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Overview of Management Issues Raised by the 1993 Wildfires in Southern California

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Abstract. An expensive aerial seeding program on Los Angeles County land burned by the Old Topanga Fire, coincident with a declaration by state and national parks that seeding was unnecessary and undesirable on the nearby Green Meadow burn, raised important doubts in many people's minds about postfire management decisions. The results of monitoring studies on the Old Topanga Burn and Laguna Canyon Burn indicated that seeding was largely unsuccessful. In addition, seed mixtures used on these burns were touted as being "native" yet the vast majority of seed was from non-native species. True native species seeded on these sites were all perennial grasses; because these species do not normally establish seedlings after fire, it is not surprising that seeding of these native grasses resulted in no increase in plant cover.

Keywords: Aerial seeding; emergency rehabilitation; postfire recovery.

Introduction

Over a period of less than 10 days in autumn 1993, the southern California landscape exploded in massive wildfires that burned more than 80,000 ha (Fig. 1). These fires were particularly important because they touched off a storm of controversy afterwards that had far-reaching political ramifications. No sooner had the Santa Ana winds stopped fanning the flames of destruction, then the news media started fanning the flames of controversy on postfire management of burned slopes.

One situation exploited by the media was the coincidence of massive wildfires in both the western and eastern ends of the Santa Monica Mountains. The Green Meadow Fire burned over 16,000 ha of state and national park land at the western end of the range and days later the Old Topanga Fire burned nearly 7,000 ha of Los Angeles County and other smaller holdings at the eastern end (Table 1). Almost within days of the Old Topanga Fire, the County of Los Angeles announced that, as an erosion control measure, they would seed lands under their jurisdiction, at a cost of $440,000 (Fig. 2). In marked contrast, both the state and national parks announced that seeding was neither necessary nor desirable, and, not only would they not seed their lands burned by the Green Meadow Fire, they requested that the County of Los Angeles take care to avoid seeding the small pockets of park land within the Old Topanga Fire. In light of the high price tag for seeding and the conclusion that seeding was unnecessary on park land, a series of newspaper articles appeared questioning the need for this form of postfire "rehabilitation." These incidents led to a renewed debate and reanalysis of policies on postfire rehabilitation, both locally and statewide.

A second important event was the Laguna Canyon Fire, which started about the same time as the Green Meadow Fire and burned north and east of the City of Laguna Beach in Orange County (Table 1). Due to particularly old vegetation, extreme Santa Ana wind conditions, and exceptionally vivid press coverage, this fire conveyed to the public a sense of extraordinary fire intensity. Thus, testimony by experts that the unusual severity of this fire would hamper natural regeneration was accepted by many. Consequently, postfire "rehabilitation" in the form of aerial seeding and hydroseeding was considered necessary by the city, the county and the Irvine Company (a major land holder), but not by the Crystal Cove State Park, which comprised a large portion of the burn. Outside of the state park, seeding did proceed despite protests from environmentally-concerned citizens. In response to environmental concerns, the decision was made to seed with "native" species, which presumably would be more environmentally benign than seeding with non-native species. This issue of seeding with native species as a more "environmentally sensitive" approach was also raised by the County of Los Angeles in their seeding plan for the Old Topanga Fire (Fig. 2).

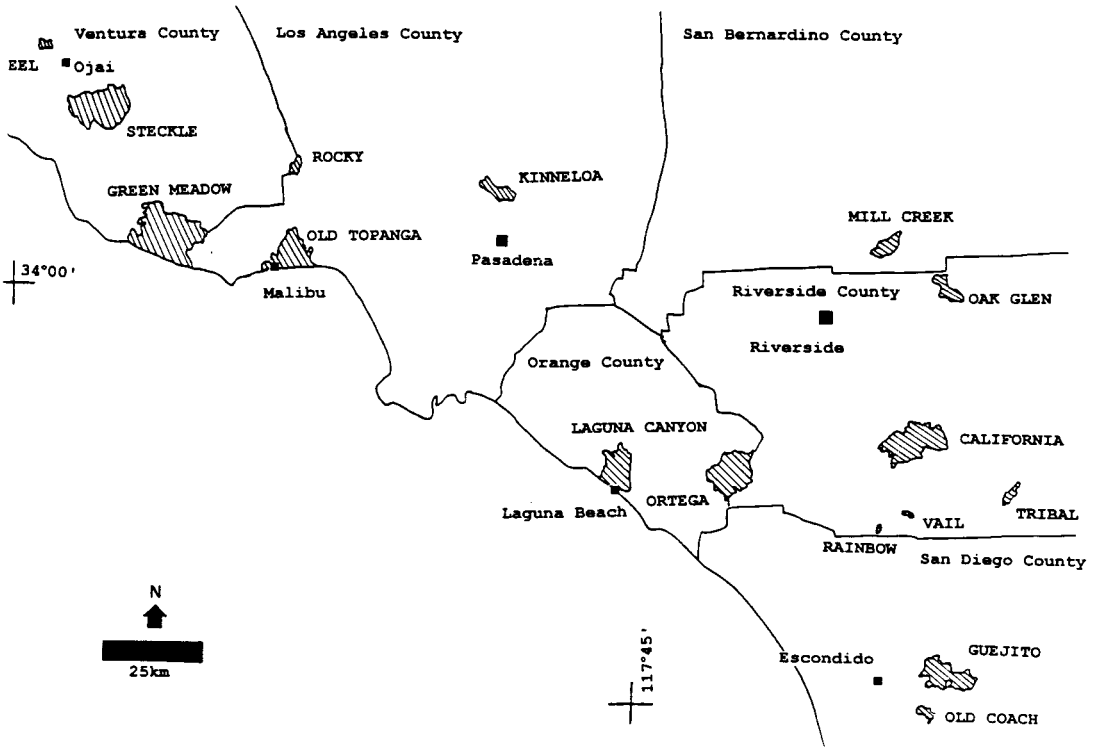

Figure 1. Distribution of fires during the autumn fires of 1993 in southern California. More detail is give in Table 1.

Table 1. Southern California fires, 26 October to 3 November, 1993. Data and fire names from (Anonymous 1993 and personal communications).

Date	Fire Name	County	Hectares Burned	Cause
26 October 1993				
	Guejito	San Diego	8,390	Power line
	Power	San Diego	16	Power line
	Green Meadow	Ventura	16,215	Arson
	Tecate	San Diego	50	Unknown
	Stagecoach	Orange	221	Arson
	California	Riverside	9,877	Power line
27 October 1993				
	Rocky	Los Angeles	772	Arson
	Steckle	Ventura	10,826	Arson
	Tribal	Riverside	903	Power line
	Kinneloa	Los Angeles	2,314	Camp Fire
	Box Springs	Riverside	1,132	Arson
	Mill Creek	San Bernardino	2,051	Power line
	Wheel	Ventura	560	Arson
	Rainbow	San Diego	15	Unknown
	Laguna Canyon	Orange	5,995	Arson
	Paradise	San Diego	24	Power line
	Vail	Riverside	217	Arson
	Ortega	Orange	8,660	Arson
2 November 1993				
	Repplier	Riverside	2,411	Power line
	Old Topanga	Los Angeles	6,836	Arson
	Oak Glen	San Bernardino	20	Unknown
	Old Coach	San Diego	866	Camp Fire

In summary, two important issues were raised by these fires and are outlined in the Los Angeles Times article of 18 November 1993 (Fig. 2). Should taxpayers foot the bill for postfire management practices that some state and federal agencies considered unnecessary and undesirable? And, can the undesirable environmental damage potentially done by seeding be alleviated by the use of native plant species?

Studies of Postfire Recovery Following the 1993 Fires

Beginning in the winter of 1994, a crew of graduate and undergraduate students from our laboratory began a study of the vegetation recovery after the autumn 1993 fires. We established 90 permanent sites distributed across 15 of the wildfires listed in Table 1. Approximately 50 of these sites were in burned coastal sage scrub and the remaining were in burned chaparral. Here I present an overview of preliminary results from the three sites where large scale postfire seeding was conducted: the Old Topanga Fire, the Laguna Canyon Fire, and the Kinneloa Fire (also known in the media as the Topanga, Laguna and Altadena fires, respectively).

At each of the 90 locations we marked out a 1000-m^2 site (20 x 50 m) subdivided into 10 100-m^2 plots and 20 1-m^2 subplots (Fig. 3). Within each 100-m^2 plot we recorded the prefire shrub composition (based on wood remains), the number and areal diameter of shrubs regenerating through vegetative resprouts and a complete species list. Within each 1-m^2 subplot we made an exact count of every plant present and the height and cover for three individuals of each species. Using maps and other information supplied by the respective management agencies, we established sites within the region seeded after the Old Topanga, Laguna Canyon, and Kinneloa fires.

L.A. Times (November 18, 1993)

CALABASAS/MALIBU

Supervisors Approve Reseeding of Fire Area

County supervisors have approved the use of $393,000 in grass seed mix to **prevent mudslides** in the Calabasas/Malibu fire area, rejecting traditional **rye grass**, which would cost only $35,000 but was opposed by environmentalists.

The more expensive mix was included in a $440,000 reseeding contract with the U.S. Soil Conservation Service approved contract, county fire officials will use helicopters to reseed nearly 7,000 acres of the 18,000-acre fire zone stretching from Calabasas to Malibu in the Santa Monica Mountains west of Los Angeles.

The federal government will pay 75% of the cost because Los Angeles County was designated a federal disaster area.

Supervisor Ed Edelman urged his colleagues to approve the mix in part because environmentalists opposed the non-native---but fast growing---rye grass. The conservation service also recommended the expensive mixture, but some activists and officials with the **National Park Service opposed any reseeding**, saying it could compete with native plants.

The county agreed not to reseed 4,069 acres of the fire zone at the request of park officials.

"We can sow rye grass and make a lot of people unhappy, or we can sow native grasses and not upset a lot of people. **We're trying to be sensitive to the environmentalist concerns" said Paul Rippens, chief of the county Fire Departments's forestry division.**

Figure 2. Los Angeles Times article 18 November 1993 illustrating several postfire management issues that attracted public and state attention. Reprinted with permission of Times Mirror Inc.

Old Topanga Fire

Seeding prescription. The application density and mixture of seeds utilized on this burn are shown in Table 2. Although the Los Angeles Times reported (Fig. 2) that a native seed mix was to be used, it is clear from Table 2 that such was not the case. Three of the four species used in the seed mix are of European origin (Hickman 1993). Only one minor component of the seed mix (*Bromus carinatus*) is native to California; however, this species would seem to be a poor choice as none of the prior postfire studies in the Santa Monica Mountains reported finding this species (e.g., Radtke 1981, Keeley and Keeley 1984, O'Leary and Westman 1988, Conard et al. 1995).

Site selection. Ten sites were established within the seeded area of the Old Topanga Fire. Sites were selected to cover the entire range of the fire and extended from the north end of Old Topanga Road to Tuna Canyon and west to Puerco Canyon. In addition to including most slope exposures and both chaparral and coastal sage scrub, an important site selection criterion was accessibility. Sites were selected in December, prior to germination of most plant species.

Results and discussion. The 10 sites were first monitored in late February 1994, approximately three months after the aerial seeding. On all 10 sites, usually

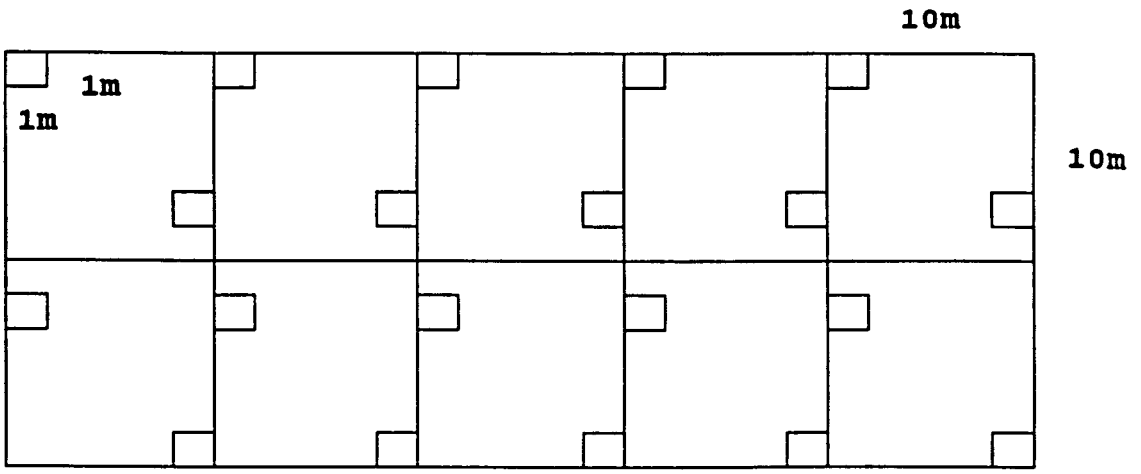

Figure 3. Sampling plot design utilized by research discussed in this paper. At each of the 90 locations we marked out a 100-m^2 site (20 x 50 m) subdivided into 10 100-m^2 plots for prefire shrub composition and shrub resprouting and 20 1-m^2 subplots for total plant recovery.

Table 2. Seeding prescription used to aerial seed the Los Angeles County and City of Malibu lands burned by the Old Topanga Fire. Seeding was done in late November 1993. Data was provided by the Santa Monica Mountains National Recreation Area, 18 August 1994. **California native species in bold.**

Seeding density	= 5.4 kg/ha (4.8 lbs/ac)
Area seeding	= 5,041 ha (12,456 ac)
Seed cost	= $ 393,500
Total cost*	= $ 87/ha ($ 35/ac)

	Percentage	
	By weight	Numerically@
Trifolium hirtum (rose clover)	49	22
Vulpia myuros (zorro fescue)	26	56
Bromus carinatus **(California brome)**	13	3
Bromus hordeaceous (blando brome)	12	19

*Total cost includes application costs.
@ Based on average number of seeds per kg (from Ransom Seed Lab, unpublished data).

2-3 of the seeded species were present somewhere on the site, reaffirming that these sites were within the boundaries of the seeding program. However, on 90% of the sites, the seeded species had substantially less than 1% cover (percentage of ground surface covered). The four sites with the greatest cover of seeded species are shown in Table 3 and it is clear that even at the "best" site (Schueren Rd.), seeded species represented less than 3% ground surface covered and 3% of the total plant cover. In other words, the natural regeneration far exceeded that attempted through aerial seeding by two orders of magnitude on most sites. These sites were monitored throughout the spring growing season, and although total cover increased, there was little change in the relative importance of seeded species. The very poor coverage produced by seeded species during the winter months is noteworthy because further increases in coverage are unlikely to have any significant effect on erosion and flooding. At no time on any site did the single native species which was seeded (*Bromus carinatus*) ever exceed more than a few plants per 1000-m^2. In summary, because the seeded species never represented more than a minor fraction of the total plant cover, the $440,000 spent on aerial seeding was clearly not a good investment on this burn.

Laguna Canyon Fire

Seeding prescription. The application density and mixture of seeds utilized on this burn are shown in Table 4. Although the seed mixture was described in the "Post-Fire Rehabilitation Report and Emergency Watershed Protection Plan" released by the City of Laguna Beach as a mixture of "native plants indigenous to the coastal plant community," the principle seed was *Vulpia myuros*, a species not considered native by the most recent flora survey for the state (Hickman 1993) or other sources (Keeler-Wolf 1995). Of the three natives used, the only one common in coastal sage scrub is *Nasella lepida*, and it represented only 1% of the seed mix (by weight; numerically all three native grasses represented < 5% of the mix). In addition, although *N. lepida* has been reported as common on burned coastal sage scrub sites, its presence is due exclusively to resprouts (Keeley and Keeley 1984). The appropriateness of all three of the native species of *Nasella* used in this mix might be questioned

Table 3. Plant cover on four sites within the seeded portion of the Old Topanga Fire. Of the 10 sites studied, these had the highest cover of seeded species. Sampling was done 21-28 February 1994.

Site	Total Cover (% ground surface covered)	Relative Coverage (% of total cover)					
		Seeded Species		Natural Regeneration			
		Native	Non-native	Perennial	Annuals	Shrubs	Non-natives
Puerco Canyon	5	0	1	70	14	9	6
Carbon Canyon	4	0	2	67	1	25	5
Old Topanga	10	0	2	18	15	65	0
Schueren	94	0	3	87	2	4	4

Table 4. Seeding prescription used to aerial seed the Orange County, City of Laguna Beach and private lands burned by the Laguna Canyon Fire. Seeding was done 17-20 November 1993. Data is from the "Post-fire Rehabilitation Report and Emergency Watershed Protection Plan, Laguna Incident", City of Laguna Beach. **California native species in bold.**

Seeding density	= 9.1 kg/ha (8.1 lbs/ac)
Area seeding	= 1,225 ha (3,026 ac)
Seed cost	= $ 424,203
Total cost*	= $ 378/ha ($ 153/ac)

	Percentage	
	By weight	Numerically@
Vulpia myuros (zorro fescue)	49	22
***Nasella cernua* (nodding needlegrass)**	26	56
***Nasella pulchra* (purple needlegrass)**	13	3
***Nasella lepida* (foothill needlegrass)**	12	19

*Total cost includes application costs.
@ Based on average number of seeds per kg (from Ransom Seed Lab, unpublished data).

on the grounds that these grasses do not normally regenerate after fire from seed, and being perennials, are not likely to have as rapid growth rates as annuals when developing from seed. This is no minor matter as the three native species represented 53% of the total bill of $424,203.

Results and discussion. Six sites were established in Emerald Canyon, within the seeded area of the Laguna Canyon Fire. No seedling regeneration was observed for any of the three native grass species used in the seed mixture, although *Nasella lepida* was quite abundant from resprouts. By late March, only 1 of 6 sites had any significant cover by the seeded species *Vulpia myuros*: 12% ground cover and 23% of total plant cover (Table 5). Thus, on 5 of the 6 sites, or more than 80% of the area seeded, the seeding effort was unsuccessful, and resulted in little increase in cover. The best site had <15% ground cover by seeded species and, based on other studies (e.g., Conard et al. 1995), it seems unlikely that this level of grass cover would have any measurable effect on reducing erosion. This was borne out by our own studies of soil loss from these slopes (Keeley unpublished data).

Hydroseeding. This is a relatively new seeding technique, in which seeds are sprayed on burned slopes in a liquid mixture containing a synthetic polymer that binds to the slope. This was used on many slopes in the Laguna Canyon Fire, especially near roads (see also Bowler 1995). We are currently monitoring two such hydroseeded sites (each paired with an adjacent non-hydroseeded control site) but the data are not yet available. While the synthetic polymer used in these mixes is quite likely very effective in holding substrate

Table 5. Plant cover on three sites within the seeded portion of the Laguna Canyon Fire. Of the six sites studied, these had the highest cover of seeded species. Sampling was done 30-31 March 1994.

Site	Total Cover (% ground surface covered)	Relative Coverage (% of total cover)					
		Seeded Species		Natural Regeneration			
		Native	Non-native	Perennial	Annuals	Shrubs	Non-natives
EC - 1	3	0	6	91	0	3	<1
EC - 2	22	0	13	34	6	47	0
EC - 3	52	0	23	57	15	5	0

on steep slopes, our studies of sedimentation from these slopes indicate that neither the controls nor the hydroseeded slopes had any significant amount of soil loss. These slopes were all north-facing with inclines from 18-25°, and soils were heavy clay. In addition, precipitation in the Laguna Beach area during the winter of 1993-94 was well below normal. Our preliminary assessment suggests that hydroseeding may not serve any useful purpose under these conditions. Observations also suggest that the seed mixtures reported for these projects may have been contaminated with other seed, as we found several species on hydroseeded sites that are uncommon or unknown from southern California coastal sage/chaparral, and were not listed in the hydroseed mix. On one site we collected a variety of *Eriophyllum lanatum* known only from northern California (J. Mooring, personal communication 1994), which suggests that some or all of the seed in the mix was not of local origin.

Kinneloa Fire

The Kinneloa Fire burned over 2,000 ha of chaparral above Altadena, Los Angeles County in the foothills of the San Gabriel Mountains (Table 1).

Seeding prescription. The application density and mixture of seeds utilized on this burn are shown in Table 6. Although the predominate components of this mix were non-native annuals, two species native to California, and commonly encountered on burned sites, were included. It should be noted that the application density was significantly higher on the Kinneloa burn than on the previous two burns discussed (cf. Tables 2 and 4). Due to presumed removal of seeds by strong Santa Ana winds, the area was seeded twice, for a total of 15.4 kg/ha.

Results and discussion. Four sites were established within the seeded area of the Kinneloa Fire and the results of two of the sites where seeded species established most successfully are presented in Table 7. Ryegrass (*Lolium multiflorum*) contributed the bulk of the cover of non-native seeded species. By the standards of a resource manager, the results from the Lake Avenue Site reflect a very successful seeding effort; seeded species comprised nearly 50% of the total plant cover. However, the dominant plant on all of these sites was the non-native mustard *Hirschfeldia incana* (formerly *Brassica geniculata*). The dominance by this species possibly reflects the "ghost of seedings-past," as mustards were the species of choice for postfire rehabilitation projects beginning in the 1930's and lasting several decades, particularly in the San Gabriel Mountain foothills (Went et al. 1952, Barro and Conard 1987). The persistence of these mustards is in part due to their polymorphic seed bank, a portion of which is dormant and fire-stimulated (Keeley et al. 1985). The persistence of mustard is one of the reasons resource managers decided during the 1950's to stop using it in postfire rehabilitation projects.

Table 6. Seeding prescription used to aerial seed the U.S. National Forest and Los Angeles County lands burned by the Kinneloa Fire. Seeding was done 8-9 November 1993 and, after a windstorm that was presumed to have removed much of the seed, it was seeded a second time on 16-18 November. Data from "Kinneloa Burned Area Rehab Summary", Angeles National Forest, revised 8 June 1994. **California native species in bold.**

Seeding density	
two applications	= 15.4 kg/ha (13.8 lbs/ac)
Area seeding	= 1,416 ha (3,500 ac)
Seed cost	= $ 143,144
Total cost*	= $ 112/ha ($ 45/ac)

	Percentage	
	By weight	Numerically@
Vulpia myuros (zorro fescue)	49	22
Trifolium hirtum (rose clover)	26	56
Lolium multiflorum **(ryegrass)**	13	3
Eschscholzia californica **(Calif. poppy)**	12	19

*Total cost includes application costs.
@ Based on average number of seeds per kg (from Ransom Seed Lab, unpublished data).

Apparently due to past and present seeding successes, the ecosystems in the foothills of the San Gabriel Mountains have been greatly altered and contain a substantial non-native component. Previous experience (Barro and Conard 1987) suggest that the ryegrass (*Lolium multiflorum*) seeded after the Kinneloa Fire will eventually die out from these sites, however, there is insufficient experience with zorro fescue (*Vulpia myuros*) and rose clover (*Trifolium hirtum*) to predict their long-term impact on these communities. There is little reason to expect the mustard (*Hirschfeldia incana*) will disappear from these sites without aggressive management.

Conclusions

Results from our studies and others (e.g., Beyers et al. (1995)), of the 1993 wildfires illustrate that postfire aerial seeding is not a highly reliable technique for establishing plant cover on burned watersheds. Under conditions experienced on much of the Laguna Canyon burn and the Old Topanga burn, natural regeneration provides far more plant cover (and costs nothing) than

Table 7. Plant cover on two sites within the seeded portion of the Kinneloa Fire. Of the four sites studied, these had the highest cover of seeded species. Sampling was done 7-28 March 1994.

Site	Total Cover (% ground surface covered)	Relative Coverage (% of total cover)					
		Seeded Species		Natural Regeneration			
		Native	Non-native	Perennial	Annuals	Shrubs	Non-natives
Eaton Cyn	100	2	7	5	7	5	74
Lake Ave	100	4	40	1	8	2	45

* Native species seeded on the site were indistinguishable from those same species arising from indigenous seed; all are included under "seeded species".

the expensive aerial seeding programs. It is clear that allocating funds to such land management practices is a gamble, and it remains to be determined under what conditions it is cost-effective. This, of course, addresses only one of the recurrent issues raised about aerial seeding. On sites where seeding is successful, such as the Kinneloa burn, questions remain as to the potential negative environmental impacts on the natural biota (e.g., Conard et al. 1995, Keeler-Wolf 1995). Incorporation of native species into seed mixes may pose less of an environmental threat; however, relatively little attention has been given to the native species appropriate for postfire seeding. I suggest the natives used in seeding the Old Topanga and Laguna Canyon burns were poor choices. The most appropriate species would be ones indigenous to the site and ones commonly establishing after fire from seed. However, adding seed of any native species assumes that the level of native plant cover establishing after fire is limited by the size of the seed bank, an assumption not supported by any scientific studies.

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