Appendix to the Whole System Conservation Concept Paper: Illustrative Examples from the North America Region of the Nature Conservancy[1]

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In this brief follow-up document to the whole system conservation concept paper ("Stepping up to the Challenge – June 2011"), our goal is to illustrate some of the key attributes of whole systems with real-world examples from nine active Conservancy projects in the North America Region. Rather than provide only one or two comprehensive case studies, here we highlight portions of numerous ambitious projects that are in various stages of development, from inception to mature projects with dedicated Project Directors. However, even the most mature projects are still works-in-progress and as such, it would be unfair to nominate any one of them as the "model" project. Instead, by showcasing numerous projects at various stages of development, we hope to motivate staff to begin to investigate how their priority conservation projects could be framed using the whole system approach. The remainder of this document is organized following the primary content areas of our concept paper: defining a whole system, considerations when implementing whole system conservation, and determining success.

Defining a whole system

The four examples below demonstrate numerous attributes of whole systems such as having a unifying ecological feature, being of sufficient size to sustain key ecological processes, providing corridors that allow for movement and migration, and including core conservation areas as well as the surrounding matrix of lands/waters. A key feature included in every example below is the incorporation of people as an integrated part of whole system conservation, which represents an important advancement in how the Conservancy approaches its work in North America.

Gulf of Mexico– *project initiated in 2010*

Whole system attribute– unifying ecological feature. The Gulf of Mexico encompasses a large, partially enclosed coastline stretching from the Florida Keys around to the Yucatan Peninsula, and connected to the Caribbean Sea and Atlantic Ocean through narrow straits.

Whole system attribute– sufficient size and complexity. There are over 5,800 miles of coastline, with coastal waters supporting more than 75% of North America's wintering waterfowl, large concentrations of wading bird breeding colonies and open waters with deep water corals and other benthic communities. The near-shore waters teem with fish and marine mammals. Along the coasts, estuaries, oyster reefs, sea grass beds, marshes, beaches, and dunes fringe coastal plains and alluvial deltas.

Whole system attribute– connectivity and linkages. The Mississippi River delivers essential freshwater and sediment inputs from up river, and creates an ecological connection to nearly one-third of the North American continent. Coastal, shallow, and deep water habitats are linked through currents and nursery areas.

Whole system attribute– social and cultural identity. Counties along the Gulf Coast are home to 14 million people, and the Gulf of Mexico provides them with both a sense of place and jobs in an economy based on fishing, tourism and recreation, energy production, and transportation.

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The Gulf's highly productive ecosystems yield significant amounts of the U.S.'s annual shrimp, oyster, and crab harvests and are the Nation's second largest fishery.

California Current– *project in formative stage*

Whole system attribute– unifying ecological feature. The California Current Ecosystem is a dynamic and productive marine ecosystem that stretches from northern Baja California, Mexico to British Columbia, Canada. This whole system is a coastal upwelling biome, as found in eastern boundary currents, and is one of the top five most productive ecosystems on Earth.

Whole system attribute– sufficient size and complexity. Encompassing the entire U.S. Pacific coast, this system sustains fisheries, modulates weather patterns and the hydrologic cycle of much of the western United States, and plays a vital role in the economy of coastal communities. Coastal upwelling supplies nutrients to globally significant canopy-forming kelp forests, and coastal estuaries provide essential nursery habitat for diadromous fish and foraging habitat for millions of shorebirds on the Pacific flyway. The current supports populations of nearly a hundred different groundfish species.

Whole system attribute– social and cultural identity. The California Current supports economically important populations of commercially valuable fish, including sardines, anchovies, hake, mackerel, and groundfish, and sustains active commercial, recreational, and tribal fisheries. Marine resources are co-managed by federal, state, county, and treaty tribes that depend on long-term productivity in this ecosystem for traditional, cultural, and commercial and sustenance harvesting.

Great Lakes– *project initiated in 1991 to develop an ecosystem approach; whole system approach and operational integration implemented in 2008*

Whole system attribute– unifying ecological feature. The Great Lakes system is defined by its abundance of freshwater. Demarcated by the watershed boundary, these massive lakes contain over 20% of the world's fresh surface water.

Whole system attribute– sufficient size and complexity. The Great Lakes encompass over 300,000 square miles of land and water. The region includes a suite of interconnected major habitat types including coastal and nearshore areas, forested systems, open water food webs, and the watersheds that feed the lakes.

Whole system attribute– social and cultural identity. From the forested regions of the north to the agricultural and urban areas of the south, the natural resources drive both the region's sense of place and its economy. The Great Lakes provide drinking water to over 40 million people and support municipal, industrial, and agricultural water uses that make this region one of the largest economic engines in the world.

Alaska-Yukon– *project in formative stage*

Whole system attribute– unifying ecological feature. The Arctic basin and surrounding coastlines include vast areas of arctic tundra linked to a frozen sea. Every summer, temperatures warm enough to thaw the snow, ice, and surface soils, revealing a complex mosaic of wetlands and rivers amid the willow thickets and other plant communities that are adapted to this harsh environment. Sea ice extent also shrinks each summer, recently to historic low levels, and reforms each winter. Accelerating loss of sea ice is the dominant changing ecological feature in the ecosystem.

Whole system attribute– sufficient size and complexity. This circumpolar ecosystem includes the lands and waters that ring the Arctic Ocean. Millions of migratory birds gather on the Arctic tundra annually to reproduce. The caribou herds that trek to the coastal plains annually are among the last great land mammal migrations on earth. Bowhead whales, walrus, polar bear, and other marine mammals live on, under, and around the sea ice.

Whole system attribute– connectivity and linkages. Annual caribou migrations link Arctic coastal plains to the forested wintering grounds to the south. The circumpolar distribution of many plant species and communities, and populations of marine mammals and migratory birds provide linkages between North America and Asia. Complex food webs link tundra-breeding migrants to coastal sea ice specialists.

Whole system attribute– social and cultural identity. The region is home to Indigenous Peoples – Inupiat in Alaska, Inuit in Canada and Greenland, and Indigenous Peoples of Arctic Eurasia in Russia and Scandinavia – who have hunted on land, sea, and ice for thousands of years. Their traditions continue alongside modern energy development driven by demand for oil and gas resources.

Considerations when implementing whole system conservation

In the concept paper we suggested that project managers consider the following when designing whole system projects: the matrix of lands and waters between conservation areas should be managed along with priority conservation areas; strategies should promote landscape connectivity and permeability; and our work should include the role and needs of people, occur at multiple scales, and effectively tie policy solutions to places. The following five examples are vastly different whole systems, but collectively highlight all of these considerations.

Saint Kitts and Nevis Caribbean– *project initiated in 2009*

Challenge. Saint Kitts and Nevis is a small island nation in the Eastern Caribbean that is witnessing a surge in human activities that place increased and often conflicting demands on coastal and marine waters. Coastal areas are under intense pressure; the biological diversity of marine habitats and the ecosystem services they provide are seriously threatened.

Strategy. Marine zoning was used to guide sustainable use of the marine environment. Marine zoning is an inclusive process and a recognized management tool that can help sustain livelihoods and economies, maintain and protect marine species and habitats, and build resilience and adaptation to climate change by allocating use across space in an integrated fashion to address ecological, economic, and social considerations.

Whole system conservation concept– incorporate the needs of people. This project had two primary guiding principles: 1) rely on the best available science for making decisions, and 2) engage stakeholders at all possible levels. A series of stakeholder meetings and government consultations were held at which an information system was used that was capable of capturing the wide range of stakeholder interests and their future vision for the marine space. Stakeholder input and science information were used to create a draft marine zoning design for the waters of Saint Kitts and Nevis. The outcome of this project represents the first comprehensive marine zoning process in the Caribbean, which will help reduce future conflicts between users while protecting critical places and key processes that sustain biodiversity.

Mojave Desert– *project initiated in 2009*

Challenge. The Mojave is an epicenter of renewable energy development pressure in the U.S. because solar resources are both exceptional and close to major urban areas. In addition, California has enacted the most ambitious renewable portfolio standard in the nation: investor- owned utilities are required to generate 33% of their electricity from renewable sources, creating a large market for renewable energy. Consequently it is not a matter of if renewable energy will be developed in the Mojave, but when and how, and unplanned energy development could have serious consequences for biodiversity.

Strategy. For the Conservancy's priorities to be relevant to inevitable energy siting decisions, an approach was needed that could account for conservation objectives while allowing room for renewable energy development. The team's strategy was to lead with the Conservancy's strength – a science based landscape assessment.

Whole system conservation concept– manage matrix of lands between conservation areas. Large, intact landscapes are more resilient to adverse changes, can maintain important ecological functions, and are easier and more efficient to manage and thus should be the focus of protection and conservation resource investments. A distinguishing feature of this landscape assessment is that not only were ecologically core lands identified, but also three additional categories: ecologically intact, moderately degraded, or highly converted. Because good conservation reserve design requires that core areas be buffered and connected, land in all categories, even those lands categorized as highly converted, may have important roles to play in protecting the full suite of the Mojave Desert's diversity while meeting renewable energy demands.

Whole system conservation concept– plan for climate resiliency. Climate projections for California's deserts are severe, with the typical summer maximum temperatures by the end of the century reaching levels that are hotter than the most extreme year documented in the last century. An analysis was conducted to identify areas most likely to be resilient to climate change – that is, areas whose physical features may buffer the impacts of projected climate change locally, and thereby facilitate the ability of species that now occur in or nearby these areas to persist through the next several decades. Next an evaluation of areas of relatively high resilience was completed to ensure they were well represented in lands in the higher conservation value categories.

Whole system conservation concept– incorporate the needs of people. Using this assessment, the Mojave team was able to demonstrate that ambitious goals for renewable energy development could be met without siting projects in areas of high conservation value. The science-based assessment has enabled TNC to influence local, state, and federal planning and permitting processes, and to work directly with energy developers and utilities to engage in strategies at the scale of problem, which is the whole system.

Northern Appalachians– *project initiated in 2007*

Challenge. The Northern Appalachians region spans two countries, four states, four provinces, and 80 million acres. It is characterized by vast, relatively unbroken forests and provides a home for more than five million people along with a suite of at-risk species, including numerous wide-ranging mammals. The region has a well-established and expanding network of large conservation areas, but increased fragmentation and the anticipated effects of climate change put the region at risk of being separated into ecological islands.

Strategy. To promote landscape connectivity, the project team forged a multi-state, multi-partner project entitled "Staying Connected in the Northern Appalachians." The initiative currently focuses on seven priority linkage areas where landscape connections for wildlife movement are at risk due to development, agriculture, and roads. Within these linkages, the team is employing a diverse suite of strategies to advance connectivity protection and restoration, including targeted land protection, road corridor mitigation, and outreach and technical assistance to municipalities and community groups.

Whole system conservation concept– manage for climate resiliency and movement. Connectivity modeling tools and wildlife surveys are being used to identify the best opportunities for conserving connections between large unfragmented forest blocks. The team's work is inspired by the ground-breaking science and vision of the bi-national "Two Countries-One Forest" collaborative and Anderson and Ferree's climate change resilience analysis[2].

*Whole system conservation concep*t– *work at multiple scales*. Connectivity is being evaluated at the scale of the entire Northern Appalachians, and methods and tools are also being applied at the finer scale of the linkage areas. Within these seven critical areas, the team has identified priority zones, parcels, and road segments and initiated on-the-ground action.

Whole system conservation concept– incorporate the needs of people. There are a mix of strategies employed which are tailored linkage-by-linkage to fit the specific human and ecological context and opportunities of each area. A community-based approach is often used that seeks to mesh connectivity work with other local values and priorities related to the forested landscape. The team is engaging with landowners to develop "working forest" easements along with other strategies and incentives to promote land management that is compatible with local economies while meeting connectivity and other habitat goals.

Colorado River– *project initiated in 2008*

Challenge. The Colorado River is legally over-allocated and water is physically growing scarcer, at the same time that environmental water needs remain unmet or unprotected. Without a basin-wide approach that can address the interdependence of water management across the entire system, TNC's deep investments at over a dozen conservation areas within the basin are at risk of failing to meet their conservation goals.

Strategy. The Colorado River Program is focused on three basin-wide strategies: 1) threatened and endangered species recovery, 2) sustainable funding, and 3) sustainable water management.

Whole system conservation concept– work at multiple scales. The nature of the challenges facing the Colorado River requires TNC to organize work at two levels. First, enabling conditions must be created for success throughout the basin. This work is best done at the basin-wide scale because the strategies (listed above) cut across sub-basins and state lines, and, therefore, are difficult for any one project site within the basin to effectively address. For example, recovery planning for the Colorado's "big river" fish species is happening at the basin scale and engaging at this scale provides a forum and opportunity to enhance environmental benefits for the whole system through, for instance, management of downstream releases from dams. The team is also working at a more localized site level to meet biological goals and ensure ecological resiliency in the face of climate change.

[2] Anderson, MG. and CE Ferree. 2010. Conserving the stage: climate change and the geophysical underpinnings of species diversity. PLoS One 5(7):E11554.doi:10.1371/journal.pone.0011554

Whole system conservation concept– incorporate the needs of people. Working at the whole system or basin scale involves a myriad of institutions and stakeholders focused on moving water around for people. The Conservancy's Colorado River Program has explicitly integrated the needs of people into conservation work through a set of guiding principles, such as reducing/minimizing conflict, increasing water supply flexibility and reliability, providing incentives for conservation, and fostering relationships with the river basin's primary stakeholders. A larger public dialogue is needed to identify additional creative solutions to the challenges facing the Colorado River. The Program aims to shape that dialogue both from the bottom up, by influencing practices across a network of 16 sites across the basin, and top down by working with the major institutional and private sector stakeholders to identify opportunities at the whole system scale where basin-wide policies are established.

Chesapeake Bay– *project initiated in 2006*

Challenge: The health of the Chesapeake Bay is inextricably linked to the health of the rivers that flow into it; this connection is defined both by the quality and quantity of water flowing downstream. Alterations to the magnitude, timing, duration, and frequency of fresh water flowing into the Bay threaten many conservation targets. At the same time, fresh water is critical as a source of drinking water and for use in industrial manufacturing, cooling for nuclear and fossil fuel power generation, agricultural irrigation, and hydropower generation.

Strategy. The strategy focuses on developing the needed science and policy tools that can be integrated into policy frameworks at multiple levels, including state and river basin commission policies, and in the re-licensing of key hydropower facilities. The approach also targets sustaining flows at multiple scales, from headwaters to large rivers to the entire Bay, by defining key ecological needs (such as habitat connectivity, nutrient and sediment delivery, and migratory fish cues) and balancing trade-offs with human needs through spatially explicit and cumulative assessments.

Whole system conservation concept– tie policy to place. Building on success at smaller demonstration sites such as the Rivanna River in Virginia, five connected projects have been developed to implement the strategy across the Chesapeake watershed and protect more than 90% of the flow into the Bay. Each project focuses on a different part of the watershed and its specific human and ecological context. One recent outcome is regulatory reform for water withdrawal permitting in the Susquehanna River basin, which delivers half of the Bay's fresh water.

Whole system conservation concept– incorporate the needs of people. On the Susquehanna the importance of basin-scale planning for hydropower production is being emphasized. The team is working with partners through the Federal Energy Regulatory re-licensing process for four dams on the lower Susquehanna to demonstrate the benefits of system-scale coordination of water management to maintain power production while ensuring that sufficient flows are available for drinking water, irrigation, and ecosystem health downstream.

Determining whole system project success

The whole system approach to conservation leads to goals that focus on maintaining system dynamics, sustaining ecological function, and delivering benefits to people; the ultimate measures we design should reflect those goals. Many of TNC's whole system projects are less than five years old; consequently, development and implementation of robust measures remain a work in progress. For now, the near-term effectiveness of Conservancy actions and strategies within our whole system projects are being tracked using intermediate results and strategy effectiveness measures following established Conservancy guidance and standards.

With the permission of the Colorado River Program, here we offer our proposal for how long-term measures might be constructed to mark achievement of conservation goals for this whole system.

Colorado River

The river, stream and riparian habitats of the Colorado River provide essential habitat for iconic and threatened species such as the southwest willow flycatcher and humpback chub. The river also provides vital water supplies for millions of people in the Southwestern United States. Over-allocation of water and alteration of natural flow regimes threaten to degrade both the quantity and quality of habitat available for species, and also undermine the Colorado River's ability to support the human populations who depend on it. The Colorado River Program is developing an integrated suite of strategies that will operate at multiple scales to protect essential fish and wildlife habitat, restore more natural stream flows, and help reduce water demand. Each strategy can and should have appropriate strategy effective measures to ensure that Conservancy actions have desired intermediate outcomes.

Long-term whole system measures for the Colorado River system may include:

> *Water availability (supply) relative to water use (demand)* – having supply consistently exceeding demand is a necessary condition for success.
>
> *Percent of river restored to natural flow regimes* – increasing this percentage, especially in tributaries and stretches of ecological importance, marks progress toward a more functional and dynamic system.
>
> *Viability of fish and flycatcher populations* – these are the species that distinguish the Colorado River system from other river systems and so are essential "parts" of the whole system.

Note that the hypothetical measures we put forward for the Colorado River are really indicators of whole system function, dynamics, and human benefits. Rather than attempt to define a comprehensive set of measures that describes all aspects of the state of the whole system, we sought a small number of indicators that represent processes, functions or services considered to be necessary for success. If the indicators point in the right direction, we can be confident that we are at least on the right track to success; conversely, if the indicators point in the wrong direction, then we will know that the sufficiency of our strategies should be reexamined.