Into cold storage. Field mustard and jewelweed (*below*) are two widespread plants whose seeds will be stockpiled for future studies.

PLANT BIOLOGY

Banking Seeds for Future Evolutionary Scientists

Imagine a time capsule filled with almost 12 million seeds. That's essentially what Project Baseline is all about. Last week, the National Science Foundation (NSF) awarded a group of plant evolutionary biologists $1.2 million to spend the next 4 years collecting and banking seeds that won't be used until 5, 10, or even 50 years from now. "It's unique in terms of anything NSF has done," says Samuel Scheiner, an NSF program director.

Proponents of the new effort are betting that the next generations of evolutionary biologists will be eager to break into this time capsule. Comparing plants grown from the stored seeds with plants collected decades from now "will provide a far better window on actual genetic change due to adaptive evolution than we have ever had before," Jeffrey Conner, an evolutionary biologist at Michigan State University in Hickory Corners, says.

With these seeds, researchers can look more objectively at how a species reacts to global warming, species invasions, new land-use patterns, or other changes in their surroundings. "If we don't do this now, there will be no way for evolutionary biologists in the near future to address the question of how environmental change, including climate change, affected these [species]," baseline project coordinator Susan Mazer of the University of California, Santa Barbara, says.

The project grew out of the realization that plant evolution occurs on time scales biologists could measure, if they had the right material in hand. In 2005, Arthur Weis, now at the University of Toronto in Canada, and Steven Franks, now at Fordham University in New York City, were able to show that a 5-year drought in California had caused evolution in the flowering time of the mustard plant *Brassica rapa* because they had predrought seeds stored in their lab freezer. Having those seeds was merely fortuitous, however. So in 2008, in an article in *BioScience*, Weis, Franks, and several colleagues proposed setting up a seed bank expressly for future evolutionary studies.

Vast repositories such as the Svalbard Global Seed Vault in Norway, and efforts such as the Millennium Project, coordinated by the Royal Botanic Gardens, Kew, are already collecting seeds from endangered and economically important plants. But those collections will be used to restore lost biodiversity, and they won't work for evolutionary studies, points out Julie Etterson, an evolutionary biologist at the University of Minnesota, Duluth, who heads Project Baseline. To be most useful for evolutionary research, the seeds must be collected in a specific way—with adequate numbers of individual plants both within a population and across populations spanning the geographic range of the species.

As they developed the concept for Project Baseline, researchers came up with 34 target species, selecting primarily plants that are well-studied by ecologists and evolutionary biologists, common, and easy to grow, as well as some close relatives of those species. They chose ones with a variety of life history traits, such as flowering time or pollination strategy, and diverse roles in their ecosystems as well. The goal is to gather 50 seeds from 200 representatives of each species from each of 20 broadly distributed locations. At those locations, the researchers will gather seeds for about 50 other plant species to round out the collections with an additional 5 million seeds. They will go to national parks, reserves, and long-term research sites, where the likelihood of the plants still being there 50 years from now is high. "No other collection has done this," Scheiner says.

But challenges lie ahead. For one, there's no national database indicating where these species grow, so the researchers will have to cobble together their field sites based on plant lists from individual locations. Second, they can't just drop into an area, collect one day, and leave; instead, they must gather seeds over several days, even weeks, to capture the variation in the population. Finally, it's not yet clear how to manage the program long term. After about 5 years, evolutionary biologists will be able to submit proposals to withdraw seeds. Such decisions can be handled in the short term by the researchers setting up the seed banks, but a better long-term solution is needed. One idea is to get the relevant societies to take on that responsibility, but those details have not been worked out, Etterson says.

The U.S. Department of Agriculture's National Center for Genetic Resources Preservation will prepare and store the seeds in liquid nitrogen and will cover those costs. It will also accept seeds collected by non–Project Baseline researchers, if they follow its guidelines. In that way, Etterson and others hope to greatly expand the scope of the effort. And the project may be able to dovetail with other collection efforts. The Center for Plant Conservation in St. Louis, Missouri, for example, has stockpiled more than 600 rare species over the past 30 years, with collections along the lines of what Project Baseline calls for. And the U.S. Bureau of Land Management is coordinating another seed-banking project called Seeds of Success.

"It's a great idea," says Johanna Schmitt, an evolutionary biologist at Brown University. "The bigger the project is, the more information there is for scientists in the future to play with."

–ELIZABETH PENNISI

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