Spatial Planning for Protected Areas in Response to Climate Change (SPARC)

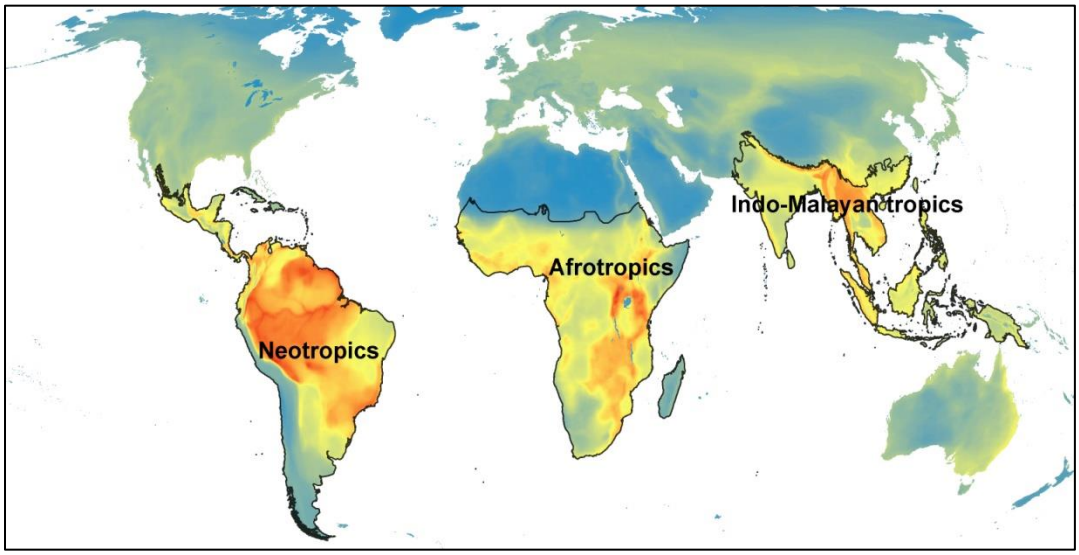
CI-GEF and Conservation International

PROJECT SUMMARY

Protected areas are the centerpiece of place-based conservation. The Convention on Biological Diversity (CBD) has supported protected areas as a conservation tool since its inception and has reaffirmed this commitment through the expansion of the global conservation estate under the Aichi targets 11. The GEF-recipient countries, GEF agencies, and co-financing partners are among the largest investors in protected area creation and management. However, these investments and their successful application are placed at risk by climate change.

The location of species' ranges will shift due to climate change as species track their unique climatic tolerances. These movements will cross protected area and national boundaries. As species shift, ecosystems will fragment, adjust and re-assemble, affecting habitat coverage and spatial representation across protected areas.

SPARC will increase the effectiveness of national protected area networks in the face of climate change by providing information on the movement of key species that reserve networks seek to conserve. This regional perspective is critical for efficient planning and management of protected areas, as it provides the basis for understanding what national actions can be taken independently, and what actions are contingent on the actions of neighboring countries.



SPARC Project Domain - Three tropical bio-geographic realms (Neotropics; Afrotropics; Indo-Malayan tropics) Blue-Red color ramp shows richness of bird species (red=high; blue=low) [www.biodiversitymapping.org]

SPARC brings a big data approach to this problem, modeling tens of thousands of species and using multiple climate change models and datasets. In doing so, the project will construct scenarios of change in the three highest diversity continental tropical regions (Neotropics, Afrotropics, Indo-Malayan tropics) to better understand threats from climate change and opportunities for adaptation of terrestrial protected area networks.

SPARC will be implemented over the course of three years (Feb 1, 2016 – January 31, 2019) and will consist of three distinct phases: 1) global data compilation and methods evaluation; 2) detailed analysis of climate change impact on species and ecosystems as it pertains to protected areas conducted by top scientists in each region; 3) synthesis and communication of findings to protected areas managers and key stakeholder groups in each region. SPARC will apply state-of-the-science spatial planning tools to help identify candidate cross-border areas for new protection to respond to climate change, as well as zones in which species' movements and ecosystem changes will best be addressed by management of existing protected areas. By the end of the project, SPARC aims to provide comprehensive analysis and decision support for terrestrial protected areas planning in the face of climate change for the 83 countries that are within the three tropical realms.

SPARC project implementation is led by a core team from Conservation International consisting of a Principal Investigator (Dr. Lee Hannah), Managing Scientist (Patrick Roehrdanz), and Financial Manager (Vlasova Gonzalez). This core team will be advised by a Science Advisory Panel comprised of leading climate-impact and protected area planning scientists with representation from the selected geographies.

Three lead regional scientists will aid in the global data compilation and will be responsible for coordinating the detailed assessments in each region. The regional lead scientists for the SPARC project are: 1) Neoptropics -- Dr. Pablo Marquet (Catholic University of Chile); 2) Afrotropics – Dr. Guy Midgley (Stellenbosch University); 3) Indo-Malayan tropics – Dr. Richard Corlett (Xishuangbanna Tropical Botanical Gardens; Chinese Academy of Sciences). In addition, three representatives from international advisory institutions will assist with data compilation, methods selection and computational resources. International data advisors participating in SPARC are: 1) Dr. Jon Lovett (University of Leeds); 2) Dr. Brian Enquist (University of Arizona; BIEN); 3) Dr. Wendy Foden (Stellenbosch University; IUCN Species Survival Commission Climate Change Specialist Group).

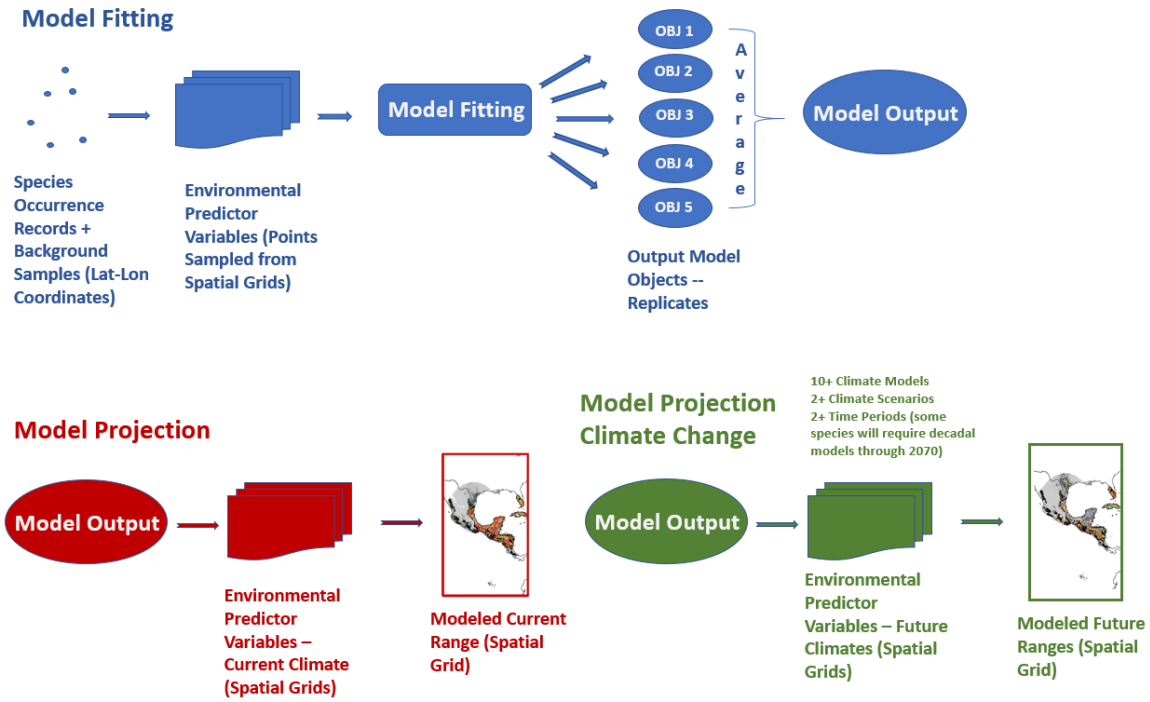
Project Timeline

Phase 1: Global data compilation and methods evaluation

The first phase of the project will be dedicated primarily to assembling the best available datasets in each region, recruiting an evaluating analytical methods to be used in common across all regions and developing analytical workflow and data management protocols. Datasets to be gathered include species occurrence records, expert verified species ranges, species traits and phylogeny, land cover, protected areas layers, climate surfaces, dynamic global vegetation model outputs and many others. Occurrence records for plant species are a particular focus for SPARC as plant species are underrepresented in other large scale species modeling and conservation planning efforts. SPARC has partnered with the Botanical Information and Ecology Network (BIEN) which has developed innovative techniques to produce a global database of plant occurrence records that have been taxonomically and geographically verified. SPARC aims to use the BIEN database as a foundation for species modeling efforts and will leverage the data infrastructure to recruit additional occurrence records that are not currently within the BIEN database to further improve geographic coverage.

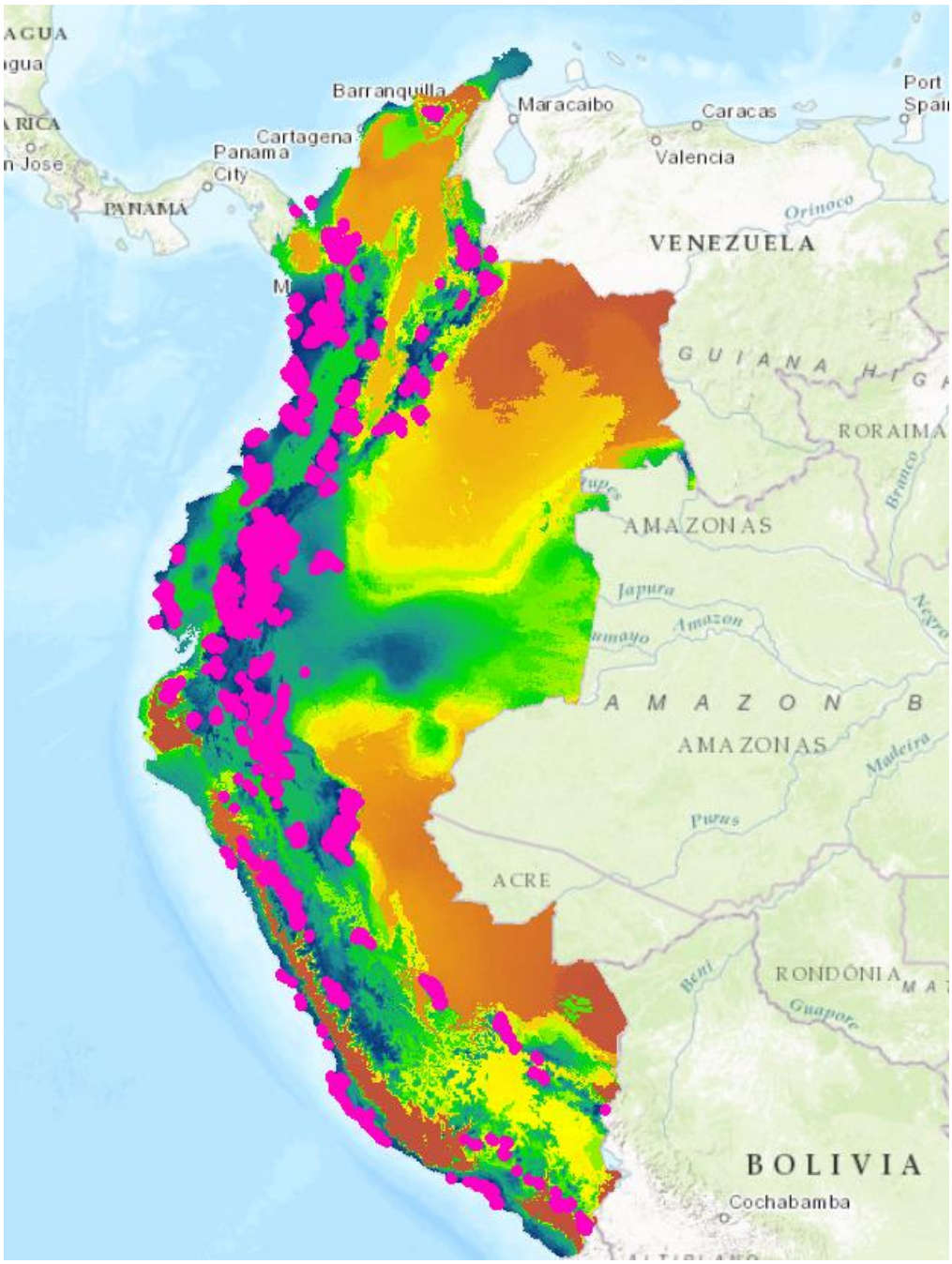
Analytical methods with respect modeled species and ecosystems responses to climate change as well as how to prioritize areas for effective conservation under climate change will also be evaluated in Phase 1. The comprehensive databases of species occurrences combined with information on species traits and

phylogeny opens the possibility for a massive modeling effort consisting of many thousands of species. SPARC aims to use innovative techniques that combine statistical models of species distribution (e.g. Maxent; GLM) with process-based models (e.g. DGVM; modified climates for CO_2 enrichment) to represent ecological processes that have been absent from other large-scale species modeling efforts.



Species distribution modeling workflow. SPARC intends to produce species range maps in current climates and under multiple scenarios of climate change for ~100,000 tropical plant and animal species. A database of high quality plant species observation records maintained by the BIEN network (www.biendata.org) will provide the informatics infrastructure necessary to effectively leverage the growing body of biological observation data.

To identify priority areas for conservation under climate change, SPARC will use two novel methods: 1) Conservation Prioritization using Network Flow (CPNF); 2) Marginal Benefit of Protection Index (MBPI). CPNF is an algorithm that optimizes protected areas through time for large numbers of species for a given set of conservation targets and land acquisition costs. A valuable aspect of CPNF is that conservation targets must be met at each modeled timestep and therefore captures the entire temporal trajectory of a suite of species responses to climate change. As an alternative to a prioritization based on species models, MBPI is a novel method that has been developed by CSIRO that makes use of their global generalized dissimilarity model. MBPI evaluates the benefit of adding each 1-km grid cell to the protected area portfolio under climate change. Grid cells that are the likely destination comparatively greater numbers of species and/or relatively rarer climates will receive greater weight in the index. SPARC is the first large scale implementation of MBPI and will provide distinct prioritization metrics for vascular plants, vertebrates and invertebrates. Widely used conservation planning tools such as Marxan and Zonation will also be used to provide a point of comparison to the novel methods described above.



Preliminary results of Conservation Prioritization using Network Flow for over 4,600 plant species in Colombia, Ecuador and Peru. Modeled species are those with greater than 10 and less than 20 unique occurrences within the three-country domain accessed from the BIEN database. Models were produced for all species in decadal timesteps 2000-2070 under an RCP8.5 projection of climate change. Areas in bright pink were selected as an optimal solution to expand existing protected areas to ensure 1,000km of protection for all species in every time step in this scenario of change. Red-blue color ramp is a complementary Zonation prioritization that uses the same species models as the network flow optimization where blue = higher priority; red=lower priority.

Phase 2: Regional Assessments

Detailed regional assessments will commence in the summer of 2017 and will bring the expertise of regional scientists to bear on an analysis of protected areas and climate change. Regional assessments will be conducted by the SPARC regional lead scientist and an assembled team of top scientists throughout each region. Regional assessments will begin with an inception meeting to launch the analysis and conclude with a synthesis meeting 8-10 months later.

Within each regional assessment, loss of species and ecosystem representation will be assessed for individual protected areas and opportunities to restore lost representation will be identified using methods consistent with the other regions. Although the entire region will be analyzed, each regional assessment will identify 2-3 multi-country focal areas that 1) are especially important for conservation under climate change based on region-wide analysis; 2) have scope for adding protected areas; 3) have ongoing or imminent real-world protected areas planning or implementation. Focal areas may be modeled at finer resolution, may use additional analytical methods and will be engaged early in the project in an effort to ensure maximum uptake of SPARC results in protected areas decision making.

Phase 3: Synthesis and Communication of Results (Research to Policy Briefs)

Following the regional analysis, SPARC will engage with stakeholders to create country and multi-country research briefs and action plans, enabling more effective and efficient planning processes informed by analyses of climate-induced changes in biodiversity, as well as changes in the major threats to biodiversity. Stakeholder groups will be directly embedded into project planning in each region and will take part in the translation of research briefs into action plans. Scientists as part of each regional assessment team will interact with a range of stakeholders drawn from GEF agencies, civil society, international organizations, government ministries and representatives of local communities that are directly affected by protected area management effectiveness.

Project outputs will be dynamic tools for visualizing and planning protected areas for climate change. System planners will see spatial plans that define areas in which new protection can maintain conservation targets even as climate changes. Protected areas managers will see management support tools that identify species likely to decline and areas in need of special management to cope with climate change. These SPARC contributions aim to support national protected areas systems that maximize representation of species and ecosystems as climate changes and hence bolster the resilience to climate change of tropical countries across the selected geographies.