

## BIOMIMICRY'S LIFE PRINCIPLES

LIFE CREATES  
CONDITIONS  
CONDUCTIVE TO  
LIFE

Optimize  
rather than  
maximize

Leveraging  
interdependence

Benign  
manufacturing

LIFE ADAPTS  
AND EVOLVES

Locally attuned  
and responsive

Integrates  
cyclical  
processes



# Biomimicry Workshop at the Great Sand Dunes NP&P

## Using Nature-based principles to solve operational challenges

**Background:** Biomimicry (from bios, meaning life, and mimesis, meaning to imitate) is a scientific discipline that seeks sustainable solutions by emulating Nature's time-tested patterns and strategies. The core idea is that Nature, after 4.8 billion years of research and development, has already solved many of the problems we are grappling with and done it in a way that fits in with our natural world.

**Challenge to Nature:** The Great Sand Dunes National Park and Preserve (GSD) is one of the most biologically and geologically diverse parks in the United States. Park Superintendent, Art Hutchinson, and the park's Chief of Resource Management, Fred Bunch, were intrigued by the idea that they could draw upon this biological diversity to solve some of the

operational challenges they were facing. When introduced to biomimicry by Marie Zanowick, Certified Biomimicry Professional from the U.S. Environmental Protection Agency, they agreed to host a team of scientists, engineers and architects for a week-long biomimicry workshop held at a remote location within the park in September, 2010.



This workshop was designed for federal government and environmental professionals seeking an intensive, interdisciplinary, and experiential introduction to biomimicry. The partnership between EPA and NPS to host the workshop expanded the base of knowledge and served to foster increased innovation. Participants from a wide range of disciplines also contributed to innovation and included experts in biology, engineering, architecture, history and behavioral science. Critical information about the organisms that live in the local ecosystem was provided by park biologists, Fred Bunch and Phyllis Bovin. Resource books and nature guilds for the ecosystem were valuable sources in discovering how nature works in the southwest Rocky Mountains.

## Biomimicry Workshop Agenda

**Workshop Overview:** Drawing on the knowledge of local organisms and Native American culture, participants completed a series of exercises that provided instruction on:

- The practical application of biomimicry as a design tool
- Biological and ecological principles relevant to design
- Examples of biomimetic success stories
- How to apply lessons from diverse ecosystems to design
- History, philosophy and ethics of biomimicry
- The interface of design and biology, and the importance of identifying function
- The methodology of applying biomimicry to solve human problems.

For information about this project, contact Marie Zanowick, Certified Biomimicry Professional at [zanowick.marie@epa.gov](mailto:zanowick.marie@epa.gov), or call 303-312-6403. For information about biomimicry, check out [www.biomimicryinstitute.org](http://www.biomimicryinstitute.org), [www.biomimicryguild.com](http://www.biomimicryguild.com) or [www.asknature.org](http://www.asknature.org).

# Challenge to Biology



**Visitors to the GSD need to stay hydrated**

The Great Sand Dunes National Park challenged the group to discover strategies on:

- 1) How does Nature provide portable hydration? Help solve the problem of too many plastic drink bottles in the park.
- 2) How does Nature respond to a soil disturbance at GSD? Design a more effective and locally attuned invasive species management strategy to help secure and hold the sand sheet.

Two teams were formed and the participants brainstormed with the local biologists, learned from local plants, animals, and ecosystems and applied life's inherently sustainable design principles to discover innovative solutions to these challenges. The outcomes from this exercise are highlighted on pages 3 and 4.

Once the participants understood the methodology and biomimicry approach, they put this knowledge to practice by solving two design challenges by asking "What would Nature do here, in this ecosystem?"

## Lessons Learned

The biomimicry workshop provided participants with a new sense of possibility, as they discovered that sustainable models already exist, right outside. They discovered a scientifically-based method for bringing Nature's ideas to the design table along with tools and resources for further exploration. The participants formed a new network of friends, inspired individuals and future collaborators. Most importantly, they awakened to a new way of viewing and valuing Nature. Alpine Camp contributed greatly to this final point. By holding the workshop at a remote location, without electricity, running water, phone or internet service, participants were "forced" to interact more fully with the natural world and were rewarded with a quiet achieved in few places, a night sky free of man-made light, and a lack of distractions that made room for deep conversations and great fire-side stories.

From a broader perspective, participants recognized the value of using a whole system's approach when addressing challenges. For example, the park recognized that many of their issues with invasive species control could be better addressed if the Resource Management Division was brought in during the initial planning phase for construction projects. Participants also found value in taking time to reflect upon their challenges instead of adopting an existing procedure or jumping quickly to the solution. For example, a few weeks after Ms. Bovin started to work in the park, she was given an assignment to re-seed a disturbed area after a construction project. With no time to research the issue, she adopted a strategy from other parks, which was not the best local solution. During the workshop she had time to reflect and learn from the failures of the past. She recognized that when working with a complex system, such as the ecosystem in the GSD, stopping to look retrospectively is critical.

The optimal team composition for using the biomimicry methodology includes someone with a business perspective. For this workshop, the Park Superintendent, Art Hutchinson, provided this expertise. During the presentation of solutions to the selected challenges, Art asked critical questions, such as "If we decide to develop a seed bank in the park, where would it be located?" and "What temperature does the building or room need to be and how much will that equipment cost?" He also provided information on current concessions contracts and time frames that would be affected if the solution to the water bottle challenge was implemented. In larger parks, this role could be fulfilled by the concessions contracting officer or someone from the business office.

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# “How does Nature respond to a soil disturbance at the GSD?”

**Case Study:** The Great Sand Dunes National Park and Preserve (GSD) challenged participants of the Biomimicry Workshop to design a more effective and locally attuned invasive species management strategy to help secure and hold the sand sheet. Initial consultations with Phyllis Bovin, National Park Service Biologist, led to the identification of soil disturbances as the highest priority invasive species management issue. Based on these consultations, the team determined that the real challenge was to design a more effective revegetation management strategy. The function of this design needed to reduce the establishment of invasive species following a soil disturbance. The strategy also had to be designed within certain parameters. In addition to the biotic, climatic, and temporal parameters surrounding the plant phenologies and ecosystem, important social parameters existed as well.

One important parameter identified as non-alterable was that the revegetation component of contracts for large scale disturbances had to be performed immediately upon construction completion, regardless of season. A lack of GSD resources and the need for stakeholder buy-in were also identified as key parameters of a design strategy. An investigation of the question “How does Nature respond to a soil disturbance at GSD?” led to the awareness that a diversity of plant phenologies within the ecosystem provide the soil with seeds of healthy, diverse plant communities that occupy most of the available niches and minimize invasive takeover. This inspiration led to the design solution of developing a GSD collected seed bank containing a diversity of local native plants that occupy different root depths and growing seasons/rates. Establishing this seed bank will allow the GSD to plant and mat this seed mixture following a large disturbance at any season while maximizing the potential for success. Previous GSD strategies based on other National Parks focused primarily on fast growing grass seed which, due to planting season or climatic forces, may not fully establish, which allows invasive takeover. Additionally, seeds were previously grown in an off-site research area and were oftentimes not available at the exact time they were needed. The team’s design solution emulates Nature through being locally attuned and responsive, optimizing seed plantings rather than maximizing fast-growing grasses, leveraging the interdependence of the diverse plant communities, integrating the cyclic process of Nature’s seed bank, and promoting resiliency. In order for GSD to develop a more effective revegetation management strategy, the team recommends the following:

1. Develop a seed bank system at the GSD that contains a diversity of GSD collected local native plant communities
  - Utilize volunteer action to collect seeds
  - Include an educational component to provide public with valuable information; could help to secure cross-divisional buy-in
  - Market the idea to key stakeholder groups in the community and seek out those who could take ownership over the approach
2. Promote divisional collaboration on planning potential new construction projects early in the process so that a revegetation component can be properly budgeted for and executed.

# “Water & Waste at the Great Sand Dunes National Park”

**Case Study:** The Great Sand Dunes National Park (GSD) faces the unique challenge of ensuring that drinking water/beverages are readily available within the Park to keep visitors hydrated; however, the by-product of this service is a large waste stream of plastic beverage bottles that has become unmanageable. Because of the extreme environmental conditions at the Park, it is critical to ensure that drinking water is readily accessible to all Park visitors for their health and safety. The Park hosts an average of 270,000 visitors each year, and is faced with the dual challenge of proper hydration of visitors as well as addressing the waste stream of left over beverage bottles.

Currently there is no recycling facility in the San Luis Valley that can accommodate the volume of plastic bottles discarded in the Park each year, so the Park is forced to dispose of the bottles in the local landfill. The Park does currently recycle aluminum cans and has a recycling relationship with a non-profit organization in Alamosa, allowing this waste product to be recycled. Most beverages currently sold in the Park (both the gift shop and vending machines) are in plastic beverage containers. The Park does sell reusable plastic beverage bottles in the gift shop, but this is a limited inventory of bottles.

The Design Team used the Biomimicry Methodology to analyze the problem. Working through the stages of the methodology allowed the team to truly understand and identify the critical functions. The team then moved into the biologize phase to understand how nature performs the identified functions. Once this stage was completed the team was able to clearly identify the dual functions of this issue, observe and analyze opportunities and obstacles, and move toward solutions inspired by nature. Two primary functions were identified; first was the function of keeping all Park visitors hydrated. The second function identified was the need to reduce solid waste generated in the Park.

**Case Study (continued):** The team looked at how nature might address these two identified functions. For example, nature keeps different species hydrated in different ways. The native Tiger Beetle draws most of its moisture from its food via metabolism, as well as spreading its wings to gather mist in the morning. To address waste, nature has systems in place where the waste of one species is used by another species. This closed loop approach ensures there is no unaddressed waste to accumulate. The biologize phase allowed the Team to identify details within the Life Principles: life creates conditions conducive to life, and life adapts and evolves.

Upon much discussion and analysis the team inspired by Nature, made recommendations in two areas:

- Park policies, practices and procedures
- Concessions contracts

For Park policies, the team recommended focusing on four areas to update and improve: education (5 separate key stakeholder groups), update Park publications, analyze and potentially revise placement of drinking stations, vending and recycling receptacles, signage for recycling and drinking water stations, availability of shade in the Park and lastly look at long term planning issues such as developing an Environmental Management System for the Park, and work towards participation with a single stream recycling facility in the San Luis Valley.

For concessions, the Park can utilize updating the annual contract with their concessioners as a way to specify more sustainable product use. Specifically, the team recommends that the Park consider selling reusable aluminum bottles at the Park. This materials choice is reusable by visitors but will also feed into the existing aluminum recycling stream via the non-profit organization in Alamosa. The aluminum bottles could be sold both in the vending machines which current sell plastic water bottles, and can also be sold in the Park gift shop. For visitors who prefer to consume flavored drinks, the team suggested selling instant dried drink packets that can simply be placed in the aluminum bottle, filled with water, mixed and enjoyed. The flavor packets have minimal packaging and can feed into the existing waste streams.

These suggestions attempt to mimic nature in the sense that existing relationships are utilized and waste is minimized.



**Alpine Camp, Great Sand Dunes National Park and Preserve**

## Recommendations:

The Earth's natural systems offer some positive, inspiring examples. Biomimicry is an approach that uses Nature as model, mentor and measure to help us understand how natural systems retain their resilience by adapting, changing and evolving new solutions in the face of adversity.

The National Park Service, along with other land management agencies, are in a position to tap into Nature's innovations, as parks have both challenges to develop sustainable operations and employees with the biological expertise to tap into Nature's solutions. Sustainability requires more than just a mechanical adoption of new policy requirements. In both natural and human systems, the rules continue to change and evolve, requiring new ways of doing business. A fundamental reframing of problems and problem solving activities is needed to foster sustainable solutions, and biomimicry is a good tool to accomplish this objective.