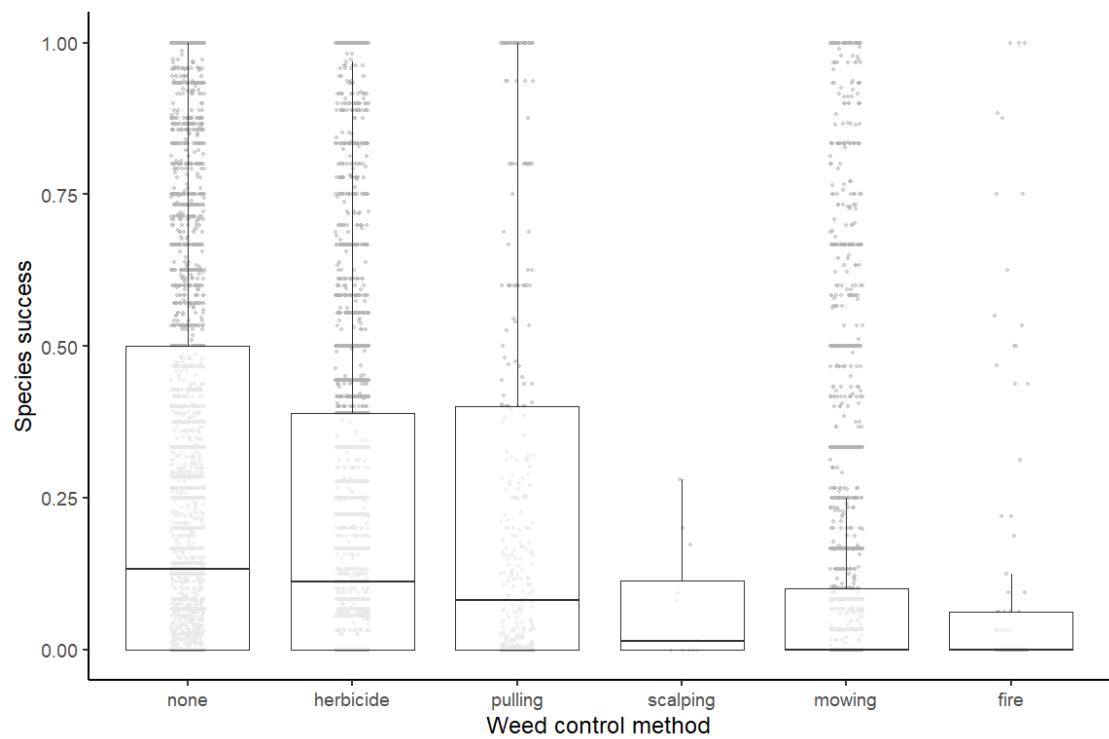
	family	species	Projects	Treatments	N	Success
SE	<chr>	<chr>	<dbl>	<dbl>	<dbl>	<dbl>
## # A tibble: 43 x 7						
## # ... with 33 more rows						
## 1 Fabaceae	Vicia americana	2	36	52	0	0
## 2 Polygonaceae	Rumex thyrsiflorus	2	3	16	0	0
## 3 Asteraceae	Machaeranthera tanaceti~	1	72	216	0	0
## 4 Grossularia~	Ribes cereum	1	72	216	0	0
## 5 Amaranthace~	Krascheninnikovia cerat~	1	36	108	0	0
## 6 Commelinace~	Tradescantia occidental~	1	36	108	0	0
## 7 Papaveraceae	Argemone polyanthemos	1	36	108	0	0
## 8 Poaceae	Sporobolus airoides	1	32	32	0	0
## 9 Asteraceae	Felicia filifolia subsp~	1	16	64	0	0
## 10 Aizoaceae	Ruschia rubricaulis	1	16	64	0	0



Supplementary Figure 20. Seeded species richness and species success. (a) Richness of established species against richness of seeded species and (b) species success (presence probability) against richness of seeded species.



Supplementary Figure 21. Species success (presence probability) against seeded species origin.



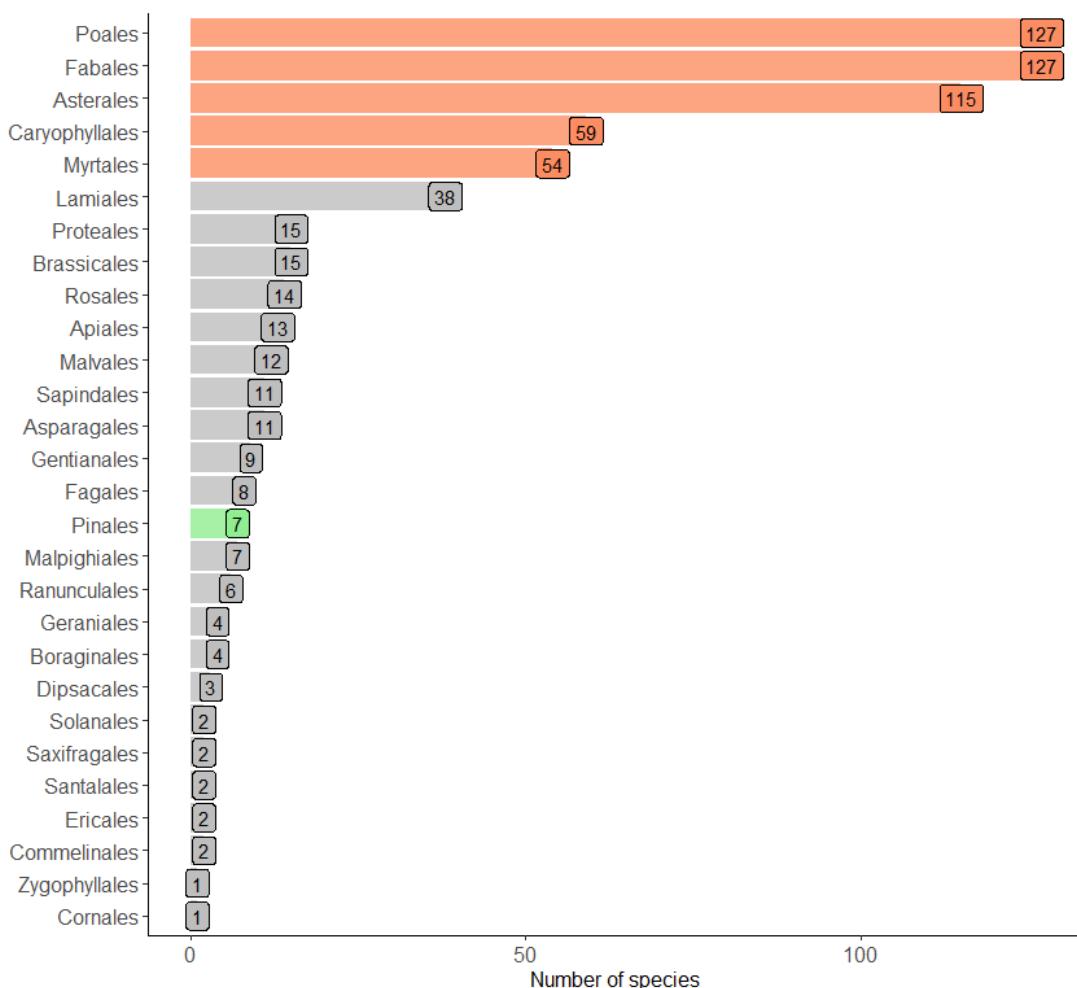
Supplementary Figure 22. Species success (presence probability) against weed control methods.

Supplementary note 4 - Taxonomic and phylogenetic coverage

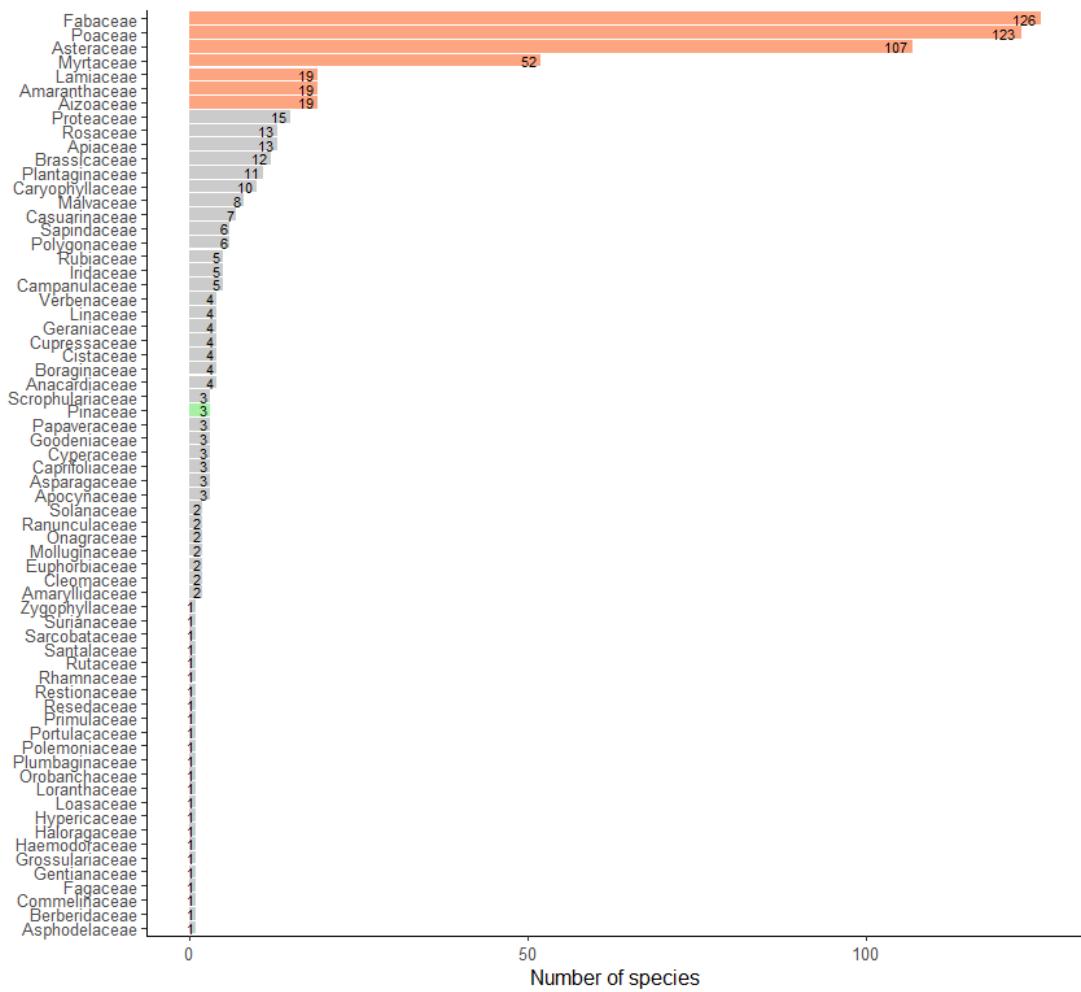
Taxonomic Coverage

In total, the GAZP dataset includes information for **671 seeded** species (from which 15 are varieties or subspecies), encompassing a wide range of land plant lineages (**28 Orders, 66 Families and 338 genus**), with **664 Angiosperms** species and **7 Gymnosperms** species (Pinaceae). The most represented orders were Fabales, Poales, Asterales, Caryophyllales and Myrtales, while the largest families in the data set were Fabaceae, Poaceae, Asteraceae.

Note: GAZP dataset also includes **community datasets** that are being processed. Therefore, the complete taxonomic and phylogenetic coverage of GAZP is much bigger than presented here - where only information about **seeded species** are shown.

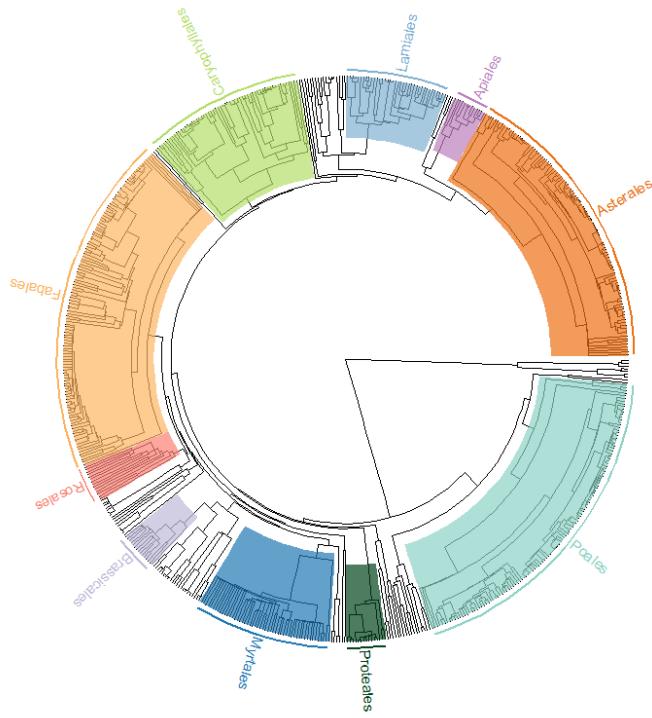


Supplementary Figure 23. Distribution of GAZP species across plant Orders.



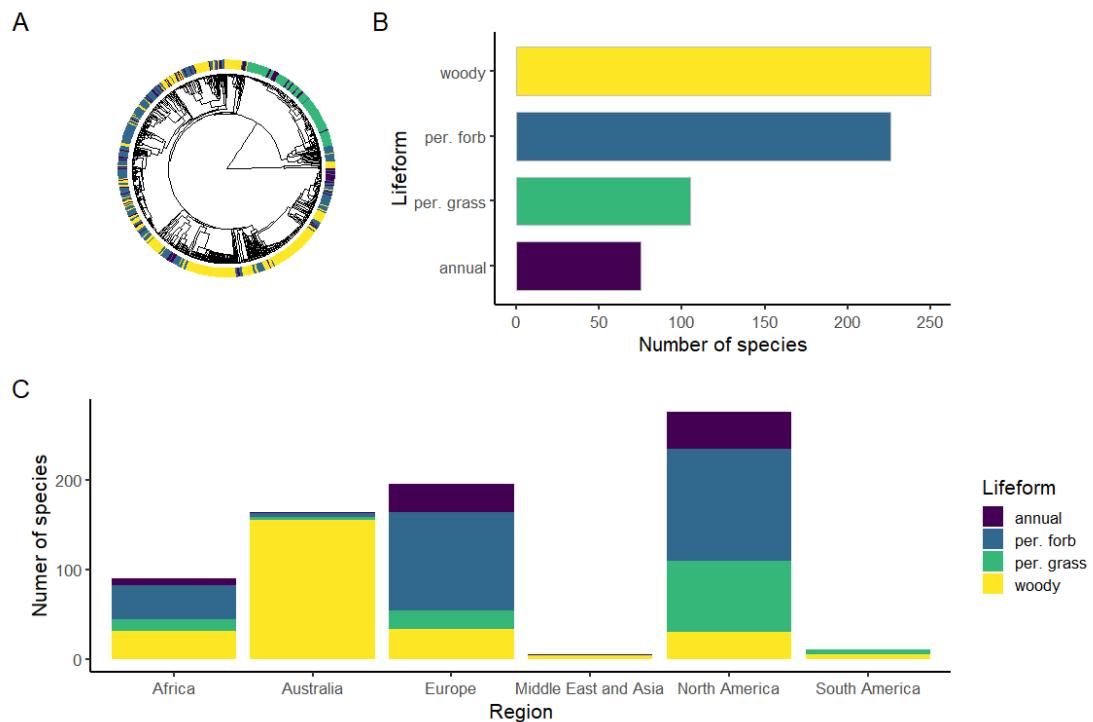
Supplementary Figure 24. Distribution of GAZP species across plant families.

Phylogenetic overview

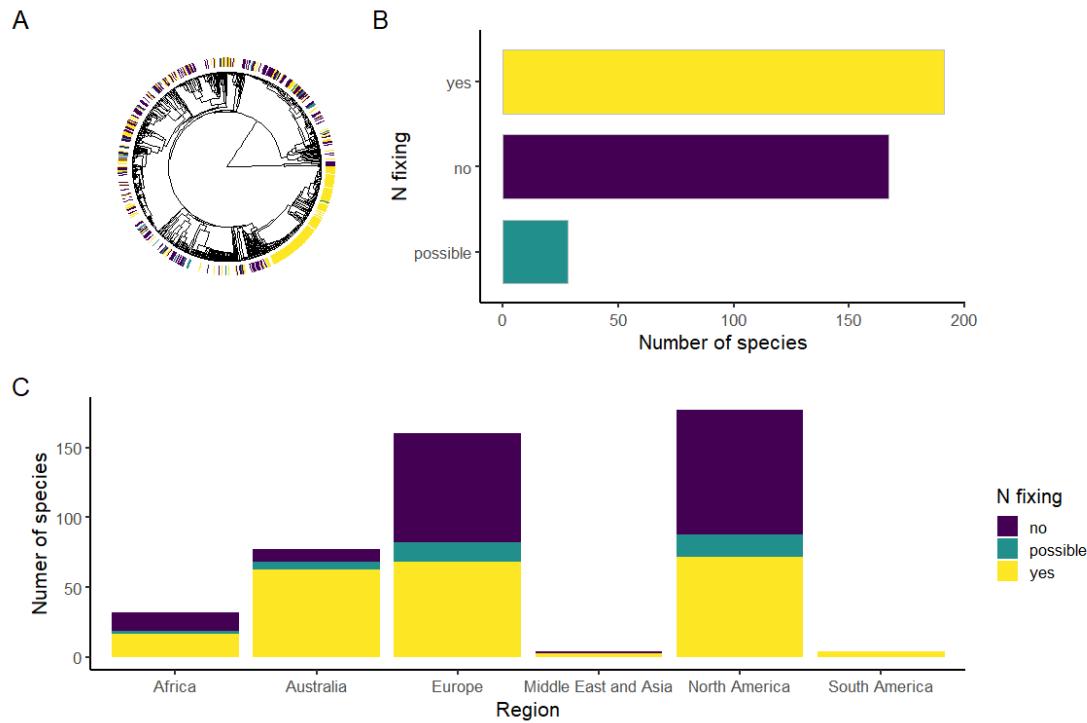


Supplementary Figure 25. Phylogeny for 656 GAZP plant species. The tree was pruned from the most comprehensive dated phylogeny for the angiosperms (Smith & Brown, 2018). Varieties and subspecies were dropped from the tree ($N = 15$). The most species rich orders are highlighted.

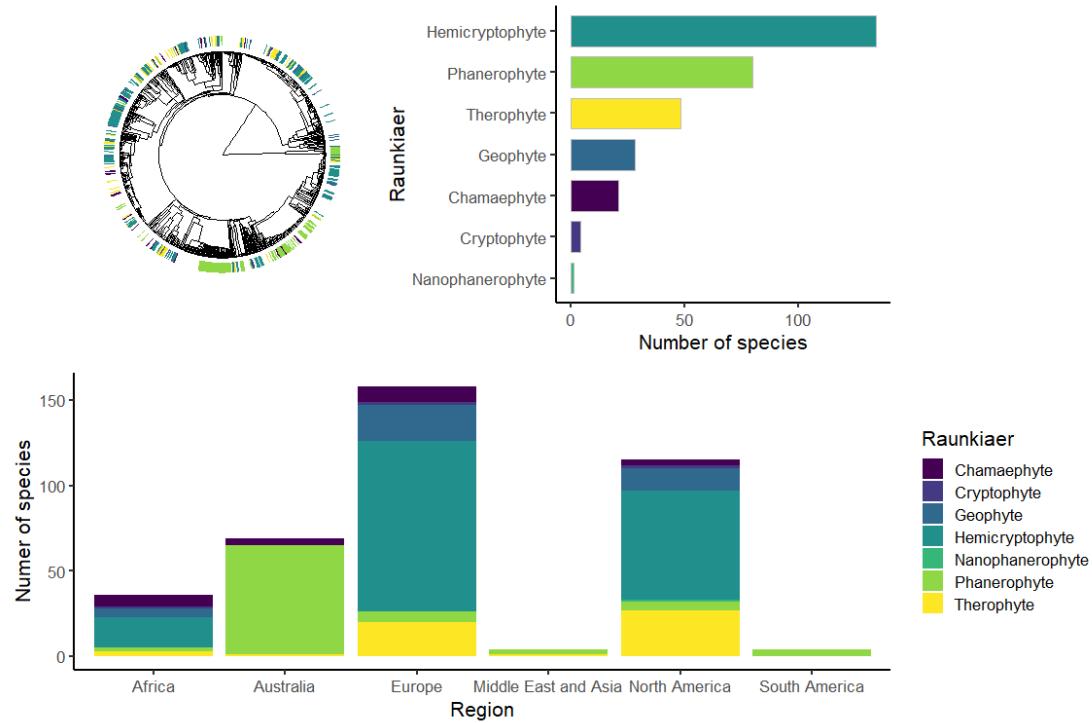
Species traits



Supplementary Figure 26. Life form for GAZP species mapped in the phylogeny (a), across species (b), and across regions (c).



Supplementary Figure 27. Nitrogen fixing for GAZP species mapped in the phylogeny (a), across species (b), and across regions (c).



Supplementary Figure 28. Raunkiaer category for GAZP species mapped in the phylogeny (a), across species (b), and across regions (c).

Species list

Supplementary Table 9. Complete list of GAZP species. The taxonomic higher level classification following The Plant List v1.1 nomenclature. Species names were checked with the R package Taxonstand (Cayuela et al. 2012) and taxonlookup (Pennell et al. 2016). Species with “NA” as epithet were only identified to the genus level by the source study

##	group	order	family	genus
## 1	Angiosperms	Apiales	Apiaceae	Anthriscus
## 2	Angiosperms	Apiales	Apiaceae	Arctopus
## 3	Angiosperms	Apiales	Apiaceae	Bupleurum
## 4	Angiosperms	Apiales	Apiaceae	Carum
## 5	Angiosperms	Apiales	Apiaceae	Daucus
## 6	Angiosperms	Apiales	Apiaceae	Eryngium
## 7	Angiosperms	Apiales	Apiaceae	Falcaria
## 8	Angiosperms	Apiales	Apiaceae	Heracleum
## 9	Angiosperms	Apiales	Apiaceae	Pastinaca
## 10	Angiosperms	Apiales	Apiaceae	Pimpinella
## 11	Angiosperms	Apiales	Apiaceae	Pimpinella
## 12	Angiosperms	Apiales	Apiaceae	Selinum
## 13	Angiosperms	Apiales	Apiaceae	Silaum
## 14	Angiosperms	Asparagales	Amaryllidaceae	Allium
## 15	Angiosperms	Asparagales	Amaryllidaceae	Allium
## 16	Angiosperms	Asparagales	Asparagaceae	Lachenalia
## 17	Angiosperms	Asparagales	Asparagaceae	Ornithogalum
## 18	Angiosperms	Asparagales	Asparagaceae	Yucca
## 19	Angiosperms	Asparagales	Asphodelaceae	Trachyandra
## 20	Angiosperms	Asparagales	Iridaceae	Babiana
## 21	Angiosperms	Asparagales	Iridaceae	Babiana
## 22	Angiosperms	Asparagales	Iridaceae	Moraea
## 23	Angiosperms	Asparagales	Iridaceae	Patersonia
## 24	Angiosperms	Asparagales	Iridaceae	Patersonia
## 25	Angiosperms	Asterales	Asteraceae	Achillea
## 26	Angiosperms	Asterales	Asteraceae	Achillea
## 27	Angiosperms	Asterales	Asteraceae	Achillea
## 28	Angiosperms	Asterales	Asteraceae	Anacyclus
## 29	Angiosperms	Asterales	Asteraceae	Arctotis
## 30	Angiosperms	Asterales	Asteraceae	Arnica
## 31	Angiosperms	Asterales	Asteraceae	Artemisia
## 32	Angiosperms	Asterales	Asteraceae	Artemisia
## 33	Angiosperms	Asterales	Asteraceae	Artemisia
## 34	Angiosperms	Asterales	Asteraceae	Artemisia
## 35	Angiosperms	Asterales	Asteraceae	Artemisia
## 36	Angiosperms	Asterales	Asteraceae	Artemisia
## 37	Angiosperms	Asterales	Asteraceae	Artemisia
## 38	Angiosperms	Asterales	Asteraceae	Aster
## 39	Angiosperms	Asterales	Asteraceae	Athanasia
## 40	Angiosperms	Asterales	Asteraceae	Baileya
## 41	Angiosperms	Asterales	Asteraceae	Balsamorhiza
## 42	Angiosperms	Asterales	Asteraceae	Boltonia

## 43	Angiosperms	Asterales	Asteraceae	Carlina
## 44	Angiosperms	Asterales	Asteraceae	Carthamus
## 45	Angiosperms	Asterales	Asteraceae	Centaurea
## 46	Angiosperms	Asterales	Asteraceae	Centaurea
## 47	Angiosperms	Asterales	Asteraceae	Centaurea
## 48	Angiosperms	Asterales	Asteraceae	Centaurea
## 49	Angiosperms	Asterales	Asteraceae	Centaurea
## 50	Angiosperms	Asterales	Asteraceae	Centaurea
## 51	Angiosperms	Asterales	Asteraceae	Centaurea
## 52	Angiosperms	Asterales	Asteraceae	Chrysocoma
## 53	Angiosperms	Asterales	Asteraceae	Cichorium
## 54	Angiosperms	Asterales	Asteraceae	Cirsium
## 55	Angiosperms	Asterales	Asteraceae	Cirsium
## 56	Angiosperms	Asterales	Asteraceae	Coreopsis
## 57	Angiosperms	Asterales	Asteraceae	Cota
## 58	Angiosperms	Asterales	Asteraceae	Cotula
## 59	Angiosperms	Asterales	Asteraceae	Crepis
## 60	Angiosperms	Asterales	Asteraceae	Crepis
## 61	Angiosperms	Asterales	Asteraceae	Cyanus
## 62	Angiosperms	Asterales	Asteraceae	Dicerothamnus
## 63	Angiosperms	Asterales	Asteraceae	Didelta
## 64	Angiosperms	Asterales	Asteraceae	Dimorphotheca
## 65	Angiosperms	Asterales	Asteraceae	Echinacea
## 66	Angiosperms	Asterales	Asteraceae	Encelia
## 67	Angiosperms	Asterales	Asteraceae	Ericameria
## 68	Angiosperms	Asterales	Asteraceae	Erigeron
## 69	Angiosperms	Asterales	Asteraceae	Eriocephalus
## 70	Angiosperms	Asterales	Asteraceae	Eriocephalus
## 71	Angiosperms	Asterales	Asteraceae	Felicia
## 72	Angiosperms	Asterales	Asteraceae	Gaillardia
## 73	Angiosperms	Asterales	Asteraceae	Grindelia
## 74	Angiosperms	Asterales	Asteraceae	Helianthus
## 75	Angiosperms	Asterales	Asteraceae	Helianthus
## 76	Angiosperms	Asterales	Asteraceae	Helianthus
## 77	Angiosperms	Asterales	Asteraceae	Helichrysum
## 78	Angiosperms	Asterales	Asteraceae	Helichrysum
## 79	Angiosperms	Asterales	Asteraceae	Helichrysum
## 80	Angiosperms	Asterales	Asteraceae	Helichrysum
## 81	Angiosperms	Asterales	Asteraceae	Helichrysum
## 82	Angiosperms	Asterales	Asteraceae	Helichrysum
## 83	Angiosperms	Asterales	Asteraceae	Heliomeris
## 84	Angiosperms	Asterales	Asteraceae	Hemizonia
## 85	Angiosperms	Asterales	Asteraceae	Heterotheca
## 86	Angiosperms	Asterales	Asteraceae	Hipicium
## 87	Angiosperms	Asterales	Asteraceae	Inula
## 88	Angiosperms	Asterales	Asteraceae	Lactuca
## 89	Angiosperms	Asterales	Asteraceae	Leontodon
## 90	Angiosperms	Asterales	Asteraceae	Leucanthemum
## 91	Angiosperms	Asterales	Asteraceae	Leucanthemum
## 92	Angiosperms	Asterales	Asteraceae	Leysera

## 93	Angiosperms	Asterales	Asteraceae	Liatris
## 94	Angiosperms	Asterales	Asteraceae	Liatris
## 95	Angiosperms	Asterales	Asteraceae	Machaeranthera
## 96	Angiosperms	Asterales	Asteraceae	Machaeranthera
## 97	Angiosperms	Asterales	Asteraceae	Osteospermum
## 98	Angiosperms	Asterales	Asteraceae	Othonna
## 99	Angiosperms	Asterales	Asteraceae	Othonna
## 100	Angiosperms	Asterales	Asteraceae	Pentzia
## 101	Angiosperms	Asterales	Asteraceae	Podospermum
## 102	Angiosperms	Asterales	Asteraceae	Pteronia
## 103	Angiosperms	Asterales	Asteraceae	Pteronia
## 104	Angiosperms	Asterales	Asteraceae	Pteronia
## 105	Angiosperms	Asterales	Asteraceae	Pteronia
## 106	Angiosperms	Asterales	Asteraceae	Pteronia
## 107	Angiosperms	Asterales	Asteraceae	Pteronia
## 108	Angiosperms	Asterales	Asteraceae	Pteronia
## 109	Angiosperms	Asterales	Asteraceae	Pteronia
## 110	Angiosperms	Asterales	Asteraceae	Ratibida
## 111	Angiosperms	Asterales	Asteraceae	Ratibida
## 112	Angiosperms	Asterales	Asteraceae	Rudbeckia
## 113	Angiosperms	Asterales	Asteraceae	Silphium
## 114	Angiosperms	Asterales	Asteraceae	Solidago
## 115	Angiosperms	Asterales	Asteraceae	Tanacetum
## 116	Angiosperms	Asterales	Asteraceae	Taraxacum
## 117	Angiosperms	Asterales	Asteraceae	Thelesperma
## 118	Angiosperms	Asterales	Asteraceae	Tragopogon
## 119	Angiosperms	Asterales	Asteraceae	Tragopogon
## 120	Angiosperms	Asterales	Asteraceae	Tripolium
## 121	Angiosperms	Asterales	Asteraceae	Tripteris
## 122	Angiosperms	Asterales	Asteraceae	Tripteris
## 123	Angiosperms	Asterales	Asteraceae	Ursinia
## 124	Angiosperms	Asterales	Asteraceae	Verbesina
## 125	Angiosperms	Asterales	Asteraceae	Waitzia
## 126	Angiosperms	Asterales	Campanulaceae	Campanula
## 127	Angiosperms	Asterales	Campanulaceae	Campanula
## 128	Angiosperms	Asterales	Campanulaceae	Campanula
## 129	Angiosperms	Asterales	Campanulaceae	Campanula
## 130	Angiosperms	Asterales	Campanulaceae	Jasione
## 131	Angiosperms	Asterales	Goodeniaceae	Coopernookia
## 132	Angiosperms	Asterales	Goodeniaceae	Goodenia
## 133	Angiosperms	Asterales	Goodeniaceae	Goodenia
## 134	Angiosperms	Boraginales	Boraginaceae	Anchusa
## 135	Angiosperms	Boraginales	Boraginaceae	Cynoglossum
## 136	Angiosperms	Boraginales	Boraginaceae	Echium
## 137	Angiosperms	Boraginales	Boraginaceae	Phacelia
## 138	Angiosperms	Brassicales	Brassicaceae	Brassica
## 139	Angiosperms	Brassicales	Brassicaceae	Bunias
## 140	Angiosperms	Brassicales	Brassicaceae	Cardamine
## 141	Angiosperms	Brassicales	Brassicaceae	Descurainia
## 142	Angiosperms	Brassicales	Brassicaceae	Descurainia

## 143	Angiosperms	Brassicales	Brassicaceae	Diplotaxis
## 144	Angiosperms	Brassicales	Brassicaceae	Erysimum
## 145	Angiosperms	Brassicales	Brassicaceae	Lepidium
## 146	Angiosperms	Brassicales	Brassicaceae	Lepidium
## 147	Angiosperms	Brassicales	Brassicaceae	Rapistrum
## 148	Angiosperms	Brassicales	Brassicaceae	Sinapis
## 149	Angiosperms	Brassicales	Brassicaceae	Thlaspi
## 150	Angiosperms	Brassicales	Cleomaceae	Cleome
## 151	Angiosperms	Brassicales	Cleomaceae	Cleome
## 152	Angiosperms	Brassicales	Resedaceae	Reseda
## 153	Angiosperms	Caryophyllales	Aizoaceae	Aizoon
## 154	Angiosperms	Caryophyllales	Aizoaceae	Amphibolia
## 155	Angiosperms	Caryophyllales	Aizoaceae	Cephalophyllum
## 156	Angiosperms	Caryophyllales	Aizoaceae	Cheiridopsis
## 157	Angiosperms	Caryophyllales	Aizoaceae	Conicosia
## 158	Angiosperms	Caryophyllales	Aizoaceae	Drosanthemum
## 159	Angiosperms	Caryophyllales	Aizoaceae	Erepsia
## 160	Angiosperms	Caryophyllales	Aizoaceae	Galenia
## 161	Angiosperms	Caryophyllales	Aizoaceae	Jordaaniella
## 162	Angiosperms	Caryophyllales	Aizoaceae	Lampranthus
## 163	Angiosperms	Caryophyllales	Aizoaceae	Leipoldtia
## 164	Angiosperms	Caryophyllales	Aizoaceae	Psilocaulon
## 165	Angiosperms	Caryophyllales	Aizoaceae	Ruschia
## 166	Angiosperms	Caryophyllales	Aizoaceae	Ruschia
## 167	Angiosperms	Caryophyllales	Aizoaceae	Ruschia
## 168	Angiosperms	Caryophyllales	Aizoaceae	Ruschia
## 169	Angiosperms	Caryophyllales	Aizoaceae	Stoeberia
## 170	Angiosperms	Caryophyllales	Aizoaceae	Tetragonia
## 171	Angiosperms	Caryophyllales	Aizoaceae	Tetragonia
## 172	Angiosperms	Caryophyllales	Amaranthaceae	Agriophyllum
## 173	Angiosperms	Caryophyllales	Amaranthaceae	Amaranthus
## 174	Angiosperms	Caryophyllales	Amaranthaceae	Atriplex
## 175	Angiosperms	Caryophyllales	Amaranthaceae	Atriplex
## 176	Angiosperms	Caryophyllales	Amaranthaceae	Atriplex
## 177	Angiosperms	Caryophyllales	Amaranthaceae	Atriplex
## 178	Angiosperms	Caryophyllales	Amaranthaceae	Atriplex
## 179	Angiosperms	Caryophyllales	Amaranthaceae	Atriplex
## 180	Angiosperms	Caryophyllales	Amaranthaceae	Atriplex
## 181	Angiosperms	Caryophyllales	Amaranthaceae	Atriplex
## 182	Angiosperms	Caryophyllales	Amaranthaceae	Atriplex
## 183	Angiosperms	Caryophyllales	Amaranthaceae	Bassia
## 184	Angiosperms	Caryophyllales	Amaranthaceae	Chenopodium
## 185	Angiosperms	Caryophyllales	Amaranthaceae	Grayia
## 186	Angiosperms	Caryophyllales	Amaranthaceae	Krascheninnikovia
## 187	Angiosperms	Caryophyllales	Amaranthaceae	Maireana
## 188	Angiosperms	Caryophyllales	Amaranthaceae	Maireana
## 189	Angiosperms	Caryophyllales	Amaranthaceae	Maireana
## 190	Angiosperms	Caryophyllales	Amaranthaceae	Manochlamys
## 191	Angiosperms	Caryophyllales	Caryophyllaceae	Arenaria
## 192	Angiosperms	Caryophyllales	Caryophyllaceae	Dianthus

## 193	Angiosperms	Caryophyllales	Caryophyllaceae	Dianthus
## 194	Angiosperms	Caryophyllales	Caryophyllaceae	Dianthus
## 195	Angiosperms	Caryophyllales	Caryophyllaceae	Saponaria
## 196	Angiosperms	Caryophyllales	Caryophyllaceae	Silene
## 197	Angiosperms	Caryophyllales	Caryophyllaceae	Silene
## 198	Angiosperms	Caryophyllales	Caryophyllaceae	Silene
## 199	Angiosperms	Caryophyllales	Caryophyllaceae	Silene
## 200	Angiosperms	Caryophyllales	Caryophyllaceae	Stellaria
## 201	Angiosperms	Caryophyllales	Molluginaceae	Hypertelis
## 202	Angiosperms	Caryophyllales	Molluginaceae	Pharnaceum
## 203	Angiosperms	Caryophyllales	Plumbaginaceae	Armeria
## 204	Angiosperms	Caryophyllales	Polygonaceae	Eriogonum
## 205	Angiosperms	Caryophyllales	Polygonaceae	Eriogonum
## 206	Angiosperms	Caryophyllales	Polygonaceae	Fagopyrum
## 207	Angiosperms	Caryophyllales	Polygonaceae	Persicaria
## 208	Angiosperms	Caryophyllales	Polygonaceae	Rumex
## 209	Angiosperms	Caryophyllales	Polygonaceae	Rumex
## 210	Angiosperms	Caryophyllales	Portulacaceae	Calandrinia
## 211	Angiosperms	Caryophyllales	Sarcobataceae	Sarcobatus
## 212	Angiosperms	Commelinaceae	Commelinaceae	Tradescantia
## 213	Angiosperms	Commelinaceae	Haemodoraceae	Wachendorfia
## 214	Angiosperms	Cornales	Loasaceae	Mentzelia
## 215	Angiosperms	Dipsacales	Caprifoliaceae	Knautia
## 216	Angiosperms	Dipsacales	Caprifoliaceae	Scabiosa
## 217	Angiosperms	Dipsacales	Caprifoliaceae	Syphoricarpos
## 218	Angiosperms	Ericales	Polemoniaceae	Collomia
## 219	Angiosperms	Ericales	Primulaceae	Myrsine
## 220	Angiosperms	Fabales	Fabaceae	Acacia
## 221	Angiosperms	Fabales	Fabaceae	Acacia
## 222	Angiosperms	Fabales	Fabaceae	Acacia
## 223	Angiosperms	Fabales	Fabaceae	Acacia
## 224	Angiosperms	Fabales	Fabaceae	Acacia
## 225	Angiosperms	Fabales	Fabaceae	Acacia
## 226	Angiosperms	Fabales	Fabaceae	Acacia
## 227	Angiosperms	Fabales	Fabaceae	Acacia
## 228	Angiosperms	Fabales	Fabaceae	Acacia
## 229	Angiosperms	Fabales	Fabaceae	Acacia
## 230	Angiosperms	Fabales	Fabaceae	Acacia
## 231	Angiosperms	Fabales	Fabaceae	Acacia
## 232	Angiosperms	Fabales	Fabaceae	Acacia
## 233	Angiosperms	Fabales	Fabaceae	Acacia
## 234	Angiosperms	Fabales	Fabaceae	Acacia
## 235	Angiosperms	Fabales	Fabaceae	Acacia
## 236	Angiosperms	Fabales	Fabaceae	Acacia
## 237	Angiosperms	Fabales	Fabaceae	Acacia
## 238	Angiosperms	Fabales	Fabaceae	Acacia
## 239	Angiosperms	Fabales	Fabaceae	Acacia
## 240	Angiosperms	Fabales	Fabaceae	Acacia
## 241	Angiosperms	Fabales	Fabaceae	Acacia
## 242	Angiosperms	Fabales	Fabaceae	Acacia

## 243 Angiosperms	Fabales	Fabaceae	Acacia
## 244 Angiosperms	Fabales	Fabaceae	Acacia
## 245 Angiosperms	Fabales	Fabaceae	Acacia
## 246 Angiosperms	Fabales	Fabaceae	Acacia
## 247 Angiosperms	Fabales	Fabaceae	Acacia
## 248 Angiosperms	Fabales	Fabaceae	Acacia
## 249 Angiosperms	Fabales	Fabaceae	Acacia
## 250 Angiosperms	Fabales	Fabaceae	Acacia
## 251 Angiosperms	Fabales	Fabaceae	Acacia
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## 253 Angiosperms	Fabales	Fabaceae	Acacia
## 254 Angiosperms	Fabales	Fabaceae	Acacia
## 255 Angiosperms	Fabales	Fabaceae	Acacia
## 256 Angiosperms	Fabales	Fabaceae	Acacia
## 257 Angiosperms	Fabales	Fabaceae	Acacia
## 258 Angiosperms	Fabales	Fabaceae	Acacia
## 259 Angiosperms	Fabales	Fabaceae	Acacia
## 260 Angiosperms	Fabales	Fabaceae	Acacia
## 261 Angiosperms	Fabales	Fabaceae	Acacia
## 262 Angiosperms	Fabales	Fabaceae	Acacia
## 263 Angiosperms	Fabales	Fabaceae	Acacia
## 264 Angiosperms	Fabales	Fabaceae	Acacia
## 265 Angiosperms	Fabales	Fabaceae	Acacia
## 266 Angiosperms	Fabales	Fabaceae	Acacia
## 267 Angiosperms	Fabales	Fabaceae	Acacia
## 268 Angiosperms	Fabales	Fabaceae	Amburana
## 269 Angiosperms	Fabales	Fabaceae	Anthyllis
## 270 Angiosperms	Fabales	Fabaceae	Anthyllis
## 271 Angiosperms	Fabales	Fabaceae	Astragalus
## 272 Angiosperms	Fabales	Fabaceae	Astragalus
## 273 Angiosperms	Fabales	Fabaceae	Astragalus
## 274 Angiosperms	Fabales	Fabaceae	Astragalus
## 275 Angiosperms	Fabales	Fabaceae	Astragalus
## 276 Angiosperms	Fabales	Fabaceae	Chamaecrista
## 277 Angiosperms	Fabales	Fabaceae	Chorizema
## 278 Angiosperms	Fabales	Fabaceae	Dalea
## 279 Angiosperms	Fabales	Fabaceae	Dalea
## 280 Angiosperms	Fabales	Fabaceae	Daviesia
## 281 Angiosperms	Fabales	Fabaceae	Daviesia
## 282 Angiosperms	Fabales	Fabaceae	Daviesia
## 283 Angiosperms	Fabales	Fabaceae	Desmanthus
## 284 Angiosperms	Fabales	Fabaceae	Erythrina
## 285 Angiosperms	Fabales	Fabaceae	Gastrolobium
## 286 Angiosperms	Fabales	Fabaceae	Gastrolobium
## 287 Angiosperms	Fabales	Fabaceae	Gastrolobium
## 288 Angiosperms	Fabales	Fabaceae	Gompholobium
## 289 Angiosperms	Fabales	Fabaceae	Goodia
## 290 Angiosperms	Fabales	Fabaceae	Hedysarum
## 291 Angiosperms	Fabales	Fabaceae	Indigofera
## 292 Angiosperms	Fabales	Fabaceae	Indigofera

## 293 Angiosperms	Fabales	Fabaceae	Jacksonia
## 294 Angiosperms	Fabales	Fabaceae	Kennedia
## 295 Angiosperms	Fabales	Fabaceae	Lathyrus
## 296 Angiosperms	Fabales	Fabaceae	Lathyrus
## 297 Angiosperms	Fabales	Fabaceae	Lathyrus
## 298 Angiosperms	Fabales	Fabaceae	Lebeckia
## 299 Angiosperms	Fabales	Fabaceae	Lotus
## 300 Angiosperms	Fabales	Fabaceae	Lotus
## 301 Angiosperms	Fabales	Fabaceae	Lupinus
## 302 Angiosperms	Fabales	Fabaceae	Lupinus
## 303 Angiosperms	Fabales	Fabaceae	Lupinus
## 304 Angiosperms	Fabales	Fabaceae	Lupinus
## 305 Angiosperms	Fabales	Fabaceae	Lupinus
## 306 Angiosperms	Fabales	Fabaceae	Medicago
## 307 Angiosperms	Fabales	Fabaceae	Medicago
## 308 Angiosperms	Fabales	Fabaceae	Medicago
## 309 Angiosperms	Fabales	Fabaceae	Medicago
## 310 Angiosperms	Fabales	Fabaceae	Melilotus
## 311 Angiosperms	Fabales	Fabaceae	Melilotus
## 312 Angiosperms	Fabales	Fabaceae	Onobrychis
## 313 Angiosperms	Fabales	Fabaceae	Onobrychis
## 314 Angiosperms	Fabales	Fabaceae	Ononis
## 315 Angiosperms	Fabales	Fabaceae	Ononis
## 316 Angiosperms	Fabales	Fabaceae	Oxytropis
## 317 Angiosperms	Fabales	Fabaceae	Podalyria
## 318 Angiosperms	Fabales	Fabaceae	Poincianella
## 319 Angiosperms	Fabales	Fabaceae	Psoralea
## 320 Angiosperms	Fabales	Fabaceae	Retama
## 321 Angiosperms	Fabales	Fabaceae	Securigera
## 322 Angiosperms	Fabales	Fabaceae	Senna
## 323 Angiosperms	Fabales	Fabaceae	Senna
## 324 Angiosperms	Fabales	Fabaceae	Templetonia
## 325 Angiosperms	Fabales	Fabaceae	Templetonia
## 326 Angiosperms	Fabales	Fabaceae	Thermopsis
## 327 Angiosperms	Fabales	Fabaceae	Trifolium
## 328 Angiosperms	Fabales	Fabaceae	Trifolium
## 329 Angiosperms	Fabales	Fabaceae	Trifolium
## 330 Angiosperms	Fabales	Fabaceae	Trifolium
## 331 Angiosperms	Fabales	Fabaceae	Trifolium
## 332 Angiosperms	Fabales	Fabaceae	Trifolium
## 333 Angiosperms	Fabales	Fabaceae	Trifolium
## 334 Angiosperms	Fabales	Fabaceae	Trifolium
## 335 Angiosperms	Fabales	Fabaceae	Trifolium
## 336 Angiosperms	Fabales	Fabaceae	Trifolium
## 337 Angiosperms	Fabales	Fabaceae	Trifolium
## 338 Angiosperms	Fabales	Fabaceae	Trifolium
## 339 Angiosperms	Fabales	Fabaceae	Trifolium
## 340 Angiosperms	Fabales	Fabaceae	Vicia
## 341 Angiosperms	Fabales	Fabaceae	Vicia
## 342 Angiosperms	Fabales	Fabaceae	Vicia

## 343 Angiosperms	Fabales	Fabaceae	Vicia
## 344 Angiosperms	Fabales	Fabaceae	Wiborgia
## 345 Angiosperms	Fabales	Surianaceae	Stylobasium
## 346 Angiosperms	Fagales	Casuarinaceae	Allocasuarina
## 347 Angiosperms	Fagales	Casuarinaceae	Allocasuarina
## 348 Angiosperms	Fagales	Casuarinaceae	Allocasuarina
## 349 Angiosperms	Fagales	Casuarinaceae	Allocasuarina
## 350 Angiosperms	Fagales	Casuarinaceae	Allocasuarina
## 351 Angiosperms	Fagales	Casuarinaceae	Allocasuarina
## 352 Angiosperms	Fagales	Casuarinaceae	Allocasuarina
## 353 Angiosperms	Fagales	Fagaceae	Quercus
## 354 Angiosperms	Gentianales	Apocynaceae	Apocynum
## 355 Angiosperms	Gentianales	Apocynaceae	Asclepias
## 356 Angiosperms	Gentianales	Apocynaceae	Aspidosperma
## 357 Angiosperms	Gentianales	Gentianaceae	Chironia
## 358 Angiosperms	Gentianales	Rubiaceae	Anthospermum
## 359 Angiosperms	Gentianales	Rubiaceae	Cruciata
## 360 Angiosperms	Gentianales	Rubiaceae	Galium
## 361 Angiosperms	Gentianales	Rubiaceae	Galium
## 362 Angiosperms	Gentianales	Rubiaceae	Galium
## 363 Angiosperms	Geriales	Geraniaceae	Geranium
## 364 Angiosperms	Geriales	Geraniaceae	Geranium
## 365 Angiosperms	Geriales	Geraniaceae	Pelargonium
## 366 Angiosperms	Geriales	Geraniaceae	Pelargonium
## 367 Angiosperms	Lamiales	Lamiaceae	Clinopodium
## 368 Angiosperms	Lamiales	Lamiaceae	Leonurus
## 369 Angiosperms	Lamiales	Lamiaceae	Origanum
## 370 Angiosperms	Lamiales	Lamiaceae	Phlomoides
## 371 Angiosperms	Lamiales	Lamiaceae	Prunella
## 372 Angiosperms	Lamiales	Lamiaceae	Rosmarinus
## 373 Angiosperms	Lamiales	Lamiaceae	Salvia
## 374 Angiosperms	Lamiales	Lamiaceae	Salvia
## 375 Angiosperms	Lamiales	Lamiaceae	Salvia
## 376 Angiosperms	Lamiales	Lamiaceae	Salvia
## 377 Angiosperms	Lamiales	Lamiaceae	Salvia
## 378 Angiosperms	Lamiales	Lamiaceae	Salvia
## 379 Angiosperms	Lamiales	Lamiaceae	Stachys
## 380 Angiosperms	Lamiales	Lamiaceae	Stachys
## 381 Angiosperms	Lamiales	Lamiaceae	Stachys
## 382 Angiosperms	Lamiales	Lamiaceae	Teucrium
## 383 Angiosperms	Lamiales	Lamiaceae	Thymus
## 384 Angiosperms	Lamiales	Lamiaceae	Thymus
## 385 Angiosperms	Lamiales	Lamiaceae	Westringia
## 386 Angiosperms	Lamiales	Orobanchaceae	Castilleja
## 387 Angiosperms	Lamiales	Plantaginaceae	Collinsia
## 388 Angiosperms	Lamiales	Plantaginaceae	Linaria
## 389 Angiosperms	Lamiales	Plantaginaceae	Penstemon
## 390 Angiosperms	Lamiales	Plantaginaceae	Penstemon
## 391 Angiosperms	Lamiales	Plantaginaceae	Penstemon
## 392 Angiosperms	Lamiales	Plantaginaceae	Penstemon

## 393 Angiosperms	Lamiales	Plantaginaceae	Plantago
## 394 Angiosperms	Lamiales	Plantaginaceae	Plantago
## 395 Angiosperms	Lamiales	Plantaginaceae	Plantago
## 396 Angiosperms	Lamiales	Plantaginaceae	Plantago
## 397 Angiosperms	Lamiales	Plantaginaceae	Plantago
## 398 Angiosperms	Lamiales	Scrophulariaceae	Myoporum
## 399 Angiosperms	Lamiales	Scrophulariaceae	Verbascum
## 400 Angiosperms	Lamiales	Scrophulariaceae	Verbascum
## 401 Angiosperms	Lamiales	Verbenaceae	Verbena
## 402 Angiosperms	Lamiales	Verbenaceae	Verbena
## 403 Angiosperms	Lamiales	Verbenaceae	Verbena
## 404 Angiosperms	Lamiales	Verbenaceae	Verbena
## 405 Angiosperms	Malpighiales	Euphorbiaceae	Croton
## 406 Angiosperms	Malpighiales	Euphorbiaceae	Euphorbia
## 407 Angiosperms	Malpighiales	Hypericaceae	Hypericum
## 408 Angiosperms	Malpighiales	Linaceae	Linum
## 409 Angiosperms	Malpighiales	Linaceae	Linum
## 410 Angiosperms	Malpighiales	Linaceae	Linum
## 411 Angiosperms	Malpighiales	Linaceae	Linum
## 412 Angiosperms	Malvales	Cistaceae	Cistus
## 413 Angiosperms	Malvales	Cistaceae	Helianthemum
## 414 Angiosperms	Malvales	Cistaceae	Helianthemum
## 415 Angiosperms	Malvales	Cistaceae	Helianthemum
## 416 Angiosperms	Malvales	Malvaceae	Hermannia
## 417 Angiosperms	Malvales	Malvaceae	Hermannia
## 418 Angiosperms	Malvales	Malvaceae	Lavatera
## 419 Angiosperms	Malvales	Malvaceae	Malva
## 420 Angiosperms	Malvales	Malvaceae	Malva
## 421 Angiosperms	Malvales	Malvaceae	Sphaeralcea
## 422 Angiosperms	Malvales	Malvaceae	Sphaeralcea
## 423 Angiosperms	Malvales	Malvaceae	Sphaeralcea
## 424 Angiosperms	Myrales	Myrtaceae	Astartea
## 425 Angiosperms	Myrales	Myrtaceae	Calothamnus
## 426 Angiosperms	Myrales	Myrtaceae	Calothamnus
## 427 Angiosperms	Myrales	Myrtaceae	Darwinia
## 428 Angiosperms	Myrales	Myrtaceae	Eucalyptus
## 429 Angiosperms	Myrales	Myrtaceae	Eucalyptus
## 430 Angiosperms	Myrales	Myrtaceae	Eucalyptus
## 431 Angiosperms	Myrales	Myrtaceae	Eucalyptus
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## 433 Angiosperms	Myrales	Myrtaceae	Eucalyptus
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## 436 Angiosperms	Myrales	Myrtaceae	Eucalyptus
## 437 Angiosperms	Myrales	Myrtaceae	Eucalyptus
## 438 Angiosperms	Myrales	Myrtaceae	Eucalyptus
## 439 Angiosperms	Myrales	Myrtaceae	Eucalyptus
## 440 Angiosperms	Myrales	Myrtaceae	Eucalyptus
## 441 Angiosperms	Myrales	Myrtaceae	Eucalyptus
## 442 Angiosperms	Myrales	Myrtaceae	Eucalyptus

## 443 Angiosperms	Mytales	Myrtaceae	Eucalyptus
## 444 Angiosperms	Mytales	Myrtaceae	Eucalyptus
## 445 Angiosperms	Mytales	Myrtaceae	Eucalyptus
## 446 Angiosperms	Mytales	Myrtaceae	Eucalyptus
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## 452 Angiosperms	Mytales	Myrtaceae	Eucalyptus
## 453 Angiosperms	Mytales	Myrtaceae	Eucalyptus
## 454 Angiosperms	Mytales	Myrtaceae	Eucalyptus
## 455 Angiosperms	Mytales	Myrtaceae	Eucalyptus
## 456 Angiosperms	Mytales	Myrtaceae	Eucalyptus
## 457 Angiosperms	Mytales	Myrtaceae	Eucalyptus
## 458 Angiosperms	Mytales	Myrtaceae	Kunzea
## 459 Angiosperms	Mytales	Myrtaceae	Leptospermum
## 460 Angiosperms	Mytales	Myrtaceae	Leptospermum
## 461 Angiosperms	Mytales	Myrtaceae	Melaleuca
## 462 Angiosperms	Mytales	Myrtaceae	Melaleuca
## 463 Angiosperms	Mytales	Myrtaceae	Melaleuca
## 464 Angiosperms	Mytales	Myrtaceae	Melaleuca
## 465 Angiosperms	Mytales	Myrtaceae	Melaleuca
## 466 Angiosperms	Mytales	Myrtaceae	Melaleuca
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## 470 Angiosperms	Mytales	Myrtaceae	Melaleuca
## 471 Angiosperms	Mytales	Myrtaceae	Melaleuca
## 472 Angiosperms	Mytales	Myrtaceae	Thryptomene
## 473 Angiosperms	Mytales	Onagraceae	Oenothera
## 474 Angiosperms	Mytales	Onagraceae	Oenothera
## 475 Angiosperms	Poales	Cyperaceae	Carex
## 476 Angiosperms	Poales	Cyperaceae	Carex
## 477 Angiosperms	Poales	Cyperaceae	Lepidosperma
## 478 Angiosperms	Poales	Poaceae	Aegilops
## 479 Angiosperms	Poales	Poaceae	Agropyron
## 480 Angiosperms	Poales	Poaceae	Agropyron
## 481 Angiosperms	Poales	Poaceae	Agropyron
## 482 Angiosperms	Poales	Poaceae	Agropyron
## 483 Angiosperms	Poales	Poaceae	Agrostis
## 484 Angiosperms	Poales	Poaceae	Andropogon
## 485 Angiosperms	Poales	Poaceae	Aristida
## 486 Angiosperms	Poales	Poaceae	Arrhenatherum
## 487 Angiosperms	Poales	Poaceae	Avena
## 488 Angiosperms	Poales	Poaceae	Avena
## 489 Angiosperms	Poales	Poaceae	Bouteloua
## 490 Angiosperms	Poales	Poaceae	Briza
## 491 Angiosperms	Poales	Poaceae	Bromus
## 492 Angiosperms	Poales	Poaceae	Bromus

## 493 Angiosperms	Poales	Poaceae	Bromus
## 494 Angiosperms	Poales	Poaceae	Bromus
## 495 Angiosperms	Poales	Poaceae	Bromus
## 496 Angiosperms	Poales	Poaceae	Bromus
## 497 Angiosperms	Poales	Poaceae	Bromus
## 498 Angiosperms	Poales	Poaceae	Bromus
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## 500 Angiosperms	Poales	Poaceae	Bromus
## 501 Angiosperms	Poales	Poaceae	Buchloe
## 502 Angiosperms	Poales	Poaceae	Calamovilfa
## 503 Angiosperms	Poales	Poaceae	Cenchrus
## 504 Angiosperms	Poales	Poaceae	Chaetobromus
## 505 Angiosperms	Poales	Poaceae	Chloris
## 506 Angiosperms	Poales	Poaceae	Chondrosum
## 507 Angiosperms	Poales	Poaceae	Chondrosum
## 508 Angiosperms	Poales	Poaceae	Cymbopogon
## 509 Angiosperms	Poales	Poaceae	Cynodon
## 510 Angiosperms	Poales	Poaceae	Dactylis
## 511 Angiosperms	Poales	Poaceae	Danthonia
## 512 Angiosperms	Poales	Poaceae	Digitaria
## 513 Angiosperms	Poales	Poaceae	Ehrharta
## 514 Angiosperms	Poales	Poaceae	Elymus
## 515 Angiosperms	Poales	Poaceae	Elymus
## 516 Angiosperms	Poales	Poaceae	Elymus
## 517 Angiosperms	Poales	Poaceae	Elymus
## 518 Angiosperms	Poales	Poaceae	Elymus
## 519 Angiosperms	Poales	Poaceae	Elymus
## 520 Angiosperms	Poales	Poaceae	Elymus
## 521 Angiosperms	Poales	Poaceae	Elymus
## 522 Angiosperms	Poales	Poaceae	Elymus
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## 528 Angiosperms	Poales	Poaceae	Enteropogon
## 529 Angiosperms	Poales	Poaceae	Eragrostis
## 530 Angiosperms	Poales	Poaceae	Eragrostis
## 531 Angiosperms	Poales	Poaceae	Eremopyrum
## 532 Angiosperms	Poales	Poaceae	Festuca
## 533 Angiosperms	Poales	Poaceae	Festuca
## 534 Angiosperms	Poales	Poaceae	Festuca
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## 539 Angiosperms	Poales	Poaceae	Helictotrichon
## 540 Angiosperms	Poales	Poaceae	Helictotrichon
## 541 Angiosperms	Poales	Poaceae	Hilaria
## 542 Angiosperms	Poales	Poaceae	Holcus

## 543 Angiosperms	Poales	Poaceae	Hordeum
## 544 Angiosperms	Poales	Poaceae	Koeleria
## 545 Angiosperms	Poales	Poaceae	Koeleria
## 546 Angiosperms	Poales	Poaceae	Leptochloa
## 547 Angiosperms	Poales	Poaceae	Leymus
## 548 Angiosperms	Poales	Poaceae	Leymus
## 549 Angiosperms	Poales	Poaceae	Leymus
## 550 Angiosperms	Poales	Poaceae	Lolium
## 551 Angiosperms	Poales	Poaceae	Lolium
## 552 Angiosperms	Poales	Poaceae	Melica
## 553 Angiosperms	Poales	Poaceae	Melica
## 554 Angiosperms	Poales	Poaceae	Nassella
## 555 Angiosperms	Poales	Poaceae	Nassella
## 556 Angiosperms	Poales	Poaceae	Oryzopsis
## 557 Angiosperms	Poales	Poaceae	Panicum
## 558 Angiosperms	Poales	Poaceae	Pappophorum
## 559 Angiosperms	Poales	Poaceae	Pentaschistis
## 560 Angiosperms	Poales	Poaceae	Phleum
## 561 Angiosperms	Poales	Poaceae	Piptatherum
## 562 Angiosperms	Poales	Poaceae	Poa
## 563 Angiosperms	Poales	Poaceae	Poa
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## 565 Angiosperms	Poales	Poaceae	Poa
## 566 Angiosperms	Poales	Poaceae	Poa
## 567 Angiosperms	Poales	Poaceae	Poa
## 568 Angiosperms	Poales	Poaceae	Psathyrostachys
## 569 Angiosperms	Poales	Poaceae	Pseudosclerochloa
## 570 Angiosperms	Poales	Poaceae	Rytidosperma
## 571 Angiosperms	Poales	Poaceae	Schizachyrium
## 572 Angiosperms	Poales	Poaceae	Setaria
## 573 Angiosperms	Poales	Poaceae	Sorghastrum
## 574 Angiosperms	Poales	Poaceae	Spartina
## 575 Angiosperms	Poales	Poaceae	Sporobolus
## 576 Angiosperms	Poales	Poaceae	Sporobolus
## 577 Angiosperms	Poales	Poaceae	Sporobolus
## 578 Angiosperms	Poales	Poaceae	Stipa
## 579 Angiosperms	Poales	Poaceae	Stipa
## 580 Angiosperms	Poales	Poaceae	Stipa
## 581 Angiosperms	Poales	Poaceae	Stipa
## 582 Angiosperms	Poales	Poaceae	Stipa
## 583 Angiosperms	Poales	Poaceae	Stipa
## 584 Angiosperms	Poales	Poaceae	Stipagrostis
## 585 Angiosperms	Poales	Poaceae	Taeniatherum
## 586 Angiosperms	Poales	Poaceae	Tenaxia
## 587 Angiosperms	Poales	Poaceae	Themeda
## 588 Angiosperms	Poales	Poaceae	Tribolium
## 589 Angiosperms	Poales	Poaceae	Tribolium
## 590 Angiosperms	Poales	Poaceae	Trichloris
## 591 Angiosperms	Poales	Poaceae	Triodia
## 592 Angiosperms	Poales	Poaceae	Triodia

## 593 Angiosperms	Poales	Poaceae	Triodia
## 594 Angiosperms	Poales	Poaceae	Triticum
## 595 Angiosperms	Poales	Poaceae	Vulpia
## 596 Angiosperms	Poales	Poaceae	Vulpia
## 597 Angiosperms	Poales	Restionaceae	Restio
## 598 Angiosperms	Proteales	Proteaceae	Banksia
## 599 Angiosperms	Proteales	Proteaceae	Banksia
## 600 Angiosperms	Proteales	Proteaceae	Dryandra
## 601 Angiosperms	Proteales	Proteaceae	Grevillea
## 602 Angiosperms	Proteales	Proteaceae	Hakea
## 603 Angiosperms	Proteales	Proteaceae	Hakea
## 604 Angiosperms	Proteales	Proteaceae	Hakea
## 605 Angiosperms	Proteales	Proteaceae	Hakea
## 606 Angiosperms	Proteales	Proteaceae	Hakea
## 607 Angiosperms	Proteales	Proteaceae	Hakea
## 608 Angiosperms	Proteales	Proteaceae	Hakea
## 609 Angiosperms	Proteales	Proteaceae	Hakea
## 610 Angiosperms	Proteales	Proteaceae	Isopogon
## 611 Angiosperms	Proteales	Proteaceae	Persoonia
## 612 Angiosperms	Proteales	Proteaceae	Persoonia
## 613 Angiosperms	Ranunculales	Berberidaceae	Berberis
## 614 Angiosperms	Ranunculales	Papaveraceae	Argemone
## 615 Angiosperms	Ranunculales	Papaveraceae	Eschscholzia
## 616 Angiosperms	Ranunculales	Papaveraceae	Papaver
## 617 Angiosperms	Ranunculales	Ranunculaceae	Consolida
## 618 Angiosperms	Ranunculales	Ranunculaceae	Delphinium
## 619 Angiosperms	Rosales	Rhamnaceae	Rhamnus
## 620 Angiosperms	Rosales	Rosaceae	Agrimonia
## 621 Angiosperms	Rosales	Rosaceae	Filipendula
## 622 Angiosperms	Rosales	Rosaceae	Geum
## 623 Angiosperms	Rosales	Rosaceae	Potentilla
## 624 Angiosperms	Rosales	Rosaceae	Potentilla
## 625 Angiosperms	Rosales	Rosaceae	Potentilla
## 626 Angiosperms	Rosales	Rosaceae	Potentilla
## 627 Angiosperms	Rosales	Rosaceae	Prunus
## 628 Angiosperms	Rosales	Rosaceae	Rosa
## 629 Angiosperms	Rosales	Rosaceae	Rosa
## 630 Angiosperms	Rosales	Rosaceae	Sanguisorba
## 631 Angiosperms	Rosales	Rosaceae	Sanguisorba
## 632 Angiosperms	Rosales	Rosaceae	Spiraea
## 633 Angiosperms	Santalales	Loranthaceae	Nuytsia
## 634 Angiosperms	Santalales	Santalaceae	Exocarpos
## 635 Angiosperms	Sapindales	Anacardiaceae	Myracrodropon
## 636 Angiosperms	Sapindales	Anacardiaceae	Rhus
## 637 Angiosperms	Sapindales	Anacardiaceae	Searsia
## 638 Angiosperms	Sapindales	Anacardiaceae	Searsia
## 639 Angiosperms	Sapindales	Rutaceae	Phebalium
## 640 Angiosperms	Sapindales	Sapindaceae	Dodonaea
## 641 Angiosperms	Sapindales	Sapindaceae	Dodonaea
## 642 Angiosperms	Sapindales	Sapindaceae	Dodonaea

## 643 Angiosperms	Sapindales	Sapindaceae	Dodonaea
## 644 Angiosperms	Sapindales	Sapindaceae	Dodonaea
## 645 Angiosperms	Saxifragales	Grossulariaceae	Ribes
## 646 Angiosperms	Saxifragales	Haloragaceae	Glischrocaryon
## 647 Angiosperms	Solanales	Solanaceae	Lycium
## 648 Angiosperms	Solanales	Solanaceae	Solanum
## 649 Angiosperms	Zygophyllales	Zygophyllaceae	Roepera
## 650 Gymnosperms	Pinales	Cupressaceae	Actinostrobus
## 651 Gymnosperms	Pinales	Cupressaceae	Callitris
## 652 Gymnosperms	Pinales	Cupressaceae	Juniperus
## 653 Gymnosperms	Pinales	Cupressaceae	Juniperus
## 654 Gymnosperms	Pinales	Pinaceae	Pinus
## 655 Gymnosperms	Pinales	Pinaceae	Pinus
## 656 Gymnosperms	Pinales	Pinaceae	Pinus
##	binomial		
## 1	Anthriscus_sylvestris		
## 2	Arctopus_echinatus		
## 3	Bupleurum_tenuissimum		
## 4	Carum_carvi		
## 5	Daucus_carota		
## 6	Eryngium_campestre		
## 7	Falcaria_vulgaris		
## 8	Heracleum_sphondylium		
## 9	Pastinaca_sativa		
## 10	Pimpinella_major		
## 11	Pimpinella_saxifraga		
## 12	Selinum_carvifolia		
## 13	Silaum_silaus		
## 14	Allium_scorodoprasum		
## 15	Allium_textile		
## 16	Lachenalia_fistulosa		
## 17	Ornithogalum_thrysoides		
## 18	Yucca_glaucha		
## 19	Trachyandra_muricata		
## 20	Babiana_fragrans		
## 21	Babiana_spp		
## 22	Moraea_bellendenii		
## 23	Patersonia_occidentalis		
## 24	Patersonia_spp		
## 25	Achillea_collina		
## 26	Achillea_millefolium		
## 27	Achillea_nobilis		
## 28	Anacyclus_clavatus		
## 29	Arctotis_acaulis		
## 30	Arnica_cordifolia		
## 31	Artemisia_californica		
## 32	Artemisia_campestris		
## 33	Artemisia_filifolia		
## 34	Artemisia_frigida		
## 35	Artemisia_ludoviciana		

```

## 36      Artemisia_ordosica
## 37      Artemisia_tridentata
## 38          Aster_spp
## 39      Athanasia_crithmifolia
## 40      Baileya_multiradiata
## 41      Balsamorhiza_sagittata
## 42      Boltonia_asteroides
## 43      Carlina_vulgaris
## 44      Carthamus_lanatus
## 45      Centaurea_diffusa
## 46      Centaurea_jacea
## 47      Centaurea_pannonica
## 48      Centaurea_podospermifolia
## 49      Centaurea_scabiosa
## 50      Centaurea_solstitialis
## 51      Centaurea_stoebe
## 52      Chrysocoma_coma-aurea
## 53      Cichorium_intybus
## 54      Cirsium_arvense
## 55      Cirsium_oleraceum
## 56      Coreopsis_tinctoria
## 57      Cota_tinctoria
## 58      Cotula_turbinata
## 59      Crepis_acuminata
## 60      Crepis_biennis
## 61      Cyanus_segetum
## 62      Dicerothamnus_rhinocerotis
## 63      Didelta_carnosa
## 64      Dimorphotheca_pluvialis
## 65      Echinacea_angustifolia
## 66      Encelia_californica
## 67      Ericameria_nauseosa
## 68      Erigeron_speciosus
## 69      Eriophyllum_africanus
## 70      Eriophyllum_microphyllum
## 71      Felicia_filifolia
## 72      Gaillardia_aristata
## 73      Grindelia_hirsutula
## 74      Helianthus_annuus
## 75      Helianthus_maximiliani
## 76      Helianthus_spp
## 77      Helichrysum_cymosum
## 78      Helichrysum_hamulosum
## 79      Helichrysum_patulum
## 80      Helichrysum_spp
## 81      Helichrysum_stoechas
## 82      Helichrysum_teretifolium
## 83      Heliomeris_multiflora
## 84      Hemizonia_fasciculata
## 85      Heterotheca_villosa

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## 86      Hipicium_alienatum
## 87          Inula_salicina
## 88          Lactuca_serriola
## 89          Leontodon_hispidus
## 90      Leucanthemum_ircutianum
## 91          Leucanthemum_vulgare
## 92          Leysera_gnaphaloides
## 93          Liatris_aspera
## 94          Liatris_punctata
## 95      Machaeranthera_canescens
## 96      Machaeranthera_tanacetifolia
## 97          Osteospermum_sinuatum
## 98          Othonna_arborescens
## 99          Othonna_cylindrica
## 100         Pentzia_incana
## 101         Podospermum_canum
## 102         Pteronia_divaricata
## 103         Pteronia.empetrifolia
## 104         Pteronia_glomerata
## 105         Pteronia_incana
## 106         Pteronia_onobromoides
## 107         Pteronia_ovalifolia
## 108         Pteronia_pallens
## 109         Pteronia_paniculata
## 110         Ratibida_columnifera
## 111         Ratibida_pinnata
## 112         Rudbeckia_hirta
## 113         Silphium_perfoliatum
## 114         Solidago_rigida
## 115         Tanacetum_corymbosum
## 116         Taraxacum_campylodes
## 117         Thelesperma_filifolium
## 118         Tragopogon_dubius
## 119         Tragopogon_pratensis
## 120         Tripolium_pannonicum
## 121         Tripteris_oppositifolia
## 122         Tripteris_sinusata
## 123         Ursinia_anthemoides
## 124         Verbesina_enceliooides
## 125         Waitzia_nitida
## 126         Campanula_glomerata
## 127         Campanula_patula
## 128         Campanula_persicifolia
## 129         Campanula_rapunculoides
## 130         Jasione_montana
## 131         Coopernookia_polygalacea
## 132         Goodenia_azurea
## 133         Goodenia_scapigera
## 134         Anchusa_arvensis
## 135         Cynoglossum_officinale

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## 136          Echium_vulgare
## 137          Phacelia_tanacetifolia
## 138          Brassica_spp
## 139          Bunias_orientalis
## 140          Cardamine_pratensis
## 141          Descurainia_pinnata
## 142          Descurainia_sophia
## 143          Diplotaxis_erucoides
## 144          Erysimum_capitatum
## 145          Lepidium_draba
## 146          Lepidium_subulatum
## 147          Rapistrum_perenne
## 148          Sinapis_alba
## 149          Thlaspi_arvense
## 150          Cleome_lutea
## 151          Cleome_serrulata
## 152          Reseda_luteola
## 153          Aizoon_canariense
## 154          Amphibolia_rupis-arcuatae
## 155          Cephalophyllum_spissum
## 156          Cheiridopsis_denticulata
## 157          Conicosia_elongata
## 158          Drosanthemum_hispidum
## 159          Erepsia_anceps
## 160          Galenia_sarcophylla
## 161          Jordaaniella_spongiosa
## 162          Lampranthus_emarginatus
## 163          Leipoldtia_schultzei
## 164          Psilocaulon_dinteri
## 165          Ruschia_aggregata
## 166          Ruschia_rubricaulis
## 167          Ruschia_spp
## 168          Ruschia_versicolor
## 169          Stoeberia_beetzii
## 170          Tetragonia_echinata
## 171          Tetragonia_fruticosa
## 172          Agriophyllum_squarrosum
## 173          Amaranthus_retroflexus
## 174          Atriplex_canescens
## 175          Atriplex_confertifolia
## 176          Atriplex_gardneri
## 177          Atriplex_lentiformis
## 178          Atriplex_littoralis
## 179          Atriplex_semibaccata
## 180          Atriplex_tatarica
## 181          Atriplex Vesicaria
## 182          Atriplex_vestita
## 183          Bassia_prostrata
## 184          Chenopodium_album
## 185          Grayia_spinosa

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## 186 Krascheninnikovia_ceratooides
## 187           Maireana_aphylla
## 188           Maireana_excavata
## 189           Maireana_rohrlachii
## 190           Manochlamys_albicans
## 191           Arenaria_serpullifolia
## 192           Dianthus_carthusianorum
## 193           Dianthus_deltoides
## 194           Dianthus_giganteiformis
## 195           Saponaria_officinalis
## 196           Silene dioica
## 197           Silene_latifolia
## 198           Silene_viscosa
## 199           Silene_vulgaris
## 200           Stellaria_media
## 201           Hypertelis_salsoloides
## 202           Pharnaceum_confertum
## 203           Armeria_maritima
## 204           Eriogonum_fasciculatum
## 205           Eriogonum_umbellatum
## 206           Fagopyrum_esculentum
## 207           Persicaria_pensylvanica
## 208           Rumex_acetosella
## 209           Rumex_thyrsiflorus
## 210           Calandrinia_ciliata
## 211           Sarcobatus_vermiculatus
## 212           Tradescantia_occidentalis
## 213           Wachendorfia paniculata
## 214           Mentzelia_aspera
## 215           Knautia_arvensis
## 216           Scabiosa_ochroleuca
## 217           Symphoricarpos_albus
## 218           Collomia_grandiflora
## 219           Myrsine_africana
## 220           Acacia_acanthoclada
## 221           Acacia_acinacea
## 222           Acacia_acuminata
## 223           Acacia_ancistrocarpa
## 224           Acacia_bidentata
## 225           Acacia_binata
## 226           Acacia_brachybotrya
## 227           Acacia_chrysocephala
## 228           Acacia_cochlearis
## 229           Acacia_consobrina
## 230           Acacia_constricta
## 231           Acacia_cupularis
## 232           Acacia_cyclops
## 233           Acacia_declinata
## 234           Acacia_ehrenbergiana
## 235           Acacia_farinosa

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## 236          Acacia_ferocior
## 237          Acacia_gerrardii
## 238          Acacia_glaucopтера
## 239          Acacia_gonophylla
## 240          Acacia_greggii
## 241          Acacia_harveyi
## 242          Acacia_hilliana
## 243          Acacia_inaequilatera
## 244          Acacia_lasiocalyx
## 245          Acacia_ligulata
## 246          Acacia_maxwellii
## 247          Acacia_mearnsii
## 248          Acacia_melanoxylon
## 249          Acacia_microbotrya
## 250          Acacia_myrtifolia
## 251          Acacia_paradoxa
## 252          Acacia_patagiata
## 253          Acacia_pinguiculosa
## 254          Acacia_pulchella
## 255          Acacia_pycnantha
## 256          Acacia_redolens
## 257          Acacia_saligna
## 258          Acacia_spongolitica
## 259          Acacia_spp
## 260          Acacia_stellaticeps
## 261          Acacia_stipuligera
## 262          Acacia_subcaerulea
## 263          Acacia_sulcata
## 264          Acacia_tetragonophylla
## 265          Acacia_tortilis
## 266          Acacia_varia
## 267          Acacia_verticillata
## 268          Amburana_cearensis
## 269          Anthyllis_terniflora
## 270          Anthyllis_vulneraria
## 271          Astragalus_bisulcatus
## 272          Astragalus_canadensis
## 273          Astragalus_drummondii
## 274          Astragalus_laxmannii
## 275          Astragalus_spp
## 276          Chamaecrista_fasciculata
## 277          Chorizema_aciculare
## 278          Dalea_candida
## 279          Dalea_purpurea
## 280          Daviesia_benthamii
## 281          Daviesia_emarginata
## 282          Daviesia_hakeoides
## 283          Desmanthus_illinoensis
## 284          Erythrina_velutina
## 285          Gastrolobium_parviflorum

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## 286      Gastrolobium_racemosum
## 287      Gastrolobium_spinosum
## 288      Gompholobium_polyzygum
## 289          Goodia_lotifolia
## 290          Hedysarum_boreale
## 291      Indigofera_monophylla
## 292          Indigofera_spp
## 293      Jacksonia_condensata
## 294      Kennedia_prostrata
## 295          Lathyrus_hirsutus
## 296          Lathyrus_pratensis
## 297          Lathyrus_tuberosus
## 298          Lebeckia_sericea
## 299      Lotus_corniculatus
## 300          Lotus_maritimus
## 301      Lupinus_argenteus
## 302          Lupinus_perennis
## 303      Lupinus_polyphyllus
## 304          Lupinus_spp
## 305      Lupinus_succulentus
## 306          Medicago_falcata
## 307      Medicago_lupulina
## 308          Medicago_minima
## 309          Medicago_sativa
## 310          Melilotus_albus
## 311      Melilotus_officinalis
## 312          Onobrychis_arenaria
## 313      Onobrychis_viciifolia
## 314          Ononis_spinosa
## 315          Ononis_tridentata
## 316          Oxytropis_lambertii
## 317          Podalyria_sericea
## 318      Poincianella_pyramidalis
## 319          Psoralea_tenuiflora
## 320          Retama_sphaerocarpa
## 321          Securigera_varia
## 322          Senna_artemisioides
## 323          Senna_glutinosa
## 324          Templetonia_retusa
## 325          Templetonia_sulcata
## 326      Thermopsis_rhombifolia
## 327          Trifolium_angulatum
## 328          Trifolium_arvense
## 329          Trifolium_bifidum
## 330          Trifolium_campestre
## 331          Trifolium_dubium
## 332          Trifolium_incarnatum
## 333          Trifolium_pratense
## 334          Trifolium_repens
## 335          Trifolium_retusum

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## 336           Trifolium_spp
## 337           Trifolium_striatum
## 338           Trifolium_subterraneum
## 339           Trifolium_willdenovii
## 340           Vicia_americana
## 341           Vicia_sativa
## 342           Vicia_spp
## 343           Vicia_villosa
## 344           Wiborgia_mucronata
## 345           Stylobasium_spathulatum
## 346           Allocasuarina_acutivalvis
## 347           Allocasuarina_huegeliana
## 348           Allocasuarina_humilis
## 349           Allocasuarina_lehmanniana
## 350           Allocasuarina_luehmannii
## 351           Allocasuarina_thuyoides
## 352           Allocasuarina_verticillata
## 353           Quercus_coccifera
## 354           Apocynum_androsaemifolium
## 355           Asclepias_fascicularis
## 356           Aspidosperma_pyrifolium
## 357           Chironia_baccifera
## 358           Anthospermum_spathulatum
## 359           Cruciata_pedemontana
## 360           Galium_album
## 361           Galium_triflorum
## 362           Galium_verum
## 363           Geranium_pratense
## 364           Geranium_pusillum
## 365           Pelargonium_capitatum
## 366           Pelargonium_cucullatum
## 367           Clinopodium_vulgare
## 368           Leonurus_cardiaca
## 369           Origanum_vulgare
## 370           Phlomoides_tuberosa
## 371           Prunella_vulgaris
## 372           Rosmarinus_officinalis
## 373           Salvia_africana-caerulea
## 374           Salvia_austriaca
## 375           Salvia_columbariae
## 376           Salvia_nemorosa
## 377           Salvia_pratensis
## 378           Salvia_verticillata
## 379           Stachys_officinalis
## 380           Stachys_recta
## 381           Stachys_rugosa
## 382           Teucrium_capitatum
## 383           Thymus odoratissimus
## 384           Thymus_zygis
## 385           Westringia_cephalantha

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## 386      Castilleja_applegatei
## 387          Collinsia_verna
## 388          Linaria_vulgaris
## 389      Penstemon_angustifolius
## 390          Penstemon_speciosus
## 391          Penstemon_spp
## 392          Penstemon_strictus
## 393          Plantago_albicans
## 394      Plantago_lanceolata
## 395          Plantago_media
## 396          Plantago_ovata
## 397      Plantago_patagonica
## 398          Myoporum_insulare
## 399      Verbascum_densiflorum
## 400          Verbascum_nigrum
## 401      Verbena_bracteata
## 402          Verbena_hastata
## 403      Verbena_officinalis
## 404          Verbena_stricta
## 405          Croton_setigerus
## 406      Euphorbia_cyparissias
## 407          Hypericum_perforatum
## 408          Linum_austriacum
## 409          Linum_lewisii
## 410          Linum_perenne
## 411          Linum_pratense
## 412          Cistus_clusii
## 413      Helianthemum_squamatum
## 414          Helianthemum_syriacum
## 415      Helianthemum_violaceum
## 416      Hermannia_disermifolia
## 417      Hermannia_hyssopifolia
## 418          Lavatera_thuringiaca
## 419          Malva_moschata
## 420          Malva_sylvestris
## 421          Sphaeralcea_ambigua
## 422          Sphaeralcea_coccinea
## 423          Sphaeralcea_munroana
## 424          Astartea_ambigua
## 425          Calothamnus_gracilis
## 426      Calothamnus_quadrifidus
## 427          Darwinia_diosmoides
## 428          Eucalyptus_angulosa
## 429          Eucalyptus_annulata
## 430          Eucalyptus_astringens
## 431          Eucalyptus_camaldulensis
## 432          Eucalyptus_captiosa
## 433          Eucalyptus_decipiens
## 434          Eucalyptus_falcata
## 435          Eucalyptus_flocktoniae

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## 436      Eucalyptus_incrassata
## 437      Eucalyptus_lehmannii
## 438      Eucalyptus_melanophittra
## 439      Eucalyptus_neutra
## 440      Eucalyptus_obliqua
## 441      Eucalyptus_occidentalis
## 442      Eucalyptus_odontocarpa
## 443      Eucalyptus_ovata
## 444      Eucalyptus_phaeophylla
## 445      Eucalyptus_phenax
## 446      Eucalyptus_platypus
## 447      Eucalyptus_pluricaulis
## 448      Eucalyptus_preissiana
## 449      Eucalyptus_spp
## 450      Eucalyptus_tetragona
## 451      Eucalyptus_tetraptera
## 452      Eucalyptus_thamnooides
## 453      Eucalyptus_uncinata
## 454      Eucalyptus_vegrandis
## 455      Eucalyptus Vesiculosa
## 456      Eucalyptus_viminalis
## 457      Eucalyptus_xanthonema
## 458      Kunzea_recurva
## 459      Leptospermum_continuale
## 460      Leptospermum_erubescens
## 461      Melaleuca_acuminata
## 462      Melaleuca_calycina
## 463      Melaleuca_cucullata
## 464      Melaleuca_glaberrima
## 465      Melaleuca_hamata
## 466      Melaleuca_leptospermoides
## 467      Melaleuca_nematophylla
## 468      Melaleuca_pentagona
## 469      Melaleuca_suberosa
## 470      Melaleuca_uncinata
## 471      Melaleuca_undulata
## 472      Thryptomene_baeckeacea
## 473      Oenothera_caespitosa
## 474      Oenothera_pallida
## 475      Carex_foenea
## 476      Carex_spp
## 477      Lepidosperma_squamatum
## 478      Aegilops_cylindrica
## 479      Agropyron_cristatum
## 480      Agropyron_desertorum
## 481      Agropyron_fragile
## 482      Agropyron_spp
## 483      Agrostis_capillaris
## 484      Andropogon_gerardii
## 485      Aristida_purpurea

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## 486      Arrhenatherum_elatius
## 487          Avena_barbata
## 488          Avena_fatua
## 489      Bouteloua_curtipendula
## 490          Briza_media
## 491          Bromus_carinatus
## 492          Bromus_erectus
## 493          Bromus_hordeaceus
## 494          Bromus_inermis
## 495          Bromus_japonicus
## 496          Bromus_marginatus
## 497          Bromus_riparius
## 498          Bromus_rubens
## 499          Bromus_setifolius
## 500          Bromus_tectorum
## 501      Buchloe_dactyloides
## 502      Calamovilfa_longifolia
## 503      Cenchrus_ciliaris
## 504      Chaetobromus_involucratus
## 505          Chloris_spp
## 506      Chondrosum_eriopodium
## 507          Chondrosum_gracile
## 508      Cymbopogon_marginatus
## 509          Cynodon_dactylon
## 510          Dactylis_glomerata
## 511      Danthonia_unispicata
## 512      Digitaria_californica
## 513          Ehrharta_calycina
## 514          Elymus_canadensis
## 515          Elymus_caninus
## 516          Elymus_elongatus
## 517          Elymus_elymoides
## 518          Elymus_glaucus
## 519          Elymus_hispidus
## 520          Elymus_lanceolatus
## 521          Elymus_multisetus
## 522          Elymus_repens
## 523          Elymus_smithii
## 524          Elymus_spicatus
## 525          Elymus_spp
## 526          Elymus_trachycaulus
## 527          Elymus_wawawaiensis
## 528      Enteropogon_macrostachyus
## 529          Eragrostis_superba
## 530          Eragrostis_trichodes
## 531          Eremopyrum_triticeum
## 532          Festuca_arundinacea
## 533          Festuca_campestris
## 534          Festuca_idahoensis
## 535          Festuca_occidentalis

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## 536           Festuca_ovina
## 537           Festuca_pseudovina
## 538           Festuca_rupicola
## 539           Helictotrichon_pratense
## 540           Helictotrichon_pubescens
## 541           Hilaria_jamesii
## 542           Holcus_lanatus
## 543           Hordeum_brachyantherum
## 544           Koeleria_macrantha
## 545           Koeleria_pyramidalis
## 546           Leptochloa_dubia
## 547           Leymus_angustus
## 548           Leymus_cinereus
## 549           Leymus_triticoides
## 550           Lolium_multiflorum
## 551           Lolium_rigidum
## 552           Melica_californica
## 553           Melica_transsilvanica
## 554           Nassella_pulchra
## 555           Nassella_viridula
## 556           Oryzopsis_hymenoides
## 557           Panicum_virgatum
## 558           Pappophorum_spp
## 559           Pentaschistis_airoides
## 560           Phleum_pratense
## 561           Piptatherum_miliaceum
## 562           Poa_angustifolia
## 563           Poa_annua
## 564           Poa_compressa
## 565           Poa_fendleriana
## 566           Poa_pratensis
## 567           Poa_spiciformis
## 568           Psathyrostachys_juncea
## 569           Pseudosclerochloa_rupestris
## 570           Rytidosperma_virescens
## 571           Schizachyrium_scoparium
## 572           Setaria_macrostachya
## 573           Sorghastrum_nutans
## 574           Spartina_pectinata
## 575           Sporobolus_airoides
## 576           Sporobolus_cryptandrus
## 577           Sporobolus_spp
## 578           Stipa_capillata
## 579           Stipa_comata
## 580           Stipa_lemonii
## 581           Stipa_spp
## 582           Stipa_tenacissima
## 583           Stipa_thurberiana
## 584           Stipagrostis_ciliata
## 585           Taeniatherum_caput-medusae

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## 586          Tenaxia_stricta
## 587          Themeda_triandra
## 588          Tribolium_hispidum
## 589          Tribolium_uniolae
## 590          Trichloris_crinita
## 591          Triodia_basedowii
## 592          Triodia_epactia
## 593          Triodia_wiseana
## 594          Triticum_monococcum
## 595          Vulpia_microstachys
## 596          Vulpia_octoflora
## 597          Restio_spp
## 598          Banksia_caleyi
## 599          Banksia_media
## 600          Dryandra_quercifolia
## 601          Grevillea_stenobotrya
## 602          Hakea_commutata
## 603          Hakea_corymbosa
## 604          Hakea_laurina
## 605          Hakea_lissocarpha
## 606          Hakea_nitida
## 607          Hakea_pandanicaarpa
## 608          Hakea_strumosa
## 609          Hakea_verrucosa
## 610          Isopogon_trilobus
## 611          Persoonia_biglandulosa
## 612          Persoonia_spp
## 613          Berberis_aquifolium
## 614          Argemone_polyanthemos
## 615          Eschscholzia_californica
## 616          Papaver_rhoeas
## 617          Consolida_regalis
## 618          Delphinium_geyeri
## 619          Rhamnus_lyciodes
## 620          Agrimonia_eupatoria
## 621          Filipendula_vulgaris
## 622          Geum_macrophyllum
## 623          Potentilla_argentea
## 624          Potentilla_pensylvanica
## 625          Potentilla_recta
## 626          Potentilla_spp
## 627          Prunus_virginiana
## 628          Rosa_spp
## 629          Rosa_woodsii
## 630          Sanguisorba_minor
## 631          Sanguisorba_officinalis
## 632          Spiraea_spp
## 633          Nuytsia_floribunda
## 634          Exocarpos_sparteus
## 635          Myracrodruon_urundeuva

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## 636           Rhus_trilobata
## 637           Searsia_laevigata
## 638           Searsia_tomentosa
## 639           Phebalium_tuberculosum
## 640           Dodonaea_bursariifolia
## 641           Dodonaea_coriacea
## 642           Dodonaea_spp
## 643           Dodonaea_stenozyga
## 644           Dodonaea_viscosa
## 645           Ribes_cereum
## 646           Glischrocaryon_aureum
## 647           Lycium_andersonii
## 648           Solanum_orbiculatum
## 649           Roepera_morgsana
## 650           Actinostrobus_pyramidalis
## 651           Callitris_preissii
## 652           Juniperus_osteosperma
## 653           Juniperus_thurifera
## 654           Pinus_halepensis
## 655           Pinus_pinaster
## 656           Pinus_ponderosa
```

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