*Update on 6/9/2017: an initial proposal for a UA EGI from 2014. This received funding from WEES, and helped lead to STC effort and approval of the EG cluster hire (*[*http://egi.arizona.edu/*](http://egi.arizona.edu/)*).*

*Our new EG Cluster might develop an updated version of this for presenting to Deans and VPR*

**A case for an *Ecosystem Genomics Institute* at UA**

**Virginia Rich (SWES), Scott Saleska (EEB/SWES), Matthew Sullivan (EEB/MCB), May 5, 2014**

***What is Ecosystem Genomics?*** ‘Ecosystem Genomics’ is both a new scientific discipline and a nexus for coalescing UA strengths in environmental science, microbial ecology, genome-enabled science, and “big data” cyberinfrastucture to address the grand challenge of scaling biological information from genes to ecosystems, simultaneously advancing theory and practical solutions to problems ranging from global climate change to human health. As a science, ecosystem genomics integrates the theory and tools of *ecosystem ecology* with those of *meta-omics* approaches to open a new window on mechanisms that regulate scaling of micro- to macroscale processes. It seeks to advance predictive understandings of how biological information networks regulate natural and human ecosystem responses to change.

A UA Ecosystem Genomics Institute (EGI) would form a nucleus to advance the four *Never Settle* Strategic Priorities. The EGI would facilitate novel synergy, innovation, and new partnerships, attracting resources to support this cutting-edge area for engagement.

***What sort of science and technology is envisioned?*** The recent iBiosphere white paper (April 2012), envisioned a grand opportunity in ‘Ecosystem Genomics’. We propose an Ecosystem Genomics Institute to help realize the key iBiosphere goal to “Discover the emergent properties and processes of ecosystems through 'top down' analysis of communities, populations and organisms, and 'bottom up' analysis of genomes, transcriptomes and metabolomes. “ It is now possible to characterize the genes, transcripts, proteins and metabolites of a community (a recent and big advance!), but understanding and making predictions across levels of organization ranging from the gene to the ecosystem requires a unified framework within which hierarchical investigations could be networked to reveal cross-scale connectivity and ultimately ecosystem function. In this vision, “ecosystem function” ranges from carbon cycle response to climate change in globally critical biomes, to human microbiome response to disease. These ideas coalesce with new UA strategic goals at the departmental (e.g., the proposed EEB/MCB/ CBC/ CS cluster hire), as well as the university level (Biosphere 2 and iPlant Cyberinfrastructure). Some examples of ecosystem genomics, some of which are currently underway, include:

1. ***Global Change Ecogenomics***, pioneering the study of the integrated roles of microbial and viral ecology in global climate. This example poses such questions as:
   1. ***Can we better predict the carbon-cycle feedback to climate from thawing permafrost***, if we use genomic tools to include microbial community ecology in coupled carbon-climate models? (piloted by two Saleska/Rich DOE grants totaling $6.8M; recent papers in *Nature Communications*, *PNAS*, and in review at *Nature*).
   2. ***How do vegetation-microbial community interactions structure functional ecosystem response to landscape scale changes?***  (Biosphere 2’s LEO provides ideal opportunities for experimental investigation integrating plant ecology, hydrology, and microbial metagenomics)
2. ***Viral Ecosystem science,*** pioneering the study of viruses in cellular ‘ecosystems’ and in macroscale biomes, from terrestrial hillslopes to marine waters. A key question is:

**Are there viral species?** -- and if so, will that enable a new science of population ecology and evolution of viral communities that enhances predictive understanding of viral roles across diverse ecosystems ranging from thawing permafrosts and oceans to humans and industrial fermenters? (piloted by 3 Sullivan Moore Foundation awards totaling $6M; recent papers in *Nature, PNAS,* andin review at *Science*)

1. ***The science of microbe-virus-host interactions in the ecosystem of the human body*** – advancing the study of the interactions that define human health and disease. A key question:

Is ‘Phage therapy’ a new alternative to the antibiotic treatment of microbial diseases? (piloted by Sullivan seed funding from ABOR and Flinn Foundation totaling ~$300K)

***What is being proposed for UA?*** We propose a 5-year initiative to incubate an Ecosystem Genomics Institute to create a new axis of UA excellence in ‘genes-to-ecosystems’ science, at the leading edge of emerging and generous funding and training opportunities. This initiative begins with:

* Seed-funding (proposed here to WEES: about $160K per year for an initial period of 5 years to support the initial science (via a staff bioinfomatician and graduate student) and program coordination (program coordinator/administrative associate) to support seeking funding to support broader EGI activities. Seed funding would enable development of training and center-level proposals, organizational structure, and broader visibility and inclusivity.

Other key components of this 5-year initiative (aside from seed funding from WEES) would include:

* Creation of a central shared laboratory and meeting space (in year 1) to nucleate the EGI effort and foster cross-disciplinary interactions. In our experience, shared space is key to effective integration and innovation across the disparate disciplines of ecosystem science and genomics (initially this space would house the combined laboratories of Sullivan, Rich, and Saleska); it would serve as a core space for integrating with a broader network of collaborating researchers.
* Creation of a Graduate Interdisciplinary Program (GIDP) (starting in year 1) in Ecosystem Genomics would prepare UA students with intellectual grounding to integrate disparate fields of ecosystem sciences and genomics necessary to contribute new science to this emerging field.
* Four Strategic faculty hires (over the next two years), in four critical areas (CV’s for ‘search image’ leading researchers in each of these four areas are attached):
  + Natural/global change ecosystem sciences (who can link to microbial genomics)
  + The human ecosystem (and associated microbial/viral genomics)
  + Proteomics technology/engineering.
  + Genomically-enabled ecosystem modeling (mid-career candidates)
* An energetic agenda for pursuing grants (years 1 through 5). We would seek high-dollar grants from federal and private sponsors. On the immediate horizon are:
  + A new NSF ‘Partnership in International Research and Education’ (PIRE) proposal for graduate education and training. This would build on Saleska’s previous highly successful Amazon-PIRE (anticipated title: “Scale and sustainability: Linking genes, ecosystems, and societies to carbon cycle processes and global change in Amazônia”)
  + A new UA-led NSF-funded Science and Technology Center (STC) in Ecosystem Genomics (see attached pre-proposal currently at UA VPR’s office, under consideration to be one of UA’s 3 STC submissions; organization of this STC pre-proposal and recruitment of proposed Center co-directors Monson and Wing was spearheaded by Saleska and Sullivan).

A UA-supported EGI would demonstrate the kind of strong institutional commitment sought by NSF in these large proposals, significantly contributing to likelihood of funding success.

***Who is involved, and why?*** The initial stage is led by three core faculty already successful in attracting large-dollar ‘genes-to-ecosystems’ funding: Scott Saleska (EEB/SWES), Matthew Sullivan (EEB/MCB), Virginia Rich (SWES/EEB/MCB). Their recent grants (cumulatively ~$13M) include awards to Sullivan (DOE EMSL grant to assess how genes, transcripts, proteins and metabolites vary in viral-host model systems, and Moore Foundation Investigator Award to enable technologies that ‘see’ viruses in nature), and to Saleska and Rich (DOE Systems Biology-Carbon Cycling project, with Co-PIs from 6 institutions) that represent the projects envisioned for an ‘Ecosystem Genomics Institute’. These grants provide initial person-power and shared, *funded* interests to develop the interdisciplinary synergy needed for this new brand of science

We envision rapid nucleation of a broad research collaborative drawing from UA faculty with expertise in genomics, theoretical ecology, ecohydrology, and ecosystem sciences generally (see par­tici­pants in the proposed NSF Science and Technology Center at UA in Ecosystem Genomics, attached).

***How does UA benefit from an Ecosystem Genomics Institute?***

* funding opportunities are diverse and generous including government and private foundations.
* The science is inclusive and embraces strengths across campus (from Biosphere 2 to iMicrobe).
* **“**BIG DATA” needsinterface with flagship NSF programs ($434M NEON), and UA-led iPlant Collaborative (uniting initiatives in Health Informatics, iPlant and microbiology via iMicrobe).
* Significant opportunities exist for technological innovation, long an embraced strength at UA.
* Already at the fore-front of this emerging science, UA could be *the* global leader in this area.