Promoting Sustainability in the Grand Canyon National Park

WINTER 2013

Life creates conditions conducive to life.

Life's Principles :

- **Evolve to survive**
- **Be resource (material and energy) efficient**
- **Adapt to changing conditions**
- **Integrate development with growth**
- **Be locally attuned and responsive**
- **Use life-friendly chemistry**

Using Nature-based Principles to Solve Challenges

Introduction

Biomimicry (from *bios,* meaning life and *mimesis,* meaning to imitate) is the conscious emulation of life's patterns to solve human problems.

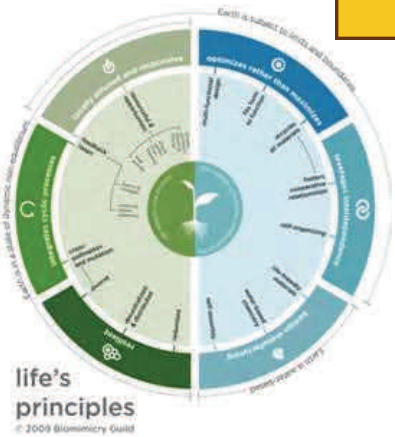
The core idea is that Nature, after 3.8 billion years of research and development, has already solved many of the problems we are grappling with and done it in a way that fits in with our natural world.

Life must synthesize, use, and dispose of chemicals in the same environment in which it eats, sleeps, and rears its young. By necessity, life does this in a sustainable way. What better source for inspired solutions than Nature's time-tested systems.

2012 Biomimicry Workshop

Marie Zanowick, the first Certified Biomimicry Professional in the federal government, organized a Biomimicry Workshop sponsored by the US Environmental Protection Agency. She recruited two dozen participants from the public and private sectors—among them architects, biologists, designers, educators, engineers, and naturalists—from around the West. The group was divided into four challenge teams. The "Communicate" Project Team is diverse: biologist John Brink, retired from USEPA, Denver, CO; life scientist (Diana Hammer, US EPA, Helena, MT; environmental protection specialist (Deirdre Hanners, former US National Park Service—AZ/CA); and graphic designer Greg Varhola, Boulder, CO).

The rest of this paper discusses the Team's Biomimicry process. the results of its Challenge to Biology, and applications for creating sustainable communities.



Challenge to Nature

The Project Team chose to test Biomimicry as a methodology to identify ways to create human communities that behave in ways that sustain themselves.

More specifically, the Team sought to identify ways that Nature can provide models that would lead to more sustainable behavior among the approximately 2500 year-round residents of the Grand Canyon National Park (GCNP).

Grand Canyon National Park

Stunning Vistas of the Grand Canyon

The Grand Canyon National Park (GCNP) is a UNESCO World Heritage Site and one of the crown jewels of the National Park system. The 1-mile deep canyon affords visitors the opportunity to see the inspiring and iconic vistas revealed by the down-cutting force of the Colorado River.

In addition to its stunning vistas and geology, GCNP's one million-plus acres encompass several major ecosystems that provide refuge to numerous rare, endemic and threatened animal and plant species.

GCNP's extensive cultural and archaeological treasures span 12,000 years from the present-day Havasupai Native American community that resides in the Canyon now to ancient Pueblo and Paleo-Indian settlements, whose presence is evidenced by archaeological sites throughout the Park.

President Theodore Roosevelt set the tone for the today's stewardship of these resources after he visited the Grand Canyon in 1903 and said: "*The Grand Canyon fills me with awe. It is beyond comparison—beyond description; absolutely unparalleled throughout the wide world... Let this great wonder of nature remain as it now is. Do nothing to mar its grandeur, sublimity and loveliness. You cannot improve on it. But what you can do is to keep it for your children, your children's children, and all who come after you, as the one great sight which every American should see.*"

The Park's 2500 year-round residents, including National Park Service employees, contractors, concessionaire staff and all their families face the daily challenges of protecting this legacy while serving the needs of the Park's more than 4.5 million annual visitors.

The Grand Canyon Visitor Center (South Rim), with the photovoltaic solar panels in place. The photovoltaic system is producing about 30 percent of the power used by the visitor center. NPS photo/website

Sustainable Practices at the GCNP

Past and Current Efforts—Some Examples

The National Park Service has taken many steps to operate GCNP in a way that is consistent with Theodore Roosevelt's words.

It offers a public **Compressed Natural Gas (CNG)-powered shuttle** bus system at the South Rim to ease congestion, reduce greenhouse gas emissions, and improve the visitor experience. In 2011, a popular **bike rental** concession was started to provide visitors with the option to see the views by bike.

In an effort to **combat solid waste**, GCNP has eliminated the sale of water packaged in individual disposable containers, which previously comprised an estimated 30 percent of its waste stream. Instead of offering water in individual disposable containers, the Park implements a **"Reduce, Reuse and Refill" program** that encourages visitors to refill their own water bottles at convenient drinking water filling stations around the Park.

GCNP also offers a **robust recycling program** for the workspaces and residences in the Park and a composting program for permanent NPS employees.

The NPS also works with the concessioners and partners in the Park to collect electronic, or e-waste, for recycling. In 2012, the NPS alone collected 4.75 tons of **e-waste**.

Other **special wastes** the Park collects and recycles include batteries, used oil and anti-freeze, propane canisters, tires, oil filters, fluorescent lamps, scrap metal and pallets.

Continued Challenges to Operating Sustainably

In spite of these actions, the Park continues to face many challenges in achieving the environmental results and level of participation needed in order to consider the GCNP's operations truly sustainable.

These challenges range from community members who express ideological objections to anything considered "green," to residents who simply do not have the knowledge or the willingness to align their habits with the Park's sustainability efforts.

These challenges are a factor in the Park's fluctuating diversion rate, which ranges from **25 percent to 40 percent** from year to year and month to month.

Executive Order 13514 requires Federal Agencies to achieve a 50% recycling and waste diversion rate by 2015.

Asking the Right Questions

What does Nature have to say about overcoming these challenges?

At the heart of the Biomimicry methodology lies the *function* question:

How does Nature do _____ ?
(ask this for *any particular function*)

Whatever the challenge, it has to be broken down into one or more function questions in order to find similar functions in Nature. In Biomimicry terminology, this is called **biologizing the question.**

Recognizing that the challenge of sustainability goes far beyond waste management, recycling and composting, the Project Team thought that a barrier to greater community participation in the GCNP's sustainability efforts was the **lack of community**.

The team analyzed previous efforts to promote sustainability and it seemed that the GCNP was doing a good job offering programs, information, and outreach but those impressive efforts just weren't translating into sustainable actions and behaviors among the GCNP residents.

As a result, the Project Team chose to ask the deeper questions:

How does Nature Create Community?

How Does Nature Create Communities that are Sustainable?

The next step was for the Project Team to investigate Nature's approach to solving these challenges.

The team broke the challenge down further into the functions found in Nature for creating community. Specifically, the team asked, *How does Nature influence, motivate, coordinate, and foster cooperation within and among communities or species to sustain itself?*

Refining that question somewhat, the Project Team then asked:

How Does Nature Influence, Motivate, Coordinate and Foster Cooperation to Create Communities that are Sustainable?

In the process of answering this question, the Team looked to Nature for examples of how to foster sustainable behaviors, lower barriers to sustainable behaviors, and identify leverage points to advance sustainability.

Once identified, these Nature-based strategies could be applied to promoting sustainability in the Grand Canyon National Park and elsewhere.

Exploring How Nature Creates Community

What would Nature do?

Certain Fig Tree species have developed reward or sanction strategies to sustain the fig tree community.

Methodology

To explore ways Nature creates community, the Project Team surveyed published **scientific and academic literature** on a broad range of subjects, ranging from biology to human behavior.

The Project Team received help from Nessly Torres, a US EPA student intern who provided support to the 2012 Biomimicry Workshop and Webinar series. The Series is archived at http://peakstoprairies.org/library/webinars/.

The Team used the extensive resources available on **AskNature.org** to identify strategies Nature uses to create and sustain communities. AskNature.org is a database of Nature's strategies developed by the Biomimicry 3.8—the company takes its name from Nature's 3.8 billion years of research and development.
After reviewing hundreds of articles that potentially had something to say about how Nature creates community, the Team prepared **abstracts** of a dozen or so of the most promising articles.

The process of abstracting involves recognizing the **function** that a particular set of behaviors or processes in nature carries out or serves, and then studying the **strategy** that Nature has used to carry out that function.

From there, the Team could translate that strategy into a **design principle** that could guide a Nature-based or Biomimicry approach to meeting the Team's challenge to biology, namely *How Does Nature Influence, Motivate, Coordinate and Foster Cooperation to Create Communities that are Sustainable?*

Then, based on that design principle, the Team could design or **evaluate** specific actions applicable to the task of fostering sustainable behavior in GCNP.

How Does Nature Motivate?

Certain **fig tree species** have evolved to save their energy by producing smaller numbers of flowers and less pollen. In order to successfully reproduce, they must depend on specialized wasps to actively pollinate their fruit. Wasps that "cheat" (i.e., don't do their specialized pollinating job) suffer sanctions in the form of a reduction in their own reproductive success. [1]

Thus, the function of this specialized arrangement is to *create community* - indeed a highly specialized and interdependent community. Nature's *strategy* of penalizing the wasp by lowered its reproductive success if it does not actively pollinate the fig helps ensure that the interdependence between these species continues to benefit them both. In other words, this strategy ensures the continued survival of the fig tree – wasp community in question.

A Biomimicry **design principle** that may be drawn from this is that highly specialized cooperative communities need effective sanction mechanisms to maintain themselves. This design principle might then be used to create or assess specific actions that could be taken in response to the design challenge.

Taking a design principle like this one a step further through the Biomimicry process involves evaluating its fit with the challenge or task at hand and how well it harmonizes with all of life's principles (see sidebar on page 1) and the context of the design challenge, namely Grand Canyon National Park.

The example of the highly specialized fig tree – wasp mutualism, fits well with many of life's principles nicely, but is it a good fit in the context of GCNP?

The Team felt that the answer to this question is "No" because we couldn't very well say to the GCNP community, "recycle or die," although Nature certainly can and does say this.

What Other Strategies Does Nature Use to Create Community?

Asking Nature

The Team found more potentially useful strategies as it continued to explore Nature's strategies for coordinating behavior, fostering cooperative relationships, communicating for the benefit of the community, and recycling and allocating resources. Some of Nature's strategies that are applicable to GCNP follow.

How Does Nature Influence ?

Members of a tropical Acacia tree species, **Acacia drepanolobium**, partner with four different **ant species** over the tree's lifetime. The short-term effects or influences of each ant species range from mutualistic to parasitic, depending on the phase in the tree's life cycle. None of the species makes a "perfect" partner. But the overall fitness of the Acacia trees was greatest when inhabited by all four ant species over the full span of its lifetime. [2]

Acacia drepanolobium

A **design principle** that can be derived from this is:

In a long-lived community or system, the succession or sequence of actors can contribute to the survival of the system in different ways, depending on the life stage of the system or community.

The effects of all components have to be considered together – not just the individual pieces.

Ants swarm the Acacia thorn

Thus, we could apply this concept to our challenge to create community in GCNP by tapping the strengths and **identifying individual champions** within of each of the three Park communities to influence others and create community over the long term.

How does Nature Coordinate?

Cell-to-cell communication between **bacteria** is mediated by signal molecules that trigger changes in gene expression in response to population density and other factors. Bacteria are not limited to communication within their own species.

They are also capable of "listening in" and "broadcasting to" unrelated species to intercept messages and modify cohabitants' behaviors.[3] This is example of **quorum sensing behavior.**

The **design principle** this suggests is that *quorum sensing mechanisms enable populations to instigate a collective behavioral response to environmental or other signals or challenges.*

We see this in human societies as a "tipping point" – that point where something new suddenly becomes the norm and is "just the way things are done."

We can apply this to our challenge to create community by working with the **early adopters** and **sustainability champions** to promote and emphasize the positive, sustainable behaviors practiced by friends and neighbors in their communities.

This **bottom-up, networking approach** to behavior change focuses on leading by example and modeling the desired behaviors.

Quorum Sensing Bacteria

How does Nature...

Influence?

Motivate?

Coordinate?

Cooperate?

form sustainable communities?

More of Nature's Strategies

Communities depend on mutually beneficial relationships.

Employee bike sharing at the GCNP

Be Resource Efficient—with energy and materials .

How does Nature Cooperate?

There are many examples of mutualism or symbiosis, which are forms of co-operation among species and other entities. One example from nature is **sea anemones** that host **anemonefishes** (genus *Amphiprion*), which afford the sea anemone some degree of protection from other fish that prey on anemones because the anemonefishes are territorial and drive them away.

In turn, the anemonefishes live within, and depend on, the sea anemone's stinging tentacles for protection against predation by fish that eat anemonefishes. [4]

The Industrial Symbiosis network in Kalundborg, Denmark, represents an example of cooperative, mutually beneficial relationships in a system created by humans.

The Industrial Symbiosis Network reduces the intake of virgin materials and lowers the production of waste through a collaborative web of knowledge, material and energy exchanges.

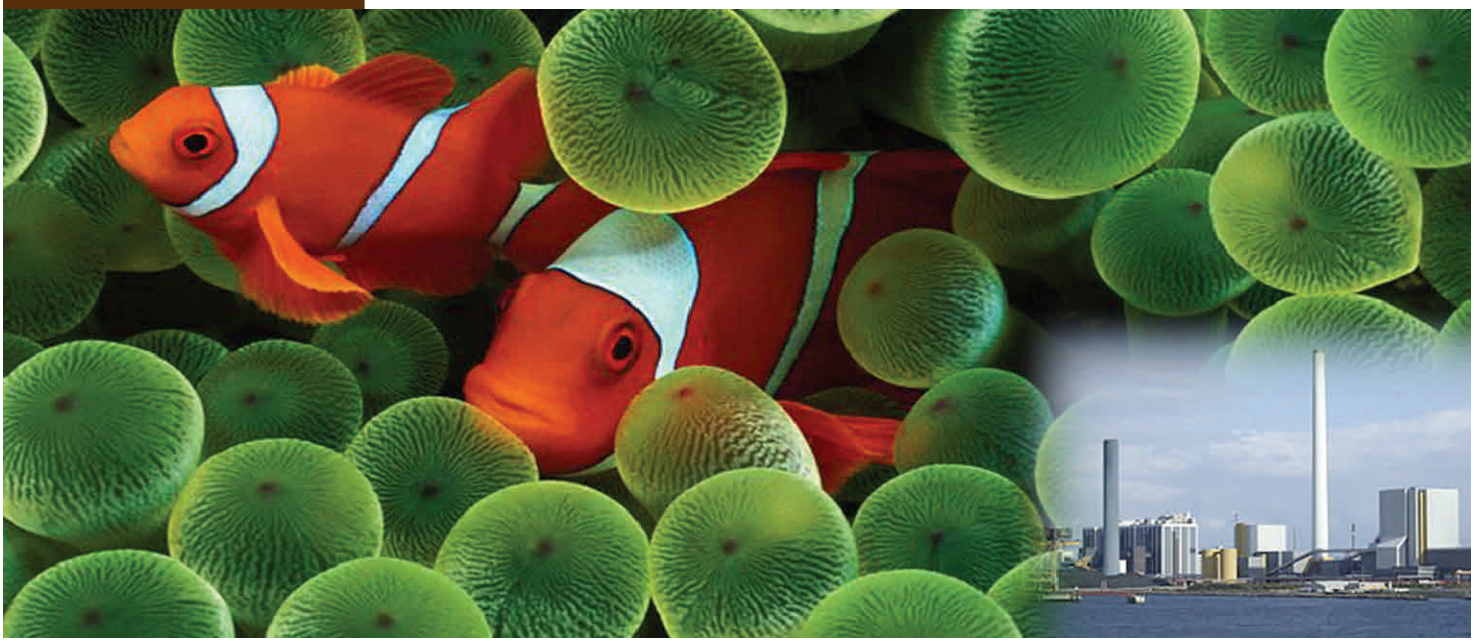
Social Network Analysis indicates that these exchanges evolved informally over time, initially in response to limited availability of water resources in the area. [5]

The **design principles** that can be drawn from these examples are:

- *Communities depend on mutually beneficial relationships*, and
- *Through cooperation, resources (materials and energy) can be used more efficiently* (one of Life's Principles).

We can apply these design principles from Nature to our challenge by looking for ways to **share resources** and **create opportunities** for mutually beneficial exchanges – for example: **holding community gear swaps, and creating a free-cycle website**.

In the large photo below: Anenomefishes and how they interact with Sea Anenomes for their mutual benefit. The small insert: The Kalundborg Industrial Park in Denmmark., an example of industrial symbiosis and industrial ecology.



Design Recommendations for the Park

Recommendation #1: Organize the Park's functions to mimic life

Organizations that mimic life outperform their peers by being highly networked to facilitate feedback and information exchanges within the organization and outside it. They recognize that **people and relationships** are the primary means by which they build **network capacity** and create value. They **strengthen and empower employees** by practicing servant leadership. They also give employees **decision-making authority** in their areas of competence and hold them **accountable** for results.

They optimize their use of physical resources by **closing the loop** so the waste of one process becomes food for another.

In doing so, they aim for factor efficiencies by producing more value for customers with less input of energy and materials.

They are exceptionally open in the ways they **share information** with employees and in their desire for stakeholder feedback.

They know such **openness** builds trust, learning capacity and adaptability.

Most importantly, they nurture the larger living systems of which they are a part (Nature, society, markets) because they understand the inherent connection of all life. [6]

How Recommendation #1 embodies Life's Principles:

- Integrate Development and Growth
- Evolve to Survive
- Adapt to changing conditions
- Be locally attuned and responsive
- Be resource efficient.

Recommendation #2: Create a Free-Cycle Program

Park residents are inclined to throw away unwanted items rather than haul them 80 miles to Flagstaff.

GCNP can set up a Free-Cycle area where Park residents can leave their usable items. The space can be cleaned out once a week of items not claimed and the rest can be hauled by a Green Team member to Flagstaff.

Free-Cycle is already being successfully implemented in other communities.

Successful Free-Cycle programs exist around the world, including places like Boulder, Colorado, Helena, Montana, and Flagstaff, Arizona. For more information: www.freecycle.org .

How Recommendation #2 embodies Life's Principles:

- Integrate Development and Growth
- Evolve to Survive
- Be locally attuned and responsive
- Be resource efficient.

Recommendation #3: Identify and Work with Champions within each Park Community

The champions can influence behavior from **top down** or **bottom up**, working within their organizations at work as well in their neighborhoods. These champions can be invited to Green Team meetings.

Optimize physical resources by "closing the loop" - as Nature does

How Recommendation #3 embodies Life's Principles:

- Evolve to Survive
- Adapt to changing conditions
- Be resource efficient.

Recommendations for the Park—cont'd.

Recommendation #4: Conduct surveys and focus groups to identify barriers.

The Park's **Green Team** can write the survey and distribute through the entities in the Park for feedback.

Focus groups can be held for the three main groups: **NPS Employees, Concessioners**, and other **residents**.

How Recommendation #4 embodies Life's Principles:

- Adapt to changing conditions
- Be locally attuned and responsive

Recommendation #5: "It's Our Park" Campaign

Build an "It's Our Park" campaign to **create an identity** and build community and **increase commitment to sustainability**.

Consider **cross-organizational events** and perhaps a **challenge** to another national park to engage all park residents.

How Recommendation #4 embodies Life's Principles:

- Adapt to changing conditions
- Be locally attuned and responsive

For details on the research into Nature's Genius, see the accompanying matrix: Life's Design Principles for Creating Community

References:

1 Jandér KC; Herre EA. 2010. Host sanctions and pollinator cheating in the fig tree–fig wasp mutualism. Proc. R. Soc. B. 277(1687): 1481-1488.

2 Palmer TM; Doak DF; Stanton ML; Bronstein JL; Kiers ET; Young TP; Goheen JR; Pringle RM. Synergy of multiple partners, including freeloaders, increases host fitness in a multispecies mutualism. PNAS. 107(40): 17234–17239.

3 Atkinson S; Williams P. 2009. Quorum sensing and social networking in the microbial world. J R Soc Interface. 6(40): 959-78.

4 http://www.asknature.org/strategy/2639d706b8ac175f18c2e5bf72bc6875

5 Domenech, T., & Davies, M. (2011). Structure and Morphology of Industrial symbiosis networks; The case of Kalundborg. *Procedia Social and Behavioral Sciences, 10.*

6 http://thenatureofbusiness.org/2012/11/03/companies-that-mimic-nature-out-perform-those-that-do-not/

This **Report** and its **recommendations** are meant to be a **guide**—helping generate ideas that could lead to workable **solutions**—solutions that can be applied to this National Park as well as other locales. The authors found Biomimicry to be a **powerful tool** to tap into Nature's genius to create **sustainable solutions** which follow **Life's Principles.**

The Grand Canyon National Park has taken some great strides toward implementing sustainable practices in its operations and in the services it offers to its visitors. However, the Park still faces challenges in rallying the support of its staff, contractors and concessionaires.

How will Nature help you solve your next challenge?

What would Nature do?

The Park could be more successful in meeting these challenges and achieving the goals of the Federal Executive Orders on environmental performance if it began to take a more Biomimetic, systems-oriented approach to sustainability.

Biomimicry offers a perspective and a set of tools GCNP can use to protect the legacy voiced over a century ago by President Roosevelt and sustain it through the 21st century and beyond.