

Western Hummingbird Partnership Action Plan

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Female Broad-tailed Hummingbird (*Selasphorus platycercus*)

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*Working together to maintain thriving
hummingbird populations and their habitats*

I. Executive Summary

The Western Hummingbird Partnership (WHP) is a developing network of partners collaborating to build an effective and sustainable hummingbird conservation program through science-based monitoring, research, habitat restoration/enhancement, and education/outreach efforts. WHP goals are to support projects, develop programs, and build partnerships that investigate what hummingbirds need to survive, successfully reproduce, and maintain thriving populations; and then to inform land managers, policy makers, and the public so habitats can be managed in ways that help hummingbirds and their communities thrive. In addition to directly influencing the conservation of hummingbirds and their habitats, the WHP can also contribute to an agency's ability to meet their greater goals/priorities for conservation of ecosystems in general.

Hummingbirds live only in the western hemisphere, where they are the second most diverse family of birds with over 80% of hummingbird species relying on a mosaic of forested habitats for key life history stages. They are specialized nectar-feeders that present morphological, ecological and physiological adaptations for this diet and serve as pollinators for a wide array of native plants that often occur in early successional stages of forest re-growth. The Western Hemisphere provides the geographic boundaries for the Partnership, but the WHP will begin with an initial focus on western North America (USA and Canada and Mexico).

Despite their diversity and extreme popularity with humans, hummingbirds have received relatively little attention from a conservation standpoint. Much remains unknown about basic life history such as their breeding biology and the importance of insects in their diet. Due to their unique attributes and small size, other landbird conservation efforts fail to adequately address hummingbird conservation needs. Yet, recent evidence suggests worrisome population declines in some species. Given the diversity of habitats and land-ownerships that hummingbirds utilize across the western hemisphere and the number of hummingbird species which migrate annually across the USA, Canada, and Mexico, a tri-national partnership is needed to achieve effective conservation of hummingbirds and their habitats in North America.

This Action Plan summarizes the background, creation, and development of the WHP, and prioritizes key action items recommended by partners in 2009. Objectives of the plan are to:

- Provide a central framework which establishes the foundation from which WHP-related actions are developed.
- Review hummingbird conservation issues and recommend action items that address these issues.
- Prioritize action items.
- Work with partners to develop program plans and implement projects based upon the priority action items.

During reviews of recommended actions, major topics emerged and actions needed to build the foundation of each topic were prioritized. The major topics and their associated priority action items are:

- Design an effective hummingbird monitoring program that will build upon existing programs.
 - Evaluate available monitoring data from existing programs.
 - Where possible, integrate hummingbird monitoring efforts with existing efforts.
- Address gaps in knowledge and key research questions through scientific investigations
 - Develop conservation genetic techniques for investigating hummingbird conservation issues.
 - Through tri-national collaborations, determine causes of declining populations for Rufous Hummingbirds by first determining how Rufous populations are connected.
- Enhance conservation through education and outreach projects
 - Develop a hummingbird knowledge base by first compiling and consolidating existing information on hummingbirds.
 - Launch the Western Hummingbird Information Network (WHIN), a web-based clearinghouse for information relative to hummingbirds and their conservation.

- Manage / Restore hummingbird habitats.
 - Determine the kinds of information needed by land managers to manage hummingbird habitats and identify the spatial scales at which such information is most useful.
 - Synthesize information about the effects of fire regime and habitat restoration on hummingbird ecology and on the restoration and regeneration of key nectar plants important to hummingbirds in North America.
- Evaluate changing distributions and phenologies of hummingbird nectar resources within the context of climate change and invasive species.
 - Develop a matrix of interactions between hummingbird species and their floral resources.
 - Identify best actions to address the needs created by changing phenologies.

The WHP will build upon the foundation of this Action Plan to coordinate hummingbird conservation efforts in the USA, Mexico, and Canada, and will work with existing conservation organizations and efforts so resources can be effectively used towards hummingbird conservation. It will be organized as a nonprofit joint venture under the auspices of HMN with action committees, a coordinator, and a Management Board that guide the development and integrity of WHP programs. WHP partners will work together to identify and prioritize needs, collaborate on implementation, peer review WHP protocols and products, and more. The focus on hummingbirds, a particularly charismatic group of species, will contribute to the conservation of important habitats and can serve as an indicator of the impacts of a changing climate on wildlife. With clearly defined partners and focus, the WHP has the potential to have far-reaching conservation impacts.

II. WHP Vision and Mission

The mission of the WHP is to work together to maintain thriving hummingbird populations and their habitats for present and future generations.

The vision of the WHP is a broad network of partners collaborating to:

- develop an efficient and effective conservation program that investigates what hummingbirds need to survive, successfully reproduce and sustain viable populations through science based monitoring, research, habitat restoration/enhancement, and education/outreach projects; and
- inform land managers, policy makers, and the public so habitats can be managed in ways that help hummingbirds and their communities thrive.

The WHP will be organized to enable and encourage active participation by partners who will work together to identify and prioritize needs and collaborate on implementation. Partners are empowered to make individual contributions consistent with the WHP's mission but are encouraged to work and consult with others. The WHP will work in conjunction with other conservation efforts, so available resources can be most effectively used to address hummingbird conservation issues.

III. Background and history of the Western Hummingbird Partnership

Despite their diversity and extreme popularity with humans, hummingbirds have received relatively little attention from a conservation standpoint. Recent evidence from the Breeding Bird Survey and other sources suggest worrisome population declines in some hummingbird species that breed in the western United States and Canada. For most hummingbird species in North America, particularly Mexico-restricted species, and throughout the Western Hemisphere, scientists have inadequate information to determine the causes of observed declines, assess population trends, or even provide a basic understanding of the range, movements, and natural history.

The Hummingbird Monitoring Network (HMN) was started in 2002 to address the conservation needs of hummingbirds and became a non-profit organization in 2004. It is a science-based, project-driven organization dedicated to the conservation of hummingbird diversity and abundance throughout the Americas. The Network's objectives are to: 1) Maintain long-term **monitoring** sites that represent a region's hummingbird diversity and estimate hummingbird abundance so population trends can be detected; 2) Encourage and support **research** projects that promote hummingbird conservation; 3) Help **preserve** hummingbird habitats; and 4) **Educate** by disseminating information about hummingbirds to land management agencies, federal and state biologists, land managers/owners, the scientific community, educators, students, and the general public. HMN was founded by three scientists and began monitoring hummingbird populations in Arizona and California. In 2004, it expanded to Canada when a naturalist and master bander joined this coordinated monitoring effort and established a number of field sites across British Columbia. Currently, scientists, biologists, and citizen scientists working at over 30 study sites in western Canada and USA participate in this coordinated effort. Field sites are chosen based on geographic, habitat, and disturbance factors and are evaluated via hummingbird diversity and abundance patterns, levels of breeding activity, and migration stopover use. The broad distribution of study sites now allows questions to be posed and answered at landscape levels.

As the Network gathered information that supported concerns over population declines of the Rufous Hummingbird (*Selasphorus rufus*)—a Partners In Flight Species of Continental Concern, HMN began expanding the network to include monitoring sites in the Rocky Mountains where important southbound migration routes occur, built collaborations with a Canadian scientist who would investigate how to link breeding and over-wintering populations through the use of stable isotopes, and began working with Mexican scientists and students to develop a hummingbird conservation program in Mexico. HMN's first workshop for training Mexican students in hummingbird field study techniques was funded by the Sonoran Joint Venture, ProNatura, and HMN in 2006 and helped four student from the University of Culiacán in Sinaloa define their undergraduate theses.

During the North American Ornithological Conference (NAOC) held in October 2006 in Vera Cruz, Mexico, a number of hummingbird biologists and conservation professionals met to discuss starting a conservation program for hummingbirds in Mexico. Most in attendance were from Mexico and agreed that hummingbirds needed a conservation program and that they would like to explore developing a program with HMN. Four months later, the Universidad de Guadalajara and HMN co-sponsored this first workshop title **“Hummingbird monitoring and conservation along North American migratory corridors: a workshop in memory of Bill Calder.”** This workshop became an avenue to honor Dr. William Calder, who was a pioneer and mentor for hummingbird conservation in Mexico, was a professor at the University of Arizona and had unexpectedly passed away a few years earlier. This workshop marks the beginning of “la Red de Monitoreo de Colibries (RMC)” with founding partners from Universidad de Guadalajara (Jalisco), Universidad Nacional Autónoma de México (UNAM, Mexico D.F. and Morelia, Michoacán), and HMN. Additional workshops have been sponsored by RMC and supported by the USFS. The latest workshop resulted in new collaborations with El Colegio de la Frontera Sur (ECOSUR, Chiapas) who joined the RMC this year.

The mission of the United States Forest Service (USFS) is to sustain the health, diversity, and productivity of the Nation's forests and grasslands to meet the needs of present and future generations. Under the National Forest Management Act (NFMA), the Forest Service is directed to “provide for diversity of plant and animal communities based on the suitability and capability of the specific land area in order to meet overall multiple-use objectives.” (P.L. 94-588, Sec 6 (g) (3) (B)). The January 2000 USDA Forest Service (FS) Landbird Conservation Strategic Plan, followed by Executive Order 13186 in 2001, all reference goals and objectives for integrating bird conservation into forest management and planning. Since most North American hummingbirds live in and rely on forests, the USFS is an important partner for hummingbird conservation. The USFS currently manages resources on 191 million acres throughout the USA, but relies heavily on lands under other ownerships to support conservation of shared species, including migratory birds.

In late 2008, a *Memorandum of Understanding between the USDA Forest Service and the US Fish and Wildlife Service to Promote the Conservation of Migratory Birds* was signed. The intent of the MOU is to strengthen

migratory bird conservation through enhanced collaboration and cooperation between the Forest Service and the Fish and Wildlife Service as well as other federal, state, tribal and local governments. Within the National Forests, conservation of migratory birds focuses on providing a diversity of habitat conditions at multiple spatial scales and ensuring that bird conservation is addressed when planning for land management activities. The International Programs branch of the USFS provides assistance in protection and sound management of the world's resources *under the International Forestry Cooperation Act of 1990 (PL 101-513 Title VI; 6 U.S.C. 4501-4505, November 5, 1990, as amended 1992 and 1994*. Specifically, the *Wings Across the Americas* (WATA) Program represents an integrated and collaborative approach to bird, bats, and butterfly conservation internationally and across all USFS program areas. Concern for health and sustainability of hummingbirds prompted the WATA Program to approach the USFS Pacific Southwest Region (R5) for initiation of an international effort to address this concern. Based on partner recommendations and WATA funding, R5 partnered with HMN in development of the Western Hummingbird Project which has now become the Western Hummingbird Partnership (WHP). The first step of which was to organize a tri-national workshop to begin the necessary building and expansion of partners.

In April 2009, scientists, land managers, and conservationists from Mexico, the United States, and Canada came together for a multi-day workshop in Tucson, Arizona, funded by USFS International Programs and HMN, to discuss the conservation needs of North American hummingbirds. This first major meeting of the Western Hummingbird Partnership included 82 representatives from 34 diverse institutions that included government agencies, non-profit conservation organizations, universities, and individuals. The workshop goals were to: create a common understanding about the state of knowledge and conservation of hummingbirds; identify gaps in our knowledge; and develop recommendations for key actions and projects that will best use the available resources to advance hummingbird conservation (see Appendix A). The workshop culminated with a partner meeting at El Coronado Ranch in the Chiricahua Mountains where conclusions and recommendations were made by the group (see Appendix B).

While the information generated at the April 2009 Workshop was being used to create this Action Plan, a variety of projects and activities promoting hummingbird conservation are already underway. Many of these were high priority action items identified at the 2009 Workshop. A list of the current WHP and HMN activities, including a description, project lead and contact information, and associated partners for each activity are presented in Appendix C. The initial list of the WHP hummingbird species of interest is presented in Appendix D and reflects those species found throughout western North America.

The intent of the WHP is to collaborate on the development of an effective conservation program that investigates what hummingbirds need to survive, successfully reproduce, and maintain viable populations, and then to inform land managers and policy makers so habitats can be managed in ways that help hummingbirds and their ecological communities thrive. We will accomplish this by building partnerships and collaborations between USFS regions across the west, other governmental agencies, non-profit organizations, and universities at the federal, state, and provincial levels in Canada, Mexico, and the USA. The conservation programs developed will include science-based monitoring, research, habitat restoration/enhancement, and education/outreach, with the mission of working together to maintain thriving hummingbird populations and their habitats. The focus on hummingbirds, a particularly charismatic group of species, will contribute to the conservation of important habitats and can serve as an indicator of the impacts of a changing climate on wildlife. With clearly defined partners and focus, the WHP has the potential to have far-reaching conservation impacts.

IV. Conservation issues facing hummingbirds

Many hummingbird species are long distance migrants travelling between the USA, Canada, and Mexico; therefore, a tri-national partnership is critical for effective hummingbird conservation in North America. Seventeen species regularly occur in the USA and Canada, of which thirteen are neotropical migrants that overwinter in Mexico (US Fish and Wildlife Service 2008). Hummingbirds live only in the western hemisphere, where they are the second most diverse family of birds (approximately 340 species). Their diversity is well

represented among North American bird families with 57 species, of which 40% are endemic to North America, 14% are substantially shared among the nations, 30% are migratory, and 14% are of high conservation concern (Berlanga et al., 2010).

Despite the wide distribution and cultural popularity of hummingbirds, knowledge of their basic life history and biology has many fundamental gaps. For example, all of the Birds of North America (BNA) accounts for hummingbirds identify information gaps in breeding biology as a priority for future research. Nests are undescribed for over 60% of the 48 currently threatened or endangered hummingbird species (Wethington and Finley 2009). There is a paucity of demographic information, including information on birthrate and mortality. The physiology of hummingbirds during reproduction is almost completely unknown. Habitat requirements for all life phases are not fully understood for most species.

Hummingbirds are specialized nectar feeders with morphological, ecological, and physiological adaptations for this diet, and serve as pollinators for a wide array of native plants (Stiles 1981, Brown and Bowers 1985, Rosero 2003, Temeles and Kress 2003, Gegear and Burns 2007). They depend almost completely on nectar for their energetic supply, and their survival depends upon a reliable supply of suitable nectar-producing plants that are frequently associated with early successional stages of forest re-growth. Almost 300 plant species identified from the literature were listed by Ornelas et al. (2007) as producing nectar used by hummingbirds. Most of the data come from geographic areas in the USA, Mexico, Costa Rica, and Brazil. In western USA, about 130 plant species are pollinated by hummingbirds (Johnsgard 1997).

In addition to nectar, hummingbirds prey upon insects, which provide an important source of protein (Schuchmann 1999). For many hummingbird species, aquatic insects are important prey items during the nesting cycle; thus, management of water resources in the arid west is likely an important conservation issue. Although insects are critical components to hummingbird diets, the real dietary importance of insects remains largely unknown and is under studied.

Forests are the primary habitat for over 80% of hummingbird species (Stotz et al. 1996). In the tropics, the diversity of hummingbirds is highest in montane/sub-montane forests (Schuchmann 1999). This pattern of forest-associated diversity continues northward, where the highest diversity of hummingbirds in the USA occurs in the pine/oak woodlands of southeastern Arizona (Wethington et al. 2005). These woodlands are included in the montane evergreen forest classification (Stotz et al. 1996), which has the highest number of at-risk hummingbird species (Wethington and Finley 2009). There are many unknowns regarding the needs of the various species of hummingbirds, particularly related to habitat requirements for insect prey, timing of nectar resource availability, nest sites, and other habitat requirements at different temporal and spatial scales.

There are indications that at least some hummingbird populations are declining. Partners in Flight (PIF) has identified three of the 13 neotropical migrants that breed in the USA and Canada and over-winter in Mexico as Watch List Species—Costa's (*Calypte costae*), Calliope (*Stellula calliope*), and Rufous (*Selasphorus rufus*)—and a fourth—Lucifer (*Calothorax lucifer*)—as a Stewardship Species (Rich et al 2004). The USFWS 2008 Birds of Conservation Concern also listed Costa's, Calliope, Lucifer, and Rufous as well as Allen's (*Selasphorus sasin*), Blue-throated (*Lampornis clemenciae*), and Buff-bellied (*Amazilia yucatanensis*); seven species in total nationally. In the recently released PIF Tri-national Vision, eight additional Mexican species are identified as species of high conservation concern in North America (Berlanga et al. 2010). They are Short-crested Coquette (*Lophornis brachylophus*), Mexican Woodnymph (*Thalurania ridgwayi*), Blue-capped Hummingbird (*Eupherusa cyanophrys*), White-tailed Hummingbird (*Eupherusa poliocerca*), Mexican Sheartail (*Doricha eliza*), Emerald-chinned Hummingbird (*Abeillia abeillei*), Garnet-throated Hummingbird (*Lamprolaima rhami*), and Wine-throated Hummingbird (*Atthis ellioti*). Based upon data from the Breeding Bird Survey since the mid 1960s, Rufous Hummingbird has an estimated 63% population loss and is considered a common species in steep decline by both PIF (Berlanga et al. 2010) and Audubon (National Audubon 2008). However, due to hummingbirds' small size, rapid movement, high-pitched vocalizations, unique flight abilities, and other factors, techniques used to monitor most landbirds generally fail to provide adequate hummingbird

population information. Long-term population trend data are considered adequate for only four of the 16 species that regularly breed in the USA and Canada (Rich et al. 2004). Population trend data for other hummingbird species in the Western Hemisphere are insufficient or non-existent.

Three primary threats—global climate change, invasive species, and habitat destruction—were identified at the April 2009 WHP Workshop as being of highest concern for hummingbirds. Perhaps, the greatest threats to hummingbird survival is the effect of changing climates on flowering phenology, where even minor changes in climate can produce large changes in nectar availability and in blooming dates that may decouple the mutualism between hummingbirds and the plants they pollinate. Loss of forest habitat either by direct destruction or alteration by invasive plants is also of great concern. Modification of hummingbird habitats continues to increase and will likely change the distribution and viability of hummingbird communities, as well as exacerbate the impacts of climate change on plant phenology (e.g., Bazzaz 1998, Gienapp et al. 2005).

Fire is a factor of particular concern in western North America with regard to managing hummingbird habitats. Fires impact hummingbirds by affecting nesting substrate, foraging resources (nectar and other foods), predation, migration habitat, wintering habitat, and presence of invasive plant species. Characteristics of fire that are important for hummingbird conservation include: spatial, temporal (seral/successional stages), severity, vegetation/habitat type (e.g., forest, shrubland, desert, etc), and historic fire regime (which incorporates many of the other factors). Fire management practices, such as prescribed burning and post-fire restoration, can have significant effects on the regeneration of nectar resources and could be developed as a valuable management tool for enhancing and restoring hummingbird habitats.

In PIF's Tri-national Vision, the most steeply declining species in temperate forests are birds dependent on disturbed and early successional habitat. Managing a mosaic of age classes of forests, as well as maintaining natural disturbance regimes such as fire, will be necessary to reverse declines of many forest birds (Berlanga et al. 2010). Since hummingbirds depend upon a variety of age classes of forests for nesting and foraging, addressing their conservation needs could provide land managers with a way to develop the needed mosaics of forest age classes and do this with the valuable support of a diversity of conservation professionals and volunteers. Thus, the WHP can also contribute to an agency's, a land manager's, and/or a landowner's ability to meet their greater goals/priorities for conservation of ecosystems in general.

V. WHP conservation actions

Four main conservation objectives for the WHP were identified by USFS and HMN and affirmed by partners at the workshop. They are: (1) maintain and increase monitoring and improve its quality; (2) stimulate needed research to investigate life history and habitat requirements that can inform management; (3) improve and increase management actions that help restore and enhance hummingbird habitats; and (4) increase public awareness and support for hummingbirds and conservation of their habitat through education, volunteer opportunities, and public outreach.

Monitoring

Effective monitoring is the backbone for any conservation program. It is needed to understand the health and sustainability of animal populations and the distribution / phenology of their required resources. Effective monitoring detects population trends and emerging problems. It also generates research questions applicable to the maintenance of populations and then, when needed, evaluates the effectiveness of management actions on restoring populations and habitats (Soule and Orians, 2001).

There are many challenges to sustaining monitoring efforts. By its very definition, monitoring is ongoing and long-term, and, thus, can be expensive to sustain. Another significant challenge is the requirement to clearly identify and address monitoring needs and questions, then identify and implement the methodologies that gather the data required to answer the questions in a cost-effective way.

Monitoring needs of hummingbird populations are similar to other animal populations, but techniques used to monitor hummingbirds must consider their specialized ecology and physiology. Existing long-term population trend data are considered adequate for only 4 of the 16 species that regularly breed in the USA and Canada (Rich et al. 2004). Trend data for other hummingbird species in the Western Hemisphere are insufficient or non-existent. To maintain thriving hummingbird populations, it is important to understand (1) trends in hummingbird distribution, abundance, and movement patterns; (2) population dynamics, such as survivorship, productivity, and other demographic factors; (3) the effects of broader resource changes on hummingbirds; and (4) emerging threats or problems.

Due to their high metabolism rates, hummingbirds are particularly dependent on their nectar resources for survival. It is likely that the distribution and timing of these floral resources have been instrumental in the evolution of hummingbird movement and distribution patterns (Rappole and Schuchmann 2003). Therefore, it is critical to monitor nectar availability and plant phenology in concert with hummingbird populations.

Fundamental needs for monitoring hummingbirds and the resources on which they depend include:

- Standardized techniques and reporting.
- Status and trends in temporal changes in hummingbird distribution, abundance, and movement patterns.
- Population dynamics, such as survivorship, productivity, and other demographic factors.
- Effects of landscape-scale resource changes on hummingbirds
- Status and trends in nectar resource availability and plant phenology.
- Identification of emerging threats or problems.

The ability to collect, maintain, and interpret monitoring data is critical to the success to the WHP mission. Therefore, organizations involved with bird monitoring are essential partners. Implementation of effective and coordinated hummingbird monitoring will contribute to meeting the goals set forth in the NABCI's Opportunities for Improving Avian Monitoring (U.S. NABCI Monitoring Subcommittee 2007). In addition, monitoring data can provide useful information to various on-going conservation efforts, such as Audubon's Important Bird Areas (IBAs) Program.

Research

Designing effective measures to conserve hummingbirds requires accurate knowledge about their biology and environmental requirements. Predicting risks to populations and future status and viability of hummingbird populations is predicated on having accurate information on the present and past status. Scientific inquiry that is well-designed, carefully conducted, peer-reviewed, and publicly accessible is the key for providing answers. Peer review of science requires a community of experts who are qualified and able to perform impartial, informed, and complete review. Unlike many other avian families, the published scientific record for *Trochilidae* is lacking in a number of areas. Fundamental gaps in information include:

- Landscape scale abundance and distribution.
- Spatial arrangement of reproduction sites and feeding areas.
- Breeding biology and nest site requirements.
- Identification of food types used to provision young and a determination if these foods differ significantly from those consumed by adults.
- Clear definition of breeding season.
- Identification of nest predators.
- Temporal and spatial differences in reproductive strategies.
- Structure and dynamics of populations (panmictic, metapopulations, disjunct populations, or other).
- Levels of genetic diversity over space and time, within and between species.
- Accurate identification of sex, age, species – the basics for constructing life tables.
- Patterns of movement of individuals and their genes: gene flow, migration patterns.
- Patterns and changes over space and time.
- Environmental attributes important to population health of each hummingbird species.

- Effective population sizes: how many and which individuals reproduce?
- Identification of the major threats to hummingbird populations.

Especially important are research efforts relevant to pragmatic problem solving for on-the-ground conservation actions. Quality research requires cultivation through funding programs with long-term vision and solid organizational structure. Therefore, research institutions are core partners within the WHP.

Habitat restoration and enhancement

Over 80% of hummingbird species require forested habitats to fulfill a life history component; therefore, the USFS is a key partner in hummingbird conservation. Other land managers that provide important habitats for hummingbirds include federal agencies such as the Bureau of Land Management, U.S. Fish and Wildlife Service, and the National Park Service, the Mexican government, Canadian land managers, state and provincial governments, and private land management organizations. A critical objective of the WHP is to collect and make available to forest and other land managers the most up to date information and tools needed for effective hummingbird habitat management. Specifically, information is needed that will enable land managers to (1) develop and implement projects to restore or enhance habitat for hummingbirds; (2) assess the effects of management activities on hummingbirds or develop project designs that minimize negative impacts; (3) effectively monitor hummingbird responses to habitat restoration projects or other management activities; and (4) identify ecosystem-scale goals and objectives for use in land management planning that benefit hummingbirds and other species (e.g., Forest Land and Resource Management Plans).

Forest-related habitats are not static and are affected by a variety of direct and indirect influences. The natural resources that these habitats comprise also have commercial value. Resources such as timber, firewood, clean water, minerals, game and fish, berries, mushrooms and many others are commonly harvested from the land and contribute to the constantly changing environment of these habitats.

Other influences are less obvious or direct, but also contribute to changing environments. Stressors such as wildfire, ground water pumping, insect or disease outbreaks, invasive species, and chemical pollution also contribute to changes in forested habitats.

Gaining a better understanding of what and when specific habitats and components are needed by hummingbirds and identification of components that are detrimental to hummingbirds will enable land managers to work within their mission toward ensuring sufficient distribution and abundance of desired components on the landscape while minimizing those that are less desirable.

Recognizing that change is inevitable and, in many cases, desirable, the intent of the WHP to provide land managers with the tools necessary to manage this change in such a way as to maintain thriving hummingbird populations as possible within agency constraints, recognizing that land management organizations have diverse and sometimes conflicting directives. Effective habitat restoration and enhancement can be achieved through being aware of and managing for abundance diversity of necessary forested habitats and habitat components.

Specific information that should be developed for land managers includes:

- Information on the life history characteristics and habitat needs of breeding, migrating, and wintering hummingbirds.
- Maps of the breeding, migration, and wintering ranges of hummingbirds.
- Information on how various land management activities and other stressors affect hummingbirds and their habitats.
- Identification of primary threats to hummingbirds and their habitats.
- Identification of important habitat components for which to manage.
- List of recommended plants for restoration, commercial and/or personal use.
- Prioritization of habitat improvement needs.
- Identification of habitat improvement techniques.

The WHP will also develop effective ways to distribute this information to land managers throughout western North America.

Education and Outreach

The highly charismatic nature of hummingbirds and the corresponding public interest in them provides a strong basis for successfully integrating public outreach, environmental education, and citizen science components into conservation efforts for these species. While the current gaps in our knowledge about many of the ecological attributes of hummingbirds can present a challenge for the design of education and outreach programs, they also represent an opportunity to involve the public in collecting valuable basic ecology information and to become invested in hummingbird conservation. The WHP seeks to make credible knowledge about hummingbirds available and to engage wide audiences through citizen science and outreach programs that address gaps in our scientific understanding of these species and the conservation challenges they face.

Given the migratory nature of many hummingbirds in North America and the large number of species concentrated in Central and South America, education and outreach efforts will focus on the need to conserve all pertinent hummingbird habitats, including breeding areas, wintering areas, and migration corridors. Each of the major conservation concerns identified for hummingbirds (climate change, invasive species, and habitat loss) span hummingbirds' ranges, and successful conservation initiatives will need to address these challenges throughout the Americas. This will necessitate an international approach and require partnerships between many different groups to be effective. With such a widely varying (birders, ranchers, land managers, researchers, students, community representatives, and others) and culturally diverse audience, design of outreach and education programs must be targeted to specific audiences to be effective.

In addition to the acknowledged gaps in our scientific understanding of many hummingbird species, there appears to be a lack of knowledge among much of the public about the conservation challenges facing hummingbirds, despite a widespread appreciation for these species. These gaps in public knowledge span the spectrum from broad scale issues such as a lack of understanding about the migratory nature of many hummingbirds (and thus the need to support conservation efforts throughout their range), to more specific issues such as the impacts of hummingbird feeders (and the need to properly maintain them). Furthermore, there seem to be some audience-specific knowledge gaps related to hummingbird conservation and public outreach, environmental education, citizen science. The scientific community may not be fully aware of the current state of our knowledge about hummingbirds and their associated conservation challenges.

Fundamental needs for hummingbird education and outreach include:

- Development of a centralized information web portal for data storage, information exchange, management recommendations, feeder care, forage plant lists, etc.
- Develop a cadre of trained citizen scientists to assist in science-based monitoring, research and other WHP programs.
- Inform public regarding conservation threats to hummingbirds: invasive species, disease transmission through improper feeder care, cats, lack of funding for conservation
- Expand outreach, link to existing efforts such as IMBD, Nature Watch, USA National Phenology Network, etc.

VI. WHP prioritized actions

The priority actions contained within this plan are built upon the information generated at the April 2009 workshop and during subsequent meetings and communications. Objectives of the action plan are to:

- Provide a central framework which establishes the foundation from which WHP related actions are developed.
- Review hummingbird conservation issues and recommend action items that address these issues.

- Prioritize action items so we make progress toward the WHP objectives.
- Work with partners to develop program plans and implement projects based upon the priority items.

During reviews of recommended key action items, major topic areas emerged; hence action items are organized within topic areas and prioritized within topic. The major topic areas are: (1) a comprehensive science-based hummingbird monitoring program integrated with existing efforts, (2) research focused on answering key questions and filling in existing knowledge gaps (3) management / restoration of hummingbird habitats, (4) enhance conservation and information exchange through education/ outreach projects, and (5) mitigate the effects of changing distributions and phenologies of hummingbird nectar resources.

Within each topic, actions that build the foundation on which other action items depend are prioritized first and are written in blue. Once the foundation is built for each topic, new and current action items will be re-prioritized based upon emerging conservation issues and a review of available resources. This iterative prioritization process will guide the development of WHP programs and the implementation of projects that will best use the available resources to advance hummingbird conservation. The major topic areas and their associated recommended action items are:

Monitoring

- Evaluate geographic and species coverage and information available from existing monitoring programs and qualitatively evaluate existing monitoring programs' ability to monitor health, distribution, and abundance of hummingbird populations at a variety of scales.
- Build upon existing monitoring efforts and design a coordinated monitoring program for hummingbirds that:
 - Includes peer-reviews of protocols by scientists and sharing of results.
 - Allows comparison of data for breeding, migration, and over-wintering populations.
 - Accommodates differences in monitoring options appropriate for each country.
 - Identifies threats and areas of concern (e.g., population sinks, disease centers, etc.).
 - Prioritizes geographic regions where monitoring occurs for winter, breeding, and migratory populations.
 - Defines additional monitoring information needed to assess population issues at the landscape level.
 - Devises a way to quickly and accurately assess abundance and diversity.
 - Uses the most effective monitoring methodologies to provide reliable information on migration and breeding.
- Increase data collected at current monitoring sites, such as pollen for floral resource questions, and provide other data such as feathers needed for research efforts.
- Expand on existing volunteer hummingbird monitoring programs such as Project Feeder Watch, eBird, and HMN's efforts. Develop skills needed for monitoring programs and involve the public in data collection.
- Build capacity for monitoring in all countries that is sustainable and supports/maintains currently established monitoring stations.
- Identify areas of high diversity and endemism (e.g. Hot Spot and GAP analyses) and use this information to help prioritize the development of the monitoring program as well as identify important habitat communities, that could be sinks and indicative of much worse conditions elsewhere.

Research

- Investigate hummingbird population health, disease, and conservation genetics.

- Through tri-national collaborations, determine causes of declining populations for Rufous Hummingbirds.
- Determine the effects of different reproductive strategies and variability in breeding season by species and locale. Much information is missing especially in Mexico and throughout Central and South America.
- Develop and test models regarding key life stage/overwinter/migration/breeding habitat resources to identify limiting factor/relative importance. Assess methods for gathering data on home range size and spatial arrangement of breeding sites.
- Identify key elements of insects in hummingbird diets. What percentage of hummingbird diet are insects? What insects are prey items? What plants and other resources are needed by these insects? Look into the possibility of using nitrogen [isotope?] analyses (versus gut sampling) to determine the seasonal/spatial dietary importance of arthropods.
- Develop an historical perspective of the distribution of hummingbirds and their pollinator plants using plant and animal collections.
- Determine how predation (e.g., by small mammals, corvids, raptors, woodpeckers, etc.) and competition (e.g., inter- and intra-) impact hummingbird populations? Are nest predators a limiting factor, or a significant impact on populations?
- Explore the use of body mass as a general measure of hummingbird health. Is fat storage indicative of preparation for migration? Differences between species and distances between stopover sites.
- How is migration triggered?
- Identify key information gaps and develop additional research projects for these emerging needs.

Habitat restoration and enhancement

- Determine the kinds of information and at what scales such information may be helpful for managers to conserve or restore hummingbird habitats.
- Synthesize the literature and current state of knowledge on the effects of fire ecology and disturbance restoration on hummingbird ecology and on the restoration and regeneration of key nectar plants important to hummingbirds in North America.
- Gather existing information regarding impacts of land management actions on hummingbirds, and/or their wintering, breeding, foraging, and migratory habitats. Management actions of highest interest include energy development, grazing, vegetation management (including use of herbicides and pesticides), and fire/disturbance restoration.
- Manage for maintenance and enhancement of aquatic resources/riparian habitats.
- Develop best practices and guidelines for land managers. These should include managing habitat for wintering, breeding, foraging (especially nectar resources), and migration, and should include guidelines relevant to a variety of management actions, including timber harvest, fuels management, grazing, maintenance of hydrologic function, restoration projects, etc.
- Evaluate how the three countries in North America are currently managing for hummingbirds and identify opportunities for improvement.
- Develop best management practices for private land owners and the public.
- Develop post-fire rehabilitation guidelines for activities such as Burn Area Emergency Rehabilitation (BAER) so restoration of hummingbird nectar resources is encouraged.
- Develop guidelines for nectar producing plant restoration projects.
- Prepare a Conservation Needs Assessment and Strategy for Hummingbirds. A key element in implementation of this objective is to include a list of nectar producing plants used by hummingbirds.

Education and Outreach

- Develop a hummingbird knowledge base by first compiling and consolidating existing information on hummingbirds (e.g. literature review, ‘gray literature’, other observations, eBird, non-hummingbird banding station records of hummingbird captures/releases, etc.).
- Launch the Western Hummingbird Information Network (WHIN), a web-based clearinghouse for information relative to hummingbirds and hummingbird conservation, current development funded through USFS International Programs (See Appendix C for additional information).
- Engage wider audiences in WHP citizen-science programs such as hummingbird population monitoring, feeder watches, and phenology monitoring.
- Synthesize current knowledge of hummingbird ecology in North America. Include vegetation lists for forest structure, forage species, cover, etc., as well as a description of vegetation use by nesting and foraging guilds.
- Summarize conservation status for North American hummingbird species and increase the public’s knowledge about hummingbirds and their conservation issues (particularly the need for protection of wintering, breeding, and migratory habitats).
- Disseminate information about how to use native plants to attract hummingbirds to gardens. Indicate what seed mixtures should be used and which should be avoided to benefit hummingbirds, and where the best locations might be for pollinator gardens.
- Continue to update information to the WHIN to keep it current on the state of our knowledge about hummingbirds.
- Given the ubiquitous use of hummingbird feeders, disseminate information about proper feeder maintenance and the potential for diseases and risks associated with improper feeder maintenance. Consider distributing information with each hummingbird feeder purchase.
- Prepare a directory of accredited organizations/groups involved in peer-reviewed hummingbird research and conservation.
- Establish a network that permits sharing information from different teams working across North America.

Address effects of changing distributions and phenologies of hummingbird nectar resources

- Develop a matrix of interactions between hummingbird species and their floral resources using current literature and collections. This will provide a comprehensive list of nectar producing plants used by each hummingbird species occurring in all three countries. The list will be the first step in describing habitat relationships, phenology and perturbation responses of important nectar producing plants through space and time. Map these floral resources and monitor their phenologies.
- Identify best actions to address the needs created by changing phenologies.
- Prepare a white paper that outlines the expected changes in the climate of western North America and potential direct and indirect effects these changes may have on hummingbird species.
- Implement transnational monitoring and information sharing to address climate change effects and other large-scale processes on hummingbird populations and required resources.
- Develop a Geographic Information System (GIS) that models effects of changing phenologies on hummingbird distribution and movement patterns and then develop predictive models with changing climate conditions (temperature, moisture, abundance of free water, fire).

VII. Future directions

In order to implement the vision and the mission of the WHP, the WHP will be organized to enable and encourage active participation by partners who will work together to identify and prioritize needs and collaborate on implementation. All partners are empowered to make individual contributions consistent with the

WHP's mission but are encouraged to work and consult with others. A main goal of the WHP is to work in conjunction with other conservation efforts, so available resources can be most effectively used to address hummingbird conservation issues.

To ensure successful implementation, formalization of the WHP structure is necessary. Therefore, we propose that the WHP be organized as a nonprofit joint venture under the auspices of HMN. This recommended structure is modeled after migratory bird conservation joint ventures initiated and funded by the U.S. Fish and Wildlife Service (USFWS) that have proven to be successful conservation tools for broad-scale issues engaging partners with overlapping conservation goals. When funding is secured, the joint venture model has been successfully adapted to work within a nonprofit organizational and administrative framework. The proposed organizational structure of the WHP has three levels of organization: (1) a Management Board, (2) a paid Coordinator, and (3) Action Committees. In addition, a reliable funding source needs to be developed to support the Coordinator and implementation of priority action items. To date, HMN has acted as the fiduciary agent for the initial WHP seed money and has provided the administrative structure for WHP activities and will continue in this role for future fund management.

1. The Management Board will make programmatic decisions for the WHP and will comprise partner representatives and others with desired skills. The Management Board will determine priorities among action items defined by the committees; identify and pursue funds for priority activities and projects and for the coordination and administrative services provided to WHP; and approve allocation of funds provided by or through partner.
2. The Coordinator will work to maintain and enhance coordination among partners and Action Committees and facilitate implementation of actions identified by the Management Board. The Coordinator is the "face" of the WHP, will receive a salary, and will report to the Management Board once this governing body is functioning and providing resources to continue the WHP. During the development phase of the WHP, Dr. Susan Wethington, Executive Director of the HMN, will continue to serve as the Coordinator for the WHP.
3. The Action Committees are the architects of the WHP. The focus of the Action Committees is to ensure effective accomplishment of the WHP actions items. We propose that the WHP develop six committees to guide the following programs: Monitoring; Research; Habitat Conservation/Management, Education/Outreach, Nectar Resource Conservation, and the Western Hummingbird Information Network (WHIN). Partner participation is requested.

The development of partners and funding sources is critical for the success of the WHP. Initial partners were brought together in the April 2009 Workshops (see Appendix A). Outreach to other partners that include universities, other nonprofit organizations, government agencies, and individuals is on-going and must continue. For example, additional government supported programs and agencies that we need to engage are State Wildlife Agencies individually and through the Association of Fish and Wildlife Agencies (AFWA) and Western Association of Fish and Wildlife Agencies (WAFWA), PIF, existing Joint Ventures, North American Bird Conservation Initiative (NABCI) partners, and broader participation by the USFWS. Involvement by State Wildlife Agencies and the USFWS is particularly important given their regulatory role in managing species and priority missions of furthering species conservation. There is a similar need for outreach to other partners in universities and other conservation organizations that are active throughout the Western Hemisphere, especially in Canada and Mexico for our initial focus. In addition, we need to look into nontraditional partner opportunities to further the WHP mission and facilitate effectiveness of other program facets. For example, companies focused on hummingbird-related products, such as hummingbird feeders, would likely be interested in promoting hummingbird conservation.

An additional objective is to find ways to include hummingbird issues into other new and on-going conservation projects. Existing efforts include the Neotropical Migratory Bird Conservation Act; Partners in Flight (PIF), especially within the goals of their new "Saving Our Shared Birds: The PIF Tri-National Vision for Landbird Conservation"; NABCI; the Audubon Society's Important Bird Areas (IBAs) effort; and many others. This

Action Plan is the foundation from which to coordinate hummingbird conservation efforts throughout the western hemisphere, with an initial focus on western North America.

VIII. Authors and their contact information

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IX. Acknowledgments

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XI. Appendices

Appendix A: The April Workshop, 2009

As a first step in formalizing this partnership, participants in a multi-day workshop at the annual meeting of the Cooper Ornithological Society in Tucson, Arizona discussed the conservation needs of North American hummingbirds. This first major meeting of the Western Hummingbird Partnership included 82 representatives from 34 diverse institutions. These institutions included government agencies, non-governmental conservation organizations, universities and individuals. The workshop goals were to: create a common understanding about the state of knowledge and conservation of hummingbirds; identify gaps in our knowledge; and develop recommendations for key actions and projects that will best use the available resources to advance hummingbird conservation. Conservation topics addressed at the workshop included hummingbird life history and habitat needs; population trends / coordinated monitoring; phenology and climate change; effects of fire on hummingbird resources; diversity, distribution and abundance patterns; citizen science, public outreach, and environmental education; and other conservation issues. From responses to WHP's questionnaire about the workshop, participants indicated that the major conservation issues for hummingbirds were covered. Participants in the April workshop included:

FIRST NAME	LAST NAME	ORGANIZATION
Doug	Altshuler	UC Riverside
Maria del Coro	Arizmendi	Universidad Nacional Autónoma de México (UNAM)
John	Arnett	DoD Luke AFB/ DoD-PIF
Valer	Austin	Cuenca Los Ojos
Alona	Bachi	Tucson Hummingbird Project; University of Arizona
Karen	Bagne	Rocky Mountain Research Station
Janet	Baker	
Carol	Beardmore	US Fish and Wildlife Service-Sonoran Joint Venture
Humberto	Berlanga	CONABIO
Chelsea	Berns	Iowa State University
Anne	Bradley	The Nature Conservancy
Rick	Brusca	Arizona-Sonora Desert Museum
Howard	Buchanan	Hummingbird Monitoring Network
Wendy	Burke-Ryan	Hummingbird Monitoring Network
Lorene	Calder	
Cheryl	Carrothers	USFS Pacific Southwest Region
Danielle	Chi	USFS Intermountain Region
Rita	Colwell	Hummingbird Monitoring Network
Sarahy	Contreras-Martinez	Universidad de Guadalajara
Diana	Craig	USDA Forest Service
Jim	Cunningham	Dominican University of California
Laura	Davis	Hummingbird Monitoring Network
Jennie	Duberstein	Sonoran Joint Venture / U.S. Fish and Wildlife Service
Kirk	Emerson	
Sophia	Engel	
Fred	Engelman	RMNP/Volunteers in Parks
Tena	Engelman	RMNP/Volunteers in Parks
Holly	Ernest	UC Davis
Ron	Escano	US Forest Service
Elissa	Fazio	Hummingbird Monitoring Network
Richard	Feldman	McGill University
Deborah	Finch	U.S. Forest Service, Rocky Mountain Research Station
Tom	Gardali	PRBO Conservation Science

Harold	Greeney	Yanayacu Biological Station & Center for Creative Studies
Perry	Grissom	National Park Service
Beth	Hahn	USDA Forest Service
Patricia	Harverson	Sul Ross State University
Dauna	Hod	Sul Ross State University
Adam	Hutchins	Dixie National Forest
Stephanie	Jones	US Fish and Wildlife Service
Edwin	Juarez	Arizona Game and Fish Dept.
Daniel	Kissling	UC San Diego
Heidi	Lauchstedt	Arizona State Parks
Greg	Levandoski	Rocky Mountain Bird Observatory
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Brian	McGill	University of Arizona
Rocio	Meneses Ramirez	Benemérita Universidad Autónoma de Puebla
Jessi-Ann	Michaelson	George Fox University
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Bill	Noble	National Park Service
Larry	Norris	National Audubon
Ben	Olewine	George Fox University
Don	Powers	Univ. of California, Univ. of Arizona
Mary	Price	Arizona State Parks
Joanne	Roberts	UNAM
Claudia	Rodriguez-Flores	Hummingbird Monitoring Network
Lee	Rogers	Hummingbird Monitoring Network
Gary	Romig	US Forest Service Rocky Mt. Research Station
Vicki	Saab	UNAM
Jorge	Schondube	US Forest Service
Debbie	Sebesta	The Institute for Bird Populations
Rodney	Siegel	USDA Forest Service Rocky Mountain Research Station
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Dawn	Wilson	Southeastern Arizona Bird Observatory
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Appendix B: The first WHP partner meeting at El Coronado Ranch

The COS/WHP workshop culminated with a partner meeting at El Coronado Ranch in the Chiricahua Mountains in April 2009. The following white paper, written by Dr. Rodney Siegel who is the Executive Director of The Institute for Bird Populations, summarizes this meeting:

Recommendations from the First Tri-national Meeting of the Western Hummingbird Project

In April 2009, scientists, land managers, and conservationists from Mexico, the United States, and Canada came together for a multi-day workshop in Arizona to discuss the conservation needs of North American hummingbirds. This first major meeting of the Western Hummingbird Project included representatives from diverse institutions, including government agencies, non-governmental conservation organizations, and universities (see participants list, page 2).

The following conclusions and recommendations were made by the group:

Conclusions

- Recent evidence from the Breeding Bird Survey and other sources suggest worrisome population declines in some hummingbird species that breed in the western United States and Canada.
- Adequate information for determining the causes of observed declines, assessing population trends of all but a few hummingbird species, or even providing a basic understanding of the range, movements, and natural history of most species (particularly Mexico-restricted species) is lacking.
- Safeguarding hummingbird species that are ‘shared’ by all three countries of North America requires international cooperation.
- Hummingbirds’ roles as nectar-feeders and pollinators may make them particularly ecologically important, and particularly vulnerable to changes in habitats and climate.
- The charismatic nature of this family of birds provides great potential to engage people in addressing conservation issues facing hummingbirds and their habitats.

Recommendations

- Develop and bolster efforts to monitor population trends and demographics of hummingbirds.
- Pursue research to determine the causes of hummingbird population declines, to better understand hummingbird ecology, and to identify management actions that will benefit hummingbird populations.
- Develop effective conservation measures and decision support tools that will enable land managers to take action to benefit hummingbirds.
- Implement conservation actions based on existing information, even if the information is incomplete.
- Monitor the efficacy of management actions.

To address these recommendations, the Western Hummingbird Project urges:

- **Policy-makers and grant-makers** to support actions and initiatives that will help safeguard North American hummingbird populations.
- **Researchers** to join us in collecting better information about the distribution, population trends, demography, and ecology of hummingbird species.
- **Land managers and landowners** to protect, manage, and restore hummingbird habitat.

For more information please contact:

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Participants at the April 2009 meeting of the Western Hummingbird Project at El Coronado Ranch, AZ.

Alexander, John	Klamath Bird Observatory
Arizmendi, Maria del Coro	Universidad Nacional Autónoma de México
Austin, Josiah	Cuenca Los Ojos
Austin, Valer	Cuenca Los Ojos
Berlanga, Humberto	Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (CONABIO)
Carrothers, Cheryl	U.S. Forest Service - Pacific Southwest Region
Contreras-Martinez, Sarahy	Universidad de Guadalajara
Craig, Diana	U.S. Forest Service - Pacific Southwest Region Sonoran Joint Venture / U.S. Fish and Wildlife Service
Duberstein, Jennie	University of California at Davis
Ernest, Holly	U.S. Forest Service - Pacific Northwest Region
Escano, Ron	U.S. Forest Service - Dixie National Forest
Hutchins, Adam	Rocky Mountain Bird Observatory
Levandoski, Greg	U.S. Forest Service - International Programs
Lively, Carol	Benemérita Universidad Autónoma de Puebla
Meneses Ramirez, Rocio	Royal Roads University
Moran, Jonathan	National Park Service
Norris, Larry	Hummingbird Monitoring Network
Rogers, Lee	U.S. Forest Service - Rocky Mountain Research Station
Saab, Vicki	Universidad Nacional Autónoma de México
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Wethington, Susan	U.S. Forest Service - Dixie National Forest
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Zermeño, Gabriela	

The mission of the Western Hummingbird Project (WHP) is to maintain thriving populations of hummingbirds in western North America through habitat restoration and enhancement, population monitoring, research, and education and outreach projects. The WHP is a broad network of partners collaborating to

- develop an efficient and effective conservation program that investigates what hummingbirds need to survive, successfully reproduce and sustain viable populations; and
- inform policy makers so habitats can be managed in ways that help hummingbirds and their communities thrive.

Appendix C: Current program activities and projects of the WHP

Currently, the WHP, HMN, and other partners are addressing hummingbird conservation issues with the following actions and priorities. This section of the document is dynamic and will change as new projects begin and others end; as projects expand to include more and/or different partners and new conservation issues arise. The projects are identified with active committees associated with the WHP's main program areas—monitoring, research, habitat restoration/enhancement, and education/outreach—and with conservation issues that likely have over-arching impacts on hummingbird conservation such as the changing distribution and availability of hummingbird nectar resources due to climate change.

MONITORING:

- **PROJECT NAME:** Evaluate available monitoring data from existing programs.
PRIMARY CONTACTS: Tom Gardali, PRBO, Rodney Siegel, IBP, Susan Wethington, HMN
KEY PARTNERS: USFS-IP, HMN
SUMMARY: The following existing monitoring programs will be assessed to determine the adequacy of current monitoring programs to sample hummingbirds: ¹HMN (Hummingbird Monitoring Network; <http://www.hummonnet.org/>), MAPS (Monitoring Avian Productivity and Survivorship; <http://www.birdpop.org/maps.htm>), MOSI (Monitoreo de Sobrevivencia Invernal; <http://birdpop.org/MoSI/MoSI.htm>), MAWS (Monitoring Overwinter Survival; <http://birdpop.org/MoSI/MoSI.htm>), BBS (Breeding Bird Survey; <http://www.pwrc.usgs.gov/BBS/>), BBC (Breeding Bird Census <http://www.pwrc.usgs.gov/birds/bbc.html>), CBC (Christmas Bird Count; <http://www.audubon.org/Bird/cbc/>), eBird (<http://ebird.org/content/ebird/>), GBBC (Great Backyard Bird Count; <http://www.birdsource.org/gbbc/>), CMMN (Canadian Migration Monitoring Network; <http://www.bsc-eoc.org/birdmon/cmmn/main.jsp>); FeederWatch (<http://www.birds.cornell.edu/pfw/>). Once completed, this assessment will provide information on which species are well-sampled, where, and for what metrics. Equally important, the table will highlight gaps in coverage of species, geographies, etc. Finally, the table could also help us make recommendations for expanding and improving existing programs to better sample hummingbirds.
- **PROJECT NAME:** HMN's Coordinated Monitoring Program
PRIMARY CONTACTS: Dr. Susan Wethington, HMN
KEY PARTNERS: USFS, BLM, NPS, DoD, RPBO, CLO, AMNH-SWRS, AZSP, AZGFD, Audubon Arizona, UA-Steward Observatory, private landowners, citizen scientists, volunteers
SUMMARY: The goals of HMN's monitoring program are to: 1) To determine the best long-term monitoring sites for hummingbirds in North America; 2) to effectively sample their populations so trends can be detected; and 3) to use the resulting information to assist in their preservation and protection. The coordinated monitoring program is a systematic banding study that generates knowledge about hummingbird diversity, abundance, productivity, and survivorship at a number of sites. We choose these sites based upon geographic factors, such as elevation, longitude, and latitude, and vegetation types. Once every other week, we band hummingbirds from late March through October. We use other counting techniques to assess relative abundance of hummingbirds at the sites. Results from each site are evaluated to determine which ones are contenders for long-term monitoring or if a new site should be added and evaluated. Thus, HMN provides information about which areas support a high diversity and abundance of hummingbirds, which areas are important breeding sites, the timing of hummingbird occurrence, and their seasonal movement patterns. Our work helps define the areas needed to maintain hummingbird diversity.

- PROJECT NAME:** Creating a Mexican hummingbird banding program for members of the RMC.
PRIMARY CONTACTS: Dr. Susan Wethington, HMN
KEY PARTNERS: UNAM, UdeG, ECOSUR, USGS-BBL
SUMMARY: Banding is an effective methodology for studying population dynamics of birds. Yet, bands for hummingbirds have not been available for use on resident Mexican hummingbird species. One of the first actions of the RMC was to make bands with advice from the USGS BBL and make these bands available to Mexican biologists who have the appropriate permits to conduct population studies on Mexican birds, who have the skills needed for banding hummingbirds, and who are willing to work with other members in the RMC so banding records can be shared. The RMC also provides training in hummingbird banding techniques and skills for interested professionals.
- PROJECT NAME:** Develop a hummingbird feeder watch
PRIMARY CONTACTS: Dr. Rachel McCaffrey, HMN
KEY PARTNERS: Audubon, UNAM, PRBO-WHIN, USFS
SUMMARY: This program will be a citizen-science based initiative to advance North American hummingbird conservation by engaging the general public in the U.S. and Canada, and trained students in Mexico, into contributing information on hummingbird abundance, richness, and movement on a continental scale. This project will develop collaborative partnerships and use the World Wide Web to bring hummingbird conservation and education opportunities into the homes of millions of people who enjoy feeding hummingbirds in their backyards.

RESEARCH:

- PROJECT NAME:** Conservation Genetics of Hummingbirds: DNA Sequence Assessment toward Development of Nuclear DNA Single Nucleotide Polymorphism Markers
PRIMARY INVESTIGATOR: Dr. Holly Ernest, UC Davis Veterinary School
KEY PARTNERS: USFS-IP, HMN
SUMMARY: Hummingbirds are one of the most species-rich avian families (Trochilidae, over 335 species) in the world, yet have among the least information necessary for conservation planning. Very little is known of many of the most basic population parameters, such as population sizes and structure, demography, rates of species hybridization, genetic diversity, and threats to persistence. Determination of level of extinction threat and conservation planning requires such basic knowledge of population biology.
Molecular genetics methods have emerged as powerful tools to assess indicators of population structure, genetic diversity, and viability of wildlife species. However due to multiple historical reasons, including lack of sampling opportunity in birds that typically weigh less than 5 grams, population genetic molecular markers have not yet been available to address key questions.
This proposal outlines an approach to initiate development of a suite of molecular genetics tools to differentiate species, identify hybrids, determine population structure, and assess genetic diversity. Seed funding for preliminary laboratory research will allow pilot study of DNA sequence differences among and within species and start the development of single nucleotide polymorphism (SNP) genetic markers and reference DNA data bases for hummingbird species and populations.
- PROJECT NAME:** The Use of Stable Isotopes to Establish Migratory Connectivity in Rufous Hummingbirds (*Selasphorus rufus*)
PRIMARY INVESTIGATOR: Dr. Jonathan Moran, Royal Roads University
KEY PARTNERS: RPBO, HMN, USFS-IP,
SUMMARY The Rufous Hummingbird (*Selasphorus rufus*) is a familiar sight in many parts of British Columbia and Alberta, where it arrives during its annual northward migration each spring; a number of the birds spend the winter in Mexico, others overwinter along the Gulf Coast of the USA. Unfortunately, its numbers are declining in several parts of its range in North America. The pattern of decline is uneven, with some populations apparently stable from year to year, while others show a reduction in the number birds returning each year. The aim of the study is to determine whether or not the birds that breed in British Columbia and Alberta represent a single migratory population, or whether the disparity in *S. rufus* numbers returning each spring to different sites

can be attributed to geographical differences in wintering range between sub-populations. Using analysis of deuterium (a stable isotope of hydrogen) in the feathers of migrating birds, it is possible to track the annual migration of *S. rufus* with a degree of precision previously unavailable. Deuterium levels in the environment can be predicted, with a gradient of increasing concentration running from NW to SE in North America. Thus, isotopic analysis of feathers allows us to determine the latitude at which an individual bird was feeding at the time it was molting.

- PROJECT NAME: Interspecies interactions improve Black-chinned Hummingbird (*Archilochus alexandri*) nest success

PRIMARY INVESTIGATOR: Dr. Harold Greeney, Yanayacu Biological Station

KEY PARTNERS: HMN, AMNH-SWRS, Coronado National Forest, CLO, UNAM

SUMMARY: This project began in 2007 with the goal of studying the breeding biology and natural history of migratory hummingbirds in southeastern Arizona. During the first year we discovered that Black-chinned Hummingbirds (*Archilochus alexandri*) were choosing to cluster their nests around *Accipiter* hawk nesting sites and, by doing so, realizing increased nesting success. In subsequent years we began to study the intricacies of this interaction, discovering that *Accipiter* nest placement creates a behaviorally mediated trophic cascade by altering the foraging behavior of predatory Mexican Jays and creating a three-dimensional enemy-free nesting habitat for hummingbirds. The project runs annually from April to August at the Southwest Research Station.

HABITAT RESTORATION AND ENHANCEMENT:

- PROJECT NAME: Explore the effects of fire on hummingbird communities in Mexico and USA.

PRIMARY CONTACT: Sarahy Contreras, UdeG, Dr. Vicki Saab, USFS-Research

KEY PARTNERS: Las Joyas Scientific Station, Sierra de Manantlan, USFS-IP, HMN

SUMMARY: Forest fires are a major cause of ecological disturbances in pine-oak forests in Jalisco and Mexico. Predictive models of global warming indicate that risk of forest fires will increase in Western Mexico, and will affect vegetation types not currently affected by fire. Despite its importance, there are few rigorous studies on the effects of fire on wildlife and biodiversity in Mexican forest ecosystems. This research will describe the impact of fire on a hummingbird community in different vegetation types to maintain or produce the landscape patch patterns needed by hummingbirds. First, it will seek to define functional groups based on their response to fire. Undertake a multi-scale analysis at three levels: a) population level, for measuring parameters of selected migratory and residents species abundance, age and sex ratio, and survival, in different successional stages post-fire for defining habitat criteria; b) at community level by measuring richness, evenness, species, migration phenology and diversity; and c) at the landscape level (Sierra de Manantlán and South Coast regions of Jalisco) it will incorporate parameters generated from the population and community levels to a geographic information system to analyze the discrepancy between existing conservation units and distribution of species according to their habitat requirements and the spatial-temporal dynamics of habitats.

- PROJECT NAME: Compile current information related to abundance and distribution of nectar-producing plants on pre and post-fire landscapes.

PRIMARY CONTACT: Cheryl Carrothers and Diana Craig, USFS-R5

KEY PARTNERS: TNC, USFS – Research, NPS

SUMMARY: After obtaining current list of forage plants, conduct electronic review of existing USFS data sets for presence. Assess distribution and abundance against fire history, looking for trends reflective of an association/dependence between those species and fire and any associated actions. This effort will contribute to an understanding of the ecology of these forage plants, help define suitable hummingbird habitats at the local scale and contribute to the identification of habitat continuity or lack of at the landscape scale.

EDUCATION AND OUTREACH:

- PROJECT NAME: Western Hummingbird Information Network (WHIN)

PRIMARY CONTACTS: Michael Fitzgibbon, PRBO, Cheryl Carrothers, USFS R5

KEY PARTNERS: USFS-IP, KBO, LaMNA, HMN, RMBO, UNAM, UdeG, RRU

SUMMARY: The Western Hummingbird Information Network (WHIN) is a website of the Western Hummingbird Project (WHP) that acts as a clearinghouse for information relative to hummingbirds and hummingbird conservation. Our current geographic focus is Mexico, the western US and western Canada. The mission of WHIN is to discover, archive, present and visualize information on hummingbirds, help apply that information to the landscape and conservation efforts, and to identify and highlight the issues and opportunities that are important to hummingbird conservation.

- **PROJECT NAME:** Hummingbird network to promote collection and contribution of data to the new hummingbird portal being developed as part of CADC/LaMNA.
PRIMARY CONTACT: John Alexander, KBO
KEY PARTNERS: LaMNA, PRBO, USFS-IP, HMN
SUMMARY: Hummingbirds are the feathered jewels of the migratory bird world, but receive relatively little attention from a conservation standpoint, yet there are indications that populations of at least some of the species are declining. The Western Hummingbird Project (WHP) with its mission of working together to maintain thriving hummingbird populations and their habitats throughout western North America was created to address conservation issues. Two facets of this project are ongoing: One is identifying, describing and archiving existing hummingbird datasets through the Landbird Monitoring Network of the Americas (LaMNA). The other is the creation of a centralized web portal by PRBO Conservation Science for information collection, storage and dissemination. Hummingbird data (banded and unbanded birds) are needed to help advance our knowledge of their life history, habitat needs, distribution, diversity and abundance.
- **PROJECT NAME:** Provide training workshops for the expansion HMN's monitoring program
PRIMARY CONTACTS: Dr. Susan Wethington, HMN
KEY PARTNERS: BLM, USFS, NPS, ECOSUR, Audubon AZ and NM, citizen scientists
SUMMARY: Training workshops in hummingbird banding and monitoring skills are provided to biologists, scientists, and citizen scientists so HMN's monitoring program can expand to areas with hummingbird populations that can add to our abilities to detect population trends for all hummingbird species in North America. Recently training workshops have been provided to agency biologists in southern Utah and to research scientists and graduate students in Chiapas.
- **PROJECT NAME:** Provide training workshops for the expansion HMN's monitoring program
PRIMARY CONTACTS: Dr. Susan Wethington, HMN, Dra Coro Arimendi, UNAM and Sarahy Contreras M.C., UdeG
KEY PARTNERS: RMC
SUMMARY: Training workshops in hummingbird field study techniques and meetings about hummingbird conservation issues are held once every two year for RMC members as well as others interested in hummingbird conservation in Mexico.
- **PROJECT NAME:** Student internships for Mexican students for field research
PRIMARY CONTACT: Dr. Susan Wethington, HMN
KEY PARTNERS: CLO, AMNH-SWRS, YBS, USFS-IP
SUMMARY: This field program will train students in a variety of hummingbird field study techniques. The program is typically 3 months, occurs during the summer months, and is available to two Mexican students per year. Currently, the interns will be trained in hummingbird nest study techniques by participating in HMN's ongoing nest study in the Chiricahua Mountains and in hummingbird monitoring techniques, another ongoing program of HMN.
- **PROJECT NAME:** Engaging Volunteers in hummingbird conservation efforts
PRIMARY CONTACT: Tice Supplee, Audubon Arizona, Susan Wethington, HMN
KEY PARTNERS: Toyota Together Green, Audubon New Mexico, AZSP, AZGFD, Flagstaff

Arboretum,

SUMMARY: Events are planned to engage new volunteers in hummingbird conservation efforts.

- PROJECT NAME: Maintain an online bibliography of hummingbird references
PRIMARY CONTACT: Chelsea Berns, ISU-PhD student
KEY PARTNERS: HMN, USFS-IP, PRBO, RRU, UNAM
SUMMARY: The goal of this project is to provide the hummingbird community with a compilation of citations intended to be a part of the Western Hummingbird Information Network. This bibliography will continue to be updated with the most recent hummingbird literature, including conservation, ecological, and evolutionary contributions to the field. In providing one succinct assemblage of data sources knowledge can be obtained more quickly and efficiently, further enhancing the awareness, research and preservation of hummingbirds.
- PROJECT NAME: Develop educational materials and tools that improve monitoring efforts
PRIMARY CONTACTS: Susan Wethington, George West, and Rita Colwell, HMN
KEY PARTNERS: HMN
SUMMARY: A variety of materials are developed to help inform and teach participating volunteers techniques and skills needed to run monitoring stations. Currently, an Age/Sex identification guide for hummingbirds in western USA and Canada is being developed.

ADDRESS EFFECTS OF CLIMATE CHANGE ON THE DISTRIBUTION AND TIMING OF HUMMINGBIRD NECTAR RESOURCES:

- PROJECT NAME: Develop a matrix of interactions between hummingbird species and their nectar plants
PRIMARY INVESTIGATOR: Dra. Maria del Coro Arizmendi, UNAM
KEY PARTNERS: HMN, USFS-IP
SUMMARY: The purpose of this work is to compile all existing information on plants visited by hummingbirds, elaborating a database consisting on plant species on the rows and hummingbird species in the columns, and presence-absence of interaction. This database will be compiled using literature sources (peer reviewed, as well as thesis, reports and other www based information) to search for studied interactions. In a second phase, for each interaction where possible (reported in the original citation) the geographic position (latitude and longitude when possible), altitude, timing of the reported interaction (flowering and hummingbird presence), vegetation type, and full citation will be recorded. For plants recorded as important for hummingbirds' phenological data can be determined using specimens in plant collections. As plant collections contain registers for multiple years, this info can be used to search for temporal changes in phenologies. These records can be mapped using a GIS tool and predictive models can be fitted to predict possible phenological changes that can affect hummingbirds.

ACRONYMS used in this Appendix are:

AMNH—American Museum of Natural History
AZGFD—Arizona Game and Fish Department
AZSP—Arizona State Parks
BBL—USGS Bird Banding Laboratory
BLM—Bureau of Land Management
CLO—Cuenca Los Ojos

DoD—Department of Defense
ECOSUR—El Colegio de la Frontera Sur
HMN—Hummingbird Monitoring Network
IBAs—Important Bird Areas
IBP—Institute for Bird Populations
IP—International Programs
ISU—Iowa State University
KBO—Klamath Bird Observatory
LaMNA—Landbird Monitoring Network of the Americas
NPS—National Park Service
PRBO – PRBO Conservation Science
RMBO—Rocky Mountain Bird Observatory
RMC—la Red de Monitoreo de Colibries
RPBO—Rocky Point Bird Observatory
RRU—Royal Roads University
SWRS—Southwestern Research Station
UA—University of Arizona
UC Davis—University of California at Davis
UdeG—Universidad de Guadalajara
UNAM-- Universidad Nacional Autónoma de México
USFS—US Forest Service
USGS—United States Geological Survey
WATA—Wings across the Americas
WHIN—Western Hummingbird Information Network

Appendix D: Current list of North American hummingbirds covered by the WHP (Includes Central American and Yucatan Peninsula species, but does not include Caribbean species)

The following table lists the North American species which will be considered in our initial focus on western North America. Those species of high concern in PIF's Trinational Vision (Berlanga et al. 2010) and of high threat by the IUCN (CR-Critically Endangered, EN-Endangered, VU-Vulnerable, NT-near threatened) are listed first. (* denotes species of high threat but not included in the Tri-national vision). For Range categories, the countries are listed in order of importance for breeding and wintering populations.

IUCN	Subfamily	Genus	Species	English common name	Breeding Range	Wintering Range
SPECIES OF HIGH CONCERN IN PIF'S TRINATIONAL VISION AND HIGH THREAT BY IUCN						
CR	Trochilinae	<i>Lophornis</i>	<i>brachylophus</i>	Short-crested Coquette	MX	MX
EN	Trochilinae	<i>Eupherusa</i>	<i>cyanophrys</i>	Blue-capped Hummingbird	MX	MX
VU	Trochilinae	<i>Eupherusa</i>	<i>poliocerca</i>	White-tailed Hummingbird	MX	MX
VU	Trochilinae	<i>Thalurania</i>	<i>ridgwayi</i>	Mexican Woodnymph	MX	MX
NT	Trochilinae	<i>Doricha</i>	<i>eliza</i>	Mexican Sheartail	MX	MX
NT*	Trochilinae	<i>Campylopterus</i>	<i>excellens</i>	Long-tailed Sabrewing	MX	MX
	Trochilinae	<i>Abeillia</i>	<i>abeillei</i>	Emerald-chinned Hummingbird	MX	MX
	Trochilinae	<i>Atthis</i>	<i>elliotti</i>	Wine-throated Hummingbird	MX	MX
	Trochilinae	<i>Lamprolaima</i>	<i>rhami</i>	Garnet-throated Hummingbird	MX	MX
HUMMINGBIRD SPECIES SHARED BY CANADA, USA, AND MEXICO						
Common Birds in Steep Decline in PIF's Trinational Vision						
	Trochilinae	<i>Selasphorus</i>	<i>rufus</i>	Rufous Hummingbird	US,CA	MX,US
Other shared Hummingbird species						
	Trochilinae	<i>Archilochus</i>	<i>alexandri</i>	Black-chinned Hummingbird	US,CA	MX,US
	Trochilinae	<i>Archilochus</i>	<i>colubris</i>	Ruby-throated Hummingbird	US,CA	MXS
	Trochilinae	<i>Calypte</i>	<i>anna</i>	Anna's Hummingbird	US,CA	US,MX
	Trochilinae	<i>Stellula</i>	<i>calliope</i>	Calliope Hummingbird	US,CA	MX
HUMMINGBIRDS SHARED BY USA and MEXICO						
	Trochilinae	<i>Selasphorus</i>	<i>platycercus</i>	Broad-tailed Hummingbird	US,MX	MX
	Trochilinae	<i>Selasphorus</i>	<i>sasin</i>	Allen's Hummingbird	US	US,MX
	Trochilinae	<i>Calypte</i>	<i>costae</i>	Costa's Hummingbird	US	US,MX
	Trochilinae	<i>Amazilia</i>	<i>beryllina</i>	Berylline Hummingbird	MXS,US	MXS
	Trochilinae	<i>Amazilia</i>	<i>violiceps</i>	Violet-crowned Hummingbird	MX,US	MX
	Trochilinae	<i>Calothorax</i>	<i>lucifer</i>	Lucifer Hummingbird	MX,US	MX
	Trochilinae	<i>Cynanthus</i>	<i>latirostris</i>	Broad-billed Hummingbird	MX,US	MX
	Trochilinae	<i>Eugenes</i>	<i>fulgens</i>	Magnificent Hummingbird	MXS,US	MXS
	Trochilinae	<i>Hylocharis</i>	<i>leucotis</i>	White-eared Hummingbird	MX,US	MX
	Trochilinae	<i>Lampornis</i>	<i>clemenciae</i>	Blue-throated Hummingbird	MX,US	MX
	Trochilinae	<i>Heliomaster</i>	<i>constantii</i>	Plain-capped Starthroat	MX, US	MX
	Trochilinae	<i>Colibri</i>	<i>thalassinus</i>	Green Violet-ear	MX,US	MX

Trochilinae	<i>Amazilia</i>	<i>yucatanensis</i>	Buff-bellied Hummingbird	MX	MX,US
Trochilinae	<i>Anthracothorax</i>	<i>prevostii</i>	Green-breasted Mango	MX	MX,US

HUMMINGBIRD SPECIES ENDEMIC TO MEXICO

Trochilinae	<i>Amazilia</i>	<i>viridifrons</i>	Green-fronted Hummingbird
Trochilinae	<i>Atthis</i>	<i>heloisa</i>	Bumblebee Hummingbird
Trochilinae	<i>Calothorax</i>	<i>pulcher</i>	Beautiful Hummingbird
Trochilinae	<i>Campylopterus</i>	<i>curvipennis</i>	Wedge-tailed Sabrewing
Trochilinae	<i>Chlorostilbon</i>	<i>auriceps</i>	Golden-crowned Emerald
Trochilinae	<i>Chlorostilbon</i>	<i>canivetii</i>	Canivet's Emerald
Trochilinae	<i>Chlorostilbon</i>	<i>forficatus</i>	Cozumel Emerald
Trochilinae	<i>Cynanthus</i>	<i>sordidus</i>	Dusky Hummingbird
Trochilinae	<i>Eupherusa</i>	<i>eximia</i>	Stripe-tailed Hummingbird
Trochilinae	<i>Hylocharis</i>	<i>xantusii</i>	Xantus's Hummingbird
Phaethornithinae	<i>Phaethornis</i>	<i>striigularis</i>	Stripe-throated Hermit

HUMMINGBIRD SPECIES IN MEXICO AND FURTHER SOUTH

Trochilinae	<i>Amazilia</i>	<i>candida</i>	White-bellied Emerald
Trochilinae	<i>Amazilia</i>	<i>cyanocephala</i>	Azure-crowned Hummingbird
Trochilinae	<i>Amazilia</i>	<i>cyanura</i>	Blue-tailed Hummingbird
Trochilinae	<i>Amazilia</i>	<i>rutila</i>	Cinnamon Hummingbird
Trochilinae	<i>Amazilia</i>	<i>tzacatl</i>	Rufous-tailed Hummingbird
Trochilinae	<i>Campylopterus</i>	<i>hemileucurus</i>	Violet Sabrewing
Trochilinae	<i>Campylopterus</i>	<i>rufus</i>	Rufous Sabrewing
Trochilinae	<i>Doricha</i>	<i>enicura</i>	Slender Sheartail
Trochilinae	<i>Florisuga</i>	<i>mellivora</i>	White-necked Jacobin
Trochilinae	<i>Helimaster</i>	<i>longirostris</i>	Long-billed Starthroat
Trochilinae	<i>Heliothryx</i>	<i>barroti</i>	Purple-crowned Fairy
Trochilinae	<i>Hylocharis</i>	<i>eliciae</i>	Blue-throated Goldentail
Trochilinae	<i>Lampornis</i>	<i>amethystinus</i>	Amethyst-throated Hummingbird
Trochilinae	<i>Lampornis</i>	<i>viridipallens</i>	Green-throated Mountain-gem
Trochilinae	<i>Lophornis</i>	<i>helenae</i>	Black-crested Coquette
Trochilinae	<i>Phaeochroa</i>	<i>cuvierii</i>	Scaly-breasted Hummingbird
Phaethornithinae	<i>Phaethornis</i>	<i>longirostris</i>	Long-billed Hermit
Trochilinae	<i>Tilmatura</i>	<i>dupontii</i>	Sparkling-tailed Hummingbird