Frequently Asked Questions about Dune Ecological Restoration 11/17/15

The following Q&A is based on facts and insights compiled from published reports and articles and with the help of numerous professionals working in the fields of restoration ecology, geomorphology, and other related disciplines.

The references provided reflect expert literature on dune ecology. They are extensive, well-researched and a representative sample of the data currently helping guide local best practices in the field of restoration and conservation. Some of the work is local and some is not; thus application to our coastal habitat varies. Again, this compilation of resources is intended to be representative, not exhaustive.

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What is the goal of coastal dune restoration?

The goal of restoration is not only to restore the native diversity of plants and animals to the dunes, but also, where feasible, restore the natural processes that sustain dune ecosystems. Because every site is unique, goals for a given restoration project may differ. For example, the location of roads and infrastructure may constrain the amount of dune movement that is acceptable at a site. In this case, the focus may shift to restoring and maintaining ecological diversity in the absence of fully functioning processes. The patchy, open nature of dune vegetation on the semi-stable dunes allows plants to avoid direct competition, resulting in the coexistence of many different species. The open nature of the vegetation is maintained by natural disturbances including the development of periodic localized blowouts, storm and wave attack, severe wind storms, insect and mammal herbivory, burrowing, and the environmentally stressful conditions of the dunes. Our native plants and animals have evolved special adaptations that allow them to thrive in these conditions. This dynamic system allows for a diversity of plants and animals including over 40 species of native bees, over 200 plant species, and over 250 species of birds.

For more details, see (full citations at end of document):
Martinez et al. (2013)
Pickart (2013a)
Walter (2010)

What are the main methods used for doing restoration?

Locally, the majority of dune restoration work involves the removal of invasive plants, done by hand, using crews (such as the California Conservation Corps), land management agency staff, and community volunteers. In appropriate sites, mechanical removal with heavy equipment may be used. Much of the work focuses on the removal stage, because native dune plants have adaptations that make them effective colonizers. Depending on the amount of native plants that are left after removal and the susceptibility of the area to erosion, revegetation after restoration may be needed. Planting native dunegrass on the foredune can help to reduce erosion and jumpstart recovery. The participation of community volunteers in restoration is an essential ingredient for successful restoration. Community support increases the long-term viability of projects, as community members become familiar with the value of coastal dunes and become invested in their protection. The value of volunteer time is also important in providing "in-kind match" for grants from foundations and other granting agencies. Land managers do not receive funds for volunteer time.

For more details, see (full citations at end of document):
http://www.friendsofthedunes.org/nature/restore.shtml
Pickart (2013a)
Pickart (1997)
Pickart et al. (1998)

Who is in charge of all the local dune restoration projects?

The dunes found at Humboldt Bay and the surrounding coastline are managed by a number of different land management agencies and organizations, both public and private. Dune restoration is normally planned and carried out by the agency or non-profit that owns/manages the land. Friends of the Dunes manages restoration projects at the Humboldt Coastal Nature Center and provides volunteers for projects at other properties. Major restoration projects have occurred or are in progress at Humboldt Bay National Wildlife Refuge (Lanphere and Ma-le'l Dunes Units); the Bureau of Land Management's Ma-le'l South dunes, Samoa Dunes Endangered Plant Protection Area, and the Mike Thompson Wildlife Area, South Spit, Humboldt Bay; Manila Dunes Recreation Area, the Wildlands Conservancy's Eel River Preserve, Little River State Beach and Gold Bluffs Beach at Prairie Creek State Park.

Why is European beachgrass, which was at one time planted to stabilize drifting sand, now being removed?

While European beachgrass may have served its purpose of keeping sand from moving eastward into the bay or over roads and railroads when originally planted in the 20th century, we now know this non-indigenous, invasive grass negatively impacts biodiversity and ecosystem function. Beachgrass was originally planted near the town of Samoa in 1901 when the Vance Redwood Company had become concerned about dunes encroaching on the bay shore, potentially impeding shipping access. Later, it was planted along the now obsolete railroad tracks and near the town of Manila and has since spread up and down the coast to foredunes and back-dune areas. Based on historic aerial photography, *Ammophila* cover on the North Spit has increased by over 500% between 1939 and 1989. Its dense thicket eliminates space for native plants, pushing out rare and threatened plant species. European beachgrass impedes natural, dynamic dune processes, and reduces biodiversity. In areas where more dune stability is desired, such as on large mobile dunes near communities like Manila, that stability can be maintained and controlled through restoration that employs the use of native plants, including forest species like beach pine and Sitka spruce. Dune forest occurs naturally on the older stable dunes adjacent to our moving dunes.

For more details, see (full citations at end of document):
Buell et al. (1995)
Hart et al. (2012)
Hilton et al. (2005)
Hilton et al. (2006)
Petersen et al. (2011)
Pickart (1997)
Pickart (2013a)
Walter (2010)
Wiedemann and Pickart (1996)

What effect does dune restoration have on homes and roads?

Restoration practices are planned and carried out in ways that pose no threat to homes and roads. Most commonly, restoration is focused on restoring native species and dune processes to the foredunes immediately adjacent to the beach, far from homes and roads. The larger mobile dune fields and parabolic dunes that are still active in the undeveloped areas at the Lanphere and Ma-le'l Dunes were still receiving sand from the beach in the 1940's but have migrated a significant distance inland in the past 70 years (USFWS unpublished data). There is currently little or no connection between the beach and the parabolic dunes. The older, stabilized dunes and dunefields are relicts of previous phases of transgressive dunefield and parabolic dune development. Where dune systems occur at the boundary of subduction zones it has been hypothesized that remobilization of stabilized dunes occurs in association with megaquakes and/tsunamis. These natural areas on federal lands are managed to protect the natural dune processes, including the burial of forest as well as the birth of new forests in deflated areas and along more stable ridges. In the Manila area, European beachgrass was planted during the mid-20th century to stabilize large moving dune fields in order to protect houses and roads built over the historic dune forest at what is now the community of Manila. These dunes have become largely stabilized and pose no threat to communities.

For more details, see (full citations at end of document):
Carter et al. (1991)
Goff et al. (2008) Hesp (2002)
Hesp and Thom (1990)
Hesp and Walker (2013)
Leroy (1999)
Pacific Watershed Associates (1991)
Petersen et al. (2011)
Peterson et al. (2010)
Pickart (2013b)
Tsoar and Blumberg (2002)

What is the effect of dune restoration on tsunami hazard in our local coastal areas?

In communities such as Manila, restoration has focused primarily on the foredune and the relatively low dune ridges behind it. Between this restored foredune are and the homes and communities to the east there are much higher parabolic dunes that have been partially or wholly stabilized. Local geomorphologists agree that any protection the foredune would provide, especially in the case of a major Cascadia earthquake event, would be minimal. The current potential tsunami inundation mapping from the California Geologic Survey suggests the worst case tsunami scenario would completely overtop the foredunes on the entire North Spit regardless of whether or not restoration is done on the foredune. According to the California Geological Survey, the large parabolic dunes located several thousand feet inland from the coastline (for example, the dunes west of the community of Manila) are what provide the community of Manila refuge from direct oceanic tsunamis surges, not the foredune. Inundation of Manila, when and if it occurs during the largest of tsunamis, would most likely occur due to surges transmitted into the Humboldt Bay (eastern) side of the community; not from the side protected by the large coastal dunes. Restoration does not increase the community's vulnerability to tsunamis and continues to be important in helping to restore ecological resiliency to a rare habitat.

For more details, see (full citations at end of document):
California Geologic Survey (2013)
Carter (1991)
Davidson-Arnott (2010)

Hart and Knight (2009)
Hesp (2002)
Jungerius (2008)
Sloss et al. (2012)
Tsoar and Blumberg (2002).

What effect does removal of beach grass have on snowy plovers?

While removing beachgrass does increase potential nesting habitat for Plovers, locally, its presence is not the major cause of plover decline. Predators like crows and ravens probably have the largest negative impact on plovers, followed by human related disturbance and limited nesting habitat. The primary reason European beachgrass is removed during restoration efforts on the north spit is to increase ecological diversity and restore some natural dune processes that can sustain that diversity, which will in turn provide more suitable habitat for plovers.

For more details, see (full citations at end of document):
Colwell et al. (2010)
Muir and Colwell (2010)

How does restoration effect wildlife?

What we know from field research is that: (1) rodents have higher abundance in places with Ammophila than in restored areas, likely in part because the dense grass provides lots of cover and safety from predators, (2) rodents forage more for seeds in Ammophila-dominated places, and this feeding can affect the germination and populations of other plant species, both native and non-native, (3) medium-sized carnivores (foxes, skunks, etc....called "mesocarnivores") are more active in the restored than in the Ammophila-dominated habitats, probably because the grass cover is too dense for them to effectively hunt. There is no information to date about the impact on owls.

From this research we know that whenever a habitat changes in plant species composition and "structure" (density of cover, vegetation, height etc.) there are going to be some wildlife (and plant) species that like it, and some that don't. Ammophila came in and species responded. Managers have removed Ammophila and species responded. The management question then becomes one of values and desired outcomes. Which species do we want to promote? In the case of Ammophila, most ecologists would agree that the benefits of Ammophila removal to wild species -- such as native plants, pollinators, plovers, and mesocarnivores -- strongly outweigh the benefits of dense Ammophila cover to mice and voles.

For more details, see (full citations at end of document):
Johnson, M.D & De Leon, Y. (2015)
Maron, J.L. & Simms, E.L., (1997)

Are we losing our dune forests and are they being restored?

The biggest loss to our local dune forests has been conversion to industrial and residential development. This loss has outpaced the natural loss of forest by the encroaching dunefields. Although it may seem contradictory to manage for continued burial of the forest by the mobile dunefield, this is a natural process that has been occurring cyclically for thousands of years as rejuvenation events are followed by gradual restabilization. Of course climate change has added a wildcard to the forest’s future fate. Although the dune forest actually requires wind to allow for regeneration of pines, extreme winds occurring as the result of climate change, combined with a shrinking forest, may cause long term changes to the forest structure and distribution. Managers have plans to measure the rate of recovery in past storm impacted areas to determine whether management is needed to increase forest resilience.

To date, restoration within our dune forests has focused on invasive species removal, primarily English ivy. English ivy climbs high into the tree canopy, adding weight and increasing the chance of treefall during high winds. In addition, ivy blankets the forest floor, pushing out the diverse and unique native flora. More recently, restoration practitioners have been looking at the possibility of employing localized forest conversion at appropriate sites. This type of restoration promotes the development of forests in areas where previously mobile dune sheets have been stabilized by invasive species and removal is not feasible either because of cost, or the presence of nearby homes and infrastructure.

For more details, see (full citations at end of document):
Green (1999)
Jacoby et al. (1995)
Peinado et al. (2011)
Pickart (2013a)
Walter (2010)

Is there research to back up current restoration practices and future plans?

Yes. In our area we are fortunate to have a number of scientists and restoration professionals with years of experience studying dune processes and the effects of restoration. For example, Humboldt Bay National Wildlife Refuge ecologist Andrea Pickart and Dr. Bill Weaver, a Pacific Watershed Associates geomorphologist, are experts in their fields with years of experience consistent with a wide range of current, peer-reviewed research. Monitoring and observations of restoration sites as well as areas that have not been restored has been taking place for more than 30 years. Recently, a study of sand movement on the North Spit has been implemented and is being conducted by the Humboldt Bay National Wildlife Refuge that will help us to gain knowledge on short and medium term changes to the foredune and other dune features that occur close to the ocean. Based on multi-year measurements of changes in dune height and vegetation, we hope to model how our dunes will change as sea levels rise, and how vegetation may respond to these changes. In addition, there are numerous studies on restoration processes and impacts in the international literature (e.g. Martinez et al. 2013, Walker et al. 2013). See the list of references, many based on local studies, at the bottom of this document.

For more details see:
Lithgow et al. (2013)
Martinez et al. (2013)
Walker et al. (2013)

What is the effect of restoration on coastal wetlands?

The wetlands found in our non-forested dunes are seasonally saturated or flooded, low-lying areas that form where wind has eroded sand down to the level of the seasonal water table. These wetlands occur in troughs that form between small parabolic dunes, and as larger, more continuous wetland areas within deflation plains where sand has been scoured out and moved inland as the transgressive dunefields migrate downwind. Wetlands in the coastal dune system are not static features. They can be buried along their western margins when blowouts in the foredune become small parabolic dunes that migrate inland. They also expand eastward in the deflated areas that form as transgressive parabolic dunes and dunefields migrate to the east. Non-native species, especially beachgrass, have significantly altered both dune and wetland processes. When European beachgrass encroaches around dune wetlands, these features become unnaturally static. When restoration is carried out, new tongues of sand are able to move into the deflation plain, which can result in localized wetland loss. These losses are offset by the formation of new wetlands or the expansion of established wetlands in areas where European beachgrass is removed.

For more details, see (full citations at end of document):
Grootjans at al. (2002)
Hesp and Walker (2013)
Hilton (2006)
Humboldt Bay National Wildlife Refuge Report: Ma-le'l Dunes Restoration Photo Documentation (2011)
Nordstrom et al. (1997)
Pickart (2013a)

What is the impact of restoration on dune hydrology?

Restoration on the broader dune systems of the north spit, such as Lanphere, Ma-le'l, and Manila, has little impact on dune hydrology. Locally, hydrology is shaped by our Mediterranean climate with dry summers and wet winters. During the rainy season, fresh water percolates rapidly through the sand, recharging the freshwater table. A freshwater "lens" floats on top of the underlying saltwater table that extends from the bay to the ocean. The thickness of this freshwater lens fluctuates seasonally in response to rainfall. During periods of high or sustained rainfall, the freshwater table rises causing the seasonal wetlands to become flooded. The wetlands themselves form when wind scours and deflates an area until the surface reaches the summer water table, after which sand can no longer be picked up and carried by wind. So, our wetlands all form at the elevation of the summer water table during a given year.

On the North Spit, there is very little expression of the salt water table beneath the dune system because of the size and thickness of the freshwater lens overlying it. The wetland plants in the dune swales along most of the Spit are freshwater wetland species. These species do, however, tolerate slightly brackish conditions that can occur from salt spray or occasional overwash near the ocean. On smaller sand spits like the Elk River Spit, South Spit, and Eel River Spits, the freshwater lens is thinner or less persistent, and washover events (where waves overwash the spit) are more common. In these areas true brackish marshes can occur in the dunes.

For more details, see (full citations at end of document):
Grootjans et al. (2004)
Martínez and Psuty (2007)
Nordstrom (2004)
Nordstrom et al. (1997)
Pacific Watershed Associates (1991)
Pickart (2013a)
Sloss et al. (2012)

Are land managers concerned about storm surges that could overtop dunes and bring salt water into wetlands?

Blowouts in narrow sand spits like the South Spit and Eel River sand spits do provide a path for storm surge overwash, which is a natural process in these systems and results in the brackish marshes that exist in these low, narrow dunes. Overwash is far less common on the North Spit, which has a more substantial foredune backed by a broad system of dune ridges. Occasional storm-related erosion and overwash may occur locally, but is an infrequent event. As discussed above, wetland dune species have a tolerance to slightly brackish conditions, and would not be impacted in the long term by isolated washover events. It is important to keep in mind, however, that we may have entered a period of increased "extreme events" due to climate change. It is difficult to predict how our dunes will respond if we have more frequent coincidence of spring tides and storm surges. Under such conditions both native and invaded foredunes are likely to experience greater erosion (see below).

For more details, see (full citations at end of document):
Carter (1991)
Hesp (2002)
Martínez and Psuty (2007)
Nordstrom (2004)
Pacific Watershed Associates (1991)
Sloss et al. (2012)

How might climate change and sea level rise impact dune restoration plans?

Adaptive management will play an increasingly important role as we enter an era of new climate conditions for which there is no historical knowledge base. Conservationists and scientists generally agree on some basic tenets for this type of management that include the continued emphasis on biological diversity and landscape resilience. In terms of biodiversity, the more genetic diversity that is contained in a system, the greater the probability that organisms will be able to adapt to changing conditions. Resilience defines the ability of an ecosystem to recover following a disturbance event. Functional dune ecosystems are naturally dynamic, diverse and resilient. As such, they offer important advantages and protection in the face of climate change (and ecological changes), increased coastal erosion and flooding, and longer term sea-level rise. For instance, dunes have the ability to translate or move laterally landward with rising seas, as long as there is an area or space to accommodate them. As they do so, dunes can maintain a buffer of sediment to protect backshore wetlands and infrastructure. Provided dune systems can maintain a positive net sediment budget (i.e., sand still moving into the dunes from the beach) dunes may be able to migrate while keeping dune forms intact. Because dunes are dynamic systems, dune migration and maintenance often involves foredune erosion and scarping and blowout formation that help the system maintain resilience and move landward or recover from disturbance events (e.g., big storm events). The presence of diverse, native dune-building plant species is important for maintaining sediment exchanges across the landscape and preserving broader ecosystem resilience during periods of disturbance and longer-term climatic changes. Dune management has already shifted to an increased emphasis on promoting dynamic landforms and diverse native plant communities when invasive species are removed, or when blowout activity increases along existing native foredunes. The ongoing research at Humboldt Bay NWR (mentioned above) is intended to enlarge our understanding of climate change impacts and will help to inform future management.

For more details, see (full citations at end of document):
Carter (1991)
Davidson-Arnott (2005)
Hesp (2002)
Martínez and Psuty (2007)
Nordstrom et al. (1997).
Pickart (2013b)
Sloss et al. (2012)
Walker et al. (2013)

How are restoration projects regulated and monitored?

Restoration carried out by local and state governments, non-governmental organizations and private parties must be consistent with Coastal Development Permit for the subject property, which is approved by a state or county agency. Federal restoration projects are subject to a different process in which the Coastal Commission must approve the agency's determination that restoration is consistent with the policies of the Coastal Act. The lead agency determines whether or not the project causes significant environmental impacts as defined under the California Environmental Quality Act or the National Environmental Policy Act. Often, permits require monitoring of the results of restoration to demonstrate whether the project is meeting permit conditions or a pre-set goal. Monitoring techniques vary by project and may be as simple as photo-monitoring or include the measurement of quantitative variables like vegetation cover. Monitoring beyond that required through the regulatory process is sometimes carried out to help land managers adaptively manage properties and resources for which they have jurisdiction.

For more details, see (full citations at end of document):
Darke et al., (2013)
Walker et al. (2013)

Dune FAQ Bibliography

Note: The list of references below represents some literature on dune ecology. Some of the work is local and some of it is from far-away places; application to our coastal varies.

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