CYBERINFRASTRUCTURE, **THE BEHIND-THE-SCENES CAPACITY** THAT ENABLES NEW SCIENCE

Scientists working in environmental areas increasingly work in collaborative teams that span disciplines, with complex and ever larger data sources. Datasets are now continuously streamed from remote sources, ranging from small sensors deployed across field sites to satellite and airborne sensing platforms. At smaller and smaller scales, advances in microbiology and genetics have similarly created extraordinary new data challenges. Finding solutions and opportunities from complex environmental challenges requires systems approaches and large computational data analyses and visualizations that increasingly seek to bring together both biophysical and human data.

The Montana Institute on Ecosystems is building capacity to help scientists work together and address these growing big data challenges. These activities are framed as cyberinfrastructure, the combination of storage, communication, and computational technologies and technical and domain science experts who address these big data needs. Clearly the challenges of big data are beyond the resources of any one program or organization, and the IoE is working to make strategic advances and build cyberinfrastructure partnerships to enable new science.

The IoE's cyberinfrastructure includes tools to help researchers work together as virtual teams, particularly across a large and sparsely populated state like Montana. Video conferencing, file sharing, and even social media are now standard tools used by scientists and students, and the IoE wants to ensure good connectivity among its researchers. Websites no longer simply provide a digital brochure; they are interactive and provide access to underlying databases and resources.

At the heart of cyberinfrastructure and big data, however, are technologies that collect and manage data. The IoE has developed the Virtual Observatory and Ecological Informatics System (VOEIS) that automatically collects and stores data from remote environmental sensors in Flathead Lake, the Big Sky area, and other sites across the state. These data are then packaged and streamed to national data repositories. Partnerships with the University of Kentucky enable new visualization methods for VOEIS data. The IoE will continue to build upon the VOEIS framework to advance new partnerships, ranging from working with other states on similar challenges to engaging libraries that are transitioning to new roles on university campuses.

Providing a user-friendly resource for discovering and accessing science data is another goal for the IoE. IoE faculty affiliates **Geoff Poole** (MSU Land Resources and Environmental Sciences and **Clem Izurieta** (MSU Computer Science) are working with the Museum of the Rockies to utilize its planetarium to help people visualize water movement through complex river systems. The IoE is working to develop a web-based science gateway that will serve as a discovery portal to IoE data. In partnership with teams from Alaska, this data portal will ensure interoperable systems that support emerging science partnership projects as part of the NSF EPSCoR program.

These cyberinfrastructure efforts are part of a solution to a long-term need, one that will be addressed by advancing strategic opportunities and through new structures to help Montana's higher education programs work together. A new statewide cyberinfrastructure committee was established to provide strategic feedback to the IoE, foster information sharing, and identify and pursue new opportunities. Most of these efforts will occur in the background, but the result will enable Montana researchers to advance science that supports Montana's future.