# Humboldt Bay (/refuge/Humboldt_Bay)

*National Wildlife Refuge | California*



## Dune Restoration

*A healthy dune plant community is composed of a mixture of native grasses, forbs, and subshrubs. Dune restoration efforts have proven that these native species will recolonize degradated dunes by removing non-native species and restoring essential dune processes.*

**Introduction**

The Refuge's Lanphere Dunes Unit is home to the first dune restoration project on the west coast. Restoration began in the 1980s with early experiments to control invasive European beachgrass (*Ammophila arenaria*). By the early 1990s The Nature Conservancy (the past owner) began a large-scale mechanical eradication project that took 6 years to complete. This project became a template for dune restoration projects throughout the west coast and beyond. Most importantly, it demonstrated that by removing over-stabilizing beachgrass and other invasive plants, essential dune processes were restored, fostering the recovery of the ecosystem. Since that time, dune restoration has continued to evolve and expand. On our local dunes, over 7 miles of coastline have been restored in Humboldt and Del Norte counties, and plans are in the works that will more than double this number.

**What is restoration and why is it needed?**

We define restoration as a holistic process that results in the return of a compromised ecosystem to one that supports not just the individual parts (for example, native plants and animals), but also the underlying processes that sustain them. These processes can be both biological (for example, mutualisms, food webs or succession), or abiotic (such as hydrology, or in dunes, importantly, sand movement). Many years of research have confirmed that the plant and animal communities found on our local dunes are dependent on a finely-tuned equilibrium between sand movement and stability.  Our dune communities require repeated disturbance to maintain the patchwork of successional stages that results in high levels of diversity. These agents of disturbance take many forms, including wind (causing both erosion and deposition), salt spray, wave erosion, animal burrowing and herbivory. When these processes are curtailed by human activities, such as the introduction of invasive species, changes cascade through the system, resulting in the loss of diversity at all levels.

**Pictures: The picture on the left was taken prior to restoration efforts and clearly shows a dense monoculture of European beachgrass. The picture on the right was taken from the same location after successful restoration efforts, which returned this dune to more natural conditions.**

**How were our dunes degraded?**

At Humboldt Bay National Wildlife Refuge, we were fortunate to have acquired a relatively intact dune system, the Lanphere Dunes, which had been under the stewardship of former landowners William and Hortense Lanphere who sought to minimize the kind of extensive erosion of vegetated dunes seen elsewhere during the heyday of unregulated off-highway vehicle use. In addition, the invasion of a highly disruptive species, yellow bush lupine (*Lupinus arboreus (/refuge/Humboldt_Bay/wildlife_and_habitat/YellowBushLupine.html)*), from adjacent property to the north where it had been planted in the 1960s, was minimized by the early efforts of the late John Sawyer, Professor of Botany at Humboldt State University. He founded the annual "Lupine Bash" with the help of the local chapter of the California Native Plant Society in 1978. When the Lanphere Dunes passed into the hands of TNC in 1974,  the most significant threat besides vehicle trespass was European beachgrass, which had made incursions onto the property from both the north and south.  Since that time, Humboldt County instituted an OHV ordinance and vehicular trespass is no longer a threat. At the same time, TNC and later FWS added properties to south (now the Ma-le'l Dunes) that had been more severely degraded and required additional restoration. The Ma-le'l Dunes had a foredune completely overtaken by European beachgrass, and in the dune ridges behind the foredune, beachgrass was joined by

yellow bush lupine and iceplant (*Carpobrotus* spp.). Yellow bush lupine causes severe impacts to the dune community because it elevates soil fertility to the point where native species (adapted to low fertility levels) cannot compete, and facilitates secondary invasions by invasive annual grasses.

**Restoration Methods**

Dunes are by nature a relatively hostile environment characterized by low soil fertility, summer drought, harsh winds, variable but potentially intense solar radiation, and salt spray. The organisms that live here have adapted to these conditions with many specialized traits. Because of this, restoration necessitates the return of the system to these conditions. This process begins with the removal of over-stabilizing vegetation. In many cases, that action alone is sufficient to return the system to point where native species can recolonize, and communities can recover relatively unaided. In other cases, such as where yellow bush lupine has altered soil properties, more intensive intervention is needed.

Degraded coastal dunes are particularly suited to mechanical restoration, which mimics the physical disturbance that underpins dune processes. Mechanical restoration on our refuge has taken the form of manual removal of European beachgrass with shovels, or less commonly with heavy equipment. In a relatively intact system with a high degree of native plant cover and associated animal use, manual removal allows for very localized impacts that preserve native patches as sources for recolonization of restored areas. Although labor-intensive at the front end, this method can eliminate the need for revegetation, which can be costly.  Heavy equipment (usually tractors) are appropriate when an area is highly degraded. Tractors can be used to bury more organic soils left after invasions, and expose the mineral sand beneath. This method may require revegetation and/or a longer period of management to ensure that dunes don't become overly destabilized and slow to recover vegetation cover.

**Pictures: The picture to the left shows a large crew of laborers preparing for hours of digging to remove European beachgrass. The picture on the right is six years later, and shows that their efforts were not in vain as the plant community has become a mosaic of native grasses and forbs.**

Manual removal requires repeated visits to dig out re-sprouting *Ammophila*, which has an extensive system of rhizomes (underground stems). Plants are killed gradually over 2-3 years, which gives native plants a chance to recolonize at the same time. The initial "dig" is by far the most labor-intensive. However, consistent follow up is crucial or the beachgrass will recover. The foredune is the most susceptible area to erosion resulting from this treatment. Blowouts are a natural occurrence in our dunes, important as an agent of disturbance for maintaining diversity. We have used different techniques to maintain a healthy balance of foredune erosion and accretion during restoration, including phased removal of beachgrass along sections of foredune over time, and the planting of locally harvested native dune grass (*Elymus mollis*), a native foredune builder that can hold its own once European beachgrass is removed.  Although we have only used heavy equipment in localized areas to date, this method has been used extensively and with success elsewhere.

**Measuring Success**

An important part of restoration is monitoring the results. Our oldest restoration project at the Lanphere Dunes was carried out almost 20 years ago, and we have continued to monitor the response of the ecosystem, providing important data that has been used to support continued restoration elsewhere. Although our in-house monitoring has focused on vegetation, we have sought

outside researchers to assess responses in invertebrate and vertebrate communities. More recently, we began using topographic profiles to monitor geomorphic responses. To date, our efforts have been rewarded with positive results. Plant communities have been shown to respond quickly, moving through different successional stages over time. The earliest restored areas are now indistinguishable from those that were never degraded. A study published by a researcher at San Francisco State University confirmed that terrestrial arthropod abundance and richness has also been restored. We know from the work of students at Humboldt State University that the use of the dunes by small rodents and some bird species (including raptors) is actually enhanced by European beachgrass invasion, and we have seen an expected decline in some abnormally high densities of rodents to the level normally associated with these communities.  To see time-series photographs documenting this dramatic response, see Lanphere dune restoration photopoints (/uploadedFiles/Region_8/NWRS/Zone_1/Humboldt_Bay_Complex/Humbolt_Bay/Sections/Documents/LanRestPhotopoints2017.pdf) and Ma-le'l dune restoration photopoints. (/uploadedFiles/Region_8/NWRS/Zone_1/Humboldt_Bay_Complex/Humbolt_Bay/Sections/Documents/Ma-le'l_Photopoints2017.pdf)

### It Takes a Village To Restore a Dune

Our restoration has been funded by a number of entities, including U.S. Fish and Wildlife Service, The Nature Conservancy, California Department of Corrections and Rehabilitation, California Department of Fish and Wildlife, California State Coastal Conservancy, and the National Fish and Wildlife Foundation. We have depended heavily on our longtime partners, the California Conservation Corps, as well as the generosity of the Sheriff's Work Alternative Program and the hard work and muscle of the California Department of Forestry and Fire Prevention crews. But up-front funding is not enough to ensure the long-term results of restoration. Our partners, Friends of the Dunes, have provided a continuing source of volunteers, and equally important, have been the backbone of community involvement and education, building sustained public support for our work.

*Leafcutter Bee*

*The leafcutter bee (Megachile wheeleri) is one of the of specialized, solitary, ground-nesting bees that are crucial to the survival of our native dune mat community. The leafcutter bee, shown here pollinating dune goldenrod, cuts semi-circular pieces from goldenrod leaves and uses them to construct its nest cell. Native bees are gaining increased attention as pollinators due to the decline of the imported honey bee (Apis mellifera) through colony collapse disorder. Photo courtesy of Andrea Pickart.*

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