BLENDING PERSPECTIVES

Blending Perspectives to Collectively Address Climate Change Issues Across the Western Gulf Coast and Southern Plains

SCIPP

Southern Climate Impacts Planning Program
Louisiana State University
University of Oklahoma
In partnership with the U.S. Fish and Wildlife Service

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A summary report of World Café sessions at a regional climate change workshop sponsored by the U.S. Fish and Wildlife Service and U.S. Geological Survey

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Southern Climate Impacts Planning Program
Louisiana State University and the University of Oklahoma

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EXECUTIVE SUMMARY

The U.S. Fish and Wildlife Service (FWS) Southwest and Southeast Regions partnered with the U.S. Geological Survey (USGS) to host a climate change workshop in Austin, TX during August 2009 entitled "*Climate Change: The Western Gulf Coast and Southern Plains*." This very well attended workshop was the second such regional climate change workshop to be hosted in as many years with the previous meeting occurring in Tucson, AZ in 2008, which was focused on southwestern ecosystems.

During the 2-day Austin workshop, the Southern Climate Impacts Planning Program (SCIPP) was invited to help facilitate a series of four climate-themed collaborative discussions which broke the audience of more than 200 attendees into tables of six to eight people. These discussion sessions - which were part of an exercise called the World Café - brought together unique perspectives of the meeting attendees to discuss climate change issues critical to western Gulf Coast and Southern Plains ecosystems. Meeting participants drew largely from the FWS (56.6%), the USGS (10.2%), and the Texas Parks and Wildlife Department (10.6%) with the remainder representing other federal agencies, academia and research, private companies, non-profits, and others. The discussions provided a wealth of valuable information spanning the four major topics of: 1) stressors, 2) needs and priorities, 3) assisted migration, and 4) creating and maintaining connectivity on the landscape. The following summarizes the common themes identified during the World Café Exercise as well as associated recommendations stemming from these.

Common Themes

There are three overarching themes that encompass many of the specific issues that were discussed at length during the multi-part World Café exercise. The overall theme was that of maintaining balanced and healthy ecosystems under changing conditions and climate. The second theme was about making good decisions, which rely significantly upon having critical information and tools flexible enough to be used as necessary in a specific case. The final overall theme included finding ways to better work together on the many levels required to assist ecosystems and maintain health and balance.

Maintaining balanced and healthy ecosystems is a current challenge due to the many stressors already placed on plants and wildlife. Ecosystem stressors identified by meeting participants included items such as habitat fragmentation and infringement, pollution and water issues, barriers to migration, and land use changes; many of which are a direct result of human activities. Added to this is the fact that stressors often have a cascading effect and leave ecosystems even more vulnerable to the growing stressors of weather extremes and climate change. Invasive species were identified by meeting participants as the most critical of the present stressors, and yet this stressor would have a more difficult time becoming established if not for the presence of other stressors.

Accomplishing the goal of sustaining vibrant and healthy ecosystems requires an ability to make wise decisions. Oftentimes that ability is dependent on having critical information upon which decision-making can be based. Many of the participants expressed concern that much of the species-specific, ecosystem-specific, and climate projection information is not available or are associated with an unacceptable level of uncertainty. Participants also expressed that there appears to be no holistic approach to making critical decisions, yet it was noted that decisions oftentimes need to be made on a case-by-case basis. Thus making the best information available and providing an overall strategy that allows flexibility are important steps to achieving a goal of sustainable and healthy ecosystems even under the threat of a changing climate.

Finally, it was recognized that accomplishing this goal of sustaining vibrant and healthy ecosystems will take an "all-hands-on-deck" approach. There will need to be new partnerships to generate required and critical information, to make decisions around the present and future landscapes, to implement those decisions, and to communicate and educate at all levels. Those new partnerships need to include research scientists along with natural resource managers, community members along with agency staff, and businesses and decision-makers of all levels. The needs are great so the ability to develop and work in partnership needs to be flexible and open to be able to accomplish the critical goal of maintaining vibrant and healthy ecosystems that are so important to both the built and natural world.

General Recommendations

- Work diligently to remove as many present stressors as possible from natural ecosystems as healthy ecosystems can better resist perturbations of all kinds.
- Make a concerted effort to generate and widely share required information to support wise decision making on many levels.
- Develop and provide overarching strategies to approach and address critical decisions related to natural ecosystems and their potential climate impacts (e.g., issues surrounding invasive species or identifying possible new migration routes and corridors).
- Streamline and make efficient and flexible options for creating and maintaining beneficial partnerships.

INTRODUCTION

Observations reveal that the warming of the earth's climate is unequivocal, as indicated by the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (2007)[1]. This warming is largely attributed to the human-induced release of greenhouse gases, an activity that results in greater levels of warming than would otherwise occur. This stance is widely supported by the scientific community and is well documented in the ever-growing set of peer-reviewed reports and publications on the topic. The recent State of the Climate 2009 Report[2] has found that the past decade (2000-2009) was the warmest on record and indicates that the Earth has been warming for the past 50 years. While changes in earth's climate are not identical from location to location, global averages indicate an upward trend in the overall temperature of the planet.

In the United States alone, temperatures have risen across the lower forty eight states since 1901 with seven of the top ten warmest years having occurred since 1990[3]. In addition, the world's oceans - which are a critically important component of the climate system - have exhibited a surface warming trend and have been warmer the past three decades than any other time since measurements began in the late 1800s. A myriad of other changes have also been observed including increases in heavy downpours, rising sea levels, rapidly retreating glaciers, lengthening growing seasons, thawing permafrost, longer ice-free seasons in oceans and other water bodies, and earlier snow melt[4]. Figure 1 depicts the myriad of indicators that point toward the warming of the Earth's climate system. Such changes present our society and nation with a growing set of issues not previously experienced or historically prepared for, which in particular will have significant impacts on natural resource management due to the sensitivity of these systems.

The Department of Interior (DOI) is positioned at a unique point in time marked by increasing challenges due to climate change, yet new opportunities to implement key strategies for managing those challenges. During the past several years, DOI has demonstrated considerable leadership in the area of climate change through a variety of activities including the development of regional Climate Science Centers, the establishment of a national fish and wildlife climate adaptation strategy, as well as the formation of a network of Landscape Conservation Cooperatives (LCCs). Not only are these activities key to the future success of meeting DOI's mission, these activities represent a growing, new wave of national activity in the area of climate change that is now well identified across many federal organizations. With increased federal activity on climate change comes with it a greater need to coordinate efforts and share expertise and knowledge to solve common problems. In light of this need, the Southwest Region of the FWS has began to formally engage the United States Geological Survey (USGS), other natural resource management agencies, academia, non-profits, interests groups, and others to collectively address these issues, increase cross-agency dialogue, and identify areas of common need.

This growing partnership was demonstrated through a joint FWS/USGS sponsored regional climate change workshop held in Tucson, Arizona in August 2008, which brought together approximately 200 resource managers to discuss the issues of climate change impacts on the ecosystems of the southwest U.S. Out of this meeting grew a substantial interest to host another collaborative workshop focused on the habitat and wildlife of the southern plains, the western Gulf Coast, and attendant riparian areas. This second regional workshop, held in Austin, TX in August 2009 brought together a diverse audience of FWS and USGS employees, resource managers,

"Climate change is a critically important issue that promises to significantly change the way we view and manage habitat, refuges, endangered species, and other species in the Southwest Region. This workshop, along with the Tucson meeting a year ago, sets the stage for the upcoming climate-related challenges in the Southwest Region that we are already beginning to face, but are only just beginning to identify."

- Dr. Benjamin Tuggle, Region 2 Director
U.S. Fish and Wildlife Service

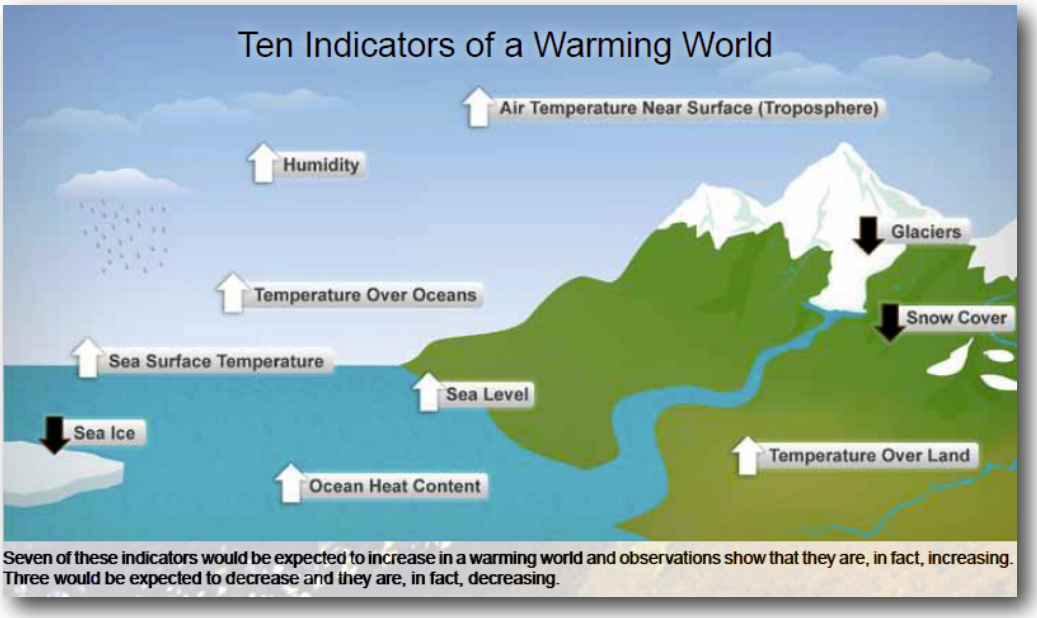

Figure 1. Different indicators of increasing global temperatures (National Oceanic and Atmospheric Administration).

university participants, and other interested groups. Through a combination of scientific presentations, application-focused talks, and an interactive series of group break out activities (World Café exercise), the collaborative workshop succeeded in initiating a critical exchange of information and ideas regarding climate change issues in the Southern Plains. The remainder of this report will focus in particular on the World Café exercise undertaken at the workshop and the information gleaned from the set of collaborative discussions.

WORKSHOP SUMMARY

The workshop was planned, organized, and hosted by the FWS Region 2 (Southwest) and FWS Region 4 (Southeast) in collaboration with the USGS Central Region and was entitled *"Climate Change: The Western Gulf Coast and Southern Plains."* The 3-day workshop was held at the Sheraton in Austin, Texas on August 10-12, 2010. On the evening of August 10th, workshop participants took part in a poster session focusing on natural resource management and related climate change issues. The full days of August 11 and 12 brought together a collection of nationally respected climate change scientists and leading regional & local experts in resource management who provided a series of thought-provoking presentations on resource management related issues across the South. These talks provided the contextual background for the interactive World Café exercise sessions held over the two-day period. A total of 235 participants attended the meeting representing 34 different organizations including federal and state agencies, non-governmental organizations, and universities (participant list is available in Appendix A). The most widely represented organizations for the meeting came from the FWS (133 attendees), Texas Parks & Wildlife Department (25 attendees), and USGS (24 attendees). The specific job functions of the participants was quite varied and included regional directors, coordinators, refuge managers, water resource managers, staff researchers, and coastal resource managers. The eclectic nature of the region, which includes a substantial portion of the Gulf of Mexico coastal region across the east, desert ecosystems across the west, riparian areas, and other habitats contributed to the mix of diverse backgrounds of the participants.

The schedule for the two full workshop days included introductory presentations by agency leadership, a keynote address by Dr. Virginia Van Sickle-Burkett, thirteen half-hour presentations, a panel discussion and the 4 World Café discuss exercises (see Appendix B for more details on the meeting schedule). Presentations fit within a series of different thematic headers including: 1) mitigation strategies for offsetting and reducing

greenhouse gases, 2) coastal habitats and climate impacts, and 3) adaptation strategies.

The World Café exercise presented an opportunity for meeting participants to delve deeper into topics presented throughout the workshop in a more intimate, small group setting. In addition, the World Café also served as a critical forum for information and knowledge exchange with the goal of collectively identifying critical climate change issues in the region, determining key priorities and needs, and gaining a broader perspective of challenges experienced by colleagues. Questions for the World Café were developed by the Southern Climate Impacts Planning Program (SCIPP) in partnership with colleagues at FWS. Together, FWS and SCIPP colleagues organized the layout of the session, coordinated logistics, and helped facilitate the discussion exercises through a brief training session with meeting participants as well as volunteer facilitators and note-takers at the workshop. SCIPP is one of 11 National Oceanic and Atmospheric Administration (NOAA) supported Regional Integrated Sciences and Assessments (RISA) programs, with the primary mission of co-developing science and information tools in partnership with decision-makers across the Southern U.S.

OVERVIEW OF SCIPP

The Southern Climate Impacts Planning Program (SCIPP) is a National Oceanic and Atmospheric Administration (NOAA)-supported Regional Integrated Sciences and Assessment (RISA) program that serves the climate research and information needs of the south-central United States. Established in August 2008, SCIPP is a joint research program of the University of Oklahoma (OU) and Louisiana State University (LSU) with combined expertise provided through the Oklahoma Climatological Survey, Louisiana Office of State Climatology, Department of Geography and Anthropology at LSU, Southern Regional Climate Center at LSU, and National Weather Center at OU.

RISA is a unique stakeholder-driven research and engagement program that focuses on regional climate issues across the United States through collaboration of eleven university-based research programs. SCIPP's engagement and research concentrate on several critical climate issues in the Southern U.S., including multi-hazard preparedness (severe storms, droughts, floods, hurricanes, extreme temperatures, etc.) as well as coastal impacts of climate change and variability. SCIPP addresses these regional climate issues by developing strong relationships with partners, decision makers, and other stakeholders, conducting pertinent and regionally relevant scientific research, and providing critical information, products, tools, and education.

Figure 2. Geographic coverage of SCIPP and lead research institutions.

Climate Issues in the South

From the arid conditions that exist across western Texas to the humid subtropical conditions along the Gulf coast, SCIPP is home to a diverse set of climate regions. However, as varied as its climate is, the region is challenged by many of the same problems – notably, the high occurrence of climate hazards that regularly impact the region. In fact, since FEMA disaster declarations began in 1953, SCIPP states have been among the most disaster declared in the U.S. As of August 2010, half of the 6-state SCIPP region was ranked within the top 6 most disaster declared states, while the entire SCIPP region ranked within the top 14. It can also be noted that FEMA disaster declarations do not include droughts, which also affect the region.

Climate issues critical to SCIPP are especially pronounced along the extended western coast of the Gulf of Mexico. Coastal locations are impacted by significant marine-related climate hazards, including hurricanes, storm surges, and flooding - all of which are likely to be affected by climate change. In addition, relative sea-level rise (as influenced by land subsidence and climate change) pose significant planning challenges for communities located in areas where these impacts may be greatest.

Stakeholders

Natural hazard and climate planning is at the forefront of SCIPP's engagement, research, and education efforts. In partnership with others working in the region, SCIPP aims to engage:

- Emergency managers
- City/community-level planners
- Natural resource managers
- State planners
- Local government officials

Additional audiences include:

- General public
- University/academic research groups
- City developers
- Non-profit organizations
- Environmental organizations
- Insurance community

Program Priorities

SCIPP is a stakeholder-driven climate research and engagement program. It is designed to conduct physical and social science-related research in the interest of decision-makers across the south-central U.S. Results of scientific research and engagement lead to the development of new products and tools that directly address needs of stakeholders across the region. Education and outreach is another key focus of SCIPP that involves many local partners, and is provided to enhance climate literacy as well as to train on new products and tools.

WHAT IS THE WORLD CAFÉ?

The World Café is a formalized method for bringing together a variety of perspectives to discuss important, yet challenging questions. The goal of the activity is, that through mixing a set of people with differing viewpoints, areas of expertise, and knowledge bases, a group can work together to address difficult questions and problem-solve. The unique aspect of the concept is that the World Café works to cross-pollinate unique viewpoints and ideas by continually mixing discussion groups. Following each discussion session, individuals are asked to disperse and join new partners at different tables. Through this process, participants are continually exposed to different perspectives and knowledge sharing is enhanced.

The World Café exercise for the FWS/USGS climate change meeting brought together approximately 200 participants representing a range of professions and backgrounds. To promote interaction and create a more relaxed setting, tables were limited to no more than 8 participants. Each table was set up with a facilitator to help guide discussions as well as a table note-taker with a laptop computer to capture the group's conversations. Facilitators and note-takers were identified prior to the meeting and briefly trained the morning of August 11 to ensure a productive and successful series of exercises. Several additional facilitators and note takers were also assigned and trained at the start of the first day's session to complete the set of 24 separate table discussions.

The discussions occurred over a series of four 45-minute sessions held over two days of the workshop. The theme for Day 1 was "Critical Issues and Information: Today and Tomorrow" and included discussion topics on "Stressors" and "Needs and Priorities", while the theme for Day 2 was "Climate Adaptation: Strategies and Challenges" and featured discussions on "Assisted Migration" and "Creating and Maintaining Connectivity on the Landscape." Groups had 45 minutes per session to discuss the questions and provide answers as led by the table facilitator. Following the session, groups were asked to leave their table and join a new one for the next discussion (note: facilitators and note-takers stayed at their original tables). Through this process the array of resource managers, coastal managers, refuge personnel, agency leadership, scientists, individuals from academia, and others in attendance, had multiple opportunities to share their collective knowledge, capacity, and expertise to address the questions posed. At the end of the last discussion each day, a brief report back time was provided for groups to highlight major themes and reveal particular areas of disagreement.

SCIPP and colleagues at FWS jointly developed the questions for the sessions throughout the spring and early summer of 2009. Major topics were identified up front based on experiences at the 2008 workshop, and questions were subsequently drafted and iterated to accompany the different themes. One question was replicated from the 2008 workshop in Tucson, AZ, thus providing an opportunity to compare results across years.

WORLD CAFÉ QUESTIONS

DAY 1 - AUGUST 11, 2009 - CRITICAL ISSUES AND INFORMATION: TODAY AND TOMORROW

Discussion 1: Stressors (45 minutes)

1. Please list the most critical stressors at present facing the various plants, animals, and ecosystems for which you are responsible. Rank the top 5 stressors (with 1 being the most critical; use each rank only once). If possible, explain why each of these stressors is so critical.
2. What tools or processes do you have now for dealing with those present stresses?
3. In your opinion, how will climate change interact with or affect the current stressors facing the various plants, animals, and ecosystems for which you are responsible? Are your current tools or processes sufficient to deal with stressors when you include climate change? Do you think there will be new issues that arise because of climate change?

Discussion 2: Needs and Priorities (45 minutes)

1. Looking to the future of conservation work, what critical new information or options would you identify as priorities to help you deal with potential future issues (due to climate change) identified during Discussion 1. *Please prioritize your future needs and be as specific as possible.*

High priority (critical to have/know)	**Medium priority** (important to have/know)	**Low priority** (good to have/know)

2. As a hypothetical exercise, suppose you have a budget of $100 to distribute between 12 climate-change related science, management, and outreach priorities over the next 5 years as indicated in the table below. Spend your $100 (no more, no less) on these priorities, with more funds going towards items you determine to be more important and fewer (or no) funds going towards items of lesser importance. Feel free to write in new priority items if needed and include those in your budget spending and explain why they have been added. Please first complete this exercise individually by writing your answers below. Once everyone is finished, discuss with your table and produce a new, group answer (you'll have to compromise!).

Priority	Funds	Priority	Funds
Climate change education & training programs for agency decision-makers (regional or national)		More science to study climate-ecosystem connections (including species responses to climate)	
Climate change education programs for the public		Pilot projects to demonstrate climate change adaptation strategies at a landscape scale	
Improve climate monitoring		Identify practical climate change adaptation options for natural resource managers	
Improve data access and climate change information sharing		Habitat conservation and/or restoration	
Improve ecosystem monitoring		Landscape-scale conservation planning (i.e., looking across ownership boundaries)	
Improve climate model projections		Improve communication and collaboration with partners	

3. Consider your group's top 3 spending priorities in question 2, what makes these the most important? Consider your group's lowest spending priority item(s), why do you think these warrant the least funding?

DAY 2 - AUGUST 12, 2009 - CLIMATE ADAPTATION: STRATEGIES AND CHALLENGES

Discussion 3: Assisted migration (45 minutes)

1. Assisted migration is the process of relocating members of a species to a new region for the purposes of establishing a new, permanent habitat. What are the pros and cons of this process? Please list as many as 5 pros and 5 cons.
2. What do you think conservation policy should be regarding assisted migration?
3. What approach would you use to decide which plants and animals should be the focus of an assisted migration effort? Identify criteria that could be used to determine which species should be assisted and when.
4. What information would you need to develop an assisted migration plan? Please identify your priorities and any challenges that you may encounter.

Discussion 4: Creating and maintaining connectivity on the landscape (45 minutes)

1. What options and strategies do you have now to work with conservation partners to develop and maintain connectivity between parcels of land?
2. What options would you like to have to make the process work more effectively and efficiently?
3. How might climate change present new challenges to landscape connectivity? Please provide some examples.
4. Do you envision any tools, strategies, research studies, or other items that may help to address potential future landscape connectivity issues that are associated with climate changes?

WORLD CAFÉ ANALYSIS

Meeting participants provided a wealth of information on a variety of topics covered through the four separate World Café sessions held over the two-day workshop. Answers to all questions were reviewed, synthesized into common themes, and analyzed in depth. The following section highlights the findings of the analyses and is provided in a question-by-question format to allow for the answers provided to be analyzed in the context of the questions posed. Each individual question includes a short summary as well as a more in depth analysis of the answers provided. A complete set of collated responses from all World Café session groups is included in Appendix D for further reference.

Discussion 1: Stressors

Discussion 1 (Stressors), Question 1: *Please list the most critical stressors at present facing the various plants, animals, and ecosystems for which you are responsible. Rank the top 5 stressors (with 1 being the most critical; use each rank only once). If possible, explain why each of these stressors is so critical.*

Summary

The first World Café discussion session focused on the topic of stressors and required the groups to consider the most critical stressors impacting plants, animals, and ecosystems. Collectively, invasive species were by far the most commonly identified stressor across all the participant groups. Other top mentioned stressors included habitat fragmentation and loss as well as many issues involving water, including water supply and quality. Stresses resulting from continued expansions in the energy industry were also commonly noted as well as green energy alternatives. Other themes emerged and are included in further detail below.

Analysis

Workshop participants were very consistent in the input they provided regarding external stressors on plants, animals, and ecosystems. Invasive species were by far the most commonly identified stressor with nearly every group listing this near or at the top of their respective lists. While robust explanations were not provided, it was briefly indicated that invasive species act as 'opportunists' that exploit species less able to adapt to changes, thus their significance as a stressor. Habitat loss and fragmentation was the next most frequently identified stressor on natural systems. Example sources of habitat fragmentation included landscape 'chopping' which results in regions no longer being able to support ecosystems, physical barriers such as border fences and highways or roads, conversion of land to other uses such as commercial, industrial, residential, or agricultural, and others.

Rank	Stressor
1	Invasive species
2	Habitat loss & fragmentation
3	Water supply & freshwater inflow
4	Water quality
5	Urban development

Table 1. Top stressors impacting ecosystems. Rank corresponds to the number of times a stressor was mentioned across all group discussions.

Another pervasive theme throughout the stressors discussion was that of water. This included a diverse range of aspects relating to water including quality, supply, use, surface and groundwater changes, salinity changes, saltwater intrusion, recreational use, and water rights. In particular water supply and quality (in this order) led all water categories in terms of the number of times mentioned. Common descriptions mentioned reductions in water supplies and growing demand coupled with a variable climatological component as primary stressors. Reduced water quality was mentioned to be a significant contributor to disease and an overall degradation in species health. Changes in the natural temporal cycle of water were another commonly repeated stressor due to the cascading effects it has on plants and animals that depend on water at a given time. Human influences were commonly noted as well including the manmade build-up of waterways (which can

affect downstream transport to natural systems), the creation or proposal of new reservoirs resulting in the destruction of bottomland ecosystems, and the existence of water rights that result in unfavorable usage of water.

Stresses resulting from continued expansions in the energy industry were also commonly noted. Interestingly, both traditional fossil fuel as well as green energies were mentioned in the discussions as serving as a source of strain on natural systems. In particular, concerns regarding wind farm developments both inland (across western OK and TX) and along the coast were frequent due to the impact wind power has on numerous bird and other animal species. Fossil fuel concerns were more focused on the byproduct of production in decreasing both air and hydrologic quality. In addition, the transition of land use from natural landscapes to those supporting oil and natural gas exploration, wind production, or solar production were noted.

Figure 3. Some workshop participants had significant concerns regarding the impact of wind energy on some animal species (Photo credit: Oklahoma Wind Power Initiative).

Another commonly addressed stressor on wildlife and natural systems was that of weather extremes. The Western Gulf Coast and Southern Plains experiences numerous hazards spanning water (droughts, floods), storms, hurricanes, high and low temperatures, wildfires, and severe winter storms. While these hazards have always occurred and will continue to do so, any significant alterations in the regional coverage, temporal occurrence, and frequency of weather hazards can and will have impacts on species sustenance. Considerable concerns were raised regarding *"floodier floods"* and more extended drought periods, all of which would have non-negligible effects on natural systems, animals, and plants. The effects of these extremes were noted to have a chain effect on natural systems that ultimately impacts the system as a whole. Such examples include imbalances in insects during extended dry periods and significant saltwater intrusion during and following strong hurricanes.

Although redundant with the section focusing on "habitat loss," one common theme that bears direct mention from this discussion is that of human population growth and urbanization. Numerous groups specifically indicated the tremendous stressor humans are on natural systems. The examples are many, but include items such as habitat loss due to urbanization and development, modification of natural water systems (lakes, reservoirs, rivers, drainage, etc.), strong dependency on natural resources necessary for ecosystems, pollution and chemical byproducts, and creation of barriers preventing migration (fences, roads, dams, etc.). With future population increases expected across much of the South, this stressor may only amplify with time.

Discussion 1 (Stressors), Question 2:
What tools or processes do you have now for dealing with those present stresses?

Summary

Question two of the first World Café session continued on the theme of stressors and specifically focused on tools present for managing stressors. Tools mentioned throughout the group discussions included education, conservation, land acquisition, land restoration, land preservation, plant and animal species monitoring and removal, planning, regulation, and partnerships. While many of the strategies focus largely on better use of resources, learning, or planning for use of land, other groups identified regulation as one of the

most critical tools for protecting environmental systems and establishing accountability. Another significant common theme identified was that of partnerships. It was echoed throughout that without partnerships and collaboration between different groups many of these various tools for managing stressors are much less effective than they could be.

Analysis

The second question on the first World Café session was a follow up to the question posed on human stressors on natural systems. Specifically groups were asked to describe tools and processes available for dealing with human-induced stressors. The analysis of group responses revealed a series of common themes, which included:

- Education
- Conservation
- Land acquisition, restoration, preservation
- Monitoring and removal of invasive species
- Planning
- Regulation
- Partnerships

Education, in its many forms, was among the most frequently mentioned tools for managing stressors. A variety of educational focuses were mentioned including conservation (land use, recycling, water, etc.), scientific education on current research and understanding of human impacts on natural systems, as well as education as a tool for garnering social support for these issues. The intended audience for these efforts is wide and includes the general public, decision-makers, and policy-makers. Given the variety of audiences, educational objectives vary with each particular group. Efforts with the general public have a goal of spreading the word to many, which can include aspects such as impacts of humans on natural systems, conservation options to implement at home, and establishing more awareness of the issues. In this vein, education with the general public is more in the realm of outreach and establishing an open and honest relationship around the science. Education with decision-makers is distinctly different and aims to provide critical information needed for developing strategies, planning, and taking action. Depending on professional backgrounds, key local, state, or regional decision makers likely have varying degrees of familiarity with issues relating to wildlife management issues. Education within this audience has to be strategically aimed at different sectors in such a way that it can be incorporated into their decision-making processes. Much of this can be most effectively accomplished through targeted training efforts and workshops that work to introduce the science as well as associated tools, information, and strategies in an open and non-confrontational forum. One of the other key audiences mentioned in participant responses were those of policy-makers. For instance, one group expressed that, *"we also need leaders … who are making decisions based on environmental importance, not financially advantageous options."* Leaders with high levels of understanding of current environmental issues strongly based in good science are paramount to the development of effective policies and regulations. This particular audience is a key one to inform due to the significant influence they have on decision-makers, the general public, and others.

Numerous aspects of conservation were indicated as viable tools for managing human-induced stressors on ecosystems and wildlife. In particular, the common theme focused on by many of the groups was conservation development, conservation easements, landscape scale conservation, and water conservation. One group defined conservation development as, *"subdivisions that are conservation oriented, communal lands, communal water use, with preserve spaces…"* Or in other words, bringing people with strong interests in conservation together to live sustainably and with reduced impacts on natural resources. A significant challenge with this strategy is the high level of motivation and dedication (as well as replication) required to make this effort successful. Conservation easements were another very frequently mentioned resource management strategy. Easements are a method for limiting the amount of development (commercial, industrial, or other) that occurs on a given property and are agreed to between a landowner and a government agency. A particular strength of conservation easements is that once established, the restrictions in place are binding on all future owners of the property and thus the easement exists in perpetuity. A landowner who agrees to place a conservation easement on their land benefits not only from protecting the land from buildup, but also from a number of tax incentives. One way in which this

strategy can be used is to purchase protected habitats and easements to form larger areas protected from build up. In this way conservation easements can be considered a landscape scale conservation strategy. In general, conservation easements are an effective tool for restricting build-up on properties and help to maintain natural resources and wildlife present on the land. Community based conservation was also emphasized in several group discussions. Some of the issues highlighted included barriers to migration due to split private ownership. An example of how this could be mitigated through employing community-based conservation includes developing migration corridors to support adaptation. Water, recycling, and other resource conservation efforts were also commonly mentioned in the group discussions. Much of these efforts have to be tied to educational efforts and campaigns that promote efficient use of resources at the consumer level.

Somewhat similar to the conservation theme is the process of land acquisition, restoration, and preservation. The general concept is that through the purchase of a collection of neighboring parcels of land and subsequent restoration to its original state, natural ecosystems and wildlife can be maintained and preserved for many future generations. This strategy is best represented through the State Park, National Wildlife Refuge, and National Park systems that have in some cases been established and maintained throughout the U.S. for well over the last 100 years. The process works to identify vulnerable, yet unique landscapes and associated wildlife critical to preserve and maintain. Numerous groups identified this tool as a key strategy for managing the collection of human-induced stressors on plants and wildlife.

Maintaining the proper balance of wildlife and plant species on the landscape is another key item indicated by groups in question 2. One such way groups recommended addressing this issue was through ecosystem monitoring and removal of invasive species. Much of these activities are necessary to prevent the unnatural spread of invasive species through early detection and rapid response. In order to do this effectively, numerous groups indicated that it is critically important to determine what does (and does not) need to be monitored. To determine that would depend on the complex and value-laden task of species prioritization. Also on the theme of invasive

Figure 4. The National Wildlife Refuge system represents one key natural resource management tool. Shown above: The Wichita Mountains National Wildlife Refuge (Photo credit: U.S. Fish and Wildlife Service).

species, several groups mentioned the importance of determining the effectiveness of eradication efforts and indicated that more research is needed into the introduction and spread of invasive species. While those are research questions, it was quite apparent that the respondents considered monitoring for invasive species and their control key tools for maintaining healthy ecosystem balance.

The general theme of planning, which comprises landscape scale and land use planning was another common strategy mentioned by the groups for managing human-induced stressors on wildlife and natural resources. These different planning types, while different, are based largely on the same principles of function, form, and practicality. The objective is to utilize space in such a way that it maintains the economic and social health of a community while also sustaining the critical balance of natural resources. Landscape scale planning pertains more to the use of larger tracts of land in such a way that natural resources are not overused and wildlife is provided opportunities to move about freely and naturally. Land use planning is a fairly broad term, but pertains largely to wise and efficient use of land for the benefit of local economies and populations while also benefiting the environment. Urban planning is more focused on the development of highly populated areas, yet plays a critical role in hydrologic developments and other aspects that affect ecosystems. Regardless of the types, all of these are critical tools for

maintaining the health of natural systems in areas in which developments are occurring.

While many of the strategies mentioned to this point focus largely on better use of resources, learning, or planning for the use of land, numerous groups identified that regulation is one of the most critical tools for protecting environmental systems and natural resources. Together, the groups denoted a variety of specific regulations and systems; these included the Endangered Species Act, Migratory Bird Treaty Act, Lacey Act, Coordination Act, Oil Pollution Act, Clean Water Act, Comprehensive Environmental Response Compensation and Liability Act, Total Maximum Daily Loads, and National Pollutant Discharge Elimination System. The establishment of these various regulations combined with effective enforcement discourages improper practices and holds people accountable for misuse or mistreatment of natural systems.

One final common theme identified through the analysis of group answers for this question was that of partnerships. It was echoed throughout that without partnerships and collaboration between different groups, much of these various tools for managing stressors are much less likely to be effective. This emerged perhaps more as a "need" rather than a tool itself, but in a way it is both. Better coordination, as noted by participants, was deemed necessary at multiple levels including federal, state, and local. In general, partnerships were deemed critical for essentially all tools mentioned, be it education, conservation, regulation, monitoring, and so on. It was generally mentioned that partnerships and collaborations would result in more effective use of expertise, which would yield the best management results.

While the comprehensive set of management tools present numerous opportunities for coping with the overwhelming myriad of stressors, it was also noted by several that these tools are not enough. Comments such as, *"We don't have all the tools we need; even those tools we have are not being properly implemented or used most efficiently"* highlight that the challenges presented to natural resource and wildlife management are not few and require the cooperation of many.

Discussion 1 (Stressors), Question 3: *In your opinion, how will climate change interact with or affect the current stressors facing the various plants, animals, and ecosystems for which you are responsible? Are your current tools or processes sufficient to deal with stressors when you include climate change? Do you think there will be new issues that arise because of climate change?*

Summary

The concluding portion of Discussion 1 focused on the effects of adding climate change to the current myriad of stressors impacting plants, animals, and ecosystems. Participants presented a range of issues they felt climate change would influence with habitat change and migration being two of the most commonly echoed issues. The second part of the question focused on the sufficiency of tools for managing these stressors when climate change is included. A common response was that, *"the tools that we have are not adequate to address the current situation."* The final portion of this question focused on participant opinions regarding new issues as a result of climate change. Much of the group answers to this question fit into the categories of 'needs' or 'concerns' and are detailed in greater depth in the following analysis.

Analysis

A review of the participant generated answers revealed a number of common themes, so answers were subsequently grouped into primary categories. In general, answers for this section were a bit shorter than previous ones. Being the first World Café Discussion series of the workshop, participants were still learning how to manage their time, so this likely played a role. Added to this is the fact that this question included multiple parts that were fairly open-ended, which required time that some groups did not have available. While the response volume was generally smaller, the groups provided equally valuable input and in many cases the open-ended nature of the questioning resulted in more insightful responses.

Participants presented a range of issues they felt climate change would influence. Habitat change and the resulting migration of plants and animals were among the most commonly echoed issues. In particular, habitat loss through fragmentation and through *"changes we can't control."* One potential source of habitat loss was indicated through the expanded coverage of wind farms in conjunction with an expected strong push for green energy in the future. Wind farms pose a risk to numerous species, particularly for those that rely significantly upon landscapes used for wind power. Other changes mentioned focused on shifting populations of rare and endangered species, which were noted to result in changes for the worse (and in some cases, changes for the better). In general, it was noted that with habitat changes, species range changes, extensions, and migrations would result. In these cases it would be difficult to identify an invasive species versus a species that was adapting more quickly and extending its range to account for its changed habitat.

Water was another critically important, common issue of focus for most groups. In general, most groups felt that reduced water quantity and quality would be a fairly likely scenario when adding climate change to the current situation. Changes in the general hydrologic cycle were also mentioned. Numerous groups expressed concern regarding a shift towards more heavy precipitation/runoff events and associated more frequent (and longer) drought episodes. In this situation, the overall water inflow to the system may be the same (or higher), but the shift towards more heavy events (and droughts) would not benefit the hydrologic health of the system. Related to these heavier precipitation events, numerous groups also highlighted an increased risk of erosion and sedimentation that would alter habitats. Concerns over increased frequency and magnitude of drought focused heavily on the spread of invasive species, particularly for long duration events.

Sea-related impacts of interest included sea-level rise concerns and associated "bulk-heading" to protect developments that would result in significant negative net results on wetlands. The continuation and increase of harmful algal blooms in the Gulf of Mexico were also highlighted, which would have subsequent effects on species, fisheries, industry, and recreation – as one group put it, it would *"filter up the food web."*

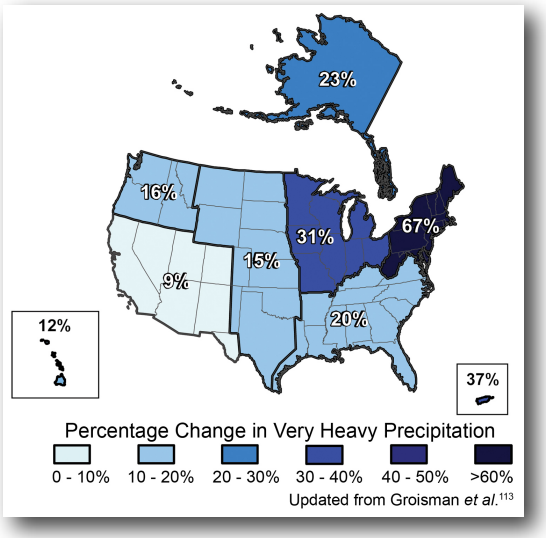

Figure 5. Participants expressed concern regarding increasing precipitation extremes. Research has found that very heavy precipitation events increased during 1958-2007 (Image credit: U.S. Global Change Research Program).

Anticipated impacts on fisheries were not limited to the Gulf of Mexico. A number of groups indicated an added strain on the freshwater fishing industry due to decreases in the carrying capacity of estuaries, decreasing habitats, and an overall decrease in the amount of freshwater. Another added stressor that could be amplified by climate change was that of disease, and as some groups indicated, *"new diseases."* With the prospects of warmer temperatures, changing habitats, and altered hydrology in conjunction with climate change, numerous groups indicated that increasing pests, disease, and in particular, outbreaks, would be possible. All of these would undoubtedly put animals and natural systems under increasingly greater levels of stress.

Not all the issues highlighted by the discussion groups focused on negative impacts. Several indicated potential benefits in the agricultural sector due to a lengthening of the growing season. Forestry was another sector mentioned as a possible winner, largely due to increased growth rate in some regions due to warmer conditions and longer growing seasons. Interestingly, a couple groups indicated that climate change would bring about some changes that are neither good nor bad – just different. For instance, scientists, decisions makers, and others will have to learn how to adapt their processes to a different world in which

previous ways of doing things may no longer be appropriate.

As a follow-up question, participants were asked, "are your current tools or processes sufficient to deal with stressors when you include climate change." A highly common response of many of the groups was along the lines of, *"the tools that we have are not adequate to address the current situation."* Several groups indicated that laws and policies need to more rapidly adjust to respond to these issues. Others mentioned that there are an abundance of tools, but *"We STILL do not know what the local (regional) effects will be; the projections are too broad still."* Much emphasis was placed on the need for good, local information, *"tools may be adequate, but not applied enough. May need to be redesigned to apply at the local level."* Other groups indicated that the operations of many landscape management offices is static and that they are in no way equipped to handle a dynamic system in the future. In general, the participants provided an overwhelming sense of ill-preparedness for future stressors when climate change is added to the mix. In some instances groups conveyed a sense of helplessness in how to manage future conditions.

In the final part of this multipart question, discussion groups were asked, "Do you think there will be new issues that arise because of climate change?" Many felt that there would be new issues, and in general, a common theme that emerged was that of the "unknown." Items such as unknown habitat changes, unknown species shift, unseen benefits, uncertainties with future migrations, distributions, and habitats. In general, groups tended to indicate items with negative ramifications, such as disease, changing distributions of native species, increased ecosystem changes due to competition and drivers, and effects on human population. Several groups highlighted how climate change may bring about a change in the way things are done such as the way in which stressors are prioritized, or how we as a society will use new and different resources. On the topic of energy, one group indicated that alternative/green energy sources may bring about significant negative effects. Interestingly, this topic came up throughout participant answers during Discussion 1 and represents a clear concern over a technology that is generally thought of in the public realm as a low impact, 'no-brainer' to the traditional fossil fuel energy sources.

In addition to the answers directly addressing the questions posed, some participant answers did not directly address the questions, but provided additional valuable input. These comments and thoughts fit largely within the categories of 'needs' and 'concerns.' Focusing first on needs, many of the comments precipitated out of answers provided to the second and third questions in this discussion section. Many respondent comments focused on needs such as *"more multiagency cooperatives"*, *"improved coordination between entities"*, and *"more education."* In another common theme, numerous groups spoke similarly regarding the need for the planning process to become more adaptive and flexible as well as a for bureaucracy to be reduced. Many groups indicated that information is key and that science needs to be translated so it is more useful and supportive of good decision making. On the topic of tools, groups indicated that needs exist for *"holistic management tools"*, *"better habitat planning"*, *"more knowledge"*, and *"more connectivity."* Others mentioned the need for vulnerability assessments on multiple levels that can help to identify which species need the most work, and which ones should be the focus of restoration and recovery efforts.

On the theme of 'concerns', several common answers emerged in the group responses. One of the key words reiterated by many was *"unknowns."* Of particular concern to many are unknown, or unforeseen consequences of climate change on natural systems. As one group put it, *"there are known unknowns and unknown unknowns."* Or as another group put it, *"Great concern that we do not yet know what we do not know."* Other common areas of concern focused on the tendency of humans to be *"more reactive than proactive"* and for focus to *"quickly shift from one crisis to another."* Groups also focused quite a bit on the issue of invasive species versus range expansion. As one group put it, *"Are range extensions to be considered invasives? Are these due to climate change? Were they happening anyway?"* It appears that many groups hoped that some sort of system or

"Great concern that we do not know what we do not know."

protocol could be established for helping to define this issue as it will likely become amplified as climate changes. Other groups touched on assisted migration and asked the rhetorical question, *"do we start moving species around or let it be?"* while others felt that we, *"may have to do triage and just save what we can."* In general many of the participants seemed hopeful that strategies focused on conservation could be maintained, but there was concern expressed that humans would react, *"out of fear; re-prioritization away from conservation."* These additional pieces of insights highlighted many of the critical issues seemingly at the front of the minds of the participants at this climate change workshop.

Discussion 2: Needs & Priorities

Discussion 2 (Needs and Priorities), Question 1: *Looking to the future of conservation work, what critical new information or options would you identify as priorities to help you deal with potential future issues (due to climate change) identified during Discussion 1. Please prioritize future needs and be as specific as possible.*

Summary

Meeting participants produced a set of priorities for dealing with potential future issues due to climate change. These needs were separated into the different priority levels including high (critical to have/know), medium (important to have/know), and low (good to have/know). Participants produced a significant list of high priorities, which were subsequently grouped into 4 major thematic categories including science, education/outreach/ partnerships, funding, and other resources. Medium and low priorities included far fewer items and generally fit into the themes of science and taking action.

Analysis

The needs that were listed as **high** priorities (critical to have/know) fell into 4 categories: *science* (basic and applied); *education/outreach/partnerships*; *funding*; and *other resources*. The *science* category was by far the largest and most inclusive. Many of the specifics included more regional or local scale information from models (downscaled) such as projected impacts that if known could support better planning and decision-making including vulnerability and risk assessments. Another fairly major category included among others: monitoring in relation to development, protected areas, establishing baselines and developing inventories, invasive species, water needs and uses (human and ecosystem), and to address specific information needs all in relation to a changing climate.

The category of *education/outreach/partnerships* included a call for general and specific education and outreach efforts where the audiences included the general public but also legislators and decision-makers. A specific theme here was how to assist in helping people to actually understand that climate change is real, on-going, and that it will impact the natural resources and thereby humans. They called for education efforts to find new ways to express this scientific understanding such that it would become the impetus for behavioral changes and more sustainable decisions. The partnerships identified as needed were of two types: 1) scientists working with resource managers, and 2) resource managers and scientists working together to educate on proper conservation techniques to on-the-ground staff as well as to those who plan and support on-the-ground efforts.

Most of the listings identifying *funding* as a priority were quite general. Two specific needs for funding were identified: habitat restoration and protection, and in the educational sense of helping people to recognize that if ecosystem services are lost due to climate changes then there will be health impacts to human populations.

Other resources that were identified as high priorities were generally around the need for the development of specific regulations, strategies (e.g. land conservation), policies (e.g. groundwater management), or authorities (e.g. land use planning, land acquisition). One additional resource priority need was specifically identified: a centralized source for relevant climate change research information.

High priority (critical to have/know)	Medium priority (important to have/know)	Low priority (good to have/know)
Science: • More regional and local scale information from models • Vulnerability and risk assessments • Invasive species • Monitoring (particularly for developments) • Establishing and developing inventories • Water needs and uses • Address specific information needs **Education, outreach, & partnerships:** • Educational efforts aimed at public, legislators, and decision-makers • Increased collaborations between scientists and resource managers • Scientists and resource manager education and training efforts for field staff **Funding:** • Habitat restoration and protection • Education on impacts to ecosystems **Other resources:** • Development of effective regulations and policies for managing natural resources • Centralized source for climate change research information	**Science:** • More specific information on how species respond to changing climate • Invasive species vs. range extension • Socioeconomic studies **Taking Action:** • Acquisition and conservation of lands • Restoration and removal of barriers limiting migration in maritime environments • Incentives for managing lands and wetlands **Other:** • Database management • Information sharing within and between federal agencies	**Science:** • Modeling salt water intrusion • Studies, inventories, and surveys • Expansion of hydrologic gauge network **Other:** • Regulations

Table 2. Prioritized list of synthesized needs, broken into high (critical to have/know), medium (important to have/know), and low (good to have/know).

Medium priority (important to have/know) items identified were far fewer in number than the high priority items described above. This smaller number of items still reflected a rather wide range of categories. The greatest number of items could be grouped into the *science* category and arranged into basic and applied classes as above. An example of the basic science category could include more specific information on how species respond (to a changing climate) while an applied science effort might include decisions on when a species is exotic or invasive as species ranges change. Other applied research efforts mentioned included socioeconomic studies, database

management, and sharing of information within and outside the agency.

A second medium priority category could be titled: *taking action*. This category includes such specifics as: acquisition and conservation of lands in mitigation of sea-level rise, restoration and removal of barriers that limit water movement in fresh and saline environments; and incentives for managing land and wetlands, among others.

Two others specific suggestions that do not fit into the above groupings were identified as medium priorities. They were: partnerships including education on better practices for public, regulators, other researchers, and population reduction incentives-even up to sex education or taxes on increasing numbers of children.

The final category of **low** priorities (good to have/know) was extremely sparse in that only 4 items were specifically identified as low priorities. Three of the four specific items would be classified in the *science* category. While the three items identify modeling (under specific salt water intrusion conditions), studies/inventories/surveys, and expansion of the hydrological gauge network, it is important to remember that a low priority is still information that is good to have. The only other specific low priority item identified was regulations.

There were 22 items listed in the responses to this question that were not prioritized in any way. It was difficult to determine if the items were the needs prior to prioritization or in addition to those needs that were prioritized by so many groups – some wording was quite similar but for others the wording was distinctly different. In general, all of these additional notes could be easily collated with the previously listed priorities with no significant number of unique sentiments. One comment stands out, though, as unique and not included in any of the categories above: "*If we take the actions we think we need to we may not see the results for a significant amount of time.*" That is an important concept that could be included in the education efforts focused on both the public as well as decision-makers.

Discussion 2 (Needs and Priorities), Question 2: *As a hypothetical exercise, suppose you have a budget of $100 to distribute between 12 climate change-related science, management, and outreach priorities over the next 5 years. Spend your $100 on these priorities with more funds going towards items you determine to be more important and fewer (or no) funds going towards items of lesser importance. Feel free to write in new priority items if needed and include those in your budget spending and explain why they have been added.*

Summary

Meeting attendees were provided with a set of 12 climate change-related science, management, and outreach categories and asked to prioritize. Participants were given a hypothetical $100 to allocate to different categories as desired, with more funds going towards areas deemed to be higher priorities. Results revealed the following as the top 5 priorities:

1. Habitat conservation and restoration
2. Climate change education programs for the public
3. More science to study climate-ecosystem connections
4. Landscape-scale conservation planning
5. Improve ecosystem monitoring

Results were also compared to an identical exercise conducted at a similar meeting held in Tucson, AZ in 2008. Overall, participants at these separate meetings identified many of the same top priorities including ranking items #2, #3, and #4 (above) in the top 5 both years. The most significant difference in the results was that *habitat conservation and restoration* (#1 above) was ranked in the middle of the list in 2008.

Analysis

The spending exercise in this question was included in an effort to quantify the relative importance of various climate change-related priorities of meeting attendees. The intent of the

session was to reveal priorities that were more (and less) important to the attendees as a whole to determine areas of general consensus as well as disagreement. Responses were reviewed, quality controlled for consistency (allocated funds had to sum to $100), and analyzed. A nearly similar version of this exercise was conducted at the 2008 meeting in Tucson, AZ thus creating an opportunity to compare results.

The graph shown in Fig. 6 shows the average participant spending for each of the categories included in the exercise (note that users were able to write in new categories - which are not included in Fig. 7). Participants allocated the highest amount of funds to habitat conservation and restoration, with an average of nearly $17 spent per attendee (out of 97 total, quality-controlled responses). This result contrasts fairly significantly with the results of the Tucson 2008 meeting, which found habitat conservation and restoration to be ranked in the middle of the priority spending at approximately $6. Other top spending categories shown in Fig. 6 include climate change education programs for the public (ranked #1 at the Tucson meeting), more science to study climate-ecosystem connections (ranked #3 at the Tucson meeting), and landscape-scale conservation planning (ranked #2 at the Tucson meeting).

Overall, the top spending categories - with the exception of habitat conservation and restoration - matched up very closely with the results found at the Tucson 2008 meeting. While each of these meetings had some repeat attendees, both drew largely from the states in which they were held, thus the audiences sampled were significantly different. The fact that such similar results emerged from these two meetings implies a general consensus among this community, particularly for top priority actions.

Items ranking in the bottom of the list and thus representing the lower priority items included: improving climate model projections, climate change education and training for decision makers, improving communications with partners, improving climate monitoring, and improving data access and information sharing. Justification behind the lower priority items was subsequently asked in Discussion 2, Question 3 and is included in that analysis.

Figure 7 identifies the number of times each spending category received the highest allocation of funds for all 97 participants. Like Fig. 6, habitat conservation and restoration was the top spending item, followed by more science to study climate-ecosystem connections, and climate change education for the public.

In addition to the spending categories provided as part of the exercise, several participants wrote in new priority spending categories from which a portion of the $100 was allocated. Those additional categories included:

- Working with policy-makers to develop smart growth approaches
- Emergency rescue (water, bringing into captivity, etc.)
- Social sciences
- Tying financial incentives to long-range climate change mitigation actions
- Shape new policies
- Invasive species
- Law and regulations

While it is not possible to quantitatively analyze these new add-in priorities, qualitatively these categories provide further insight into areas of importance to meeting attendees.

As a secondary exercise, participants were also asked to prioritize the spending categories collectively as a group in an effort to see how the results changed when compromising. Groups used a variety of different methodologies for prioritizing, which included adding up each person's scores, ranking the priorities through voting, and re-allocating the $100 as a group. While these differing methodologies produced answers that could not be compared one-to-one among all the participant groups, the top priority items were inferred through identifying categories receiving the highest rankings or highest monetary allocations. This brief analysis found 2 primary priorities identified by a vast majority of the 15 table groups; these included *habitat conservation and/or restoration* with six #1 rankings and *climate change education programs for the public* with five #1 rankings. The remainder of the #1 priority selections were dispersed among the other 10 spending priorities with none receiving more than two #1 rankings. These results are consistent with the top priorities identified in Fig. 6.

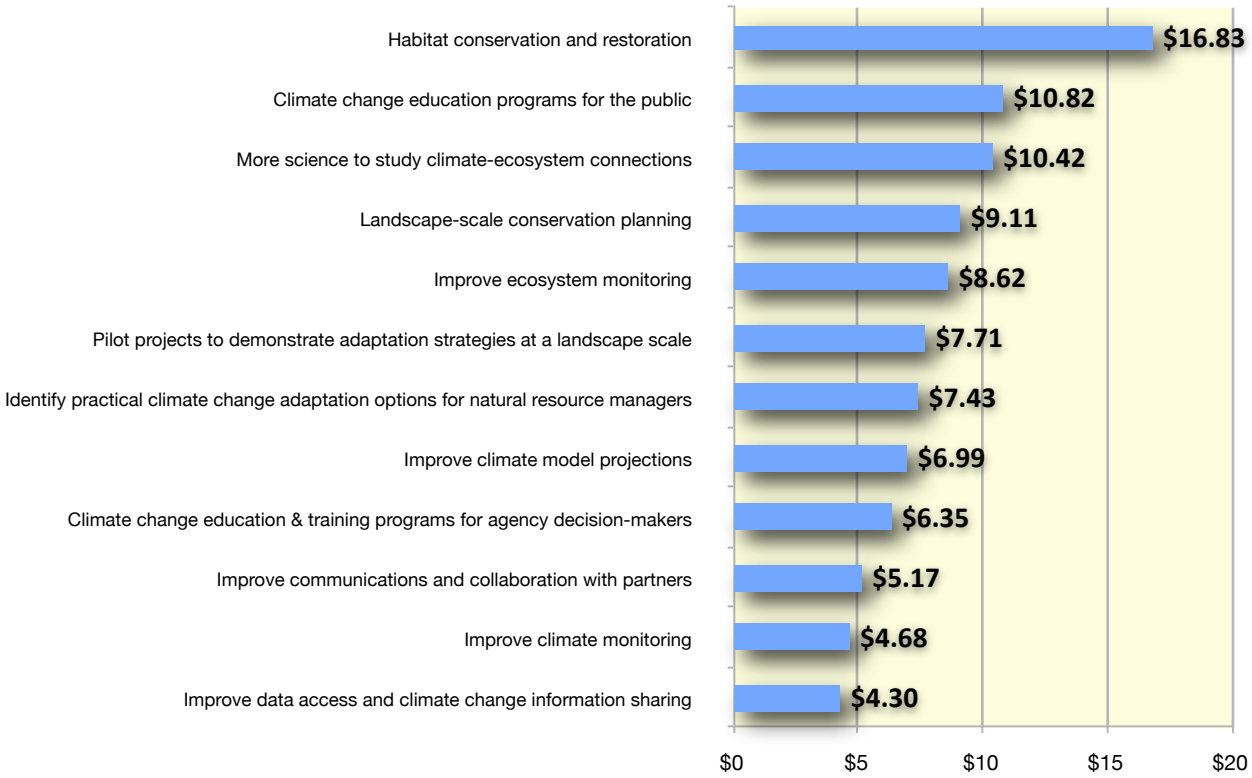

Figure 6. Priorities spending exercise. Values represent average participant spending for each category (includes 97 individual responses).

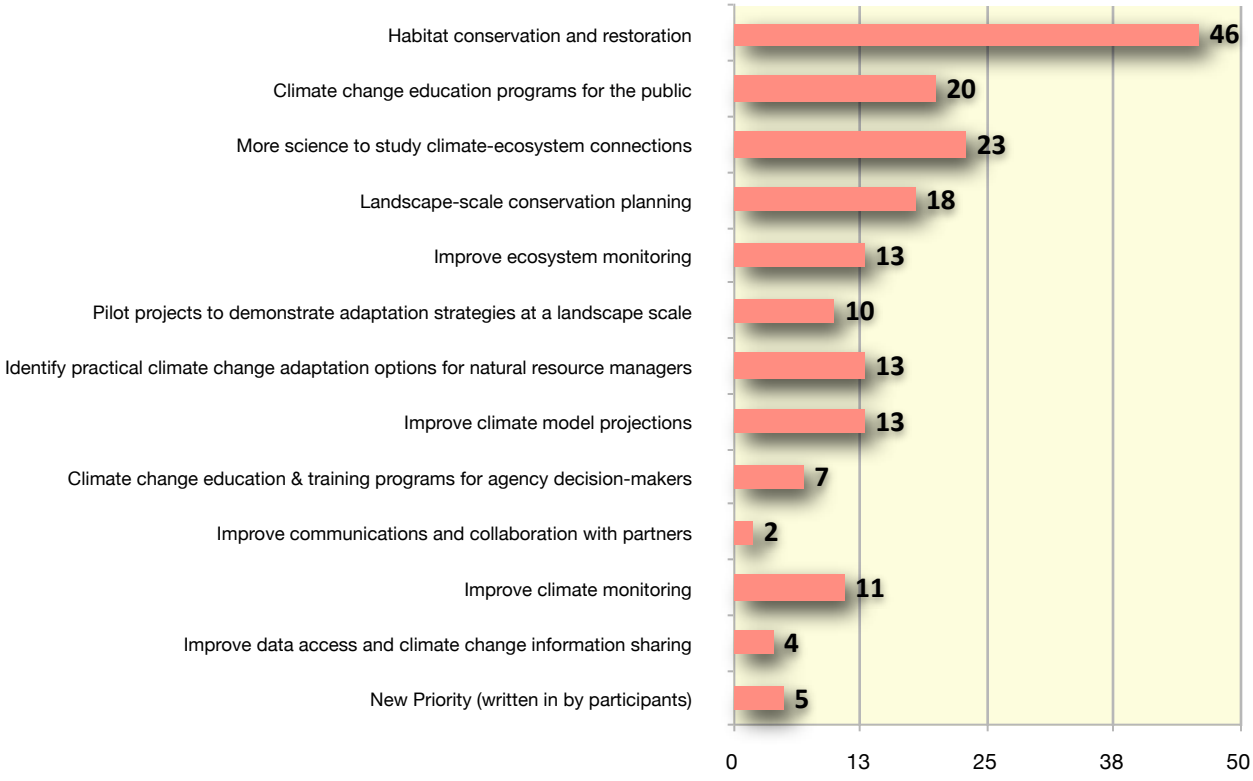

Figure 7. The number of times a spending category received the most funding (n=97). Note: Some participants gave equal maximum amounts to multiple categories.

Discussion 2 (Needs and Priorities), Question 3: *Consider your group's top 3 spending priorities, what makes these the most important? Consider your group's lowest spending priority item(s), what do you think these warrant the least funding?*

Summary

Participants were asked to provide justification for the top and lowest group priority items found in Discussion 2, Question 2. While tables had some differing priorities, generalities emerged from the answers. Common top priorities - particularly *habitat conservation and restoration* as well as *climate change for the public* - were described to be extremely urgent items that would have significant effects on other priorities. On the other end, items classified as low priority items - such as *climate monitoring, ecosystem monitoring,* and *improving data access and sharing* - were felt to be redundant with efforts elsewhere, activities that are fairly well done already, or items that do not require much funding for improvement. Participant responses for this question were less comprehensive than for other portions of the World Café exercise but revealing nonetheless.

Analysis

The concluding question for the first day of the World Café exercise focused on better understanding the group prioritization selections in Discussion 2, Question 2. The purpose of the question was to gain further insight into the collective decisions the groups made in identifying both top and low rated priority items involving climate change during the next 5 years. While many groups ran out of time to answer this question (either partially, or in full), answers provided by groups completing this question are analyzed here.

The groups provided some interesting reasons for justifying the group-established priorities. Focusing on top priorities first, many of these items were identified as things that:

- *"we can do now"*
- *"[are] valuable to everyone"*
- *"must be done now"*
- *"we have the tools to do these"*
- *"need to be done first to accomplish the lower priorities"*

While top priorities selected varied somewhat by groups, the general reactions were that top priority items were important, achievable, and needed to happen first. As revealed in the analysis on Discussion 2, Question 2, *habitat conservation and restoration* was among the most commonly selected top priority. Some of the specific group justifications for this priority included:

- *"Habitat conservation and restoration is the key to coping with uncertainty."*
- *"If possible to identify what is important, then protect it. Can't wait, must be done now."*
- *"Species are going to need a corridor to migrate and adapt to climate change or they will go extinct. Action is required now and may not be able to wait as communities and conservationists are all modeling impacts."*
- *"Habitat conservation combined with landscape-scale conservation planning to save natural systems while we can before it is too late."*

From the above set of bullets it is clear that urgency is a common theme for those having selected *habitat conservation and restoration* as one of their top priorities.

Climate change education for the public was another category designated by many as a top priority. The following present some of the reasons for its selection:

- *"May make the biggest impact on future generations by educating the public now."*
- *"Public demand is what drives politicians."*
- *"People have to know this will affect their kid's ability to play football."*

In general, participants identified public education as a critical priority due to the significant influence the public has in bringing attention to key issues. Justifications for other "top" priority areas were relatively few, and thus are not highlighted in further depth.

On the other end of the spectrum, the meeting participants provided some valuable responses in justifying "low" priority spending areas. Generally, these items were described as:

- *"Not producing immediate results."*
- *"[Items we are] already doing a lot of."*
- *"Already widely available."*

In particular, the categories of *climate monitoring* as well as *ecosystem monitoring* were identified by many of the groups as being relatively low priority compared to the other 10 items included in Discussion 2, Question 2. Examples of reasons groups put this as a low priority include:

- *"Monitoring is being done by several agencies already."*
- *"With limited resources we seem to be doing OK."*
- *"Already doing a lot of monitoring."*

Improving data access and information sharing was another low priority item identified by numerous groups. Some justifications included:

- *"Data access and sharing information is not something that needs money to accomplish."*
- *"The framework is already in place. We just need to further implement and make accessible for all."*

Overall, groups indicated that essentially all of the 12 items included in the exercise are of critical importance for addressing climate change issues. Through prioritizing the fairly wide-ranging set of action items, each of the groups were forced to think big picture and determine the most critical items that would result in the most significant advances in the next 5 years. To review more participant responses provided for this question, please see Discussion 2, Question 3 in Appendix D.

Discussion 3: Assisted Migration

Discussion 3 (Assisted Migration), Question 1: *Assisted migration is the process of relocating members of a species to a new region for the purposes of establishing a new, permanent habitat. What are the pros and cons of this process? Please list as many as 5 pros and 5 cons.*

Summary

In this question, participants were asked to evaluate the pros and cons of assisted migration. Generally, none of the respondent groups were enthusiastic about the prospect of undertaking assisted migration. However, even with that caveat many participants felt that there were numerous reasons to begin more strongly considering this adaptation strategy for a changing or more variable climate. Participants felt that assisted migration could support diversity of the gene pool and survival of species. One of the most commonly mentioned conditions for making such a decision was the level of vulnerability of the species to extinction. Other considerations in the discussions included who, how, when, and under what authority would such a judgment to initiate movement of a population be made. A major obstacle to address included the importance of increasing knowledge of possible consequences and the many uncertainties and unknowns. For example, what are the chances that a newly moved species would become an invasive and out-compete traditional species? Other concerns included issues such as the costs (financial and human) and whether or not lessons learned from previously failed efforts would be applied appropriately.

Analysis

In general, none of the groups of respondents were enthusiastic about the prospect of undertaking assisted migration for a number of reasons that will be identified below. However, many felt that there were numerous reasons to begin considering this as an option or a tool in the repertoire of how to assist plant and animal communities in adapting to a changing or more variable climate, under somewhat specific conditions. Before getting into

the specifics, there were two philosophical and ethical points that might underlie the entire premise. These are that any program of assisted migration would go against the idea of the survival of the fittest. The other overarching ethical question posed was around the idea of creating a garden or a zoo in an ecosystem that is still functioning and wondering how this compares to the possibility of extinction.

Many of the respondents highlighted the opportunity that assisted migration could offer toward increasing the diversity of the genetic pool by preserving species and even moving them to locations of similar species with the hope of increasing the gene pool. Groups felt that assisted migration efforts could increase survival of species and contribute to maintaining species diversity considered important in healthy and viable populations. It could be an important tool in the set of options available to assist populations to survive and thrive in a rapidly changing climate.

The conditions under which assisted migration efforts might be undertaken fell into three major and two minor categories. All of these could contribute to the creation of policy around developing and employing assisted migration programs. Two of the major categories included: employing such efforts to save a species that would likely go extinct or be "listed" (e.g. last resort effort or population in isolation), and moving a species around artificial or man-made barriers that they could not otherwise navigate themselves. Non-navigation reasons included:

- The organism (plant or animal) was virtually or totally stationary and reproduced slowly or only nearby, or
- The change was happening so quickly that they would not have time to move around the barrier (i.e., no easily available corridor) before conditions were unsuitable for them.

The third major category was that decisions needed to be made on a case-by-case basis. For example, a slow reproducing organism might be more favorably chosen over a fast reproducer to be moved because it would be less likely to over-compete those species already in the location. In other words the species with the highest potential to become invasive or otherwise detrimental to their new home might be avoided.

The two minor conditions under which assisted migration efforts might be undertaken included:

- Who, how, when, and under what authority would such a judgment to initiate movement of a population be made, and
- The need to be ready with regulations and systems to implement such a policy.

Are there legal limitations or jurisdictional authorities around moving species that would need to be addressed? There also was a concern that it could require the loss of some species to create enough public concern necessary to generate political will and funding to implement assisting migration policy. Once that interest was generated, however, there could be no major lag time to create the policies to implement it. Otherwise a loss of public support for the process would be possible.

Figure 8. Meeting participants were not enthusiastic about implementing assisted migration as a new plant and wildlife management strategy, however, it was generally agreed that the option must be considered moving forward (Photo credit: U.S. Fish and Wildlife Service).

In considering the option of developing a program to assist migration of plants and animals many of the responding groups mentioned a number of concerns around any such program. Those concerns included:

- The potential for the moved species to become an invasive in the new location and out-compete the natives in that location;

- The potential to spread diseases;
- The concern over hybridization possibilities;
- Any number of unintended and secondary consequences; and
- The fact that past bio-control efforts have not always been successful.

There were numerous uncertainties that were highlighted by the various responding groups that could be of concern when planning and implementing any assisted migration program. The uncertainties included high concern regarding species survival in a new location as well as some concern over *"do we know enough?"* Questioning if enough is known relates in this case to numerous pieces of unknown information around any particular species. Such unknowns include the fact that often it is not just the temperature and precipitation regime in a location that contributes to species success but also that it could be a favored food source or any other unknown specifics for a particular species. It is even unknown if the transplanted species will remain in the new location. There appear to be a variety of information pieces that were felt to be lacking to assure a successful effort. Such questions would be appropriate for future research programs.

Costs of assisted migration efforts were also a focus of discussions. There was a concern that there could be a high cost (money and labor) to such efforts with a low probability of success. There was also concern that there is a limited amount of funding available to various fish and wildlife efforts and the respondents did not want to see money expended on something that could possibly have a low rate of success and result in less funding available for other efforts.

Several concerns were expressed regarding impacts on the specific population being assisted. Concern surrounded depleting an existing population through loss of genetic diversity or due to an inability to move the population. Other concerns included a lack of appropriate food sources in their new location as well as impacts to meta-populations. Would assisted migration efforts leave the original population genetically depleted?
There were a few issues identified that would fall into a category that could include communication, education, and collaboration efforts being available or necessary. For example, it was thought that there might be a need for a public awareness or outreach effort to avoid public resistance (e.g. the Mexican grey wolf) and to take advantage of a teachable moment for the public on climate change. It seemed to some that any assisted migration effort might be an opportunity for collaboration and development of support both with the public and with other potential collaborators. There seemed to be the possibility of an economic opportunity (wildlife observation) as well as an opportunity to use this effort as a science tool to increase knowledge among a variety of potential participants.

Discussion 3 (Assisted Migration), Question 2: *What do you think conservation policy should be regarding assisted migration?*

Summary

The respondents suggested that there were five categories that represented their thinking on what should be included in conservation policies. Those five were:

- When to implement an assisted migration effort;
- How that effort should be carried out;
- Which organisms should be included;
- What information is needed to plan and carry-out such an effort; and
- Precautions.

Analysis

The policy issues easily grouped into five basic categories with a few additional *other issues* mentioned by only one or two groups. The five categories that represented numerous responses were: when to implement an assisted migration effort; how that effort should be carried out; which organisms should be included; what information is needed to plan and carry-out such an effort; and precautions.

As was clearly identified in the pro and con question (Discussion 3, Question 1) about assisted migration, the majority of the respondents felt that any assisted migration program should be implemented as a last resort or very near last resort

effort to prevent a species from going extinct or being listed as endangered. Groups expressed concern that all decisions regarding when an effort should commence need to be based on a case-by-case basis; carefully undertaken to try to assure the greatest success possible; and before it is too late (i.e. before the gene pool is too small to be healthy; or too much change has happened while hoping it will not become a reality).

There were numerous comments on how any assisted migration policy should be planned and implemented. A number of groups suggested that any plan should incorporate the historical range and rate of movement in the projection of where a species might be introduced as well as where that species might occur as a result of a changed climate. This type of planning should apply to both plants and animals. In addition to this type of location selection it was suggested that there might be areas set aside for experimental introduction and other areas set aside that would be left natural where no introductions would be undertaken. Another policy consideration is to expand migrations beyond single species to groups of species in order to maintain ecosystem integrity. Along with an introduced species effort there was a suggestion that habitat restoration also be undertaken and that plants and animals both be introduced in appropriate locations (e.g. more southerly plants in more northerly locations but also into habitats that meet current criteria for species success). With the concern over the possibility that the introduced species could become competitive it was suggested that introductions occur in places that are either isolated or that have plants and animals that are considered generalists. A pilot project with umbrella or keystone species might be a good way to begin.

On choosing which specific species to consider for assisted migration there were four considerations identified. The most threatened species were again the ones that were mentioned specifically as a high priority but there was an opposing thought. It was thought that a more common species might be more likely to succeed and thus should be the choice. Clearly the chance of success was a critical consideration and mentioned in many forms in other categories. Finally, the concern over competitiveness was again raised when suggesting that a species chosen for assistance ought to be one that has a small range or a species that has natural barriers to movement, perhaps a slow reproducing species or one that is in some ways range limited.

The information needed to support policy decisions around choosing when, how, and which species to assist in migrating to new locations under rapid climate change included numerous aspects related to projecting future conditions as well as the requirements of the chosen species. Knowing or projecting what habitat and locations will be critical and appropriate to any specific species in the future will require not only location specific climate projections (e.g. downscaled climate forecasts with improved precipitation projections) but also ecosystem modeling including the specific species under consideration. Other questions that would need additional information include: how adaptable is the species; what specific conditions does it require for success; what are the chances that it will be successful; what are the concerns and possibilities around species hybridization; what are the food web considerations necessary for success; and how might this species impact the current ecosystem interactions. All of these considerations could be listed criteria and ranked in importance for any conservation policy decision.

While only three groups specifically mentioned precautions many others hinted at them by their concerns over the potential for hybridization and competitiveness between the introduced species and the current species in the location. Monitoring and plans to "undo" any introduction (e.g. remove the newly introduced species) should be part of any conservation policy around assisted migration. Part of this complete planning includes the need to have adequate financial and staff support to develop the plan, gather or generate the needed information around multiple issues, weigh the alternatives and options, develop a back-up plan, carry out the implementation, monitor the effort, and be ready to implement the back-up plan if needed.

There were a few other issues that were identified and are noted here. Are there regulatory issues that need to be addressed around future critical habitats to even allow this to happen? How can the issues of alpine species, for example, be addressed if there is no longer any suitable habitat available? What about other species that have no more suitable habitat under a changing climate, e.g., Arizona cypress, Douglas fir, short horned lizards, and certain trout species? How might they be

handled in developing a conservation policy? And finally, in developing a conservation policy, might a decision be made to limit assisted migration efforts in response to only man-made or only natural destruction events?

Discussion 3 (Assisted Migration), Question 3: *What approach would you use to decide which plants and animals should be the focus of an assisted migration effort? Identify criteria that could be used to determine which species should be assisted and when.*

Summary

Participants were asked to consider possible criteria for determining which species to support through possible assisted migration efforts. The most often mentioned critical condition for choosing a plant or animal to be put on an assisted migration list was its *level of endangerment*. The second most mentioned criterion was the *chance of success* if such relocation were undertaken. The majority of responses suggested that specific species chosen for any assisted migration program should include keystone or umbrella species that are considered beneficial or critical to maintaining ecosystem health and function. Other respondents expressed that prioritizing species should include a global ranking, with warm fuzzy charismatic species that could easily help to garner public and community support for the effort.

Analysis

The most often mentioned critical condition for choosing a plant or animal to be put on an assisted migration list is its *level of endangerment*. This large effort of assisting plants or animals to migrate to locations that will presumably be better suited for them in the future is no small undertaking so it should be applied when the organism is at a "hard edge." The workshop participants described those as the following types of situations:

- The organism is in danger of extinction or is threatened;
- The population is so small that it is in danger of being unable to sustain itself (e.g., limited genetic viability);
- The habitat is disappearing (e.g. high alpine species);
- The organism is unable to move itself or move quickly (least mobile);
- Barriers prevent movement; or
- There is no other option for avoiding extinction.

Another perspective is that the focus should include animals that are still healthy enough to be moved easily and succeed. There was one mention of letting a species proceed on its own with no interference or assistance and see what happens.

The second most mentioned criterion was the *chance of success* if such relocation were undertaken. There are a number of questions and considerations that have to be addressed, including:

- Is there suitable available habitat?
- Is there an appropriate niche available for the assisted organism in the new location?
- Does the location have any evidence of prior habitation of this organism?
- Is it possible to be proactive to make the move while the organism and community are still healthy and diverse?
- What are the concerns for competition for the introduced organism and those already in the location?
- Is there a concern for hybridization and loss of the original transplant?
- Are there other risk concerns that should be evaluated and managed?

All of these issues would need to be determined and assessed scientifically before any decision about the chance of success could be determined. The majority of responses suggested that specific species chosen for any assisted migration program should include keystone or umbrella species that are considered beneficial or critical to maintaining ecosystem health and function. Additionally, each species choice should be made on a case-by-case basis. Other respondents expressed that prioritizing species should include a global ranking, with warm fuzzy charismatic species that could easily help to garner public and community support for the effort.

If such an effort is to be undertaken, then the respondents suggested that it be through developing refuges, creating corridors, acquiring appropriate habitat in many locations (e.g., high alpine regions, set-back coastal regions, etc.). They also suggested that there should be an ecosystem or landscape approach where multiple species are moved together rather than moving single species. For example in a prairie take an entire piece of prairie topsoil including fungi, microbes, the actual soil and move the entire system together.

There were two final issues mentioned in the responses to this question: authority and cost. Does the Fish and Wildlife Service have the authority to undertake any such assisted migration effort? Perhaps the agency should be given that authority legally to avoid any issues. Additionally, the cost of implementing such a program is unknown and a variety of questions arise:

- How much would it actually cost to move a species?
- Is there enough funding to implement and monitor the program and address any problems that might arise?
- Is it worth the expense and effort to try to save any specific species?
- Would the money be better spent in relocation or in preserving other species in their native range?

Figure 9. A major question posed by meeting participants - just how expensive and feasible would it be to implement an assisted migration effort for a species? Shown above: Piping plover (Photo credit: U.S. Fish and Wildlife Service)

The discussions certainly revealed that there are a range of complex issues involving assisted migration as a wildlife management strategy. Whether or not such a strategy should be implemented down the road is and likely will be up for debate for the foreseeable future.

Discussion 3 (Assisted Migration), Question 4: *What information would you need to develop an assisted migration plan? Please identify your priorities and any challenges that you may encounter.*

Summary

Participants were asked to identify information needed to develop an assisted migration plan, as well as priorities and any challenges that would arise. Answers provided fell into the categories of habitat and ecosystem, the specific species and population, time scale and trends, and potential interactions. In addition to the information needed, participants identified numerous challenges, which fit into the themes of resources, political, cooperation and partnerships, and public perception and education. While the respondents identified some of the most critical information needs and challenges, many also voiced their concerns about the caution that should be an underlying factor in any assisted migration plan particularly related to the inevitable lack of complete information and the possibility of unexpected consequences from this type of deliberate human intervention.

Analysis

The information considered important to develop an assisted migration plan falls into numerous categories with many of them overlapping and all with an underlying note of caution. The categories include: the habitat and ecosystem; the specific species and population; time scale and trends; and potential interactions. One team expressed: *"Our table feels that it is such an extreme measure that it should only be done with comprehensive information about the species and proposed habitat-and only with extreme caution."*

Around the choice of a new habitat there are numerous pieces of needed information. Some that were identified for a specific location included:

- Species specific habitat suitability information including historic range, tolerance information, downscaled climate projections;

- Maximum and minimum range of abiotic and biotic factors and their importance to the species in question;
- Baseline ecosystem data and functions;
- Ideal habitat conditions for the species;
- Organisms already in the location and the likely interactions with the introduced species;
- Is the best new habitat on public or private lands?

The species specific and population information needs included (among others):

- Species biology;
- Historic ranges;
- Prior restoration success or failure and why;
- Necessary or critical species interactions;
- Predation;
- Competitive abilities;
- Adaptive abilities (e.g., is it possible to identify and learn new migratory routes);
- Population status;
- Effective population size;
- Original range and ideal habitat;
- Ability for the species to migrate on its own;
- Genetic information to determine if the species is adding new genetic diversity;
- Models and projections to determine if new range will be sustainable and for how long will it be appropriate.

Some of the timescale and trends issues or indicators needed are:

- What is the time scale to consider in planning?
- When do we act?
- Need time series analysis - trends over time to determine how long the location will be appropriate (e.g., 5 years or 50 years due to a changing climate or sea-level rise, etc.)
- When events need to commence (e.g., after drought events – when do we release wildlife back into the environment? Or when should a population be moved?)

Potential interactions is critical information in assessing the potential likelihood of success of any assisted migration effort and could include aspects such as the potential for predation, competition, or the possibility of becoming an invasive species in the new location. Understanding potential interactions of native and non-native species with one another and their transition during climate change are also important. It is critical to know past interactions that were necessary for survival of the new specie (e.g., specific pollinator, fungus for a specie) so that these factors can be incorporated into the move.

What is needed to monitor any assisted migration effort is critical and includes the identification of indicators of concern as well as what actions to take if those criteria were met. These would help to decide when to implement and what to do if an introduction is going poorly.

There are a variety of challenges associated with the development and implementation of any assisted migration effort. Those challenges include resources, political, cooperation and partnerships, and public perception and education. Focusing first on resource challenges, these would include:

- Financial – costs for all the steps to plan, implement, and monitor the program; to acquire the necessary land and information; and to train personnel;
- Personnel – to have knowledgeable personnel available to staff all the necessary steps;
- Time – to develop plans, to implement plans, to save species, to gather and assess required information;
- Information – all of the required information will take time and personnel and resources to generate.

Political challenges could be seen in competition for which species are saved; inter-jurisdictional issues between and among communities, states, countries, and various other entities. Cooperation and partnership challenges could include where to develop corridors for species to cross boundaries - not just jurisdictional boundaries but also ecosystem boundaries. This would require cooperation between private landowners, municipalities, scientists, and resource managers. Public perception and the need for public education around these efforts could be an important challenge especially when attempting to develop new migration corridors across public and private lands.

Discussion 4: Creating and Maintaining Connectivity on the Landscape

Discussion 4 (Connectivity on the Landscape), Question 1: *What options and strategies do you have now to work with conservation partners to develop and maintain connectivity between parcels of land?*

Summary

In this final discussion of the World Café exercise, meeting participants were asked to focus on the topic of creating and maintaining connectivity on the landscape. In particular, this initial question asked participants to describe strategies for working with conservation partners. Overall three major types of strategies were identified, which included land acquisition, partnerships, and cooperative programs with incentives. Respondents described that there appears to be no overall strategy for maintaining connectivity, but instead decision support tools are being applied on species-specific or situation-specific bases. Overall, it was emphasized that education and trust are two critical keys that determine the success of all strategies in the landscape connectivity area.

Analysis

There are some general comments that begin this discussion and place all the specifics in a useful context. One of the groups mentioned that at present there is no overall strategy for connectivity and indicated that decision support tools are being used and decisions are being based on species-specific or situation-specific strategies to develop connectivity. It was also mentioned that management strategies based on eco-regions or watersheds are recent introductions into this process. Other groups mentioned that while there seem to be very few limits, present regulations and bureaucracy are stumbling blocks preventing creative and innovative programs from emerging as well as current programs from being as effective as they could be. For example, some respondents suggested that in some programs various government agencies are discouraged from directly soliciting farmers or landowners, but rather must depend upon third parties, partners, and collaborators to educate and interest landowners in those efforts and activities. Another example mentioned that while decision support tools are being used for determining conservation lands of interest, government agencies cannot identify which land areas are chosen for conservation and incentive programs.

Several other overall comments were provided. It was mentioned that any program developed needs to have benefits for all parties involved. Another comment indicated that it would be valuable to develop models and scientific information to support appropriate management decisions and develop a spatial footprint (geospatial map) to illustrate land acquisition initiatives to shareholders so all understand the implications and needs of the effort.

There were three primary strategies identified that are presently available to support the implementation of land connectivity efforts. Those include: land acquisition; partnerships; and cooperative incentive programs. Land acquisition efforts are those that include working with a variety of other agencies (e.g., non-profits, State, land trusts, private entities, etc.) to purchase ecologically significant land. Acquisition allows for actual transfer of property rights but can be expensive and also requires that the new owner be responsible for any development or conservation plans that include the acquired property.

Partnerships are being developed for a variety of issues within and among numerous levels of authority and jurisdiction. Groups involved in partnerships can include, among others: private landowners; tribes; federal, state, and local agencies; non-governmental organizations; and intergovernmental groups. Some partnerships are related to managing properties that are already owned in a manner that is acceptable to all involved, while other forms of partnerships are undertaken to acquire land. Furthermore, other partnerships are being developed to:

- Provide grants that result in public ownership of properties
- In the development of joint ventures and cooperative agreements around a variety of programs and strategies;

- In support of many fish and wildlife efforts;
- To identify, conserve, and restore ecological corridors (e.g., refuges working to fit into adjoining state/federal agency land plans to create larger corridors).

Partnerships are an extremely useful strategy for supporting a variety of wildlife programs and are particularly useful for developing and maintaining wildlife corridors.

The third major category identified as a strategy for developing and maintaining connectivity was cooperative programs that could include incentives. Some specific examples provided by participants included:

- The Prairie preparation program - an effort to recruit farmers to work together to maximize habitat;
- Various Farm Bill programs that had both pros and cons (Pro - immensely popular. Con - not permanent and may be rescinded with land transfer through sale, etc.);
- Gulf coast prairie program - comprised of a governing group that is made up of not only federal and state agencies but also community members;
- The Nature Conservancy eco-region planning program;
- Various private lands cooperatives and incentive programs;
- Coastal, wetland, and estuary programs and grants;
- Capital trade programs that include payments for ecosystem services, community economic benefits, State and federal incentive programs, and market-based programs to stimulate habitat conservation.

Other cooperatives that have been established include those that support harbor agreements, environmental flow agreements, fish passage projects, fish advisory groups, and land exchanges. In addition to incentives mentioned earlier, others include tax benefits, grants, and carbon sequestration credits. It was noted that there are a number of mandated mitigation programs and projects. These can include easements, reserved acquisition, and best management practices.

It was emphasized that the success of any of these strategies depend on two key items: education programs and good relationships with private land owners. In the education area it was noted that it is critical to educate the public on the ecosystem services provided by corridors. This could be accomplished by identifying critical groups and individuals who could spearhead such effects as the development of joint education and outreach programs or even a social marketing campaign.

Finally, building trust and good working relationships with the public and with private landowners is perhaps the most critical step in making all of the above mentioned and any new options successful. Participants indicated that developing friends groups and holding coordination meetings could help to build relationships as well as a conservation ethic. It was also expressed that avoiding the use of "power" such as eminent domain to take land would greatly help in building trust between federal agencies and the public. Trust is the unspoken and critical factor in many of the cooperative and volunteer agreements and it must be fostered to ensure the success of connectivity efforts.

Discussion 4 (Connectivity on the Landscape), Question 2: *What options would you like to have to make the process work more effectively and efficiently?*

Summary

In this second question of the Connectivity discussion series, participants were asked to highlight options for improving landscape connectivity. A key item emphasized by many of the participants was that the process needed to be much more streamlined in terms of the many steps involved in the process. In addition to this, groups also communicated that there were needs for more resources and planning tools of many types. Incentives were another fairly common suggestion, albeit converse to the notion of greater involvement by federal authorities.

Analysis

The option that generated the most responses was around streamlining the many parts of and inputs to the processes that are needed to maintain land connectivity. Respondents suggested the need to streamline:

- The time involved in the appraisal and acquisition processes (e.g., easier applications and quicker turnaround times from federal and state sources of funding, set 90-day deadlines for appraisals, etc.);
- The paperwork required (i.e. reduce it);
- The process of putting agreements into place;
- Coordination and more timely communication within and among the many entities involved;
- The grant process into one source rather than many, including longer advanced knowledge of announcements of opportunities;
- Regulations and bureaucracy perceived as stumbling blocks.

In addition to streamlining portions of the process, some suggested that an increase in effectiveness might need to include updating infrastructure as well as new or more frequently implemented federal authorities. Some examples of this suggestion include:

- Giving federal agencies the ability to help farmers and land owners manage their own properties by having the agencies take on the risks usually associated with other 3rd party agencies;
- Improving the acquisition process to look beyond the price per acre of land;
- More frequent use of land condemnation;
- More use of regulations, reserved acquisition, and easements;
- Changing acquisition boundaries to make more land available.

The next most mentioned options were the need for more resources and planning tools of many types. Resource needs were mentioned in relation to direct funding to acquire properties, the ability to pay more if needed, and in the need for more trained personnel to carry out the programs. In the discussion around planning tools, some of the tools identified were technical in nature like models and scientific information available to support various entities with management decisions, such as:

- Better GIS habitat maps;
- Predictive mapping to identify where gaps do or will exist in corridors;
- Spatial representation for environmental sensitivity of the landscapes;
- A biologically based ranking system;
- Indicators that species concerned will take advantage of the actions undertaken.

Other types of planning tools included the development of clear goals and objectives for actions within and among various members of the wildlife and conservation community. This could include identifying what the acquisition plan should be before any action occurs. Respondents also mentioned the need for adequate time to prioritize work and the ability to utilize 3rd party appraisers in this effort.

In a somewhat opposite perspective to the idea of increasing the use of federal authorities, a number of groups mentioned that incentives ought to be used rather than penalties. They expressed that increasing incentives such as land swaps, awards, tax code incentives, and even the incentive to hire a consultant could make the process of developing more connectivity in the land more effective and efficient.

Public education and outreach efforts and building relations with landowners around a conservation ethic were also ideas of how to more effectively and efficiently create land connectivity. This included the idea that the public needs to understand that some of the decisions they make will contribute to whether a species lives or dies. It was also suggested that there are groups that could be relied upon to deliver effective outreach efforts.

The final note was in relation to partnerships. There are partnership funding opportunities, grants, and cooperative agreements that could assist in supporting an effort to create more connectivity. These and other partnerships could be more effective if the grant sponsors were more responsive to partner input and had the ability to be more flexible in implementing programs.

Discussion 4 (Connectivity on the Landscape), Question 3: *How might climate change present new challenges to landscape connectivity? Please provide some examples.*

Summary

In this third question, respondents provided examples of new challenges that climate change will pose to landscape connectivity. The answers provided by participants highlighted four major challenges, including physical changes, human dimensions, uncertainties, and increased opportunities for conflict. These issues are analyzed in further detail below.

Analysis

In general, the respondents to this question felt that climate changes will make the issues surrounding landscape connectivity more difficult for four primary reasons:

- The physical changes and their resulting consequences,
- The human dimensions of the response to physical changes,
- The uncertainties surrounding climate change impacts on any specific parcel of land,
- A growing potential for conflict.

When considering impacts of climate change on landscape connectivity, the most apparent are those due to physical changes. Impacts such as:

- Changing temperatures and extremes
- Reduced temperature differences from day to night and warmer temperatures (especially during winters)
- Changing precipitation patterns, including annual amounts, heavy downpours, and time between rains
- Sea level rise
- Increasing strength in storms, and the resulting impacts on river and stream levels (high and low)
- Narrowing coastal corridors
- Droughts

All of these changes would be inconsequential if they had no impacts on living things. So the real concerns are the consequences of these physical changes such as habitat loss, disruption, fragmentation, isolation, and migration. For example, sea level rise that disconnects or submerges marshes and other presently upland habitats as well as changes in salinity gradients and flow will impact many species and at various stages of their life-cycles. The same could be said for river species whose water levels depend on rainfall or for mountain species that rely on temperatures at particular elevations. Many animals depend on specific locations for propagation, nurseries, nesting, and food sources. Many plants require particular physical conditions for growth. Changes to those conditions will result in changes in plant ranges, changes in timing of fruiting, or even their demise. The animals that depended on those plants for foods will also either have to change their ranges, find other food sources, or become locally extinct. This pattern can play itself out in any number of ecosystems that are impacted by changes in the physical conditions - temperature, precipitation regimes, and sea level - that surround them.

When such changes occur, they often open up niches for what are commonly called invasive species. Those species called invasive are not normally found in a particular location, often are fast reproducers, and often have few predators. They can frequently out-compete the traditional members of an ecosystem and as a result change the ecosystem relationships. An issue surrounding climate changes and invasive species is the difficult question: when are invasive species actually migrating species that are better suited to the new environment?

Figure 10. Is the Mountain Pine Beetle expanding its range due to increasing temperatures? If so, can (or should) it be considered an invasive species? (Photo credit: U.S. Forest Service)

The human dimensions aspect of climate change and the impacts on maintaining land connectivity fall into a number of categories. One of those categories includes the decisions that people make in relation to climate changes. Those decisions can be related to the development of alternative energies and their impacts on the land. For example, a new wind energy development may result in fragmentation of a critical habitat. That wind farm - or other actions such as diverting rivers during droughts - may become barriers to some species or may have other detrimental impacts to wildlife and natural areas.

Another area of concern is moving people and infrastructure to previously undisturbed areas and the potential disruption that it could cause. Those same undisturbed areas could hold potential for other forms of sprawl (e.g., ranchettes) when the population continues to grow and the available land is limited. One participant group mentioned the issue of converting forested lands to grasslands for new developments, which contribute further to forest fragmentation.

There were several issues mentioned in relation to the human dimensions surrounding climate changes and connectivity. The first of those related to the fact that the public recognition of climate changes and their impacts lag behind reality, which in turn cause a delay in appropriate actions being undertaken. One issue mentioned was that human attention span is short compared to the long-term problem solving that is needed to address climate changes. Another related point made was that the solutions are long-term and political cycles are short term. All of these concerns imply the critical nature of political leadership and the need for education programs.

The uncertainties around impacts to connectivity include the notion that it is impossible to know what specific habitats will look like in the future. Will some rivers become disconnected because of drought? Will some water bodies become so warm that present species can no longer survive and thrive? Will habitats actually change in ways that were not predicted? It is difficult to manage in the face of such long-term uncertainties. Another issue around uncertainty involves purchasing priorities – should they be changed to accommodate the possibility that land acquisition boundaries might shift or how does one plan present and future land purchases when it is unknown if the land will still be appropriate at a given time in the future.

The final major point involving connectivity and climate change involves that of conflict. Conflict may emerge between conservation efforts and other land use efforts involving energy, water, or agriculture. Another potential area for conflict is the possibility that additional numbers of private landowners may need to be involved in any conservation and corridor development effort. The larger the number of individuals involved, the larger the potential for differing goals and conflict. Keeping public sentiment on the side of conservation was thus an important consideration.
A few general comments were also included in this conversation around climate impacts. Those were that it is critical to understand where the vulnerabilities will exist with a changing climate and that assessments would be needed. Management practices need to be flexible in order to address a changing climate and thus changing management needs. And finally there was a concern that it might be important to allow agencies to change or broaden their core focuses to better deal with the impacts and consequences of a changing climate.

Discussion 4 (Connectivity on the Landscape), Question 4: *Do you envision any tools, strategies, research studies, or other items that may help to address potential future landscape connectivity issues that are associated with climate change?*

Summary

The final question of the multi-part World Café exercise focused on tools, strategies, research studies and other items to help with landscape connectivity in a changing climate. Tools identified included a variety needed for gathering information (such as LIDAR, mapping, modeling, and databases) as well as tools for responding. Several examples of research were provided and are detailed more in the analysis. Many strategies were provided, which largely fit into the following categories: coordination and collaboration at multiple levels; education and public awareness;

resources; monitoring; and legal, regulatory, and management options.

Analysis

Respondents identified a number of tools, research needed, and strategies believed to be useful in helping them address future landscape connectivity issues in relation to a changing climate. Many of the specific items identified fall into one of three categories.

The tools identified covered a wide range of possible spectra and uses including information gathering as well as responding. Some of the information gathering tools include:

- LIDAR
- Mapping (GIS, habitat mapping, remote sensing data)
- Modeling (both present and future conditions, large and small scale)
- Development of two new databases:
    - A landowner database to identify who owns any property that might be important for a future acquisition for potential new corridors
    - Land use data that are temporally relevant and that would allow some standard ecological classifications

The tools suggested for responding include:

- Emerging technologies (desalinization and carbon reduction)
- Older technology (rain barrel)
- Regulatory options - condemnation and land acquisition
- Indicator option - monitoring of indicator species to identify when action is needed

One major category of research that was identified relates to projections and predictions:

- Sea-level rise rates
- Temperature and precipitation in specific locations in the future
- Species movement and migration patterns and how they might change under a changing climate
- Species that are likely to have their environment move away from them (slow migrators)
- Small-scale niche models

The second major research category focuses on the need for more specific information around life history and baseline requirements for survival of many species. Two groups specifically mentioned the need for research on invasive species and one included a focus on how they might be controlled with biological methods. The final specific request was for more research on natural corridors. A general request was to learn more and fill the knowledge gaps.

The strategies that were identified clearly had themes that included: coordination and collaboration at multiple levels; education and public awareness; resources including funding and other types of support; monitoring; and legal, regulatory, and management options. Coordination and collaboration was called for within and among various levels of government as well as between private entities and government. The issues that would benefit from collaboration and coordination could include:

- The identification, protection and restoration of functioning ecological corridors including those under private ownership
- The proactive preserving of prime ecological habitat corridors as well as guidance for avoiding projected important future corridors
- Development of comprehensive planning and strategies for limiting fragmentation of habitats before it occurs
- Improvement of current and development of additional partnerships
- The development of risk assessment strategies and vulnerability assessments that would likely cross boundaries
- Improving communications among stakeholders
- Identifying what information is needed
- Interdisciplinary training programs
- Identification of priority areas
- The ability for FWS to have access to a science-based research branch or the development of one

Education and public awareness were considered prime options for helping to address potential future landscape connectivity issues in association with climate change. It was deemed critical to develop greater public awareness around these complicated issues at all levels. Public education was deemed a key to success in developing present and future landscape corridors. It was suggested that having a range of scenarios to show the public how options were weighed and developed into strategies would be an important step in generating support for actions to be undertaken.

There were three specific examples identified as having important potential in education and raising awareness. These included the Youth Conservation Corps (YCC) (already established for 15-18 year olds) as well as a possible job shadow program where young people are encouraged to work in the outdoors through special opportunities. The Civilian Conservation Corps (CCC), a predecessor to the YCC, was critical to the establishment, development, and infrastructure building in many of America's most treasured National Parks in the 1930s. Perhaps the YCC as a modern version of the CCC could be broadened and implemented to similar success. Another approach to youth could be through the creation of video games focused on how to build refuges or save a species. And finally it was noted that there needed to be education programs developed for policy makers and other decision-makers to encourage an understanding of the science needed to support wise decisions for wildlife.

Access to a number of specific resources was considered an important strategy for good decision-making around land connectivity. Of course funding was mentioned as critical and specifically around the notion that resource constraints should not be the determining factor in deciding whether or not a species is assisted. Administrative support was identified as an important resource as was more support for non-governmental organizations that assist in education efforts, working with landowners, and identifying critical habitats and threatened species.

Numerous groups mentioned the importance of monitoring. One group specifically identified the importance of maintaining current monitoring programs (e.g., the USGS water gauge network). Another group described the need to establish on-going monitoring programs at the landscape level to evaluate habitat change relative to climate changes. The development of new monitoring programs were suggested as long-term commitments that would focus on specific 'indicator species.' Finally, research and monitoring cooperatives among university, government, and non-governmental organizations might be a way to implement new monitoring programs with long-term stability and excellent data collection records necessary for understanding changing conditions.

The final category of strategies that were identified includes legal, regulatory, and management options. The legal options mentioned included the use of easements and reserved acquisition to make land available for corridors. It was suggested that regulations could be developed that would make it easier for private landowners and agencies to cooperate. Management issues included the concept that it might be important to develop genetic banks to maintain a gene pool to preserve a species. Another management option included the development and use of specific techniques such as floodwater capture and species-specific management options (e.g., ocelot tunnels and Houston toad tunnels). Finally, it needs to be emphasized that any management option must be adaptive and capable of accommodating new strategies as appropriate for conditions in the future.

DISCUSSION

The overarching theme from the series of World Café discussions during the FWS/USGS climate change meeting was how to effectively maintain balanced and healthy ecosystems under a changing climate. Climate change or not, many stressors are already disrupting ecosystem balance, which can be attributed in large part to influences of humans. Climate changes are anticipated to make many of these stressors more difficult for ecosystems and those responsible for managing them.

The management tools that are available now to address many of the present stressors (e.g., invasive species, habitat fragmentation and encroachment, water issues, and human activities, etc.) are wide ranging and include: education, conservation, acquisition, restoration, preservation of habitats, monitoring and removal of problem species, planning, regulation, collaborations and partnerships, gaining and implementing new knowledge.

These are the same tools that will be available as climate changes become more apparent and make management more difficult. It was heard throughout that while many management tools are available, present regulations and bureaucracy significantly limit the application of these tools and additionally inhibit the emergence of new innovations and necessary programs. Those difficulties keep present programs from being as effective as they could be. Because current programs are not as successful as they could be, natural resource managers are concerned that they will be even less effective when the need is greater.

A controversial tool for wildlife and ecosystem management, assisted migration was discussed at length among meeting participants as an alternative tool for handling the impacts of climate change on natural systems. In general, participants expressed significant concerns from ethical, practical, as well as budgetary standpoints. However, while viewed as a radical strategy, assisted migration was thought to be a management tool worth consideration moving into the future.

Landscape connectivity was another major issue discussed in depth at the workshop. It was alluded to that a coordinated, overall strategy involving landscape conservation has historically been absent. Attendees emphasized that a more streamlined approach complete with a coordinated information system could better support this wildlife management strategy.

A significant challenge identified in many of the presently available tools was the limitations that are placed on partnerships. Many expressed the concern that with a changing climate even broader partnerships will be required to effectively manage and they will be even more difficult to develop and maintain. Managers felt constrained by regulations and made a plea for more emphasis on encouraging incentives, particularly for developing and maintaining partnerships. Thus it was expressed that the way in which federal agencies formally handle partnerships in the future must be thoroughly re-evaluated and improved.

Two important additional contributions for maintaining balanced and healthy ecosystems include sharing new knowledge and maintaining a cautious approach to interference. Providing informative outreach programs for a variety of audiences and participants can assist in generating an understanding and greater value of the critical importance of ecosystem health for both the ecosystem and for the services that they provide to society. This improved understanding could contribute to a strengthened relationship between government spending and reducing the vulnerability of critical ecosystems. Developing and sharing new scientific knowledge around projections of climate changes, specific species life histories, or ecosystem structure and function can lead to better decision making and reductions in ecosystem fragmentation. A recognition that humans will never have a complete understanding of ecosystem functions should become the underpinnings of a cautious approach to intervention in the natural world.

Climate change notwithstanding, the health and viability of current and future plant and wildlife generations critically depend on our effective response to these challenges. Collectively, if we can respond to any or all of these identified issues, it will help to reduce present and future ecosystem stresses.

KEY FINDINGS AND RECOMMENDATIONS

Participant responses provided during the four World Café discussions at the August 2009 Fish and Wildlife Service and U.S. Geological Survey climate change workshop generated a variety of different perspectives and insights on a number of critical wildlife management issues relevant to climate change. The following brief summary highlights the major findings revealed during the World Café discussions and also includes a series of general recommendations stemming from the broad findings. The recommendations are intended to serve as guidance for the development of future strategies, policies, and plans focused on these climate change issues.

Stressors: Key Findings

- Stressors on plant and wildlife species were many and included (in decreasing order of mention): invasive species, habitat loss and fragmentation, water supply and freshwater inflow, water quality, urban development, disease, energy development, pollution, sea-level rise, weather extremes, water use, barriers to migration, hydrologic changes, sedimentation, altered temperature and precipitation, and increasing human population.

- The most readily available tools for managing these stressors included: education; conservation; land acquisition, restoration, and preservation; monitoring and removal of invasive species; planning; regulation; collaborations and partnerships; and implementing new knowledge.

- Participants suggested that the most significant impacts on stressors due to a changing climate were in the areas of habitat change and migration, water quantity and quality, altered hydrology, changes in sea-level, and diseases. Current tools were believed to be incapable of handling these changes.

Stressors: Recommendations

- Work with partners and presently available tools to reduce present stressors on wildlife. Reducing stressors will increase the health and resiliency of plants and animals to any number of future perturbations including climate changes.

Needs and Priorities: Key Findings

- Participants evaluated a series of tools and management strategies and identified the following as the top 5 priorities (in decreasing order): habitat conservation and restoration, climate change education programs for the public, more science to study climate-ecosystem connections, landscape-scale conservation planning, and improving ecosystem monitoring.

- Lower ranked priorities included: improving communications and collaboration with partners, improving climate monitoring, and improving data access and information sharing.

Needs and Priorities: Recommendations

- Habitat conservation and restoration was revealed to be the overwhelming top priority according to meeting participants. Efforts should be continued (and expanded as is feasible) in this area. Some additional resources may be needed. Strong consideration and focus should be given to maintaining connectivity and developing approaches that will better enable land acquisition efforts, especially in the future.

- Other priorities such as education programs and the needed science information may be generated with present resources or in cooperation with other agencies and organizations but should be encouraged.

Assisted Migration: Key Findings

- Meeting participants were not enthusiastic about implementing assisted migration as a new wildlife management strategy,

however it was generally agreed that the tool needs to be explored and evaluated.

- Main proposed criteria for undertaking future assisted migration efforts included the level of endangerment as well as the chance of success.

- Anticipated challenges in developing and implementing an assisted migration effort included resources (time, personnel, and money), political (inter-jurisdictional issues), cooperation and partnerships, and public perception and education, and uncertainties and unanticipated consequences.

Assisted Migration: Recommendations

- While not overwhelmingly embraced, assisted migration should be further evaluated as a potential future management strategy.

- A holistic policy around assisted migration should be developed that is flexible (e.g., case-by-case) and conservative while giving overall guidance on the approach and the critical considerations (e.g., level of endangerment and potential for success).

Maintaining Connectivity: Key Findings

- Some participants felt that there is presently no overall strategy for maintaining landscape connectivity.

- Three primary strategies that support the implementation of landscape connectivity efforts were identified as land acquisition, partnerships, and cooperative incentive programs.

- Many suggested that a more streamlined approach to landscape connectivity is needed to better support the process.

Maintaining Connectivity: Recommendations

- All agencies and programs could specifically include as a goal the development of a holistic, coordinated, and yet flexible strategy for maintaining connectivity between parcels of land determined as critical to assist species under a changing climate.

- Undertake an effort to streamline and otherwise make more efficient and effective all of the steps needed to maintain connectivity of critical landscapes.

Education and Outreach: Key Findings

- It was widely agreed that education, strategically aimed at the public, decision-makers, and policy-makers would complement and enhance wildlife management activities, strategies, and future programs.

- While all educational efforts were believed to be critically important, those efforts aimed at the public were identified as the most important due to the influence the public has on motivating key issues.

- Cooperative educational initiatives involving decision-makers (such as field staff) were encouraged to develop closer linkages between scientists/researchers and decision-makers.

Education and Outreach: Recommendations

- Focused outreach efforts specifically aimed at the public sphere are needed to garner more wide-spread support of the need for programs to address potential climate change impacts on wildlife systems.

- The development of other educational programs aimed at specific audiences should also be encouraged.

Partnerships: Key Findings

- Participants viewed partnerships as one of the most critical components for current and future wildlife management efforts, especially landscape connectivity. This included the notion of partnering with new entities and building valuable trust

relationships through projects of mutual benefit.

- The present agency approach to partnerships is often inflexible resulting in less success than might be possible under more service-oriented methods.

Partnerships: Recommendations

- FWS and other federal agencies need to continue fostering and expanding increased partnerships between groups traditionally worked with, and perhaps more importantly, new ones.

- Continue supporting cross-agency partnerships through workshops such as this one, new collaborative research ventures (such as the USGS Climate Science Centers, DOI Landscape Conservation Cooperatives, etc.), and other means.

- More linkages between scientists/researchers and on-the-ground staff are needed to yield relevant results that can be applied to real-life settings. Such interactions would ensure that research efforts are grounded in 'reality' and focused on in-the-field applications.

- Changing the agency approach to partnerships to a more service oriented one will make collaborations more effective in achieving partnership goals.

New Knowledge Needs: Key Findings

- Knowledge needs in the sciences were many and included high priority items such as: more regional and local scale information from models, vulnerability and risk assessments, invasive species, monitoring, establishing and developing inventories, water needs and uses, and other specific information needs.

- Increased cross-agency communications and data-sharing were identified as areas needing further improvement.

New Knowledge Needs: Recommendations

- Develop a capability within the agency and through partnerships to generate the needed information.

- Develop a process and agreements among agencies and other partners to widely share required new knowledge.

Invasive Species: Key Findings

- The issue of invasive species vs. range extension came up throughout the discussions thus highlighting the need for major scientific research in this area.

- Invasives were identified as the number one stressor on plant and animal systems as well as one of the most complex (and potentially detrimental) stressors when considering climate change.

Invasive Species: Recommendations

- The invasive species issue represents a major area of research that needs to continue to expand through more inter-disciplinary efforts. New initiatives including the Landscape Conservation Cooperatives and Climate Science Centers may be appropriate, new avenues for advancing such research.

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APPENDIX B. WORKSHOP AGENDA

Climate Change: The Western Gulf Coast and Southern Plains
Changing Landscapes for Fish and Wildlife Resources

August 10-12, 2009
Sheraton Austin Hotel

Co-sponsored by:
U.S. Fish and Wildlife Service's Regions 2 and 8
U.S. Geological Survey's Central Region

Monday, August 10, 2009

5:00 PM - 7:00 PM Poster Session & Welcome Reception

Tuesday, August 11, 2009

Plenary Session

Joy Nicholopoulos, Moderator

8:00 AM - 8:15 AM Introduction, Dr. Benjamin Tuggle, U.S. Fish and Wildlife Service (U.S. FWS), Region 2, Regional Director

8:15 AM - 8:30 AM Opening Remarks, Dr. Stanley Ponce, U.S. Geological Survey (USGS), Central Region, Regional Director

8:30 AM - 8:45 AM The Climate of Change: Texas' Landscapes, Now and To Come, Ross Melinchuk, Deputy Executive Director for Natural Resources, Texas Parks and Wildlife Department

8:45 AM - 9:45 AM Global and Regional Climate Change, Dr. Virginia Van-Sickle Burkett, U.S. Geological Survey (*Keynote Address)*

Mitigation Strategies for Offsetting and Reducing Greenhouse Gases

Jennifer Sanchez, Moderator

10:10 AM - 10:30 AM The Conundrum of Carbon-Nitrogen Connections for the Ecological Management of Greenhouse Gas Emissions, Dr. Robert Harriss, Houston Advanced Research Center

10:30 AM - 10:50 AM Carbon Sequestration and Fire Management: Conflict of Interest or Opportunity, Dr. Joseph White, Baylor University

10:50 AM - 11:10 AM Reducing our Carbon Footprint, Richard Morgan, Austin Energy

11:10 AM - 11:20 AM Planting for the Next Generation, Darrin Unruh, U.S. FWS

11:20 AM - 12:00 PM Panel Discussion

Lunch

12:30 PM - 1:00 PM Luncheon Speaker - Climate Change: A Three-stage Journey, Dr. Chip Groat, Center for International Energy and Environmental Policy

1:00 PM - 1:30 PM Endangered Species Recovery Champion Awards, Dr. Benjamin Tuggle, U.S. FWS

World Café: Critical Issues and Information: Today and Tomorrow
Dr. Lynne Carter and James Hocker, Southern Climate Impacts Planning Program (SCIPP)

1:30 PM - 1:45 PM	Overview of the World Café, James Hocker, SCIPP
1:45 PM - 3:30 PM	World Café, Discussions 1 and 2

Plenary Session
Tom Doyle, Moderator

3:55 PM - 4:25 PM	Climate Change Impacts on Water Supply: Is there a Problem? Dr. George Ward, University of Texas
4:25 PM - 4:55 PM	Fire and Climate, Mark Kaib, U.S. FWS

August 12, 2009

Plenary Session
Dr. Bill Ulhein, Moderator

8:00 AM - 8:15 AM	Opening Remarks, Dr. Bill Ulhein, U.S. FWS
8:15 AM - 8:45 AM	Coastal Habitats and Sea Level Rise, Dr. Jim Gibeaut, Harte Institute
8:45 AM - 9:15 AM	Sea-level Rise and Difference Modeling Approaches to Assess Change, Dr. Tom Doyle, USGS
9:15 AM - 9:45 AM	Climate Change Adaptation of Freshwater Ecosystems, Bart Wickel and Mark Briggs, World Wildlife Fund

Adaptation Strategies
Kelly McDowell, Moderator

10:10 AM - 10:30 AM	Adaptation Strategies for Conserving Bird Populations in Marshes and Coastal Forests of the Western Gulf Coast, Barry Wilson, U.S. FWS
10:30 AM - 10:50 AM	Grasslands and Climate Change, Dr. Wendy Gordon, Texas Parks and Wildlife Department
10:50 AM - 11:10 AM	Direct and Indirect Impacts of Climate Change on a Grassland Area Sensitive Species, Luke Bell, U.S. FWS
11:10 AM - 11:30 AM	Whooping Cranes - Conservation Needs to Survive Global Warming, Tom Stehn and Dawn Whitehead, U.S. FWS
11:30 AM 12:10 AM	Panel Discussion

Lunch
12:10 PM - 1:25 PM

World Café: Climate Adaptation: Strategies and Challenges

1:25 PM - 3:25 PM	World Café, Discussion 3 and 4

Plenary Session
Chris Best, Moderator

3:50 PM - 4:20 PM	Wildlife Vulnerability Assessments and Climate Change - Approaches for Setting Priorities, John O'Leary, Massachussettes Dept. of Fish & Game

Closing Remarks

4:20 PM - 4:35 PM	Dr. Benjamin Tuggle, U.S. FWS, Regional Director
4:35 PM - 4:50 PM	Dr. Stanley Ponce, USGS Central Region, Regional Director

APPENDIX C. WORLD CAFÉ INSTRUCTIONS

The World Café is an exercise designed to bring together everyone's unique perspectives and knowledge to discuss questions that matter to us all. Over the next 2 days, we will hold a total of 4 separate World Café discussions focusing on various topics relating to climate change. During each discussion session you will work together with colleagues seated at your table (~10 participants per table) to consider the particular set of questions and provide thoughts and answers to those questions. Upon the completion of a discussion session (45 minutes), we will ask everyone to transition to a new table for the next discussion so we can continue to mix and share our unique perspectives and ideas. The insights provided through these discussions will contribute to a report on future climate change priorities and planning.

Ground Rules

1. Everyone's contribution is valuable and important. We encourage everyone to participate.
2. Active listening is just as important as active speaking. The speaker has a responsibility to speak concisely and the listeners have the responsibility to not interrupt.
3. The discussion topics are meant to serve as a guide so discussions don't get off track; please address the questions in your discussions as best you can.

How It Works

1. Facilitators have been identified to help lead discussions and keep things on track as needed. Facilitators will stay at their table throughout.
2. The facilitator will ask for a volunteer to type notes and answers on the computer at the table. If no one volunteers, we ask that the person nearest the computer do this. Notes and answers to the questions should be made using word processing software (Word if possible). Please clearly denote the question number for each set of notes/answers.
3. Read all the questions in the particular discussion before starting.
4. At the end of the first discussion session each day (45 minutes), please move to another table with a mix of new people. This is an opportunity to meet others, make new connections, and develop new creative mixes. *Facilitators – please do not leave your table. Note-takers – leave the laptop at the table.*
5. After the end of the final discussion each day, we will have a brief wrap-up where we will allow participants to identify hot-button topics and high priorities for future action.

Tuesday, August 11, 2009 *Critical Issues and Information: Today & Tomorrow*	
1:30 – 1:40 PM	Introduction & Start-up
1:40 – 2:25 PM	Discussion 1 – Stressors
2:25 – 2:30 PM	Transition
2:30 – 3:15 PM	Discussion 2 – Needs & Priorities
3:15 – 3:30 PM	Report Back & Copy Files

Wednesday, August 12, 2009 *Climate Adaptation: Strategies and Challenges*	
1:25 – 1:30 PM	Start-up
1:30 – 2:15 PM	Discussion 3 – Assisted Migration
2:15 – 2:20 PM	Transition
2:20 – 3:05 PM	Discussion 4 – Connectivity
3:05 – 3:25 PM	Report Back & Copy Files

Appendix D. Collated Raw Responses from World Café Discussion Sessions

Discussion 1 (Stressors), Question 1

Stressors

- Human population growth
- Development; urbanization
- Invasive species
- Habitat fragmentation
- Land use; impervious surfaces
- Soil quality
- Water use
- Hydrologic changes
- Water – surface, groundwater
- Water supply and availability
- Water quality
- Salinity changes
- Saltwater intrusion
- Changes in water rights
- Increased river recreation
- Altered waterways
- Sedimentation
- Fire changes
- Recreation capacity/park lands/rivers
- Climate change
- Sea level rise
- Thermal tolerance
- Extreme weather events and disasters
    - Hurricanes
    - Flooding
    - Droughts
- Disease
- Air pollution
- Contaminants
- Illegal and incidental take
- Agriculture
- Forestry
- Renewable energies – wind and solar
- Energy (oil and gas)
- Lack of education
- Historical conversion
- Political boundaries, politics
- Life cycle changes in plants
- Loss of biodiversity

Stressor Rankings from top 5's (Number of times each stressor was identified)

- Invasive species: 21
- Habitat loss and fragmentation: 18
- Water supply; freshwater inflow: 11
- Water quality: 8
- Urban development: 7
- Disease: 6
- Energy development: 5

- Pollution: 5
- Sea-level rise: 5
- Weather extremes: 4
- Water use: 3
- Barriers to migration: 3
- Hydrologic changes: 2
- Sedimentation: 2
- Altered temp/precip: 2
- Increasing human population: 2

Discussion 1 (Stressors), Question 2

Tools

- Education
- Communication
- Conservation development
- Conservation easements (buying protected habitat and buying easements)
- Community based conservation
- Land conservation
- Landscape scale planning
- Land use planning
- Urban planning and forecasting
- Green space – working with local governments
- Private lands programs (i.e. Partners program, Wildlife Habitat Incentives Program)
- Recovery credits
- Inventory/Monitor
- Data collection
- Assisted Migration
- Birth control
- Environmental regulations (Endangered Species Act, Migratory Bird Treaty Act, Lacey Act, Coordination Act, Permitting, Oil Pollution Act, Clean Water Act, Comprehensive Environmental Response Compensation and Liability Act, Total Maximum Daily Loads, National Pollutant Discharge Elimination System)
- Science, research, modeling
- State wildlife action plans
- Efficient use of resources
- Grants for restoration and clean-up
- Land acquisition and restoration
- Fire management; prescribed fires
- Water management; water conservation/reuse (city, state, federal)
- Hydrologic restoration
- Soft approaches to shoreline management (living shorelines);
- Restoration
- Buying up water rights
- Working with and establishing partners; coordinate with parks
- Re-establish marshes
- Adaptive eco-types
- Redevelop wetlands
- Farm bill, replanting drought tolerant plants -- CRP/ WRP/Equip
- State programs – aquifer protections recharge areas, etc.
- Mechanical and biological controls (invasive species)
- Best management practices; learn from the past
- Economic incentives
- Funding

- Coastal preservation grants
- Improved agricultural practices
- Pilot projects
- Geospatial database for developing conservation priorities
- Non-governmental organizations
- Voluntary guidelines and working groups for energy development issues and partnerships
- Species corridor

Discussion 1 (Stressors), Question 3

Climate change interactions with stressors:

- Water quantity and availability may result in more issues related to water use
- Exacerbate fragmentation and invasive species and cause habitat changes we can't control
- Increase inflows decrease streamflows, intensify runoff events, longer drought periods, may either mitigate or exacerbate problems of altered hydrology.
- Increased erosion (can be good or bad), increased evapotranspiration, mass contamination events
- Wind farms- Climate change will indirectly increase the demand for alternative energy
- Invasive Species- drought
- Freshwater inflow- depending on how climate change effects our rainfall will increase competition for a limited resource, habitats will not migrate inland because of indirect effects and will have economic impact because there will not be storm abatement
- More storms
- Habitat migration
- Species range changes/migration/extensions
- Fundamental ecosystem shifts
- New diseases
- Increase habitat loss
- Drought
- Flood events increase erosion and sedimentation
- Migration of tropical species
- Species change in range
- Phenology, floods, drought, water quality, invasives, habitat loss, fragmentation
- Magnify just about all of them; will see replacing one habitat with another
- Sea level rise will force additional bulk-heading to protect development, exacerbating impacts of sea level rise to wetlands.
- Climate change will bring more invasive species impacts.
- Positive effects – temperature changes influencing changes in agricultural crops, some forest resources
- Fisheries impact – lack of freshwater, lack of habitat, decrease in carrying capacity as a result of changing estuaries-size
- Phenology changes, shifting populations, rare and endangered species shifts, some for better, some for worse
- Harmful algal blooms/red tide effects so changing temperatures have large effect on populations, varying in degree of severity and duration, different across gulf, but has far reaching impacts on species, fisheries, industry, recreation, filters up the food web
- Some changes not good or bad, some changes just different, adapting ourselves as researchers
- Invasive species ranges will alter with climate change.
- Increase habitat loss by:
    - Increasing human migration into undeveloped areas
    - Loss of land to sea level rise
    - Vegetation changes and losses
    - Biofuel Production, wind energy development
- Insects, pests, disease - Increasing outbreaks

Tools sufficient?:

- Our current tools and processes are not sufficient
- May need to re-tool our laws to more quickly respond to these issues and remove some of the existing restraints to wildlife or habitat management.
- The tools that we have are not adequate to address the current situation.
- Our tools are insufficient even w/o climate change! We STILL do not know what the local (regional) effects will be; the projections are too broad still
- We don't have tools right now to deal with the processes we have now…
- No – insufficient to keep up with current situation
- Tools may be adequate, but not applied enough. Funding, staffing, and education constraints. May need to be redesigned to apply at the local level.
- No - Refuge operations are currently operate in a static state
- Need policy changes in things like permitting requirements

New issues:

- Many "yes"
- Climate change will overall have a negative effect. Never be able to return to historic conditions.
- Climate change might change the way we approach prioritizing stressors.
- Unknown habitat change
- Unknown species shift
- How to use new/different resources
- Will be unseen benefits
- Diseases
- Effects on human population
- Changing distributions of native species
- Increasing ecosystem change as competition and drivers come and go with increasing frequency
- Uncertainties with future migrations, distributions and habitats as climate changes and vegetation migration occurs
- Alternative sources of energy with potential negative effects

Needs:

- Lack of ecological processes- create more multiagency cooperatives so that there are not many small projects and one big picture goal and work together
- Our planning process needs to remain ADAPTIVE
- I think we can do a lot better COVERAGE. It may not be as PRECISE coverage, but we would get more COVERAGE…
- Need to gain as much information as possible before some conservation actions are taken, but there are some restoration practices we should do now.
- Need adaptive approach and acceptance of adaptive decisions
- Transitioning the results of science to decisions
- Improving understanding of critical thresholds
- Systems to allow jurisdictions to talk regionally, remove the borders to improve dialog and management
- Amending existing regulations to address climate change
- Vulnerability assessments – local, regional, national, international view, which species need the most work, what species do we gain restoration/recovery efforts
- Holistic management and tools will be needed
- Need improved coordination between all entities.
- Reduce bureaucracy/ increase speed and efficiency in accomplishing objectives.
- Need to put together adaptive strategies.
- We need more tools including: knowledge, technology, planning, regulations, funding
- Tools needed include: better habitat planning, more knowledge, technology, funding, more connectivity
- More education is needed

Concerns:

- There are known unknowns and unknown unknowns
- Focus quickly shifts from one crisis to another
- Our nature is more reactive than proactive
- Assisted migration – do we start moving species around or let it be
- Are range extensions to be considered invasives? Are these due to climate change? Were they happening anyway?
- May have to do triage and just save what we can
- Great concern that "we do not yet know what we do not know." Will have to adapt, adapt, adapt.
- New diseases, new invasives, unforeseen impacts.
- may be dealing with unknown problems that will rear their ugly head in the future
- Reaction out of fear; re-prioritization away from conservation
- Need to define invasive species as things will be moving (invasive VS range expansion)

Misc ideas:

- Most effective strategy for coastal protection would not cost anything: cease to allow federal insurance for new structures in TX windstorm insurance association and national flood insurance program.

Discussion 2 (Need & Priorities), Question 1

High priority:

Science (basic and applied):

- Accurate predictions of rate of sea level rise (H)
- We need better predictions about what will change and downscaling what we think will happen to more local, practical, manageable solutions.
- Down scaled climate information to smaller geographical area
- Wildlife management guidelines which adapt/implement data from models
- More monitoring for better modeling verification on specific aspects of climate change
- Developing inundation maps of sea-rise – encourage proactive solutions rather than reactive.
- Produce vulnerability and risk assessment from modeling.
- Modeling community integrity of plants and animals and their vulnerability to invasive species and pests that will further exacerbate the impact of climate change.
- Identify key losses of habitat due to endemic species and isolated habitats that cannot move.
- Model freshwater inflows in light of community and environmental needs.
- Research
- Better and more extensive monitoring –smart growth and development; protected areas; baseline data; invasive species; better coverage; better and more coverage with equipment; Baseline data, especially for invasive species
- Downscaled climate models
- Improved Inventory and Monitoring targeted to address specific needs.
- Need better predictive tools at local levels to build support for conservation
- Basic information on various species at risk such as – thermal tolerances of species,
- How much can aquifers be depleted and still maintain habitat needs
- Need better tools to model the relationship between surface water and groundwater, and the habitats they affect.
- Need smaller scale models so that managers can see what is needed for their areas, based on what is predicted to happen regionally.
- Increase Research and Monitoring (Ground Truthing) for Model Validation and Accuracy
- Surface water management/Freshwater inflow
- Downscale climate change models
- Need better predictive tools at local levels to build support for conservation
- Need better invasive species models – what changes will climate change induce

Education, Outreach, Partnerships:

- Education (public, legislators)
- Education and Outreach – Battling that it is real and how can we better use our natural resources.
- Education
- Working with administration to do real conservation instead of monoculture plantings-efforts to educate decision-makers on proper conservation techniques
- Scientists need to work closer with resource agency managers
- Consider human dimensions, what are we asking the public to understand concerning climate change, prepare a message understandable by the general public, how will it ultimately affect them and create impetus for change
- Education – In all venues
- Educate to explain that the health of the human population relies upon "Ecosystem Services" in context of climate change
- Educate to explain that the health of the human population relies upon "Ecosystem Services" in context of climate change

Funding:

- Increase Funding
- Funding
- Funding to support Ecosystem Services (explaining the health of the human population to Ecosystem Services) in context of climate change
- Funding for habitat restoration and protection
- More funding and more partnerships are needed
- Adequate funding
- Adequate staffing

Resources:

- Regulation
- Acquisition of conservation lands
- Centralized source for relevant climate change research information
- Land conservation strategies
- OK –developing a state wide water plan for surface water including rules to maintain ecological flow
- Strategic Land Planning – Protection, Wildlife Corridors, Land Connection
- Implementation of actions.
- Groundwater management policy
- Land use planning authority
- Clearly articulated management goals in the context of a changing climate

Medium priority:

- More specific information on how species respond, which ones are more "plastic" than others? Triage (i.e., which ones can you save, which ones can you not save?)
- Modeling
- More money, more research!
- Models to anticipate changes in land use or plant/animal distributions with climate change
- Decisions on when a species is exotic or invasive as species ranges move.
- Species migration patterns *species tolerance (temp. etc.)
- State planning – maps non-native species
- Better database management and sharing within our agency, with other agencies, with the public
- Socioeconomic studies of the impacts of climate on the dollar amount spent for various structures (housing, etc). Convincing the insurance companies and Government that this is a loss.
- Acquisition and conservation of lands in mitigation of sea-level rise
- Restoration and removal of barriers that limit water movement in fresh and saline environments.
- Conservation easements to ease natural resources

- Water regulations and restrictions on use – including surface water and groundwater
- Incentives for managing land/wetland
- Have contingency plans/funds to take advantage of situations that occur unexpectedly
- Partnerships including education on better practices for public, regulators, other researchers
- Population reduction incentives-even up to sex education or taxes on increasing numbers of children

Low priority:

- Studies/inventories/surveys
- Regulations
- Modeling of freshwater intakes for communities which may get inundation of salt water
- No real low priorities
- Expansion of hydrological gauge network to better address climate change needs

Additional listed Needs and Priorities:

- Accurate predictions of day and night temperature changes
- Accurate predictions of intensity, level, and timing of precipitation events
- Accurate data on impacts of alternative energy strategies
- A measure of the public will for change
- How to effectively educate the public
- Where is climate change and sea level rise going to end?
- Would affect your coastal management and need to know what the timeframe is? Where will it stabilize?
- Comments: If we take the actions we think we need to we may not see the results for a significant amount of time.
- Education
- Elevation Data current/accurate.
- Making scientific data applicable to the average person (layman's terms)
- Educating legislators
- More funding
- Long term studies/inventories/surveys
- Better regulations/better application of existing regulations. More flexibility.
- Down scaled climate information to smaller geographical areas.
- Wildlife management guidelines that adapt data from models.
- Need staff and money to gather information
- Modeling impacts at a more local level
- Need more information on non-threatened/endangered species to get a better grasp of the impacts of climate change
- Tools to make predictions on species changes in a local area

Discussion 2 (Needs & Priorities), Question 2

The information provided in Discussion 2, question 2 was quantitative and is not included here.

Discussion 2 (Needs & Priorities), Question 3

Group A

Top 3

- More science to study climate-ecosystem connections
- Habitat conservation and/or restoration
- Landscape-scale conservation planning

Bottom 3 – (These aren't necessarily low priorities but are not as expensive as other measures and systems are already in place to address much of this.)

- Improve climate monitoring
- Improve climate model projections
- Improve data access and climate change information sharing

Group B

- Top three spending priorities
    - Improve Climate monitoring
    - More science to study climate ecosystem connections
    - Habitat conservation and/or restoration
- Top three because
    - Things we can do now
    - Improves science
    - Valuable to everyone
    - Needed information for policy
- Why ones ranked at the bottom
    - Not producing immediate results
    - The first priorities need to be done first to accomplish the lower priorities
    - Data access and sharing information is not something that needs money to accomplish
    - No need to duplicate effort
        - Monitoring is being done by several agencies already

Group C

Most important: Habitat conservation combined with landscape-scale conservation planning to save natural systems while we can before it is too late

Least important: climate monitoring and improving climate projections because the group felt like we should keep it funded but we already know a lot about the impacts and felt this category was already well funded

Group D

Justification

- Habitat conservation and restoration is the key to coping with uncertainty.
- Not a lot of money went to modeling because it doesn't take a lot of money to model.
- Education and outreach ranked lower because it was split into different categories. It may have received a higher rank if they were combined.
- Less money went to educating decision makers because the public can do that.
- This was a budgetary exercise, so low funding may indicate that we are currently doing an adequate job in this area.
- If Social Science was a category (1, 2, and 12), this category would have ranked higher.

Group E

Reasons for establishing these priorities – "Practical application of practices on the ground." Land managers are ready and prepared to apply the science to ground.

Group F

Top Spending Priorities
- Improve climate model
  - Must identify and define the problem and the response of the species and ecosystem
- Education and training for agency decision-makers
  - They got control over the purse strings. They will decide the priorities and the speed at which we address the issues
- More science to study climate-ecosystems connections
  - See first bullet above

Lowest Spending Priorities
- Improve climate monitoring
  - With limited resources (money) we seem to be doing OK. It can stay status quo and remain OK. We need to address the higher priorities and refine the problem.
- Improve communication and collaboration with partners
  - Although necessary, when compared to other threats it is a relative importance
  - Communication and collaboration can be achieved without a lot more extra money. We can achieve this by increasing communication rather than spending more money doing so.

Group G

Top 3 are:
- Climate change education programs for the public
- Pilot project to demonstrate climate change adaptation strategies at a landscape scale
- Habitat conservation and/or restoration

Lowest spending
- Improve climate model projections
- More science to study climate-ecosystem connections (including species responses to climate)

Group H

Highest Priorities:
- Habitat conservation & restoration
  - If possible to ID what is important, then protect it. Can't wait, must be done now.
- Improve communication and collaboration with partners
  - Improve efficiency of conservation deliverables. Eliminate redundancy. Inject science into decision-making process.
- Climate change education for public (including elected officials)
  - Know your audience, what pushes buttons changes depending on where you are. People have to know this will affect their kid's ability to play football.

Low Priorities:
- Improve ecosystem monitoring.
  - Already doing a lot of monitoring.
- Improve climate monitoring.
  - Already doing a lot of monitoring.
- ID practical options for managers.
  - Managers don't want to be told anything. Give them the top 3 priorities, they will be able to do this.

Group I

Top three spending priorities:

- Climate Change Education Programs for the public – (#2 Priority) May make the biggest impact on future generations by educating the public now.
- Habitat conservation and/or restoration (including acquisition) (#1 Priority). Species are going to need a corridor to migrate and adapt to climate change or they will go extinct. Action is required now and may not be able to wait as communities and conservationist are all modeling impacts.
- Improve ecosystem monitoring. Land managers and decision makers need to be able to predict the future and model projections.

Least three spending priorities:

- Pilot projects to demonstrate climate change adaptation strategies at a landscape scale. This is a money pit.
- Climate change education and training programs for agency decision-makers. The science is there, these folks should be in the know. Public demand is what drives politicians.
- Improve data access and climate change information sharing. The framework is already in place. We just need to further implement and make accessible to all.

Group J

High priority

- Climate Change education & training for agency decision makers and Climate Change education for public
- Improve climate monitoring to facilitate more science to study climate-ecosystems connections
- Landscape scale conservation implementation (no time for pilot studies)

Lowest priority

- Improve data access and information sharing – already widely-available

Group K

High

- Habitat conservation and restoration
- More science to study climate ecosystem connections
- Identify practical climate change adaptation options

Low

- Education for agency decision makers
- Improve climate model projections

Why?

- High – We have the tools now to do these
- Low – agency decision makers should already be aware of the issues
- Low – prefer practical models that can be implemented NOW

Discussion 3 (Assisted Migration), Question 1

Pro: Diversity/broaden gene pool-> increase survival options

- spreads out the genetic pool, increasing potential for survival ship
- Increase genetic diversity
- Saving genetic diversity that would otherwise go extinct
- Saving genetic diversity that would be in danger of destruction by storm, hurricane, habitat loss,

- In wet prairie, vulnerable to hurricane and other factors, establishment in new inland areas to preserve habitat would help preserve the population-would have to prepare the hydrology, etc. to move; cant recreate natural environment but could try to save species diversity
- Mangroves or other marsh species for soil stabilization but subject to freeze, failure,
- Increase species diversity
- Increase range of species
- Genetic viability
- Maintaining biodiversity
- Preserving the species. And habitat
- Maintain genetic integrity
- Increase biodiversity
- It could out compete invasive species
- Move species to another group of similar species you will increase the gene pool,
- Maintain (augment) biodiversity

Policy: When/choice/how/option

- Moving a species to a new geographic area where they otherwise not are able to move, possible due to a physical barrier.
- To save the species, again would have to be on a case-by-case basis.
- A species that we move could be species that fills a niche of a species that has gone extinct.
- The organism can't move
- Use as last resort
- Allow for continued existence of the species/deferring extinction
- Salvaging species – prevent extinction
- May be able to save or perpetuate a species
- Save species
- Last ditch effort
- Overcome artificial barrier
- Assist the population from going extinct
- Could prevent species from going extinct
- Having no corridor may cause an isolated genetic pool
- Problems with who decides which species will be relocated
- If there is a barrier, it might have naturally migrated, but unable to
- It might take extinction of some species to mobilize the public to care enough about it to put the political will and money to save these species. By that time if we want to do relocation we need to have a way and system to do it. Having the lag time to write new regulations after public support comes up, would be detrimental to many endangered species.
- May be the only way to save them
- Some species may not have that much of an impact
- To counter human fragmentation or barriers, such as a dam that would not naturally be there that specie could not cross without assistance
- Climate change occurring so rapidly, species might normally migrate, but cannot migrate in such a short time period. If the abiotic elements already have changed (ex. changes from prairie to desert environment) and species are just not migrating quickly enough.
- Prevention of extinction
- Could be proactive to avoid species listing or listing conditions (more cost effective than recovery)

Pro: Tool

- With expanded funding, this could be another tool to address potential concerns
- Another way of repatriating the species
- Provide a corridor where no corridor exists- would be unavailable otherwise to the species

Cons: Concerns: invasive potential/ out compete natives (competition)/unintended consequences/mistakes

- Become invasive (exotic), competing with natives

- May cause a domino effect
- Outcompeting other/native species
- Could easily turn into an invasive species if located to an endangered area or at risk species;
- Spreading disease
- Push out species in new habitats
- Controversial secondary impacts
- Facilitating invasion
- Possible unintended consequences
- Not sure of competition with native vegetation
- Disease threat
- Could spread to other places
- Spread disease
- Competition with other natives
- Hybridization
- Certain springs may have their own endemics. Introduce competition and don't know how they will compete.
- Introduce to a new habitat, is then an invasive species
- High Risk/could introduce disease
- Increase competition among species in habitat
- Competition between existing species at that location
- May limit genetic pool because you may not be able to move the entire population
- Issues with hybridization. Policy needs to be made to deal with what we do with hybridized polar and grizzly bears, etc. Spawning times are changing, etc. And reproductive barriers are torn down so species can hybridize. With hybridization, one could increase the fitness of an endangered specie, but we would also decrease purity
- Specie disrupts established community it is going to, without normal checks on its growth. Competes with native species
- The dangers of not knowing what exactly we are doing. Just look at past efforts of biocontrol
- Unexpected consequences. Not only ecological, but also social and political.
- Return of species that were mobile
- Species displacement in the area of introduction
- Some species, such as some rare plant species, don't have the capabilities to reproduce quickly, have other constraints, and are specialists. These are less likely to get out of control and disrupt new habitat. The difference between a slow-reproducing organism vs. a bug. A generalist vs. a specialist would be treated differently.
- Ecological ramifications of introducing a species into a totally new area/unintended consequences
- Stress other species/disease/quarantine

Cons: Uncertainties

- High degree of uncertainty: would they be able to survive
- Insufficient science
- Probability of success is uncertain thus unsuccessful
- Risk of failure
- Relocated species may not be as well adapted to new environment
- Don't know about species to know what they need. Small scale things like atwaters moved and they all died
- Protecting good habitat for the future trying to anticipate this. Do we know enough? Grassland to shrub thing.
- Adaptive process?
- Herps and small mammals?
- Food source diversity—i.e. minor food source availability—uncertainty of success
- Will they stay

Con: Expense
- Expense: would resources (money and time) be wasted attempting this, is there enough of a return in our investment? In other words, there was a concern that assisted migration efforts would pull funds away from other efforts.
- Waste of resources
- High cost low probability of success
- Costly
- Financial
- Expensive
- Labor intensive
- Cost associated with transfer of these species

Authority
- Limited legal and jurisdictional authority to move species

Pro/Con: Impacts on population
- Could deplete an existing population
- Loss of genetic diversity
- Maintaining biodiversity
- Animal or plant species- animals may not survive in new habitat (food availability)
- May limit genetic pool because you may not be able to move the entire population
- Genetic movement-how will this affect metapopulations

Philosophy
- Goes completely against survival of the fittest
- Ethical-is this an ethical response to essentially create a garden or zoo within and functioning ecosystem---how does this weigh against extinction

Education, public outreach+, collaboration, communication, gain knowledge
- Sends a bad signal to the public, i.e. bait bucket Billie
- Sociopolitical issues like Mexican gray wolf. Need to have education outreach process to coincide
- Promote and establish communication, potential for collaboration
- Opportunity to educate and community support
- Provides economic activity for a community (wildlife observation)
- Public resistance
- Public awareness tool
- Science tool-increase knowledge

Discussion 3 (Assisted Migration), Question 2

Categorized Policy Issues

When: Last Resort
- Moratorium
- Use as last resort
- Policy for assisting migration only as a last resort, if the only thing worse is extinction or if the only living specimens are in zoos or captivity = functionally extinct species
- Plants are functionally different…but same concepts apply
- Only for threatened or endangered species
- Do as last resort, look at taxonomic hierarchy, uniqueness, rarity,
- Conservation policy should be really strict: Species specific
- Should only be used for endangered species recovery or prevention of listing
- If going to relocate a population, don't wait until the gene pool is too small to be healthy. Start working on this for threatened species instead of only endangered ones.

- Case by case basis, concentrate on threatened and endangered species, use a triage approach to invest energy and time.

How:
- Utilize historical migration rates to project where it would occur with the change in climate.
- Should not be moving a single species but a group of species
- Establish pockets of land that species may be moved to
- For example plants, do planting of plant species in new future habitat areas.
- When possible move animals in their historic range also restore agriculture to bottomlands and intro component animals as experiment.
- Choose plants that are more southerly into more northern restoration sites. Or pocket gophers.
- Maintain ecosystem integrity
- Should relocate within historical range
- Insure that adequate research was done to make sure they would survive in this new environment
- Set aside areas suitable for introduction and set areas that will not have species introduced for any purpose, i.e. let wildness areas go on their own (barring potential legal requirements)
- Look at taxonomic hierarchy, uniqueness, rarity, evaluate habitat and put in places with generalists or in isolated locations
- Depends on species- species may be habitual (whooping cranes) may be unlikely for some species to adapt and change- new area would need to meet current criteria for species that may be migrated
- Habitat restoration
- Evaluate habitat and put in places with generalists or in isolated locations

Which:
- Focus on small ranging species, one with barriers
- Most threatened species but those might not be the best to choose. Move the more common species.
- Only move something that has a chance to be successful

Information needs:
- How do you delineate critical habitat into future?
- Insure that adequate research was done to make sure they would survive in this new environment
- Need to have criteria on deciding what species may be migrated through how adaptable each species are and what specifications they need to survive
- Should have scientific basis-some predicted/modeled expectation of success and would be sustainable
- Conservation policy- needs a list of criteria and rank importance with the potential for success- example- what are the chances of species hybridizing with other species
- Something similar to a recovery plan for endangered or threatened species where you have to measure the possible outcomes
- We must know more about a species before we move them
- Address impacts of that species to the current ecosystem
- Understand food web of habitat were species is relocated
- The conservation policies need to have downscaled climate change projection model.

Precautions
- Need to make sure that policy includes protection and monitoring for species in the area that other species will be migrated to so that existing species are not displaced
- Monitor and be prepared to take species out of environment if did not work
- Precautionary measures and have back up plan

Other issues:
- Need to be able to do this. Different approach. Do you unhook regulatory constraints with future critical habitat: Do it!

- What about alpine species (like Pika). Alpine species – Arizona cypress, Doug Fir, shot horned lizards, Guadalupe Mountain trout.
- Insure multiple issues are addressed
- Adequate financial and staff support
- Predictions may not come true- if don't act on quickly- may not have time, also may not want to act too quickly because predictions may not come true- for adaptation but also fear it
- Want to state man-made or natural events- do we want to provide assisted migration on just man-made destruction or natural destruction-include criteria on historical range- where was their historical range.

Discussion 3 (Assisted Migration), Question 3

Level of endangerment

- Triage, balanced by risk of extinction and likelihood of success
- Level of endangerment
- Only for threatened or endangered species
- Move species when hard edge happens
- So small that they cannot sustain themselves
- Maybe re-prioritize focus from most threatened to less threatened species that have a chance to do something
- Maybe write off the really on the edge.
- Genetic viability
- Determine level of catastrophe
- Least adaptable
- most imperiled species
- Prevent extinction
- Prevent listing

Likelihood of success

- Likely hood of success
- suitable habitat availability
- identify potential habitat
- Likelihood of success should be used in consideration
- If new location is part of the range
- If the niche is available
- Be proactive before risks occur
- Evidence of species being in habitat before
- Potential for success for that species
- Potential for hybridization and loss of that species
- Before genetic diversity drops below their threshold
- Relocation is feasible
- Can they migrate on their own

Habitat loss or other barriers

- Only if on verge of losing only habitat or on brink of extinction; i.e. a bird or plant pushed to brink of natural habitat on top of mountain or an island that is eroding away-relocate to possible historical habitat, expanding current territory
- Evaluate species that are potentially locked and cant migrate
- Barriers prevent movement
- Least mobile species

What species

- Select keystone/umbrella species
- Beneficial species

- Status of population
- Keystone species should be selected
- Deal with assisted migration on a case by case basis.
- Species critical to maintain ecosystem health and function

Does FWS have authority
- Create law giving FWS authority to do assisted migration

How: develop refuge; create corridors; move multiple species
- Move multiple species of habitat type, instead of just one species
- Ecosystem or landscape approach
- Develop refuge
- Create corridors
- Need land acquisition so that habitat may be available once people and wildlife are in need of escaping sea level rise

Prioritize
- Global ranking
- Warm fuzzy, charisma

Public Support
- Gather public support
- Choose species that can easily attain community support

Do nothing
- Maybe leave it alone and let it run its course

Risks
- Evaluate and manage for risk
- Risk level of the habitat be destroyed
- Species should be manageable in new environment (population won't explode, there are controls in new environment)

Science
- Use good science

Cost
- How much would it cost to move species
- Is there enough funding to implement the project
- Is it worth it to try and save them
- Would dollars be better spent in relocation or in preserving other species in their native range.

Discussion 3 (Assisted Migration), Question 4

Information priorities:
- Again, having the step down climate models, historic rate of change, vs. current.
- Habitat suitability info
- Historic range, tolerance info
- Ecosystem functions
- Prepare a recovery plan
- Need an ecological concept of the new area
- Metapopulations, gene transfer between metapopulations
- Historical information
- Identifying and learning new migratory routes

- Our table feels that it is such an extreme measure that it should only be done with comprehensive information about the species and proposed habitat-and only with extreme caution
- Know the habitat and ecosystem assessment of that species; original range and ideal habitat; most of species
- Baseline ecosystem data,
- Population status,
- Models and projections to determine if "new" range will be sustainable,
- Planning and back-up planning
- May not need any information if we cannot logistically do it
- Can they migrate on their own
- Identify potential habitat
- Evaluate species that are potentially locked and cant migrate
- Accurate Historic range.
- Do experimental introductions. What is time scale to consider?
- When do we act?
- Drought events – when do we release the critters back into the environment.
- Do species within their historic range. Habitat that was restored in former range.
- Time series analysis - Trends over time
- Genetic information - Are you introducing new genetic diversity
- Maximum and minimum range of abiotic and biotic factors - Modeling to understand the importance of abiotic and biotic factors
- Monitoring of not only the species but also the environment
- Priorities: What are the needs of the species; Can the species move on their own; Habitat restoration
- Find viable location and region- we need to know what future is going to look like,
- Need to know specific habitat requirements for specific species
- Interactions that may happen at new location,
- Need to know species biology,
- Look at predation at movement location,
- Gather existing plans and what has already been done- learn from mistakes, assess where species are now for species that have already been moved in the past
- Do not have adequate information to move entire species to new locations- may end up impairing more than helping,
- Need effective population size,
- Native and non-native species and their transition during climate change,
- All info of the biology of the species
- Biology of the new ecosystem
- Try to predict the possible interactions of the specie and the new environment
- Build models of new habitat and specie to try to predict some of these things
- The predicted climate change for the new habitat. Will it be good climate for 5 years or 50 years.
- Know past interactions necessary for survival for the new specie (specific pollinator, fungus for a specie) and move species necessary for the first species' survival too.
- Need to check all of that species' interactions with the new environment too.
- Understand distribution and physiological tolerances that result in distribution
- Understand the habitat requirements and ensure that essential requirements are in the spot where it is relocated

Challenges:

- Funding
- Ability to respond quickly
- Public perception would definitely be a challenge.
- Whose land would we put these migrating species on? There are limited federal lands…
- Extent and location of land—enough habitat to sustain a population, and there needs to be a corridor for natural migration (after assisted). So they are not isolated.
- Need a willing partnership, need support at the receiving end

- Coordination with countries
- Biosecurity
- Could easily turn into an invasive species if located to an endangered area or at risk species for out-competition by introduced plant or animal
- Political
- Financial
- Public perception
- Public education
- Should provide habitat corridors
- Work with private landowners and municipalities to provide habitat to assist with migration
- Corridor development has to be a cooperative effort between all entities
- Improve education efforts
- Priorities: Public education, funding, partnerships, time, gather all needed data, build models
- Bring stakeholders to the table.
- Constituents – what do people want and does this drive the equation?
- Money
- Time
- Staff
- Monitoring
- Modeling
- Cost
- Competition on what is going to be moved and where,
- Private land owners,
- Public interests on species migration,
- In general need more land acquisition before developers

Discussion 4 (Connectivity on the Landscape), Question 1

Land acquisition
- Work with other agencies to purchase land
- Land trusts, NGOs
- Acquisition, but that is expensive and then the owner/agency is responsible for the development/ conservation on that land
- Land Acquisition
- State programs established to purchase ecologically significant lands
- Acquisition dollars

Programs for education and restoration programs
- Social Marketing Campaign
- Educate public on ecosystem services provided by corridors
- Develop joint education and outreach programs
- Use people and groups that can spearhead these efforts

Keeping a relationship with private land owners
- Private land owners
- Friends groups
- Coordination meetings
- Building relationships with landowners to build a conservation ethic
- Must build trust with public – will not condemn land through eminent domain, etc

Partnership
- Partners for Fish and Wildlife
- Partners for wildlife
- Partnerships

    - Joint ventures,
    - Private landowners,
    - Intergovernmental NGOs
    - Cooperative agreements
- Pursue partnerships with corporate
- Work with partners to manage properties already owned
    - Build underpasses etc.
- Interagency, NGO, tribal etc partnerships
- Acquire lands through partnerships
- Grants through partners that result in public ownership
- NGO partners
- Partners Work at multiple levels (local, state, federal and international) to ID, conserve and restore ecological corridors.
    - Refuges try to fit in with adjoining state/federal agency land to create larger corridors

Conservation

- Action plans
- Conservation Easements
- Conservation Agreements
- Easements
- Conservation easements
- Voluntary conservation programs
- Conservation easements
- Conservation easement
- Conservation easements

Mandated mitigation

- Best management practices
- HCPs
- Reserved acquisition
- Easements
- Mitigation Projects

Cooperative programs including incentives

- Prairie prep program to recruit farmers to work together to maximize habitat; farm bills
- Restrictions-government agencies can't solicit farmers or land owners, but third parties, partners, and collaborators can educate and interest land owners into the program
- Decision support tool for determining conservation lands of interest; but government agencies cannot pick and chose which land areas chosen for conservation and incentive programs
- Landowner incentive programs
- Grants
- Tax benefits
- Private lands cooperatives
- Coastal program
- Farm bill
    - Farm bill programs – becoming so popular that there are waiting lists; con: not permanent and may be rescinded with land transfer through sale, etc.
- Coastal wetland grants
- Estuary programs
- Gulf of Mexico programs
- Jv's
- TNC eco-region planning
- HCP
- Harbor agreements

- Environmental flows
- RIP
- SB3
- Fish passage projects
- Sarp
- LCCS
- Fish advisory groups
- Tax incentives
- Carbon sequestration credits are becoming a very good option
- Capital trade
    - Payment for ecosystem services
    - Community economic benefit
    - State & federal incentive programs and market-based programs to stimulate habitat conservation
- Land Exchanges
- Community based document
    - Gulf coast prairie
        - Group consisting of not only federal and state agencies but also community members

Discussion 4 (Connectivity on the Landscape), Question 2

Streamline

- Policy
- Appraisal process within fish and wildlife to be quicker
- Set a deadline (length of time) that appraisers have to be done (e.g., 90 days)
- Faster and more efficient land acquisition and appraisal procedures
- Paperwork reduction
- More streamlined process for getting agreements into place (i.e. eliminate red tape, burdensome administrative requirements)
- Easier applications and quicker turnaround times from federal and state sources of funding
- Better communication from sources.
- Advanced warning of grant announcements.
- Timing of grant programs should be better.
- Better coordination across agencies.
- One wetland grant source instead of multitude.
- Regulations and bureaucracy are stumbling blocks
- Improve regulations for making purchases in a more timely manner
- Redo the contracting system

Obtain more money/other resources

- Need money to acquire land and/or conservation easements.
- Funding
- Adequate funding
- More money
- Real money in the land and conservation fund.
- Restore the land and water conservation fund.
- More money
    - more people who would like to do it than available money
    - CRP participation is falling off because people are not being paid enough money
    - competitive market value for land
- Staff numbers: more people to facilitate land acquisition

Planning tools
- Ability to use 3rd party appraiser
- Have adequate time to be able to prioritize work/identify clear goals and objectives
- Better GIS habitat maps of all areas for immediate use as needed
- Predictive mapping to identify where gaps exist in corridors
- Spatial representation for environmental sensitivity of the landscape
- Biologically based ranking system
- Identify beforehand what the acquisition plan should be
- Pretty good notion that species concerned will take advantage of the action
- Provide models and scientific information to entities so as to help them with management decisions
- Need agreement in goals for the wildlife conservation community

Incentives instead of a penalty
- E.g. incentive to hire a consultant
- Increase incentives for conservation easements
- More incentives (awards)
- Land Swaps
- Tax code incentives

Inform the public that we have to decide which species dies or lives
- Better education and outreach
- Public education
- Building relationships with landowners to build a conservation ethic
- Use people and groups that can spearhead these efforts

Partnerships
- Partnership funding opportunities (funding grants/cooperative agreements) (mimic NFHAP)
- Partnerships should work better. Grant sponsors need to listen to partners to better serve.

Increase effectiveness
- Give feds ability to help farmers/land owners manage their own properties; have feds take on the risks usually associated with other 3rd party agencies
- Improve acquisition process to look beyond the price per acre of land when more critical property also happens to be more expensive, but doesn't get purchased in favor of cheaper, less critical land
- Frequent use of land condemnation. Clone Teddy Roosevelt
- Can we do any coordination w/o condemnation authority?
- Change acquisition boundaries
    - Land availability
- Regulation
    - Regulate game fencing.
    - Regulate introduced animals.
- Update existing infrastructure
- Mitigation
    - HCPs
    - Reserved acquisition
    - Easements
    - Conservation easements

Discussion 4 (Connectivity on the Landscape), Question 3

Physical climate changes
- Changing precipitation
- Changing temperature
- Sea level rise is narrowing coastal corridors

- Changes in land/habitat
    - Drought
    - Major storm events
    - Stripping land
- Increase/decrease of freshwater flow
- Rising sea level
- Streams dry up, temp changes
- Drought

Impacts from the physical changes

- Changing precipitation and temps will have a huge impact on watersheds and aquatic ecosystems
- Sea level rise is narrowing coastal corridors
- Habitat migration
- Habitat loss
- Ineffective restoration
- Existing good habitat loss
- More invasive species issues
- Vast number of potential impacts that may deteriorate corridors.
- Invasive species
- Rising sea level, habitat disappears
- Isolated habitats
- Streams dry up, temp changes, corridors change
- Could connect or disconnect areas (for better or worse)
- Valleys flood
- Storms bisect barrier islands
- Sea level rise disconnect marshes
- Fires could have catastrophic effects, especially if followed by invasive species
- Concomitant migration, expansion, re-colonization as a result of altered habitat and changing climatic conditions
- Plant and animal species range shifts
- Climate driven habitat changes resulting in habitat fragmentation
- Effects of temperature increase on various species
- More widespread invasives and their related issues
- Disconnection between food sources during critical life stages
- Isolations of small streams, etc
- More or less rainfall/heat will change the landscape
- In aquatic systems we will need to provide habitat (for example, the Rio Grande does not have enough water)
- Climate change will not improve connectivity
- Landscapes will be further fragmented
- We will have more "islands"
- Connectivity might increase due to increases in water
- Whooping cranes – sea level rise will swamp wintering habitat
- Climate might increase the size of the barriers
- Local extirpation
- Sea level rise extinguish corridors
- Areas that were formerly connected could become islands
- Invasive species might be more suitable than native species for landscape changes

Human dimensions

- Public recognition of climate changing is lagging behind and delaying appropriate action
- Solutions are very long term political cycles are short term
- Human attention span is too short to deal with long-term problem solving
- Industrial model of green energy is causing increased fragmentation of corridors

- Wind power and other green energy development causing fragmentation
- If rivers diverted by people, drought and resulting redistribution could affect species and landscapes
- Vertical wind turbines
- Barriers
- Good areas will become high value (i.e. development, city expansion)
- Moving people from coast will increase disturbance in former agricultural lands
- Increase transmission with alt energy development
- Energy oil and gas infrastructure will have to move more effects
- Moving people from hazard areas to less hazard areas will destroy habitat with doubling population on top of that
- Forest conversion to Bahia and Bermuda grass pastures due to fragmentation due to ranchettes
- Climate change will induce vast human migrations also, which in turn will lead to new development

Uncertainties

- Uncertainty of what specific habitats will look like in the future
- Rivers could become disconnected
- Managing in the face of long-term uncertainty
- Habitat could change in ways that were not predicted
- Purchase priorities might change
    - Land acquisition boundaries might shift
    - Land might not be there in the near future due to climate change – do you buy land that might not be there?

Potential for conflict

- Conflicts between conservation efforts and other land use involving energy, water, and agriculture
- Need to keep public sentiment on our side
- Stress of climate change on private land
    - Hard to manage because dealing with several different land owners

Other

- Need to understand what the vulnerabilities are; assessments needed
- Management practices need to be flexible
- Core mission(s) of an organization/agency might change
    - NWR initially created for waterfowl might need to change its focus

Discussion 4 (Connectivity on the Landscape), Question 4

Tools

- Lidar
- GIS
- Habitat mapping
    - Improved scale
    - Remote Sensing
    - Groundtruthing
    - Models specific to bays and river areas
- Modeling
- Emerging technologies (desalinization, carbon reducer machine)
- Rain barrels
- Need more (and better) models
- Landowner database for potential future acquisition corridors for greenspace connectivity
- Indicator species monitoring might be needed
- GIS data
- Condemnation
- Land acquisition

- Modeling
- Smaller scale predictive models
- GIS tools
- Good up-to-date remote sensing data
- Land use data that is temporally relevant/standard ecological classification
- Modeling

Strategies

- Need coordination & collaboration at multiple levels (local, state, federal and international) to ID, protect and restore functioning ecological corridors
- Encourage landowner cooperatives to ID, protect and restore corridors
- Greater public awareness on all levels
- Need unlimited resources
    - Not going to let resource constraints determine which species will be assisted
- Areas to prioritize
- Proactive preserving prime ecological habitat corridors
- Reserved acquisition
- Easements
- Better education and outreach
- "Jurassic Park"
- Genetic banks
- Flood water capture
- Financial support
- Administrative support
- Regulation to make it easier for private landowner and agency cooperation
- More comprehensive plan/strategy for restricting or limiting fragmentation in the first place
- Education for private land owners
- More support for NGOs and National Wildlife Federation
- Adaptive management
- Funding
- Public Education
- FWS needs to acquire a science based research branch
- Establish on-going monitoring programs at the landscape level
- Monitoring program to evaluate habitat change relative to climate change. Long-term monitoring of landscapes to get good picture
- Maintain current monitoring programs like USGS water gages
- Create new ones that have the same long-term commitment that include change indicator species
- Long-term research and monitoring cooperatives between university, government, NGO's
- Seek to improve current and develop additional partnerships
- Species specific management techniques (ex. Ocelot tunnels, Houston toad tunnels)
- "Smart Growth" – guiding development to stay out of future corridors (based on predicted land cover changes)
- Risk assessment strategy – vulnerability assessments
- Improve communications between stakeholder
- We need to be thinking about what we need to do now
- Public education is one of the keys to success
- Educate public about the idea of space and time regarding climate change
- On the job shadowing
- Ycc
- Work with partners to develop an electronic game for kids on how to build a refuge or save a species
- Monitoring
- Adaptive management
- Early retirement

- Education of policy makers and others
- Decision-making leadership to handle tough decisions
- Within USFWS, would be helpful to be trained in multiple disciplines: forestry, fisheries, endangered species, etc.
- Multiple scenarios range of scenarios, weigh options and have strategies that have public buy-in for us to act

Research

- Highly accurate niche models
- Species movement
- Migration patterns and how they might change with climate change
- Relationship of invasive species
- What is going to happen with
    - Sea level rise
    - Temperature, etc.
- Learn more!
- Research on natural corridors
- Further research on the biology and habitat requirements of T & E species
- Further research on vegetation communities and their responses to climate change
- Baseline species and ecosystem data is critical for future comparisons
- Need life histories of all organisms to know what is required to sustain each
- Seek to identify biological control methods for invasives where feasible
- Fill knowledge gaps
- To identify which species will not migrate fast enough
- We will need predictive models and population studies

Other

- Willie Nelson's water from air
- Chevy volt

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