Climate Adapted Seed Tool (CAST)

An evidence-based tool to improve reforestation outcomes.

www.ReforestationTools.org



Climate Adaptation Mismatch

Tree populations tend to be genetically adapted to their local historical climate conditions. But the climate is changing fast. Trees are long-lived and can't disperse as effectively as animals to track their suitable climate. Reforestation is an opportunity to help trees move to reach their ideal climate conditions.



| Climate-Adapted Seed Tool | Climate-Adapted Seed Finder | imate Tracker About | | | | | |
|--|-----------------------------|--------------------------|--------------------------|----------------|-------------|---------------|-----|
| Planting Location: | Specify | nting location by: Coord | | Мар | seed source | es as: Raster | |
| Latitude | Longitude | | | Species | | | |
| 38.80198 | -120.03694 | | | Pinus ponder | osa | | |
| MALE CON | 395 | + Exar | nine Match 🕹 Tab | le 🛃 Raster | | | |
| Chico S | Le Ann | Seed | | % Decline in P | roductivity | | со |
| a start for the | Reno | Planting Location Zone | ⇒ Elevation ⇒ - | Expected 🖕 | Lower | Upper 🖕 | Sec |
| Contraction of the second of t | onal Jest | 2-5 %DP 5-10 %DP 526 | 7500 - 8000ft | 21.28% | 13.35% | 29.40% | 97 |
| YubaCity | Carson | >10 %DP 526 | 6000 - 6500ft | 2.38% | 0.57% | 4.67% | 135 |
| Strail Strail | Lake Tahoe | 531 | 6500 - 7000ft | 3.21% | 0.78% | 8.45% | 133 |
| S Rate | | 532 | 6500 - 7000ft | 3.26% | 0.65% | 12.14% | 138 |
| Roseville | - CA | vabe 531 | 6000 - 6500ft | 3.80% | 0.85% | 12.07% | 140 |
| Sacramento | They that | ine st 95 526 | 5500 - 6000ft | 4.06% | 0.88% | 9.65% | 140 |
| Vacaville Elk Grove | | 532 | 7000 - 7500ft | 4.41% | 0.38% | 14.56% | 130 |
| airfield | | 531 | 5500 - 6000ft | 5.94% | 1.04% | 12.77% | 139 |
| Antioch | SI-CARD | 526 | 6500 - 7000ft | 6.07% | 0.84% | 13.00% | 124 |
| Stockton | Aship of | 532 | 6000 - 6500ft | 6.14% | 2.02% | 13.72% | 138 |
| eandro Livermore Fremont Modesto | | Showin | ng 1 to 10 of 27 entries | s Previou | ıs 1 | 2 3 | Ne |

Spatial Accuracy and Uncertainty

CAST allows users to input precise spatial information and is also backwards compatible with California's legacy system of seed zones and elevation bands. Because of considerable climatic heterogeneity (*i.e.*, uncertainty) within the legacy spatial units, users who use precise spatial information are likely to achieve better outcomes (*i.e.*, \approx 5% greater growth rates).



A Crisis and Opportunity

% Decline in Productivity without CAST not adapted to rapidly 2050 adapt forests to climate PICO, RCP8.5 Ensem

Expected Impacts of Seed Transfer

Climate Transfer Functions

CAST uses climate-transfer functions fit to data from seed-transfer experiments to estimate the relative growth rate (*e.g.*, growth, survival) of each candidate seed source.



Selecting seed for warming climate conditions inherently involves tradeoffs between optimizing for colder conditions in the near term and hotter conditions in the long term. CAST currently defaults to balancing this tradeoff by to optimizing for anticipated climate conditions \approx 20 yrs. in the future. It also includes options for optimizing over longer or shorter time horizons.



- Trees grow to become resistant to fire more quickly
- Greater carbon sequestration
- Greater timber production
- Forest Health
- Reduced mortality

California forests are

changing climate

• With climate-adapted

seed transfer we can

take proactive steps to

conditions.

change.

• Faster recovery into desired habitat types

| Expected Impacts—if deployed across private land in CA starting in 2021 | | | | | | | | |
|---|---------|---------|--|--|--|--|--|--|
| | By 2050 | By 2060 | | | | | | |
| Additional CO ₂ Sequestered [million tonnes/yr] | 2.3 | 4.1 | | | | | | |
| Market Value of Additional CO ₂ Sequestered [million USD/yr] | \$77 | \$138 | | | | | | |
| Additional % of Net 2018 CA GHG Emissions Sequestered [%/yr] | .5% | 1% | | | | | | |
| Additional Timber Production [million board-ft/yr] | 142 | 256 | | | | | | |

Seed-Transfer Datasets

We're working to incorporate data from 368,000 trees planted in seed-transfer experiments across western North America into CAST. Forward thinking scientists began establishing these experiments in 1910 and scientists are still working to establish new experiments. However, the bulk of our data currently comes from outside California. Scaling up the number of seed transfer experiments planted in California's diverse regions will be critical to best adapting our forests to climate change.

| Species | abco | abma | acma | alru | pico | pije | pimo | pien | pipo | pisi | potr | psme | qulo | thpl | tshe |
|-------------------------------|---------------|---------------|---------------|------|-------|------|-------|---------------|----------------|-------|---------------|---------------|---------------|------|---------------|
| N. Provenances | 14 | 9 | 42 | 47 | 184 | 3 | 145 | 182 | 42 | 30 | 180 | 77 | 95 | 10 | 57 |
| N. Sites | 5 | 5 | 3 | 2 | 60 | 3 | 7 | 26 | 10 | 9 | 3 | 6 | 2 | 6 | 5 |
| N. Trees | 9.1k | 3.3k | 13.8k | 4.1k | 70.7k | 4.6k | 22.1k | 110k | 10k | 31.9k | 9k | 25.3k | 7k | 4.1k | 42.7k |
| Last Meas. Age [field-yrs] | 18-26 | 18-26 | 10 | 10 | 20-35 | 41 | 16 | 10-15 | 8-80 | 10-15 | 3 | 17- 100 | 6 | 15 | 5-25 |
| Planting Yr(s) | 1976- 1979 | 1976- 1979 | 2008- 2009 | 1995 | 1974 | 1973 | 1988 | 2000- 2005 | 1910 - 1992 | 2000 | 2000- 2007 | 1915- 1975 | 2014- 2015 | 1991 | 1993- 2005 |





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