Biodiversity Survey of the Cape (BioSCape)

Nominal NASA Field Campaign to Monitor the Dimensions of Biodiversity in a Mega-Diverse Region of Southern Africa

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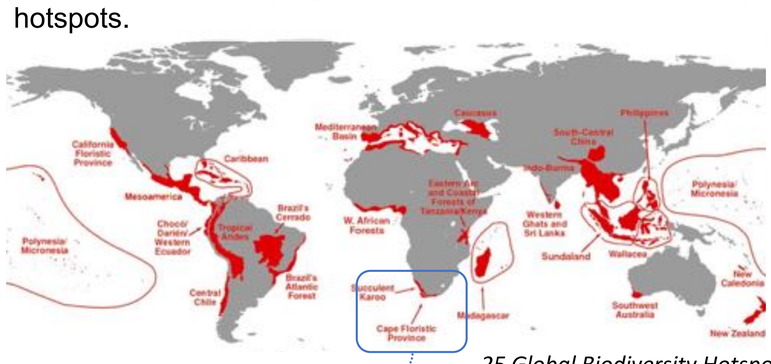
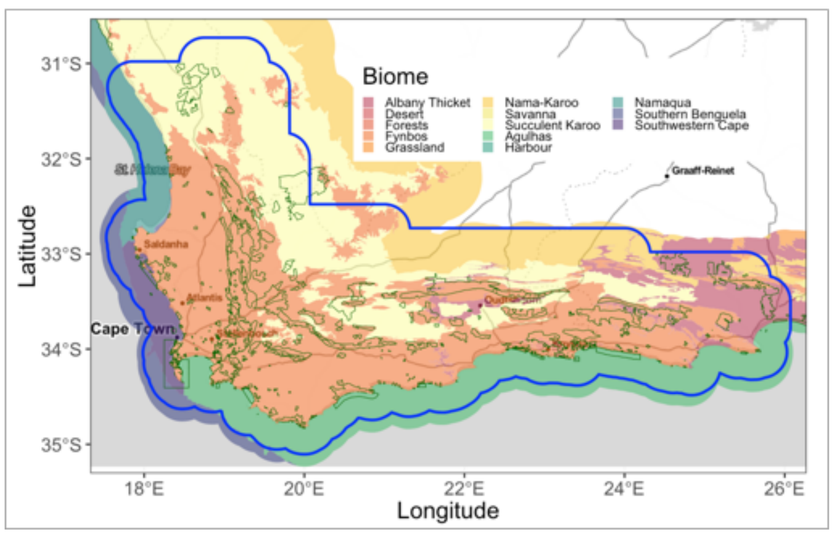
Introduction

The National Aeronautics and Space Administration (NASA) is planning to launch a new hyperspectral satellite to acquire near global hyperspectral reflectance data. In anticipation of this instrument, NASA supported the development of biodiversity field campaign scoping proposals to assess the potential utility of these data to monitor biodiversity around the planet. This project outlines plans for a field campaign in one of the world's biodiversity hotspots.



25 Global Biodiversity Hotspots (Myers et al., 2000)

Biodiversity Hotspot: Greater Cape Floristic Region (GCFR) of South Africa



The GCFR study domain (outlined in blue) contains or borders eight terrestrial biomes and five marine biomes. Green polygons represent protected areas.

The GCFR has a primarily Mediterranean climate dominated by semi-arid shrublands with species diversity rivaling mega-diverse tropical rainforests. The GCFR also contains one of the highest proportions of species of global conservation concern and nearly 78% of the plant species are endemic. It contains ≈11,500 species of flowering plants in over 1,000 genera and 178 families, with new species being discovered every year. Moreover, the region contains over 1,400 (≈ 16%) Red Data Book plant species, the highest known concentration of rare species in the world.

Science Framework

The primary objective for the proposed field campaign is to understand the structure, function, and composition of the region's ecosystems, and learn about how and why are they changing in time and space.

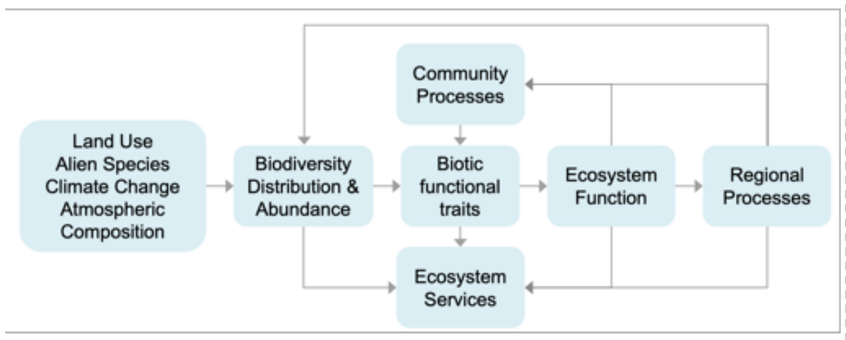
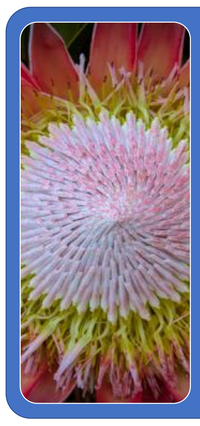


Diagram illustrating the processes to be examined in the field campaign. Figure adapted from Slingsby, et. al (2014).

Central Questions

The campaign is organized around three major themes (and several underlying objectives): 1) the distribution and abundance of biodiversity, 2) the role of biodiversity in ecosystem function, and 3) the impacts of biodiversity change on ecosystem services. Or, in other words, *where is biodiversity, what is it doing, and why does it matter*?



Distribution and Abundance of Biodiversity

1. **What is the current geographic distribution of target populations / species?**
   a) Quantify the current distribution and abundance of indicator species (native and invasive).
2. **What is the current distribution of communities / ecosystems?**
   a) Quantify the current distribution and state (e.g. extent and fragmentation) of ecosystems and biomes.
   b) Quantify the current distribution of community-level taxonomic, phylogenetic, and functional diversity (α, β, γ)

Biodiversity and Ecosystem Function

3. **What is the relationship between biodiversity and ecosystem resilience?**
   a) Identify feedbacks between the phylogenetic, taxonomic, and functional biodiversity of communities and ecosystem resilience.
   b) Quantify how biodiversity regulates nitrogen, hydrologic, and carbon-cycles; particularly in the context of change in the disturbance regime.
4. **How does changing biodiversity (including the introduction of invasive species) affect community-level structure and function?**
   a) Quantify how invasive species affect community-level taxonomic, phylogenetic, and functional diversity (α, β, γ)
   b) Quantify the impact of terrestrial invasive species on disturbance regimes in terrestrial ecosystems.

Biodiversity and Ecosystem Services

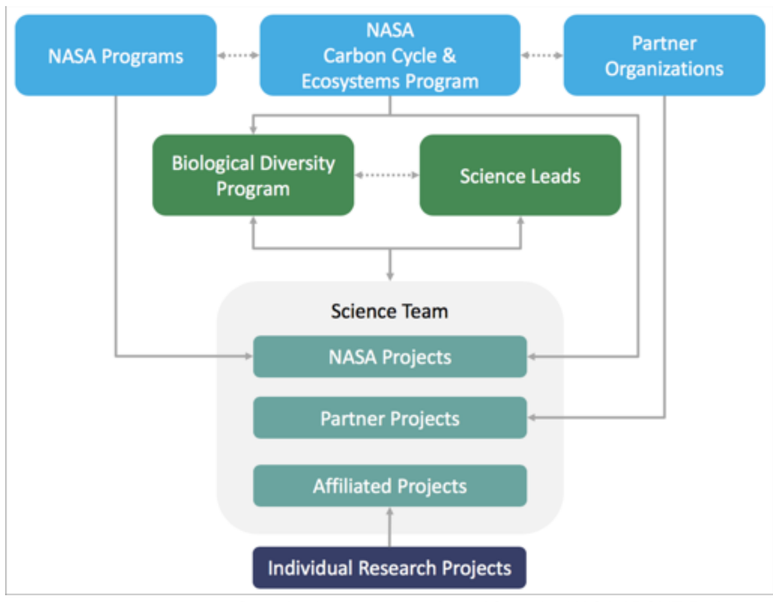
5. **What are the feedbacks between biodiversity and ecosystem services?**
   a) Quantify the impacts of community composition (and invasive species in particular) on freshwater supply.
   b) Quantify the role of marine biodiversity (and kelp beds in particular) and estuaries in regional fisheries.
6. **What are the feedbacks between biodiversity and natural and cultural resources, human health, and infrastructure?**
   a) Quantify how changing biodiversity could impact natural and cultural resources, human health, and human infrastructure

Tools & Approach

The campaign centers around the collection of new hyperspectral imagery from AVIRIS-NG, PRISM, and HyTES spectrometers combined with the LVIS laser altimeter to be carried aboard the ER-2 research aircraft. These data will be collected at ≈20m spatial resolution across much of the GCFR including aquatic and marine ecosystems. These data will be combined with existing and new observations of the spatial distribution of community composition and functional traits to enable high resolution mapping and modeling of several Essential Biodiversity Variables (EBVs) including species distributions, functional traits (e.g. leaf properties), and three-dimensional canopy structure.

Project Organization & Management

The organizational chart below illustrates the relationship between NASA and the project science leads, project science team, and other organizations.



Organization structure adapted from the NASA ABOVE Project

Summary

The GCFR is an ideal region to evaluate the capabilities of remote-sensing technology to characterize biodiversity patterns across diverse landscapes due to three important characteristics:

1. extraordinary biodiversity across multiple biomes in a compact geographic area
2. steep environmental gradients provide natural experiments
3. wealth of existing independent *in situ* data

In combination with the rich historical data and well-developed ecological understanding in this region, these new observations will enable detailed exploration into the drivers and mechanisms of change across the region including the feedbacks from changing biodiversity to regional climate, disturbance, post-fire recovery, freshwater provisioning, and other ecosystem services.

Aerial view of the Waterval Nature Reserve in the GFCR.

Contact

Please visit the link below if you would like to learn more, provide feedback, or get involved.

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References

Myers, et al. (2000) Biodiversity hotspots for conservation priorities. *Nature* 403:853–858
Slingsby, et al. (2014). The assembly and function of Cape plant communities in a changing world. In *Fynbos: Ecology, Evolution and Conservation in a Megadiverse Region*. Oxford University Press, Oxford.

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