USA: California: Revegetation Project at Marine Corps Air Ground Combat Center at 29 Palms

Overview

This project, which began in early 1995, was initiated by the National Resources and Environmental Affairs Directorate (NREA) at the Marine Corps Air Ground Combat Center (MCAGCC) as an effort to develop and test methods of native plant revegetation in disturbed areas while simultaneously controlling erosion and dust. The first effort was undertaken from February 1995 through June 1996, and involved the testing of restoration methods and procedures at the Vertical Short Takeoff and Landing (VSTOL) site. The second effort conducted under this five year program, begun in 1996 and conducted jointly with the Soil Ecology and Restoration Group (SERG) at San Diego State University (SDSU), involved the testing of restoration and revegetation methods and procedures on a heavily disturbed tank trail. The results from the Tank Trail research confirmed the use of ripping as an inexpensive method for narrow, moderately disturbed areas, such as dirt roads and parking lots, also seen in the original VSTOL restoration project. This method, combined with imprinting and direct seeding of large disturbed areas, can provide a low cost, efficient method of revegetating disturbed desert site within the MCAGCC. However, the low survival rates experienced during the first two years of the Tank Trail project, compared to the extremely high survival rates of the initial VSTOL project, highlight the impact and importance of the El Niño phenomenon to desert restoration. As part of an effort to develop revegetation procedures for the VSTOL runway, SERG also designed an experiment to determine the effect of changing the C:N ratio in disturbed soils using a variety of soil treatments and the addition of ammonium nitrate. The results of this experiment suggested that the addition of fertilizers on disturbed soils as a plant growth enhancer is impractical, and, although not apparent during this experiment, will probably benefit nonnative plant species more than native plant species.

Quick Facts

Project Location:
29 Palms VSTOL, 34.233333, -116.0613679

Geographic Region:
North America

Country or Territory:
United States of America

Biome:
Desert/Arid Land

Ecosystem:
Other/Mixed

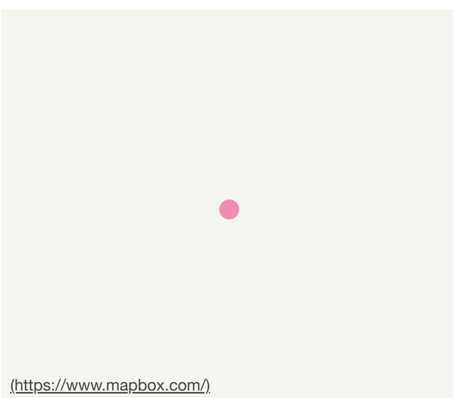
Area being restored:
17 Hectares

Project Lead:
National Resources and Environmental Affairs Directorate (NREA)

Organization Type:
Governmental Body

Project Partners:
Soil Ecology and Restoration Group (SERG) at San Diego State University (SDSU)

Location



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TIMEFRAME

Project Stage:
Completed

Start Date:
1995-02-01

End Date:
1999-03-01

DEFINING THE PROBLEM

Primary Causes of Degradation

Urbanization, Transportation & Industry

Degradation Description

The first and third studies under this five year program took place at the VSTOL site, an abandoned landing strip with runways and aircraft parking areas treated with Soil Sement, which forms a hard concrete-like surface. The area adjacent to the restoration site has a fairly loose, sandy substrate, while the site itself suffers from extreme compaction through both the impact of wheeled vehicles and the use of Soil Sement to help build the aircraft runway and taxi areas.

The second study involved the testing of restoration and revegetation methods and procedures on a heavily disturbed tank trail. This tank trail had become unnecessarily wide and was increasingly encroaching on adjacent undisturbed creosote bush scrub habitat. The site suffers from extreme compaction with a top layer (2-10 cm deep) of extremely fine dust caused by the weight of both wheeled and track vehicles over many years of use.

PLANNING AND DESIGN

Reference Ecosystem Description

Even under a harsh climatic regime, there is a wide diversity of flora and fauna at MCAGCC. In addition to the Mojave species, many species of plants and animals common to the Sonoran Desert are found interspersed with more northerly species. The Tank Trail site is located alongside an area that is dominated by creosotebush (Larrea tridentata) and white bursage (Ambrosia dumosa), typical Mojave Desert scrub habitat. The Mojave is also home to many rare endemic species. Floristically, 25% of the species are endemic (found nowhere else), with annuals exhibiting 80% endemism. Seven rare plant species have been identified and an equal number are suspected to occur at MCAGCC. MCAGCC has at least 240 vertebrate species, birds comprising the majority of the aforementioned. Approximately 169 of the bird species are neotropical migrants which pass through MCAGCC during spring and fall migrations.

The Desert Tortoise (Gopherus agassizii) is MCAGCC's only species federally listed under the Endangered Species Act of 1973 as amended. The desert tortoise is also a state listed species. The Swainson's hawk (Buteo swainsoni), Gilded flicker (Colaptes chrysoides), Bell's vireo (Vireo bellii), Willow flycatcher (Empidonax traillii) and the Golden eagle (Aquila chrysaetos) are State listed species which have been observed at MCAGCC. All, with the possible exception of the Golden eagle, are seasonal migrants.

Project Goals

The purpose of this study was to test various procedures such as site preparation, soil manipulation, irrigation methods, and plant protection to develop the most efficient methods for the restoration of native plant communities throughout the base. These techniques could be used to create suitable desert tortoise habitat on the base, while simultaneously controlling erosion and dust.

Monitoring

The project does not have a monitoring plan.

Stakeholders

This project was initiated by the National Resources and Environmental Affairs Directorate (NREA) at the MCAGCC as an effort to develop and test methods of native plant revegetation in disturbed areas while simultaneously controlling erosion and dust. The project was carried out by MCAGCC, along with the SERG at SDSU.

PROJECT ACTIVITIES

Description of Project Activities:

Pilot Study Three plots were established: the Tower Plot to test procedures to be used for restoration of areas disturbed by vehicle use such as roads and staging areas; the Runway Plot to test procedures for use on areas heavily disturbed by construction of the actual runways and aircraft parking areas; and an Undisturbed Plot located outside the VSTOL site to use for comparative analysis. Both disturbed plots were ripped, contoured and planted with seedlings grown from locally collected seeds. Seedlings in both plots were randomly selected to receive a plant protective device or to serve as a control. The Runway Plot was treated with wood chips to reestablish the impacted mineralization system, while the Tower Plot seedlings received either deep pipe or surface irrigation methods. Results demonstrated that the type of irrigation received did affect seedling growth, depending on the species involved. The addition of a soil amendment (wood chips) showed no effect, though previous experiments have shown results after two growing seasons. Numerous volunteers were seen on the Tower Plot and no volunteer plants were seen on the Runway Plot, demonstrating the lack of a viable seed bank in the heavily impacted area. Unit One To investigate different soil preparation techniques, half of the experimental quadrats were ripped to reduce soil compaction, and half were not ripped. Within these quadrats, some sections were imprinted, some were pitted and some left untreated to serve as controls. Once the soil preparations were complete, half of each treated area was seeded using a mix of native seeds. Bark mulch was applied to randomly selected quadrats. It was anticipated that mulched areas would enhance seed germination, catch organic matter, and increase water retention. A portion of the ripped and unripped quadrats were planted with Larrea tridentata and Ambrosia dumosa. Since the conventional watering regime yielded an average survival of only 13% for the 1996 plantings, replanting was conducted in March and April 1997. Three experimental irrigation treatments were implemented: flood irrigation into a watering basin, flood irrigation into a watering basin lined with a layer of punched straw mulch, and diffusion irrigation using porous ceramic capsules. In January 1998, a portion of the Tank Trail site was again replanted. The supplemental irrigation methods were abandoned and replaced with shallow basins. The different irrigation methods which had been applied to these plants at the original replanting in March and April 1997 had become irrelevant over time due to the loss of straw mulch to wind, and because the five-gallon reservoir systems had proven ineffective in the long term due to a lack of durability and a tendency to become clogged. Overall survival in the Unit One plantings was 78%. There was a significantly higher coverage of non-seeded native species in the ripped areas than in the non-ripped plots. There was a significantly greater number and coverage of seeded native plants, and lower number of nonnative species, in the imprinted plots compared to both the pitted and control plots. There was a higher percent cover of seeded native plants, a greater number of non-seeded natives, and a greater number and coverage of nonnative plants in the non-mulched plots. Twenty-four mesquite mounds, approx. 6 ft. high and 12-15 ft. long, were constructed in February 1996. Half of the mounds were constructed on a non-ripped section of the trail, and half on a ripped section. Six mesquite seedlings (Prosopis glandulosa) were planted on each mound. Due to low survivorship, the mesquite mounds were replanted twice from 1996 to 1997. In the first replanting, each seedling received Driwater placed in contact with the root zone, and a large volume deep pipe to facilitate and improve the effectiveness of future watering. Driwater was not used in the second replanting. A small area within the mesquite mounds was used to compare the survival of three native species, each with and without native mycorrhizal inoculum. Species used were Hymenoclea salsola, Atriplex canescens and Encelia farinosa. Survival in the mesquite mounds was 67%, with no significant difference in survival between the ripped south section and the non-ripped north section. 80% of the original plants in the mycorrhizal study survived, and a significantly higher number of inoculated Atriplex canescens plants died than did non-inoculated A. canescens. Unit Two This area was planted in October 1997, using a variety of irrigation methods. The initial planting used a series of 55 gallon containers with sections of irrigation tubing extending from near the bottom of each container. Each section of tubing was branched, with each branch terminating in a ceramic capsule buried near the root zone of each plant. In the next planting, a three inch diameter flexible perforated plastic pipe was used as the water delivery medium. The intent was to experiment with providing water below ground where it would be both needed and less susceptible to evaporation. In a natural basin area in Unit Two, ten Chilopsis linearis (Desert willow) were planted without supplemental irrigation. This is a wash-inhabiting species that tends to do relatively well in low-lying areas which collect water. In an extension of this idea, a group of catchments were created near the center of Unit Two. Each catchment consisted of two berms forming a water collection point at the low corner of each. The last planting in Unit Two used a variety of irrigation devices, including deep pipes of both 2 and 4 inch widths, deep pipes with ceramic containers attached at the bottom, ceramic containers alone, and controls which received no treatment. The watering regime was typically every three weeks, never exceeding one month between waterings except during the wet season (November through March). The gravity feed system had a survival rate of 81%, and the perforated pipe section had a survival rate of 87%. 80% of Chilopsis plants planted together in the basin area survived, 100% of the catchment plants survived, and 79% of the group of plants with various individual watering mechanisms survived. Vertical Short Take-off and Landing (VSTOL) Site Nitrogen Study This experiment consisted of three plots, each containing four soil treatments; alfalfa straw mulch, wheat straw mulch, sawdust mulch and a control. The different mulch materials represent a gradient in carbon:nitrogen ratios. Half of each plot was also fertilized with Ammonium nitrate. Within each of these eight subplots, four Ambrosia dumosa were planted. Each subplot was seeded over a one meter square area with both native and exotic seeds. The data collected included soil nitrogen levels above and below ground levels. Nitrate and ammonium levels were measured in each subplot. Ten months after planting, overall survivorship of Ambrosia dumosa at the VSTOL site was 78%. Soil treatments had no significant effect on plant survivorship, height, NO_3 or percent moisture. Soil treatments did have a significant effect on the other dependent variables: higher NH_4 in the alfalfa plots; higher percent organic matter in the soil amended plots; and higher pH in the control plots. With the exception of one Isomeris arborea, no seedlings were observed growing in the seeded areas.

PROJECT OUTCOMES

Ecological Outcomes Achieved

Factors limiting recovery of the ecosystem:

The principal limiting factor in this project is the availability of water. The low survival rates experienced during the first two years of the Tank Trail project, compared to the extremely high survival rates of the initial VSTOL project, highlight the impact and importance of precipitation and the El Niño phenomenon to desert restoration. If low-cost methods can be scheduled for completion during years that are predicted to experience an El Niño winter with its above average precipitation, then the survival rates will probably be well above acceptable minimums. If such efforts are accomplished during La Niña years, then survival rates will be greatly reduced. There has not been enough time, as of yet, to accurately analyze the effects of adding mulch to a restoration site. Though previous research has shown mulch to be of benefit to the reestablishment of native shrubs in slightly more mesic habitats, the lack of rainfall and moisture at Twenty-nine Palms appear to have slowed down the mineralization rate of the recalcitrant mulch to where any benefit will not be apparent for quite some time. As such, it appears that the one noticeable effect the mulch has had on the Tank Trail restoration site has been to prohibit the germination of seedlings, from both direct seeding and windblown seeds.

Socio-Economic & Community Outcomes Achieved

KEY LESSONS LEARNED

Key Lessons Learned

Results from the Tank Trail experiments demonstrate the benefits of ripping a compacted area to enhance the site's ability to revegetate. By reducing the soil strength through ripping, both water infiltration and soil mineralization increases and a plant's ability to move its roots through the soil improves. It is highly recommended that any site suffering from heavy compaction be thoroughly ripped before any other restoration activity is conducted. In certain situations, such as heavily used but narrow roadways, ripping may be all that is required, with volunteer seedlings becoming established on the site from nearby seed sources.

Tank Trail results also indicate that imprinting a large area in preparation for direct seeding can greatly improve both initial germination and overall success rates. The shallow depressions formed by the imprinter apparently enhance a direct seeding effort, but do not seem to aid in the establishment of native volunteer seedlings. It is recommended that any restoration effort that is to rely on direct seeding as the primary source of revegetation include the use of an imprinter during site preparations. If the imprinting and seeding effort can be timed to occur during a wet winter season, results should be excellent with a minimum of money and effort being expended.

Mesquite seedlings suffered heavily from initial die-off and were slow to become established. The primary reason for this problem is believed to be the timing of the mounds' construction and planting. The first group of mesquite seedlings were planted during the La Niña season of 1996-97, with little subsequent rainfall. This not only led to large die-off of seedlings, but little growth of those that survived. It was only during the wet 1997-98 winter season that any growth was noted. Those seedlings that survived and have demonstrated a belated growth spurt have been the ones with deep pipe irrigation systems. Dri-water and surface irrigation was not successful on the mesquite mounds.

The use of perforated pipe as a method to deliver water to native seedlings has shown to be the most efficient and least expensive irrigation procedure tested so far. Survival rates were greater with perforated pipe than other methods, and the system has been virtually maintenance free. The only change recommended is to use solid pipe and punch the drip holes into the pipe at specific locations near the newly planted seedlings, so that water will be delivered only to those points. Though ceramic capsules appear to have excellent possibilities, problems with loose fittings and system leaks have yet to be overcome. The use of catchments for groups of plants appears to be a successful method of irrigation, and can lead to high seedling survival rates, but is not the most efficient use of water. Much is lost to evaporation during the hot summer months when water is most necessary. Due to the need for such large amounts of water, the use of catchments is recommended only for small restoration efforts located near an available source of water.

LONG-TERM MANAGEMENT

Long-Term Management

It is recommended that data continue to be collected on the mulch plots to determine if the benefits may appear over a longer period, and that the mesquite mounds continue to be monitored to determine if those seedlings that survived and have shown growth over this last year will continue to develop into the type of well covered mounds that once thrived over much of the Twenty-nine Palms area. Continued research should also be done on the use of ceramic capsule irrigation systems; with further experimentation, ceramic capsules may yet prove to be a cost efficient irrigation method for desert restoration.

FUNDING

LEARN MORE

Other Resources

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http://www.sci.sdsu.edu/SERG/restorationproj/mojave%20desert/29palms.html
http://www.sci.sdsu.edu/SERG/restorationproj/mojave%20desert/29palms/VSTOL_Project.html
https://www.denix.osd.mil/denix/Public/News/Earthday98/Awards/29Palms_NRC/irgin29p.html

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