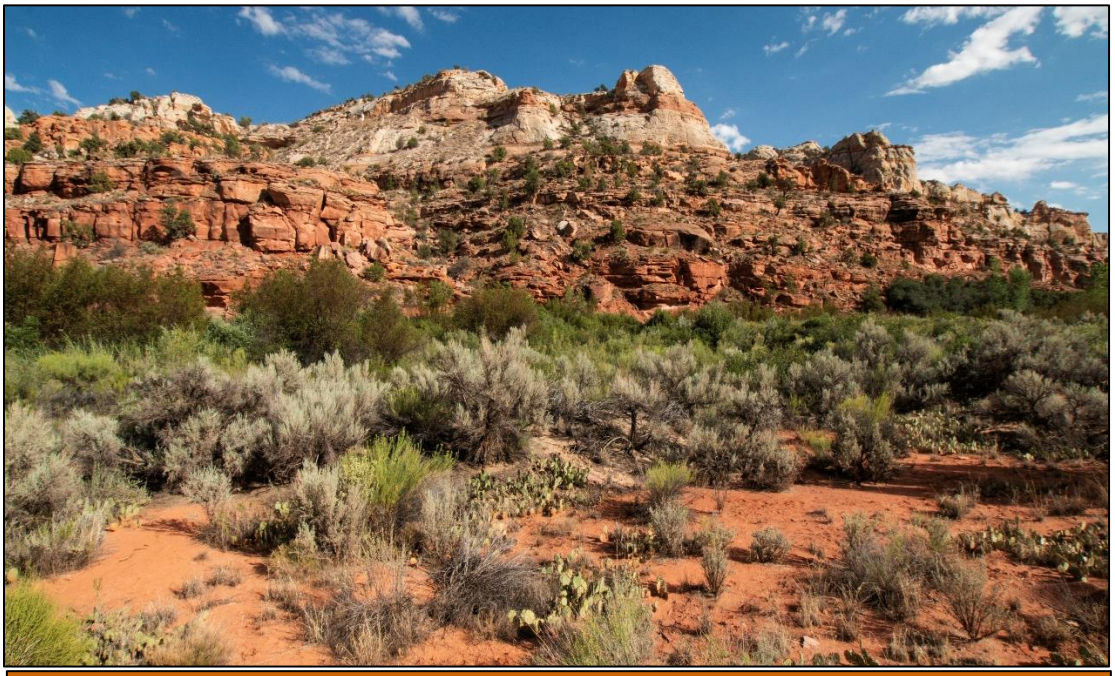

DESERT PLANTS AND THE ECOSYSTEM SERVICES THEY PROVIDE

ECOSYSTEM SERVICES
FW462
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INTRODUCTION

To some, deserts may come across as unlivable habitats. Harsh sunlight, extreme temperature changes, dry-cracked earth, tumbleweed, dry creek beds, torrential flooding, and scary creatures like snakes and scorpions. To others, they are fascinating places with geological formations, cactus and yucca, grasses, quiet and serene. The plants that live in these harsh conditions support life and play a vital role in providing ecosystem services in these regions.

This paper will review desert basics and plant adaptations as they are important to plant life histories. Next, the ecosystem services that deserts provide to humans will be presented. Risks and stressors to deserts along with topics that need further research will finish out the paper.

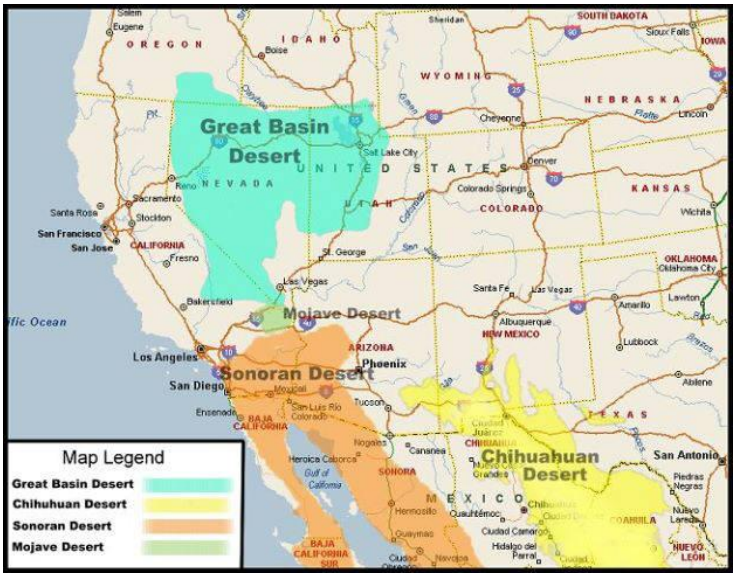

Fig. 1 – Desert Map of the United States
Source: in-the-desert.com

The deserts of the United States are quite large and span into other states and countries. There are four main deserts in the United States: (1) Great Basin, (2) Mohave, (3) Sonoran, and (4) Chihuahuan. The Great Basin desert is considered a cold desert, getting most of its precipitation in the winter through snow. The remaining three deserts are considered hot

deserts, getting most of their precipitation in the summer through rain. (Cameron 2018). Climate conditions differ in all deserts based upon their topography and the water cycle.

MOJAVE DESERT

Source: Jennifer Galas

SONORAN DESERT

Source: Jennifer Galas

CHIHUAHUAN DESERT

Source: NPS.gov

GREAT BASIN DESERT

Source: Denise Valentin

DESERT CLIMATE

Desert climates differ throughout the four deserts in the United States. Mountains and solar radiation play an important part in their extreme climate. Deserts with temperatures can reach over 100°F in the summer and go below freezing in the winter. Mountains generate less orographic precipitation and less cloud coverage, which provides the desert with intense solar radiation. At night, desert biomes can lose half of their temperature due to significant loss of

the sun's radiation (Medeiros and Drezner 2012). Topography in the desert influences what plant communities can thrive at the different elevations, which in turn affects wildlife habitat and food sources. It has been found that gradients in landscape influence the patterns and distribution of dominant desert plants (Randall et al. 2010).

Plants in the desert relies heavily on precipitation for productivity. Even though many deserts receive less than 10" of precipitation a year, it is enough water to activate production and reproduction in desert plants. (Noy-Meir 1973). Many desert plant annuals start from dormant seeds in old seed banks that are waiting for rain to activate their germination. (CNPS 2014). Most plants in the deserts are either drought-resistant or drought-evading. Sandquist (2014) defines drought-evading plants as those with higher water-use efficiency, and drought-resistant plants are those lower their levels of activity during low water availability.

DESERT PLANT ADAPTATIONS

Desert plant adaptations are important to their structure and function. They must have adaptations that allow them to withstand the extreme solar radiation, the quick change in temperatures from hot to cold or cold to hot, to reduce transpiration and loss of water, and to quickly absorb and store water from precipitation. Some desert plants can rapidly sprout new roots when rain falls; others have deep roots that reach down into the saturated soil zone for water during dry conditions.

There are two major ways plants have adapted to the harsh desert climate: (1) emerging only when climate conditions meet their survival needs, and (2) having structure and function adaptations from years of evolution. Adaptations are needed not only due to less water, but

also because of the additional salt left over once the rain evaporates. Some structure and functional adaptations to desert plants include:

- Thick, fuzzy, or waxy skin to reduce water loss and to reflect heat
- Small leaves with less surface area that helps preserve water and less exposure to heat and wind
- Dense network of shallow roots that soak up rainwater quickly before evaporation

Ghost plant (succulent)
(*Graptopetalum paraguayense*)

Source: leafyplace.com

- Large, fleshy stems for water storage. Saguaro cactus' can soak up hundreds of gallons of water after rainfall.
- Thorns and spikes to break up strong winds

Source: desertUSA.com

Saguaro cactus
(*Carnegiea gigantea*)

Source: WiserAngel

Joshua tree
(*Yucca brevifolia*)

Source: NPS.gov

- Dense network of shallow roots that can compete for rainwater

These adaptations also increase the ecosystem services provided by desert plants. Sandquist (2014).

ECOSYSTEM SERVICES OF DESERT PLANTS

Desert plants provide provisioning, regulating, supporting, and cultural ecosystem services, though smaller contributions than other biomes. Desert biomes, however, contain increased plant biodiversity, and they support important habitat for numerous terrestrial vertebrates (Taylor et al. 2017) along with rare and threatened plant species (Randall et al. 2010).

Deserts can be broken down into different habitat types. These include desert shrub, desert scrub, desert grassland, desert woodland, desert riparian, desert wetland, and desert washes. Each habitat can provide different types of services. The desert wetlands provide much needed water and water-related services that are so important in arid regions.

In Fig. 2 below, Yingshuang et al. (2019) shows how deserts can be broken down into desert ecosystem services and desert ecological resources. The ecological service assets are those are not physically traded in markets, and include regulating, supporting, and cultural services, while the ecological resource assets, the provisioning services, can largely be traded.

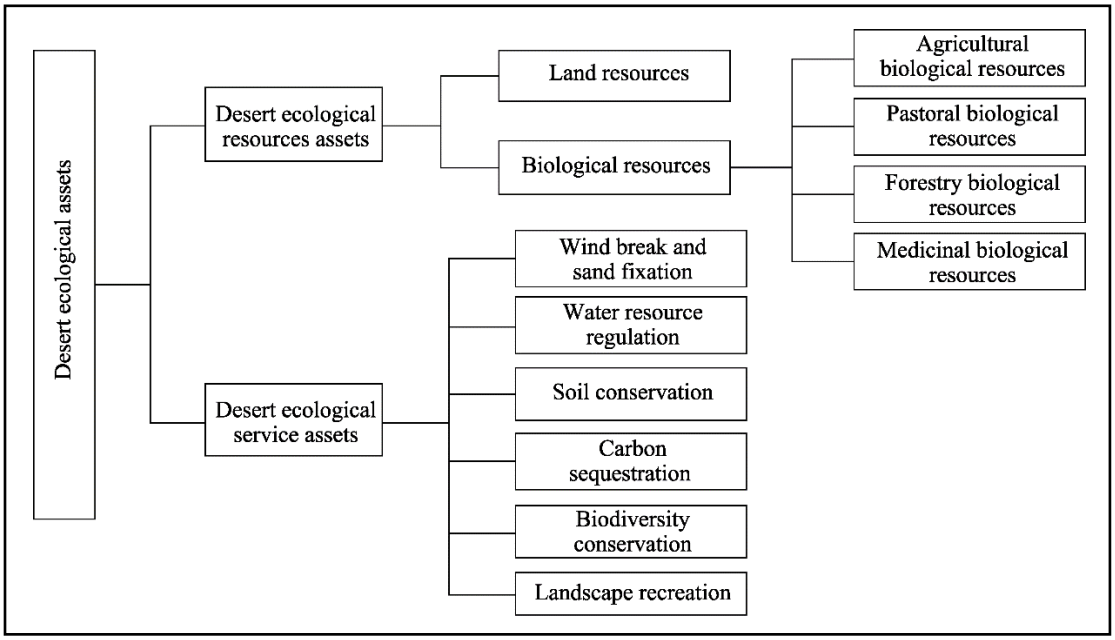

Fig. 2 – Deserts as Assets
Source: Yingshuang et al. (2019).

Provisioning Services

Provisioning services from desert plants include wild food sources for both humans and wildlife (IPCC 2007). Desert grasses, shrubs, and tree leaves, provide deer and rabbits with food, and these deer and rabbits in turn provide food for humans. Looking at Fig. 3, plants are the producers that feed the consumers who in turn feed the secondary consumers, who then feed the top predators. Even grasslands in the desert provide food for livestock. Without desert plants, this food web would collapse.

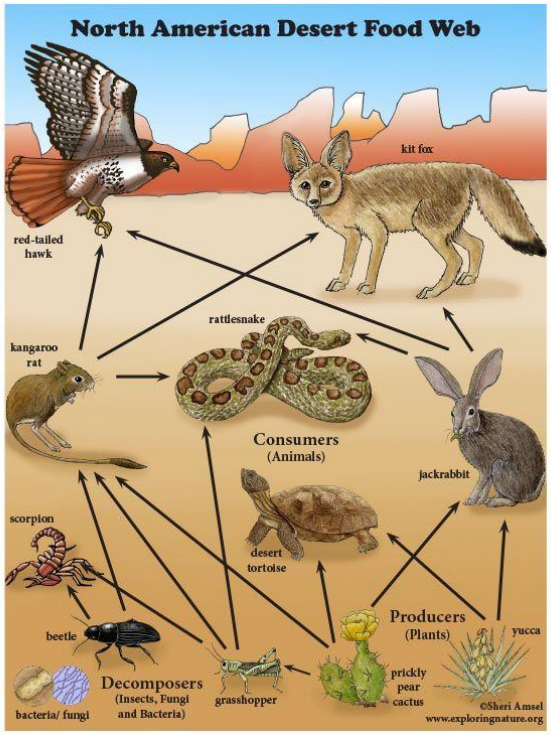

Fig. 3 – North American Desert Food Web
Source: Sheri Amsel/ExploringNature.org

Deserts provide genetic resources for drought-resistant plants through seed banks. Indigenous people use desert plants for teas, medicinal purposes (like prickly pear, chia seed, wild licorice, and yucca), and fiber (Taylor et al. 2017). Desert wildflowers, shrubs, and cactus provide pollen for insects.

Desert wetlands, springs, playas, and riparian areas provide fresh water for humans, wildlife, agriculture, and livestock. Plants in these areas provide niches and food for wildlife and shade for fish.

Regulating Services

Desert and desert wetland plants provide regulation services. Cactus and other desert plants help stabilize the topsoil and decrease soil erosion. Plants in terrestrial and aquatic

desert habitats provide flood regulation and water purification. Plants clean the air by taking in carbon dioxide and producing oxygen (photosynthesis). Plants, especially trees in the desert woodlands, sequester carbon in their trunk, roots, and soil, thereby lowering carbon dioxide in the atmosphere, which helps fight climate change.

Supporting Services

Supporting services are necessary for production of provisioning and regulating services. Desert plants support ecosystem services conducive to life including food and energy for consumers. Desert plants redistribute nutrients by forming mycorrhizal relationships with fungi, who in turn increase the biomass of their root system and make the soil more fertile.

Cultural Services

Deserts and their vegetation have cultural and traditional significance for indigenous people. They provide landscapes and plants for research and education. Deserts and their plants also provide inspiration for all types of art.

RISKS AND STRESSORS

Because deserts are large, they are to habitat loss and disturbance from human-based activities. Recreational off-road vehicle use, mining, grazing, and even military testing/training are stressors (Randall et al. 2010). According to Taylor et al., the Chihuahuan Desert is facing overuse of natural resources and the risks that come with the development of energy sources. Deserts also face human expansion and degradation due to overpopulation.

Climate change has already increased stressors to desert ecosystems. Temperatures will continue to increase, and plants will have a greater need for water. The dry season will lengthen worsen drought conditions, allow for more desertification, and change climate

patterns. Less snowpack during winter means less snowmelt in the spring, reducing water supplies to the desert even more. More intense storms will occur in the desert, causing flash flooding and soil degradation due to loss of nutrients. These changes will cause the decrease in the health of desert plants and lower their productivity (IPCC 2007).

Native desert plants will become more vulnerable to invasive plant colonization. Increased carbon dioxide concentrations have been shown to harm native plants and benefit nonnative plants (Archer and Predick 2008). Woody desert plants will have higher mortality rates due to higher temperatures and higher evapotranspiration. As less water becomes available, competition between plants will increase (Sandquist 2014).

FURTHER RESEARCH NEEDED

Further research is needed on threats to deserts and their plants, especially to sensitive plant communities. Research is also needed on soil microbes and how they adapt to climate change. Most research on deserts have been performed on small scales and a better understanding of plant, soil, and climate relationships over large scales is needed.

CONCLUSION

Desert ecosystems contain many rare and endemic plants found nowhere else in the world. They are harsh environments to live in but offer beauty and serenity. Less precipitation, increased sunlight and heat, and less nutrients make it hard for plants, but they continue to flourish and provide ecosystem services. These desert plants provide food and habitat, stabilize soils and inhibit soil erosion, and clean the air and water. Deserts and its vegetation and wildlife deserve to be protected and conserved for future generations.

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