PROJECT REPORT

Releasing the Native Seedbank

An Innovative Approach to Restoring a Coastal California Ecosystem

by Craig C. Dremann with Michael Shaw

Restorationists have a tendency to think and act like gardeners or farmers—weeding, then planting, and then weeding again. They rarely stop to think that the soil may hold a seedbank of native species just waiting to be released—a seedbank that will repopulate the site once the unwanted plants have been removed. After working carefully with a central California coastal ecosystem for more than a decade, we witnessed the remarkable potential of the seedbank-release technique to restore ecosystems here and, possibly, elsewhere in California.

In 1985, Michael Shaw purchased 74 acres of undeveloped coastal property between Santa Cruz and Monterey, California. The land contained coastal live oak (*Quercus agrifolia*) woodland, a degraded riparian creek bed, a mesic grassland bordering the creek, and open grasslands. Most of the land was, however, overgrown with a variety of exotic species, such as French broom (*Cytisus monspessulanus*), pampas grass (*Cortaderia jubata*), Harding grass (*Phalaris tuberosa*), and poison hemlock (*Conium maculatum*), along with two native plants, poison oak (*Toxicodendron diversilobum*) and Monterey pine (*Pinus radiata*). The only ray of hope in this situation were some small relic stands of native grasses and Shaw's desire to care for his piece of wild coastal California.

Land Description and Land-Use History

The property consists of rolling hills formed by ancient sand dunes. The grassland, forest, and riparian soils on the site are underlain with a subsoil of pure sand. The property has had several types of land use since the 1840s, when it was part of the original Spanish Rancho Grants. The valley floor and hilltop were farmed, the whole property was heavily grazed from 1840-1980, and the property was timbered in the past. It was most recently used as an off-site location for a moving-and-storage company, a shooting range, and a dumping area. The remnants of the shooting range included thousands of old shotgun shells, which were removed from the property in the 1980s. In addition, the hillsides and ravines were full of discarded junk, including concrete blocks, old couches and tables, and hundreds of used tires. All of this rubbish was carried out by hand and loaded on dump trucks.

Prior to Shaw's purchase, the land was the site of an unihabited cattle ranch. The previous owner advertised the property as having a "spectacular ocean-view," and she had a contractor cut a trail with a Caterpillar tractor from the valley to the ridge. Once abandoned, this trail almost immediately grew into an impenetrable

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thicket of poison oak, thistles (*Cirsium* spp.), and other exotic weeds. All in all it was not a pretty picture.

Developing a Weed-Only Strategy to Promote the Local Natives

From 1985 to 1992, Shaw did extensive work to remove the exotics. After doing some initial surveys of the property in 1992, he and I decided on a strategy that included the following five points: 1) learn to identify all the weeds and native plants on the property; 2) continue to remove the weeds, with a focus on the valley floor; 3) experiment with mowing and continue clearing with machetes; 4) dig up and bring native plants into a suburban garden to understand their functionality and interaction; and 5) when there were successes with the weed management techniques, we would expand the areas where the success occurred.

Shaw decided to focus on the valley floor because it was the most accessible, it was already being used, and it was the biggest challenge. The riparian area of the valley floor was the weediest area on the property, and consequently would be where the most dramatic changes could occur.

Shaw recognized that many exotic plant removal projects in North America rely on burning, grazing with exotic animals, or large-scale applications of herbicides. Shaw decided to do otherwise. No burning was done because the property had too much accumulated fuel and it is located in a rural/urban interface, surrounded by multi-million dollar houses. Burning is also an indiscriminate form of vegetation management. Shaw decided against grazing with exotic animals because they: 1) might eat native plants that reappeared following clearing, 2) would not eat exotics, such as French broom, Harding grass, and pampas grass, that are either poisonous or too tough, 3) would have caused more riparian damage and grasslands soil compaction, and 4) would have redistributed or removed soil nutrients that could then favor exotics. Shaw also decided against blanket herbiciding because it is too indiscriminate, and the plan was to be very selective with what

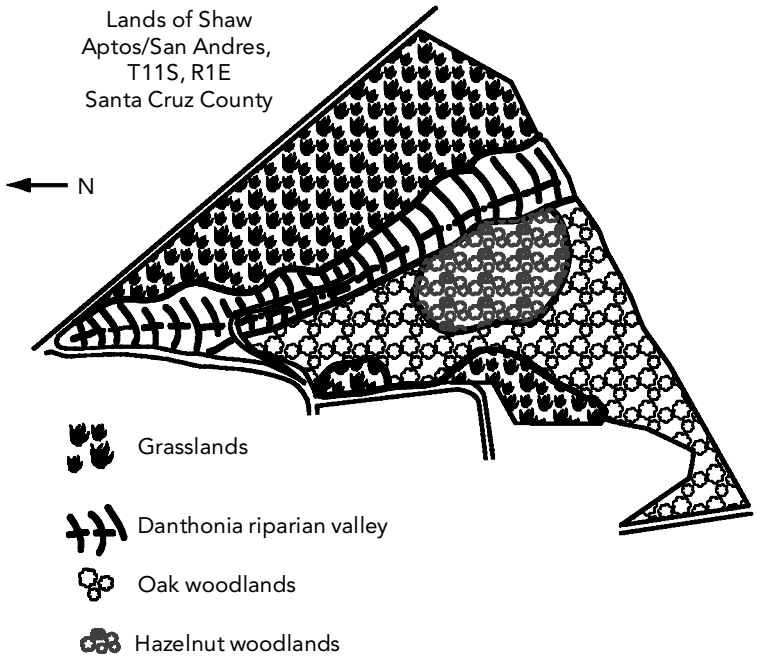

Figure 1. Map showing the location of the various plant communities on Michael Shaw's property along the Pacific coast between Santa Cruz and Monterey, California.

was being managed. Shaw felt that herbicides should only be used on plants that wouldn't respond to other management techniques. Shaw's idea was to use self-directed human energy, guided by scientific knowledge, to manage the property.

Beginning in the late 1980s and into the early 1990s, workers were assigned to the valley floor area, where they cut and removed all unwanted species that were more than six feet tall. These included French broom, pampas grass, Harding grass, thistles, hemlock, acacia (*Acacia delbata*) poison oak, and Monterey pines, the last of which had escaped from a neighboring Christmas tree farm. During the first year the absentee rancher took 12 cows off the land.

From 1991 to 1997, Shaw would periodically get depressed because all the exotics looked like too many cancers on the land. Pascual Gomez, the man who oversaw all the workers, always said, "You want it, we'll get it—there's nothing that can't be solved—it may bring new problems, but they too can be solved." When attempting to control one exotic species, Shaw found that successive invasions of other unwanted plants initially filled in the cleared areas. For example, after ridding the land of pampas grass, French broom would thickly colonize the area. Once the French broom was under control, the Harding grass would take over. Following the Harding grass, there were successive waves of bull thistles, poison hemlock, and Italian thistle (*Carduus pycocephalus*). Shaw notes, "We eventually came to realize that the removal of each species was like a mile post on the way to the ultimate goal—the release of the native species seedbank."

By peeling back successive layers of exotics, and by continuing to pay attention to new exotic seedlings, the work eventually released the native seedbank. We suspect that the exotic seedbank may have been laid down in historic waves. This phenomenon, as seen on this property, is very similar to the waves of different exotics recorded by Davy (1902)—where the northwestern coastal Californian ranchers in the 1890s could recount the order that each new exotic had colonized their land.

Initially, removing the various layers of exotics caused another problem—the release and proliferation of aggressive native species—the "big-bully" native plants. These included native brambles (*Rubus* spp.), poison oak, coyote bush (*Bac-*

charis pilularis), and stinging nettle (*Urtica holosericea*). Left alone, these species would become monocultures, but when managed, they declined in numbers and the land bloomed forth in diversity of native species.

The Valley Floor, Creek, and Danthonia Grasslands

When Shaw began his work, the 5-acre valley floor consisted of weed-infested, degraded danthonia (*Danthonia californica*) grassland, while the 3,000-foot long, seasonal creek was bordered by a degraded riparian woodland.

We soon realized that this area had severe hydrologic problems. At that time, the water in the creek came through a highway culvert upstream and was then re-funneled under the gravel road through a single steel culvert. The water shot out of the single culvert into the valley like a fire hose, cutting an 8-foot deep "drainage ditch" into the valley floor. The creek then carried the eroded soil to the Pacific Ocean. As a result of this method of water-handling, the water table dropped to 10 feet below the level of the valley floor. In addition, it deprived native plants of water and seriously stressed them during the summer. In an extensive survey (Dremann 1997), I found only four danthonia plants in a square meter area of the valley floor around the creek.

From 1999 to 2001, Shaw reconstructed the gravel road around the side of the valley to follow the slope and he eliminated any gutters or culverts for the other drainages and seeps into the valley—an unknown concept in hilly parts of the western United States. Where the road crossed drainage ways and seeps, he had a French drain built to allow the water to flow under the road without a culvert. Water now starts flowing in the creek when the first 1 or 2 inches of rainfall accumulate in autumn, but no water leaves the property until 13 inches have recharged the valley. We estimate that 40 acre-feet flowed from the upstream highway culvert into the former ditch. Now all that water is absorbed within 100 feet of the property line.

Using trade secrets technologies I have developed to repair the riparian and creek-bed areas, the water table has now risen back up to within three feet of the valley floor, and the danthonia seedbank has taken advantage. Danthonia has increased from four drought-stressed plants in 1997 to cover most of the valley floor. A person can now kick seedheads of lush danthonia plants with every step through the valley floor.

Figure 2. The restored creek on Michael Shaw's property. Prior to restoration it was an 8-foot deep ditch choked with exotic plants; today it supports native vegetation and is bordered by a danthonia meadow *(Danthonia californica)*. *Photos courtesy of Craig Dremann*

Shaw has observed that the creek repair was in essence the "spinal cord restoration" of the valley. In 1996, portions of the valley floor had 99 percent cover of exotic velvet grass (*Holcus lanatus*) and only 1 percent cover of the native meadow barley (*Hordeum brachyantherum*). Today these areas are 10 percent meadow barley and an 80-percent mix of other native plants, including rushes (*Luzula* spp.), sedges (*Carex* spp.), Pacific bentgrass (*Agrostis exarata pacifica*), goldenrod (*Solidago* spp.), and an unusual hedge nettle (*Stachys ajugoides* var. *ajugoides*).

Oak Woodlands

About half of the property is a coast live oak woodland, which, in 1985, was totally impenetrable. A maze of brambles and poison oak up to 40 feet above the ground made a 30-acre section of the land inaccessible year round. Old hazelnut trees were beleaguered and unproductive.

After Shaw purchased the property, he hired a contractor to open small parts of the woodland with a Caterpillar tractor. Since 1988, all clearing in this area has been done by hand with machetes. Working species-by-species and by cutting alone, invasive weeds (including a government-mandated erosion control mix consisting of exotic species) and aggressive natives (poison oak, brambles and stinging nettle) have been controlled. Gradually, long-dormant seeds of local native plants have sprouted and taken the place of the exotics.

Occasionally, a population of a single native species would explode following the removal of an exotic species. For instance, in 1992, thousands of California bottlebrush grass plants (*Elymus californicus*) appeared in locations where the pre-existing non-native vegetation had been manually controlled. This rare grass is only found in the coastal San Francisco Bay area, from Marin County to Santa Cruz County. It has been so rare for the last century that less than a dozen specimens have been collected from Santa Cruz County.

California bottlebrush grass is rare in large part because it needs sunny openings in the oak and conifer woodlands to grow. The lack of constant human movement or trail cutting through the dense coastal woodlands has eliminated areas of sunlight hitting the ground—light that the seeds need to germinate. Likewise, patches of up to 1,500 square feet of slender Solomon's seal (*Smilacina stellata*) have steadily expanded in areas that formerly were thoroughly shaded and supported no herbaceous plants. California tea (*Psoralea physodes*), snowberry (*Symphoricarpos albus* var. *laevigatus*), and melica (*Melica torreyana*) have all established substantial colonies on formerly unproductive ground. Hundreds of highly productive native pink currant (*Ribes* spp.) are now scattered between the oaks and native California hazelnuts, dotting the hillside with soft pink flowers in the dead of winter. The reinvigorated California hazelnuts (*Corylus californica*) often produce one dozen nuts per one feet of stem.

Within the woodlands, an excess of 50 native species that were not growing there in 1985 now exist. Today, the old oaks are much healthier and a new crop of tall, young oaks has emerged from seed. Madrones (*Arbutus menziesii*) and young manzanita (*Arctostaphylos tomentosa*) are now flourishing. Other native grasses growing in the woodland include: blue wild rye (*Elymus glaucus*), California brome (*Bromus carinatus*), slender hairgrass (*Deschampsia elongata*), and woodlands needlegrass (*Nassella lepida*).

Open Grasslands

Before the management work began, the vegetation on the hillsides and hilltops consisted of a few thousand square feet of purple needlegrass (*Nassella pulchra*). The rest of the area was covered with Spanish or wild oats (*Avena* spp.), red brome (*B. madritensis* var. *rubens*) and ripgut brome (*B. diandrus*). When all the exotics were removed, the purple needlegrass areas increased to at least five acres. Lupine (*Lupinus nanus*) also spread to cover several acres, and the native plantain (*Plantago erecta*), mariposa lilies (*Calochortus* spp.), hill morning glory (*Calystegia subacaulis*), and other native wildflowers began appearing. Prior to management, none of these species were evident. Danthonia has recolonized the level valley areas and becomes lush on a seasonal basis. Meanwhile, the native bentgrasses (*Agrostis* spp.) grow in the seeps, where they previously were not known.

The rare coast rein orchid (*Piperia elegans*) is one of the many native species that reappeared following the removal of exotic species on Michael Shaw's property. Other species that have reestablished themselves from the seedband include lupine (*Lupinus nanus*), California bottlebrush grass (*Elymus californicus*), purple needlegrass (*Nassella pulchra*), and several native bulbs (*Brodiaea, Iris, Sisyrinchium,* and *Calochortus*).

Releasing the Native Local Seedbank

The remarkable part of this whole process is that Shaw did not plant any native seeds or plants, with the exception of a little California bottlebrush grass seed sown along one new roadside. The area was effectively managed to allow the release of the native seeds and bulbs that were still in the seedbank. Why is this process possible? California native plants have developed hard seedcoats to survive Californian arid summers, when from May to November there is little to no rainfall. It is well known that species with hard seedcoats, such as lupine, maintain their viability for decades. Because the native seedbank exploded everywhere at once, we believe that the seedbank was left there when the land was populated by a high percentage of native plants. This suggests that this seedbank is at least 30 years old and, perhaps, as much as 100 years old.

Randall Morgan, an environmental consultant and a fellow of the California Native Plant Society, was hired by Shaw to inventory every plant on the property and divide the plants into local natives and exotics. Morgan also critiqued the project's performance and what it had achieved by 1996. In an unpublished report, Morgan concluded:

> Your particular low-tech, slow-and-steady, weeding-only system of habitat enhancement takes a very different approach and has been, to my eyes, more successful and "cleaner" in every way than any planting-based project I know of. The approach you are taking is conservative by any standard—no fire, no grazing, no significant surface disturbance, no wholesale spraying, no planting or seeding. Nevertheless, the results have been dramatic. Native plant diversity is remarkable for the region (over 200 species so far), formerly abundant noxious weeds are nearly eradicated, and lush multi-species 'gardens' have sprung up in places formerly monopolized by poison oak and other aggressive plants. A surprising number of native species have spontaneously (re) appeared, presumably from long-dormant seeds or bulbs. (Morgan 1996).

By 2002, success is now immediately obvious, with an overall conversion rate from 99 percent exotic cover to 85 percent native plant cover. In the past, the plant

Table 1. Exotics decreasing on the property through management (Morgan and others 1994-98).

Common Name	Scientific Name
acacia	*Acacia delbata*
annual bluegrass	*Poa annua*
annual ryegrass	*Lolium multiflorum*
Bermuda grass	*Cynodon dactylon*
brachypodium	*Brachypodium distachyon*
bull thistle	*Cirsium vulgare*
Chilean brome	*Bromus stamineus*
curly dock	*Rumex crispus*
dallis grass	*Paspalum dilatatum*
European bentgrass	*Agrostis tenuis*
farmer's foxtail	*Hordeum leporinum*
French broom	*Cytisus monspessulanus*
Harding grass	*Phalaris tuberosa*
hemlock	*Conium maculatum*
Italian thistle	*Carduus pycocephalus*
knot grass	*Paspalum distichum*
little quaking grass	*Briza minor*
Mediterranean barley	*Hordeum marinum*
Monterey pine	*Pinus radiata*
nitgrass	*Gastridium ventricosum*
orchard grass	*Dactylis glomerata*
Pampas grass	*Cortaderia jubata*
German ivy	*Senecio mikanioides*
rabbit's foot grass	*Polypogon monspeliensis*
rattail fescue	*Vulpia myuros*
rattlesnake grass	*Briza maxima*
red brome	*Bromus madritensis* ssp. *rubens*
red fescue	*Festuca rubra*
ripgut grass	*Bromus diandrus*
rose clover	*Trifolium hirtum*
silver hairgrass	*Aira caryophyllea*
six-weeks fescue	*Vulpia bromoides*
soft chess	*Bromus mollis*
Spanish or wild oats	*Avena barbata*
tall fescue	*Festuca arundinacea*
thistles	*Carduus* spp. and *Cirsium* spp.
velvetgrass	*Holcus lanatus*

(Note: Monterey pine, a native to California, is listed here because it is outside of its natural range).

communities on the property were so obnoxious that plastic rain pants were required to walk through them to protect one's legs from the thistles and ripgut brome. Today, you can walk through the area in shorts, and experience danthonia plants so lush they are like a pillow with built-in fragrances from the rare, light-pink flowered hedge-nettle that grows near them. Today, there are many species that have appeared from long-dormant seeds growing on the site, including those previously mentioned as well as California poppy (*Eschscholzia californica*), several species of lotus (*Lotus formosissimus, L. micranthus, L. purshianus, L. strigosus*), miner's lettuce (*Montia perfoliata*), mule's ears (*Wyethia angustifolia*), several native bulbs (*Brodiaea, Calochortus, Chlorogalum, Iris, Sisyrinchium,* and *Tritelia*), owl's clovers (*Castellija densiflora* and *Triphysaria pusillus*), tarweeds (*Madia exigua* and *M. gracilis*), and the rare coast rein orchid (*Piperia elegans*).

We have seen that peeling back the exotics by size, starting with the tallest (six feet or more) first and working down to the plants six inches or less can have dramatic results. The main advantage of working on this property is that the native seedbank is still viable and, therefore, the right species with the local genetic material emerge in the combinations and places where they would naturally occur. Issues that often hamper restorationists—not having the right species commercially available, not having local genetic material, or not knowing which native species existed where—were not problems since the native seedbank was alive and well.

Future Visions

Other grassland, wild land or rural/urban interface landscape projects in the arid West may want to investigate the existence of the native seedbanks in the early stages of the restoration process, to see if anything is viable and can be used to advantage. Whether or not a native plant community with a low number of exotics will evolve on Shaw's property remains to be seen. We anticipate that the area will require management in perpetuity if the native diversity is to be maintained.

Shaw eventually plans develop the property as a nature retreat where people from around the world can experience the potential of wild California ecosystems or as a prototype wildlands/housing community. On-site employee housing would be provided for land managers to continue to improve on the native plant communities. From a developer's standpoint, the paradox of all of this work is that no one in his or her right mind would do what Shaw has done. Shaw says, "Because of the Endangered Species Act—what developer or land owner would want to purchase or own the land and do what we are doing? Disincentives preclude innovation. It is no wonder that no one else is following this common sense formulation for success: Pull the weeds and manage the plants and the hydrology."

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Craig C. Dremann is owner of The Reveg Edge, Box 609, Redwood City, CA 94064, 650/325-7333, craig@ecoseeds.com; www.ecoseeds.com/nature.html. Michael Shaw, Liberty Garden, 32 Seascape Village, Aptos, CA 95003, 831/684-1057, Fax: 831/684-0768, michaelshaw@liberty-garden.com, www.libertygarden.com