

# The RECOVER Post-fire Planning Project

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# This morning's agenda

## Introductions

## Overview of the RECOVER Project

- Vision and goals

## Technical Demonstration of the Prototype RECOVER Decision Support System (DSS)

- Cloud-based RECOVER server and client web map application

## RECOVER hands-on Scenario-of-Use

- Applications for fire rehabilitation efforts
- Reaction to the RECOVER DSS

## Next Steps

- Final Stage 1 fire season assessment, Stage 2 operationalization proposal planning

## Discussion

# Overview

- RECOVER = Rehabilitation Capability Convergence for Ecosystem Recovery
- Decision Support System (DSS)
  - Support for:
    - USDO I BLM fire managers and BAER teams
    - Idaho Dept. of Lands (IDL) fire management



## Objectives

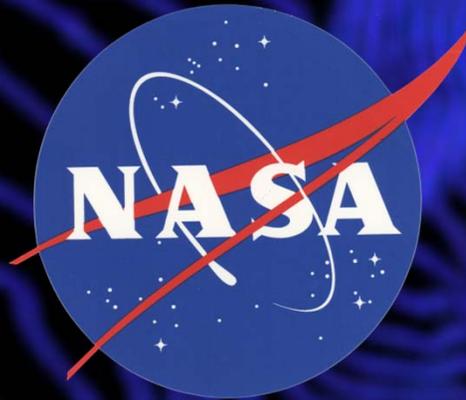
**Objective** In partnership with the Department of Interior's Bureau of Land Management (BLM) and Idaho Department of Lands (IDL), we will build and evaluate a prototype RECOVER decision support system. RECOVER will be an automatically deployable, site-specific multi-criteria decision aid that brings together in a single application the information necessary for Burned Area Emergency Response (BAER) teams to plan reseeding strategies and monitor ecosystem recovery in the aftermath of savanna wildfires.

RECOVER will use state-of-the-art cloud-based data management technologies to improve performance, reduce cost, and provide site-specific flexibility for each fire. Customized RECOVER instances will be automatically deployed in the Amazon EC2 Cloud when a fire is detected. RECOVER's decision products will be dynamically assembled from an existing network of data resources. RECOVER will automatically generate and refresh derived fire severity, fire intensity, and other products throughout the burn so that when the fire is contained, BAER teams will have at hand a complete and ready-to-use RECOVER system customized for the target wildfire. Since BAER remediation plans must be completed within 14 days of a wildfire's containment, RECOVER has the potential to significantly improve the decision-making process.

# Goals

- To improve landscape rehabilitation following wildfire by improving the decision *process*
  - More/better data...data all in one place →
  - More/better information →
  - Better informed decisions

# Acknowledgements



- Operational End-User Partners



# RECOVER

## Rehabilitation Capability Convergence for Ecosystem Recovery

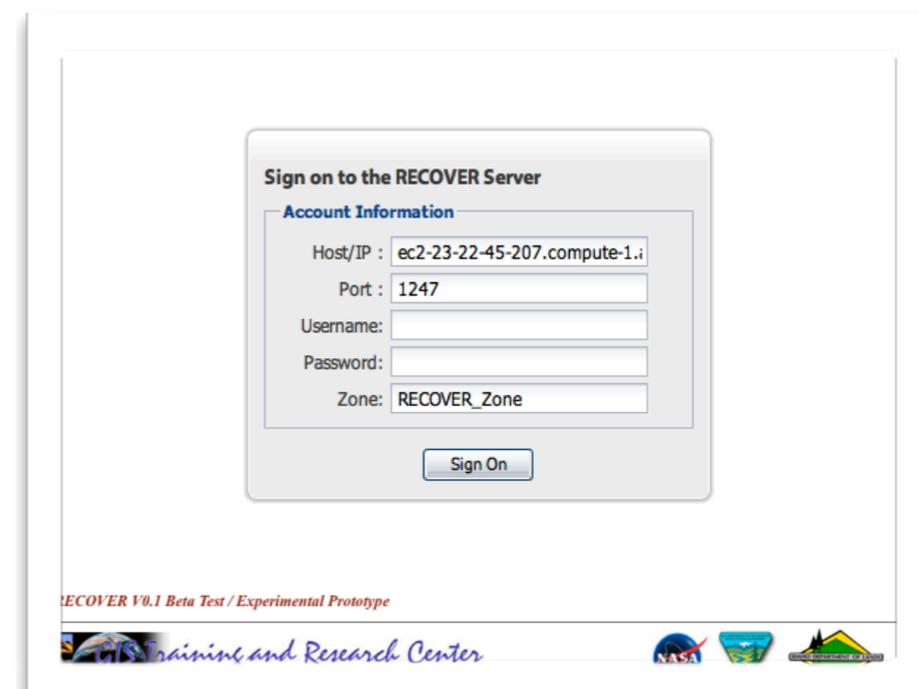
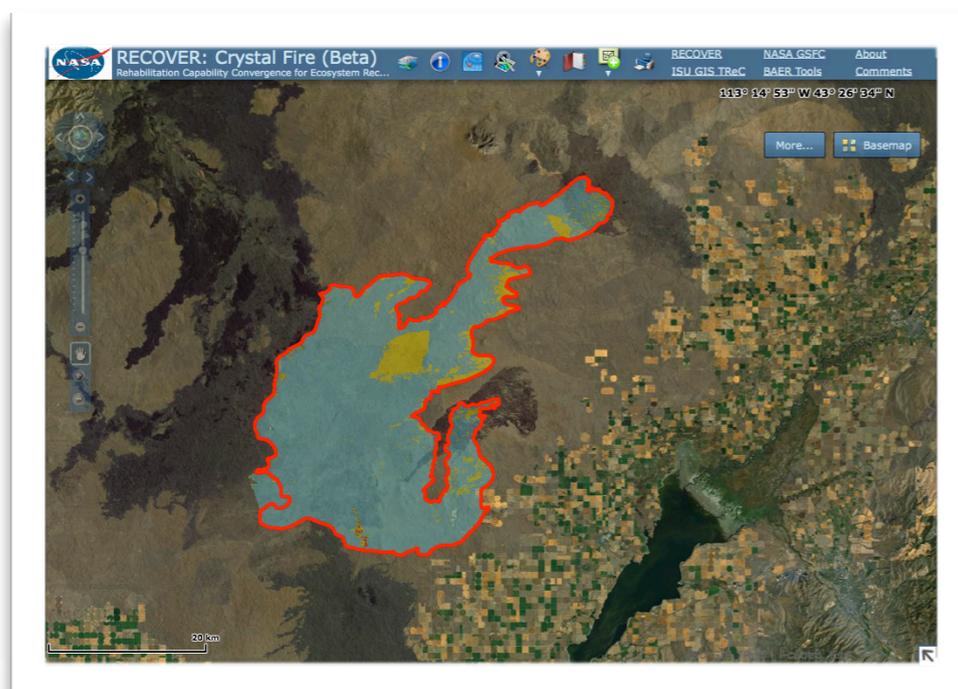
A NASA/DOI National Wildland Fires Applied Sciences Project

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# The RECOVER Project

- Goal is to build an automated (or technology-enabled) decision support system for post-fire rehabilitation planning.
- Focus is on savanna ecosystems of the Western US.
- Funded by NASA's Applied Sciences Program.
- Outgrowth of NASA-sponsored research on post-fire assessment and monitoring and decision support application development.
- Interagency Collaboration:
  - Idaho State University's GIS Training and Research Center (GIS TReC)
  - NASA Goddard Space Flight Center (GSFC)
  - DOI Bureau of Land Management (BLM)
  - Idaho Department of Lands (IDL).
- Stage 1 - Feasibility Study.
- Stage 2 - Operational Deployment.

Rangeland Ecol Manage 65:468-474 | September 2012 | DOI: 10.2111/REM-D-11-00156.1

## Assessing the Success of Postfire Reseeding in Semiarid Rangelands Using Terra MODIS

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### Abstract

Successful postfire reseeding efforts can aid rangeland ecosystem recovery by rapidly establishing a desired plant community and thereby reducing the likelihood of infestation by invasive plants. Although the success of postfire remediation is critical, few efforts have been made to leverage existing geospatial technologies to assess reseeding success following a fire. In this study, Terra Moderate Resolution Imaging Spectroradiometer (MODIS) satellite data were used to improve the capacity to assess postfire reseeding rehabilitation efforts, with particular emphasis on the semiarid rangelands of Idaho. Analysis of MODIS data demonstrated a positive effect of reseeding on rangeland ecosystem recovery, as well as differences in vegetation between reseeded areas and burned areas where no reseeding had occurred ( $P < 0.05$ ). We conclude that MODIS provides useful data to assess the success of postfire reseeding.

### Resumen

Esfuerzos exitosos de resiembra post-fuego pueden ayudar a los ecosistemas de pastizales a regenerarse rápidamente, estableciendo una comunidad deseable de plantas y reduciendo la probabilidad de infestación de plantas invasivas. Mientras el éxito del mejoramiento post-fuego es crucial, pocos esfuerzos se han hecho para aprovechar las tecnologías geospaciales existentes para desarrollar metodologías encaminadas a medir el éxito en la resiembra después de la presencia de fuego. En este estudio, información de satélite Terra Moderate Resolution Imaging Spectroradiometer (MODIS) se usó para mejorar la capacidad de determinar los trabajos de rehabilitación post-fuego, con un particular énfasis en los pastizales semiáridos de Idaho. Análisis de información de MODIS demostraron un efecto positivo de resiembra en la recuperación del ecosistema de pastizales así como en diferencias en vegetación entre áreas resembradas ( $P < 0.05$ ). Se concluyó que MODIS provee información útil para determinar el éxito de la resiembra post-fuego.

**Key Words:** fPAR, Idaho, rehabilitation, remote sensing, wildfire

### INTRODUCTION

Wildfire is a common hazard in the semiarid rangelands of southeast Idaho. Following wildfire, ground vegetation typically is changed and can leave the landscape devoid of vegetative cover. These communities frequently undergo a series of adverse ecological changes, such as soil erosion, invasion by introduced annual grasses (e.g., cheatgrass [*Bromus tectorum*] and Medusahead [*Taeniatherum caput-medusae*]), and long-term native species decline (Pierson et al. 2002; Hilty et al. 2004). Rehabilitation is often necessary after fire, particularly in areas with high variation of the terrain. Monitoring how ecological systems respond to rehabilitation efforts is a critical step for determining long-term sustainability of the communities affected and for planning future land management practices.

Over the years, increasing resources have been devoted to fire rehabilitation efforts through various federal agencies such as the US Department of Agriculture (USDA), Forest Service

This study was made possible by grants from the National Aeronautics and Space Administration Idaho Space Grant Consortium (subaward: FFK10D-SB-004) and the National Aeronautics and Space Administration Goddard Space Flight Center (N0008A9D9G).

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Manuscript received 24 August 2011; manuscript accepted 29 May 2012.

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International Journal of Wildland Fire 2011, 20, 468-474 www.publish.csiro.au/ijwf

## Assessing the susceptibility of semiarid rangelands to wildfires using Terra MODIS and Landsat Thematic Mapper data

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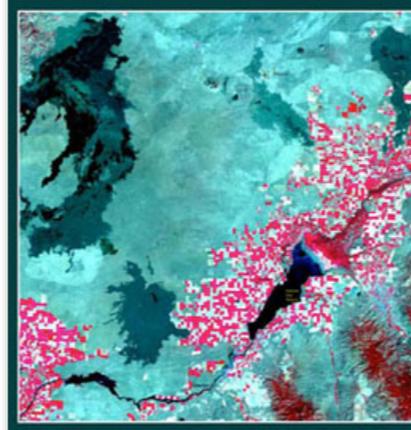
<sup>1</sup>GIS Training and Research Center, Idaho State University, 921 S 8th Avenue, Stop 8104, Pocatello, ID 83209-8104, USA, <sup>2</sup>Corresponding author. Email address: chenfang@isu.edu

**Abstract.** In order to monitor wildfires at broad spatial scales and with frequent periodicity, satellite remote sensing techniques have been used in many studies. Rangeland susceptibility to wildfires closely relates to accumulated fuel load. The normalized difference vegetation index (NDVI) and fraction of photosynthetically active radiation (fPAR) are key variables used by many ecological models to estimate biomass and vegetation productivity. Subsequently, both NDVI and fPAR data have become an indirect means of deriving fuel load information. For these reasons, NDVI and fPAR, derived from the Moderate Resolution Imaging Spectroradiometer on-board Terra and Landsat Thematic Mapper imagery, were used to represent prefire vegetation changes in fuel load preceding the Millennium and Crystal Fires of 2000 and 2006 in the rangelands of southeast Idaho respectively. NDVI and fPAR change maps were calculated between active growth and late-summer senescence periods and compared with precipitation, temperature, frorage biomass and percent ground cover data. The results indicate that NDVI and fPAR value changes 2 years before the fire were greater than those 1 year before fire as an abundance of grasses existed 2 years before each wildfire based on field frorage biomass sampling. NDVI and fPAR have direct implication for the assessment of prefire vegetation change. Therefore, rangeland susceptibility to wildfire may be estimated using NDVI and fPAR change analysis. Furthermore, fPAR change data may be included as an input source for early fire warning models, and may increase the accuracy and efficiency of fire and fuel load management in semiarid rangelands.

**Additional keywords:** biomass burning, fPAR, fuel loads, Idaho, NDVI, remote sensing.

**Introduction**  
Rangelands refer to extensive, mostly non-cultivated, non-irrigated and non-forested lands that include grasslands, savannas and shrublands where livestock grazing is a common land use. Rangelands cover ~40% of the Earth's terrestrial surface and play an important role in global ecosystem productivity (Herman and de Wit 1981; Huntington and Hopkins 1996). Wildfires are common in rangelands worldwide and have significant effects on rangeland ecosystem balance, with the most obvious effect being direct effect on vegetation communities (Muel 1970; Pierson et al. 2002; West and York 2004; Taylor 2005). In a wildfire fire, fuel is composed nearly entirely of vegetation and severe fires can leave entire landscapes devoid of vegetative cover, resulting in numerous significant climatic, ecological and hydrologic hazards (Pierson et al. 2002; Hilty et al. 2004; Collins et al. 2006). In addition, biomass burning is recognized as an important source of trace gases to the atmosphere, such as carbon dioxide, methane, carbon monoxide, nitrogen dioxide and non-ozone hydrocarbons (Czerny et al. 1979; Greenberg et al. 1984). These trace gas compounds may trap the heat radiated by the earth and contribute to the greenhouse effect (e.g. average annual CO<sub>2</sub> emissions from fires in the lower 48 states of USA were ~213 Tg CO<sub>2</sub> year<sup>-1</sup> from 2002 to 2006) (Houghton 1992; Wiedman and Neff 2007; EPA 2008). Furthermore, following a fire, vegetation communities may transition to a very different community type due to invasions by non-native species, resulting in a variety of propagated indirect effects (Thomas and Davis 1989; Hilty et al. 2004). Satellite remote sensing is an evolving technology providing regional and global imagery that has been used for many wildfire studies (Fernandez et al. 1997; Miller and Vool 2002; Wooster et al. 2003; Lentile et al. 2006; Weber et al. 2008a). These studies include both observational and modelled data and have been conducted on active fires and for detecting post-fire burn extent. For example, National Oceanic and Atmospheric Administration (NOAA) Advanced Very High Resolution Radiometer (AVHRR) imagery has been used to detect and map fire growth (Kennedy et al. 1994; Fernandez et al. 1997; Pielke et al. 1997; Siegel and Huffman 2000). MODIS (Moderate Resolution Imaging Spectroradiometer) imagery provides thermal anomalies and fire products to meet the requirements of understanding the timing and spatial distribution of fires at various regional and global scales (Wooster et al. 2003; Li et al. 2004; Miettinen et al. 2005). In addition, Landsat-5 Thematic Mapper (TM) and the Landsat-7 Enhanced Thematic Mapper Plus (ETM+) have been used to determine fire

## The Crystal Fire – Atomic City, Idaho



recovery project focused on better understanding the effects of fire along the wildland-urban interface (WUI), where certain human activities (e.g., prescribed fire and grazing) can negatively impact and potentially accelerate interrelated ecological changes. The objectives of these projects were to identify ways to prevent soil erosion, water loss, and the permanent impairment of ecosystems along the WUI (Gibbons 1995; Ercanoglu et al. 2006). Many wildfire studies indicate that successful postfire reseeding aids in the rapid establishment of a desired plant community and assists in the recovery of the ecosystem (Hubbard 1975; Beyers 2004). Fires consume the protective vegetation and organic litter cover from hillsides, which destabilizes steep slopes, causing steep slopes. Reseeded plants can rapidly stabilize soils and promote water infiltration. Furthermore, successful reseeding treatments can better control erosion and prevent loss of topsoil (Anderson and Brooks 1975; Beyers 2004). In New Mexico, postfire reseeding decreased soil loss after the Cerro Grande Fire (Miller et al. 2003), and similarly, postfire reseeding reduced hill slope erosion after the 1998 North 25 Fire in north central Washington (Riechbach et

RANGELAND ECOLOGY & MANAGEMENT 65(5) September 2012

## RECOVER: Rehabilitation Capability Convergence for Ecosystem Recovery

An Automated Burned Area Emergency Response Decision Support System for Post-fire Rehabilitation Management of Savanna Ecosystems in the Western US

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not of Interior's Bureau of Land Management (BLM), we propose to build RECOVER decision support system. RECOVER will be an automatically teria decision aid that brings together in a single application the Area Emergency Response (BAER) teams to plan reseeding strategies in the aftermath of savanna wildfires.

-of-the-art cloud-based data management technologies to improve wide site-specific flexibility for each fire. Customized RECOVER deployed in the Amazon EC2 Cloud when a fire is detected. RECOVER's ally assembled from the existing network of data resources. RECOVER's fresh derived fire severity, fire intensity, and other products throughout obtained, BAER teams will have at hand a complete and ready-to-use r the target wildfire. Since BAER remediation plans must be completed ainment, RECOVER has the potential to significantly improve the

uses on forest wildfires. RECOVER adds an important new dimension eusing on ecosystem rehabilitation in semiarid savannas. A novel involves the use of soil moisture estimates, which are an important but -fire rehabilitation planning. We will use downscaled soil moisture data mal sources currently available to begin evaluating the use of soil

## The National Invasive Species Forecasting System:

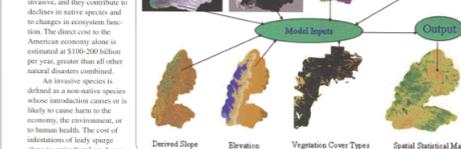
A Strategic NASA/USGS Partnership to Manage Biological Invasions

By John L. Schnase, Thomas J. Stohlgren and James A. Smith

N on-indigenous invasive species may pose the 21st century's single most formidable threat of natural disaster. During the past hundred years, non-indigenous plants, animals and pathogens have been introduced at increasing rates into all US ecosystems. A growing number of these species are becoming invasive, and they contribute to declines in native species and to changes in ecosystem function. The direct cost to the American economy alone is estimated at \$100-200 billion per year, greater than all other natural disasters combined.

An invasive species is defined as a non-native species whose introduction causes or is likely to cause harm to the economy, the environment, or to human health. The cost of infestations of leafy spurge alone to agricultural producers and taxpayers is \$44 million a year in the Dakotas, Montana and Wyoming. Aggressively invasive fish in the Great Lakes threaten a commercial fishery that supports 81,000 jobs and is valued at \$4.5 billion. Invasive Norway rats cause up to \$19 billion in environmental and economic damage every year. Non-native livestock diseases cost \$9 billion a year. In the coming decades, increased human travel and trade, and the changing types and patterns of environmental disturbance, are expected to exacerbate these impacts. Because of its high diversity of environmental conditions and habitats, the United States is especially vulnerable to invasions by non-indigenous species.

This issue has developed diverse stakeholder support, ranging from land management agencies to state governments, the agricultural industry, conservation organizations, and private landowner



Remotely sensed data plays a critical role in dealing with the problem of invasive species. NASA currently provides measurements from Terra, Landsat 7, QuickSCAT, Jason and other missions that map key ecosystem attributes needed to predict species distributions. Future missions will expand these measurements to include critical three-dimensional structure.

The National Research Council's Committee on Grand Challenges in Environmental Science has identified increased understanding of biodiversity and ecosystem functioning as one of eight "Grand Challenges in Environmental Science" that face our nation and the world today. The committee also emphasized the need to develop improved management techniques and an ecological forecasting capability for non-indigenous invasive species. NASA and the U.S. Geological Survey (USGS) are joining forces to take on this task. Their combined resources and shared expertise will result in a National Invasive Species Forecasting System for the management and control of invasive species.

46 EOM August 2002

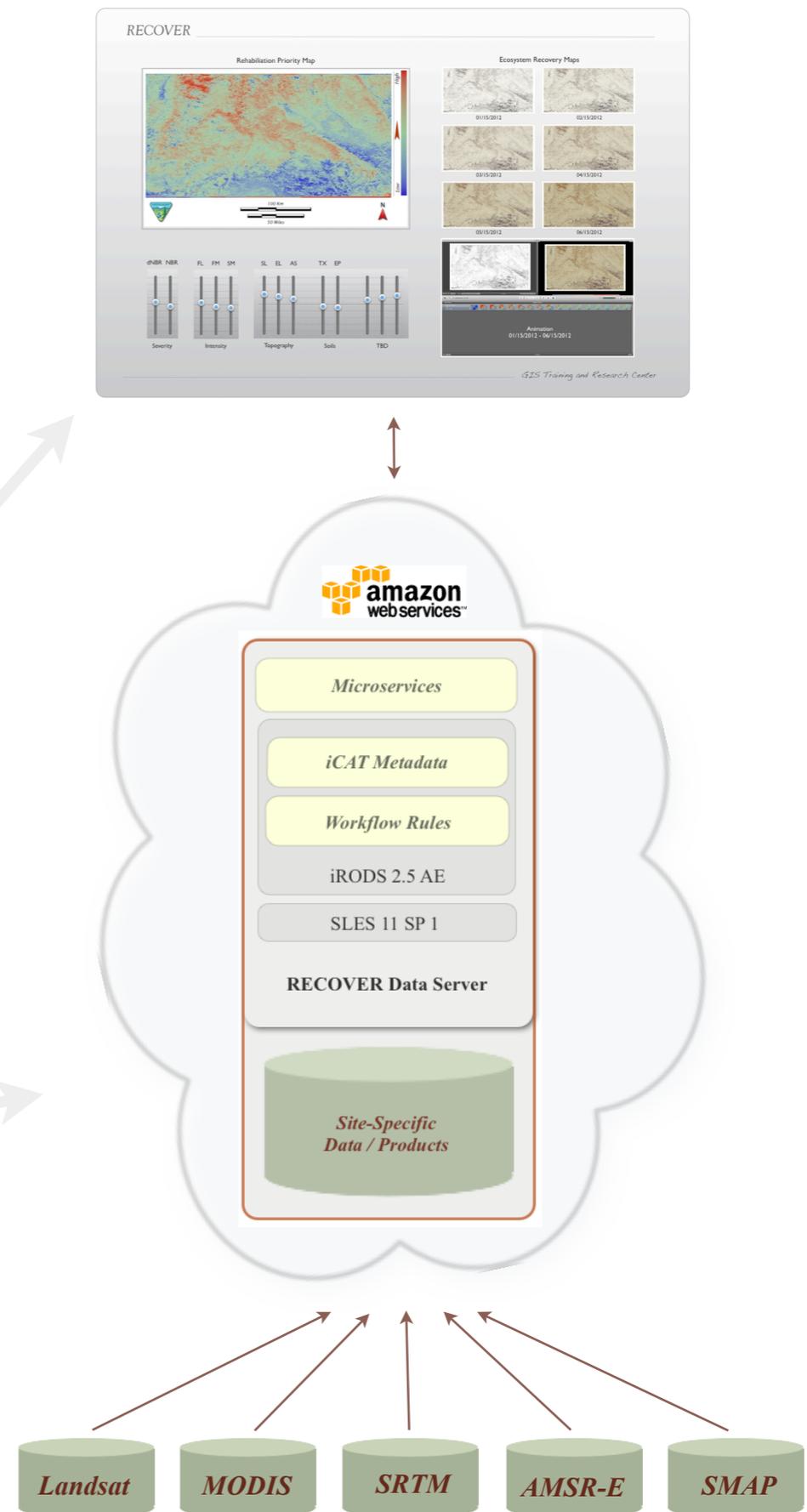
# The RECOVER System

- RECOVER brings together in a single application the information necessary for BAER team post-fire rehabilitation decision-making and long-term ecosystem recovery monitoring.
- RECOVER is a web mapping application and multi-criteria decision aid that integrates information about fire severity and intensity with other types of data to help BAER teams plan reseeding strategies in the aftermath of savanna wildfires.
- Major system components:
  1. RECOVER Clients - Desktop and mobile interfaces that are able to connect to the RECOVER Server.
  2. RECOVER Server - A cloud-based data management system that automatically aggregates site-specific data from a distributed collection of relevant web-accessible resources.

GIS TReC leading client-side development

GIS TReC, BLM, IDL, and NASA together are identifying important data sets, workflows, and decision products ...

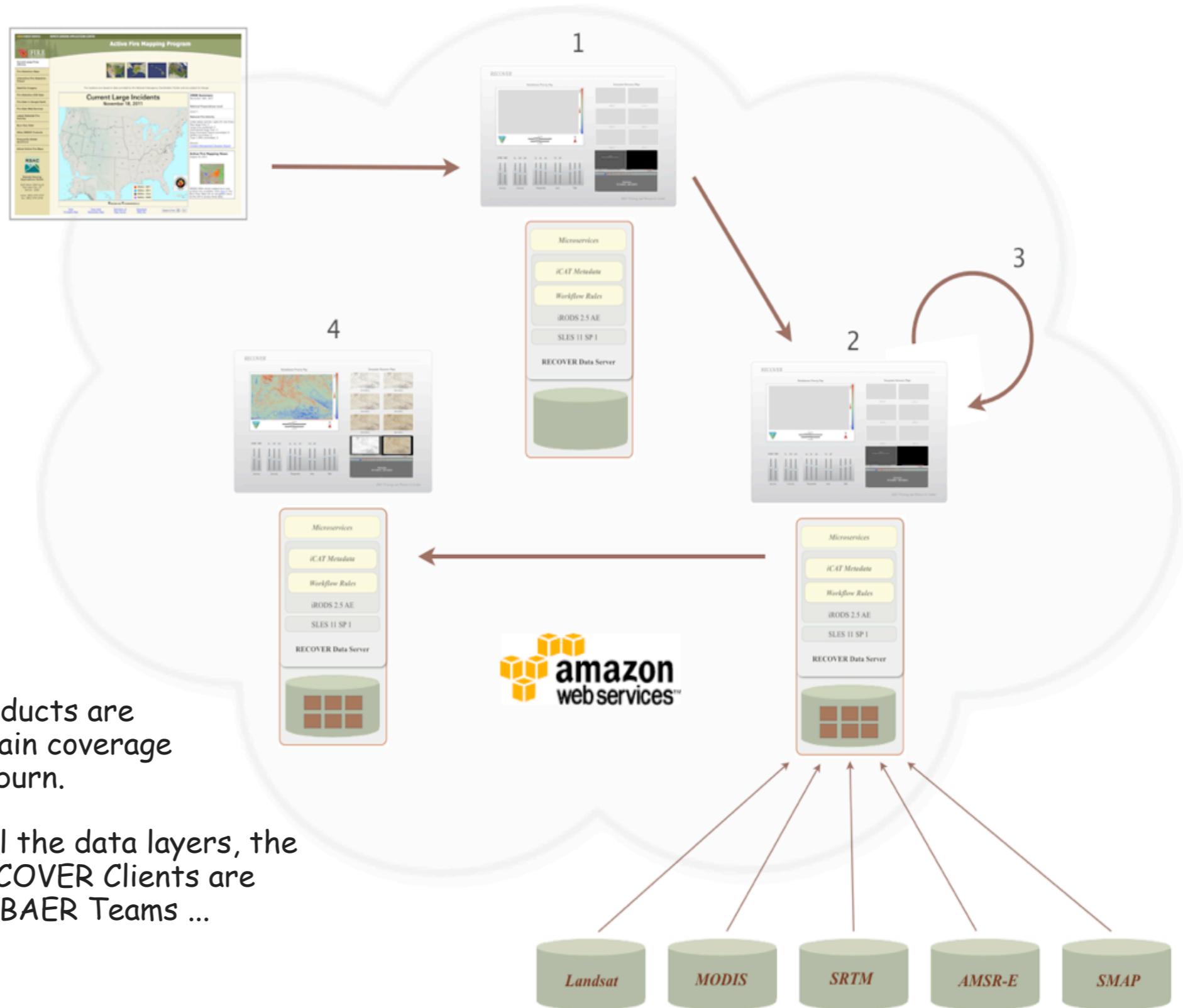
NASA leading server-side development



# The RECOVER System

The typical RECOVER use scenario goes as follows:

1. A request containing the wildfire name and spatial extent is sent to the RECOVER Server.
2. The RECOVER server connects through web services to various data resources and automatically collects tailored, site-specific data and derived products.
3. These staged, aggregated products are refreshed as needed to maintain coverage and currency throughout the burn.
4. When the fire is contained, all the data layers, the RECOVER Server, and the RECOVER Clients are immediately ready for use by BAER Teams ...



# The RECOVER Server

- Uses iRODS data grid software to manage site-specific data and metadata.

iRODS = Integrated Rule-Oriented Data System

## Background

- Open source data grid software system.
- Developed by the Data Intensive Cyber Environments (DICE) group, University of North Carolina.
- Historic roots in data grids, digital libraries, persistent archives, and real-time data systems R&D, and SRB.

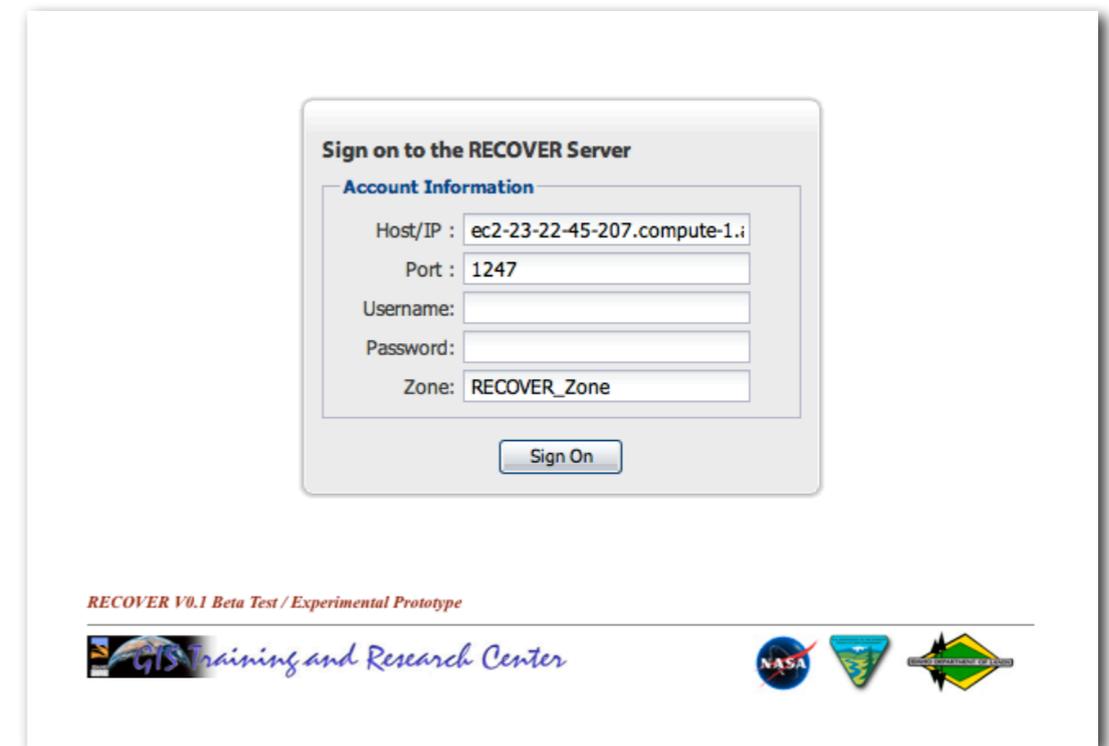
## Features

- Targets large repositories, large data objects, digital preservation, and integrated complex processing.
- Supports server-side workflows implemented by chaining execution rules together based on data policies.
- Enables scalability and extensibility.

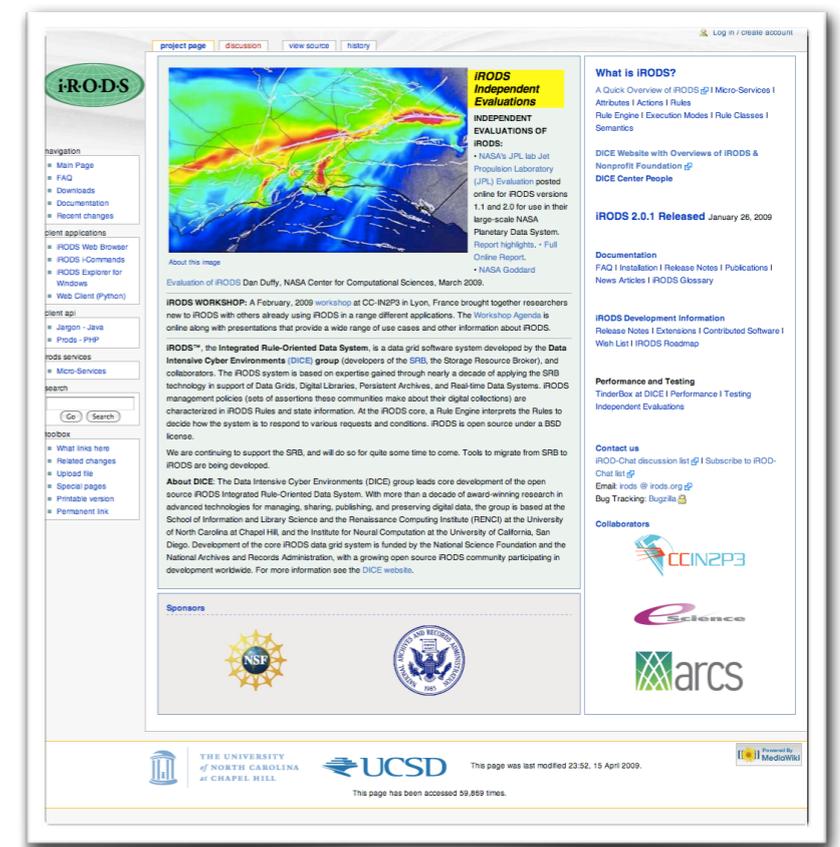
## Major Concepts

- Policies => iRODS rules.
- Mechanisms => iRODS microservices.

With iRODS metadata providing the information necessary to perform these mappings ....



[www.irods.org](http://www.irods.org)



# The RECOVER Server

- Is deployed in the Amazon Elastic Compute Cloud (EC2).

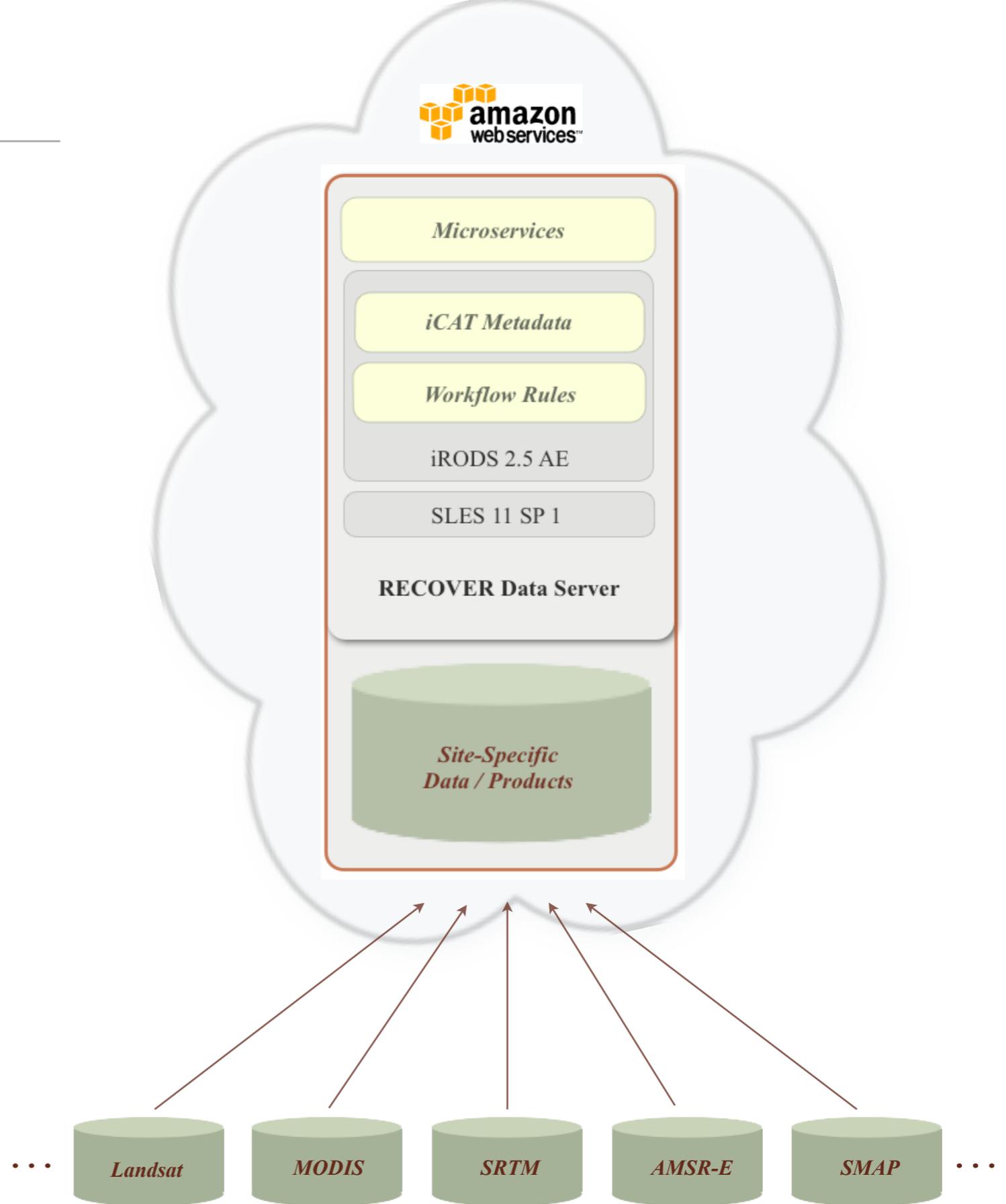
- Assembles and manages a variety of data:

### Step 1: Core Data Sets (Automatically Assembled)

- Normalized Burn Ratio (NBR)
- Normalized Difference Vegetation Index (NDVI)
- Fraction of Photosynthetically Active Radiation (fPAR)
- Net Primary Production (NPP)
- Topography Aspect (TA)
- Topography Elevation (TE)
- Topography Slope (TS)
- Soil Texture (ST)
- Soil K Factor (SKF)
- Biophysical Setting (BPS)
- Geology (GEO)
- Existing Vegetation Cover (EVC)
- Existing Vegetation Type (EVT)
- Environmental Type Potential (ETP)

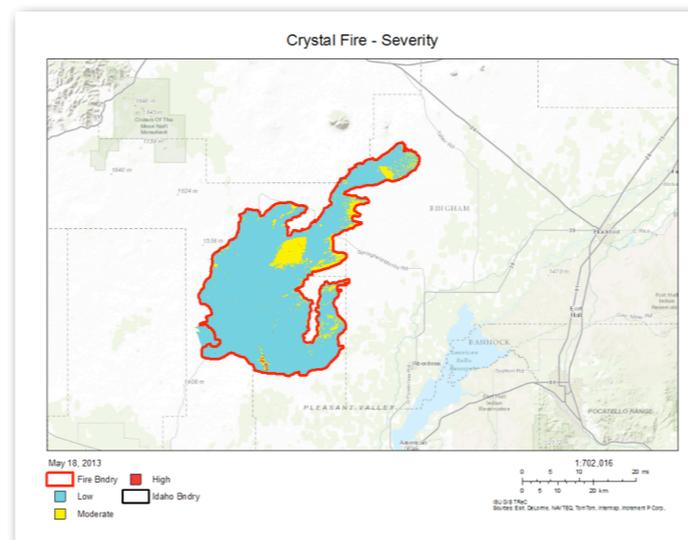
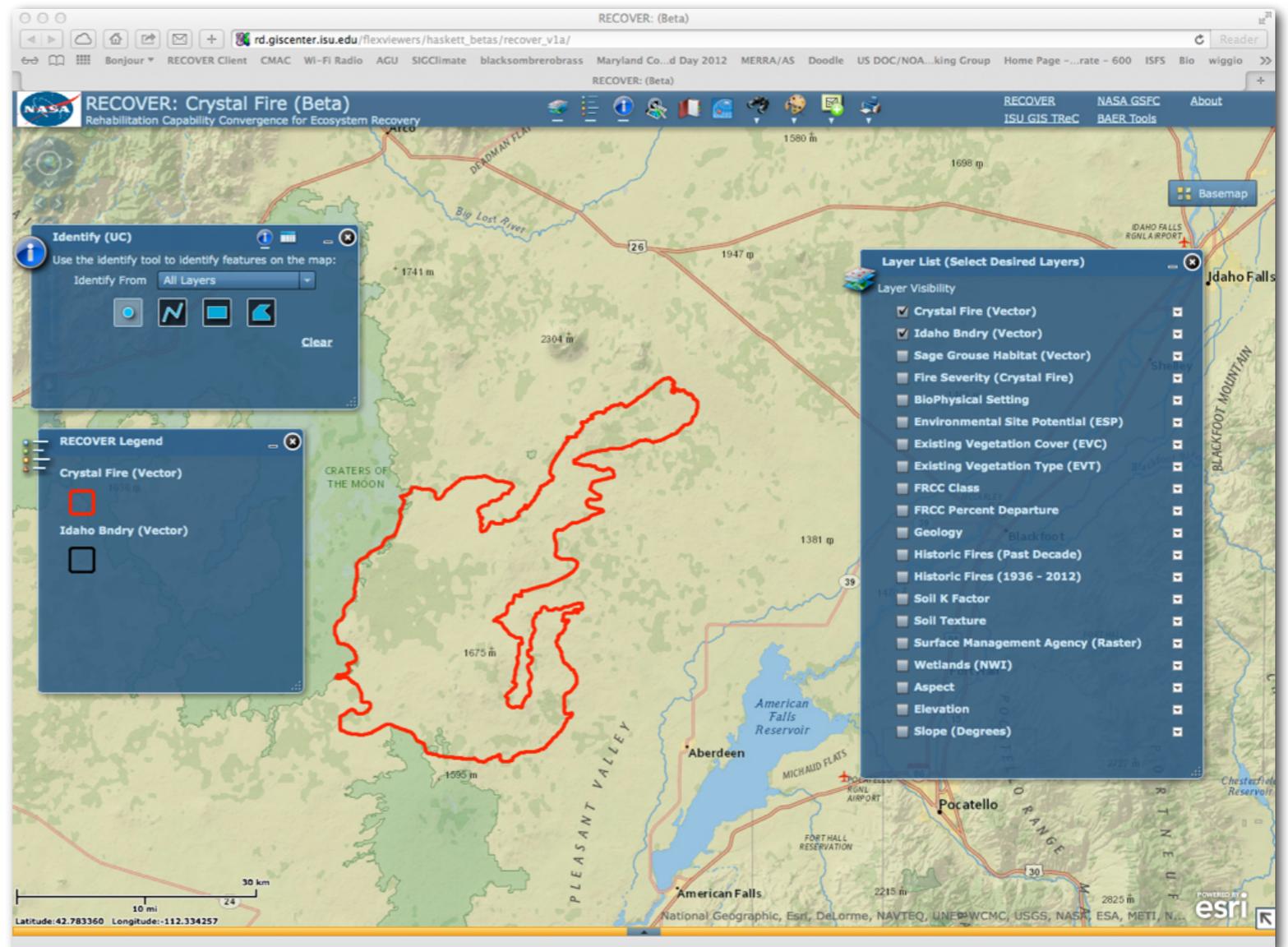
### Step 2: Derived / Ancillary (Collected and Added Manually)

- Difference in Normalized Burn Ratio (dNBR)
- Fire Severity (FS)
- Fire Intensity (FI)
- Fire Regime Condition Class (FRCC)
- FRCC Percent Departure (dFRCC)
- Historic Fires 1936-2012 (H0)
- Historic Fires 2002-2012 (H1)



# The RECOVER Client

- Adobe Flex Web Mapping Application
  - Connects to the RECOVER Server through a web services interface.
  - Allows site-specific data layers to be viewed and interrogated in a variety of ways.
  - Accommodates a wide range of base layers.
  - Additional information to aid in analysis can be uploaded through the RECOVER Client.
  - Professional, high-quality, high-resolution maps can be easily generated.
- Mobile Clients
  - Prototype RECOVER Client designed for desktop and laptop use ...
  - ... but we are beginning to work on mobile clients.



## Next Steps ...

- Stage 1 - Feasibility Study

- 1 Year (FY13) Prototype development and evaluation activity.
- Idaho fires are being used for prototype development.
- **Want to "shadow" work on at least one fire this season to evaluate.**
- Evaluate with partners and develop proposal / teaming arrangement to develop production system.

- Stage 2 - Operational Deployment

- 2-3 Year (starting in FY14) activity to develop full-scale system for regions of interest.
- (NB: There's a Stage 1 down-select!)
- Develop mobile tablet/smartphone capabilities to complement desktop interfaces.
- Enable the RECOVER platform to consume SMAP, LDCM, Suomi NPP, Reanalysis, and Climate Model data.

- **Create a modern wildfire DSS optimized for the current suite of GIS technologies and Earth observing missions ...**

**RECOVER iPad Prototype**

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App Definition Statement:

*The RECOVER iPad Prototype application provides ecologists a tool to analyze burn site recovery imagery.*

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**Initial State**  
Pins indicate fire sites, green pins indicate recent updates.  
Click the information button, "i", to view the site.



**Site View**  
The site view shows the fire boundary and a mosaic of all layers.



**Layer Selection**  
Choose layers for the mosaic. For the prototype, all layers contribute equally. Slider bars will be added later.

# RECOVER Server Demo

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ISFS-N102-Concho

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## RECOVER

Rehabilitation Capability Convergence for Ecosystem Recovery

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### RECOVER Cloud-Based Server Demonstration

RECOVER  
Rehabilitation Capability Convergence for Ecosystem Recovery

Log in to the RECOVER Server

Username: [ ]  
Password: [ ]  
[Log In]

Powered by the Idaho State University GIS Training and Research Center

NASA Idaho State University GIS Training and Research Center

00:00:00



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# RECOVER

## Rehabilitation Capability Convergence for Ecosystem Recovery

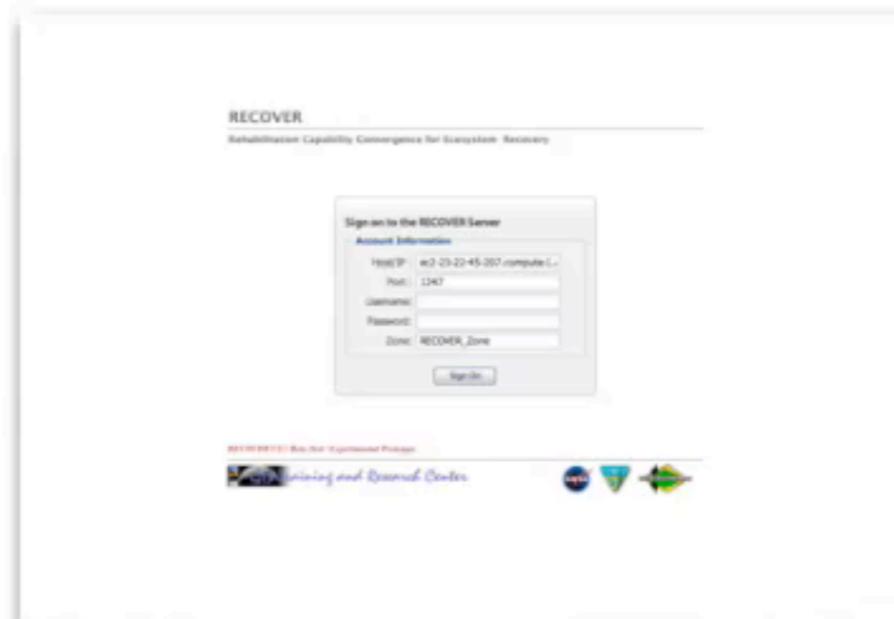
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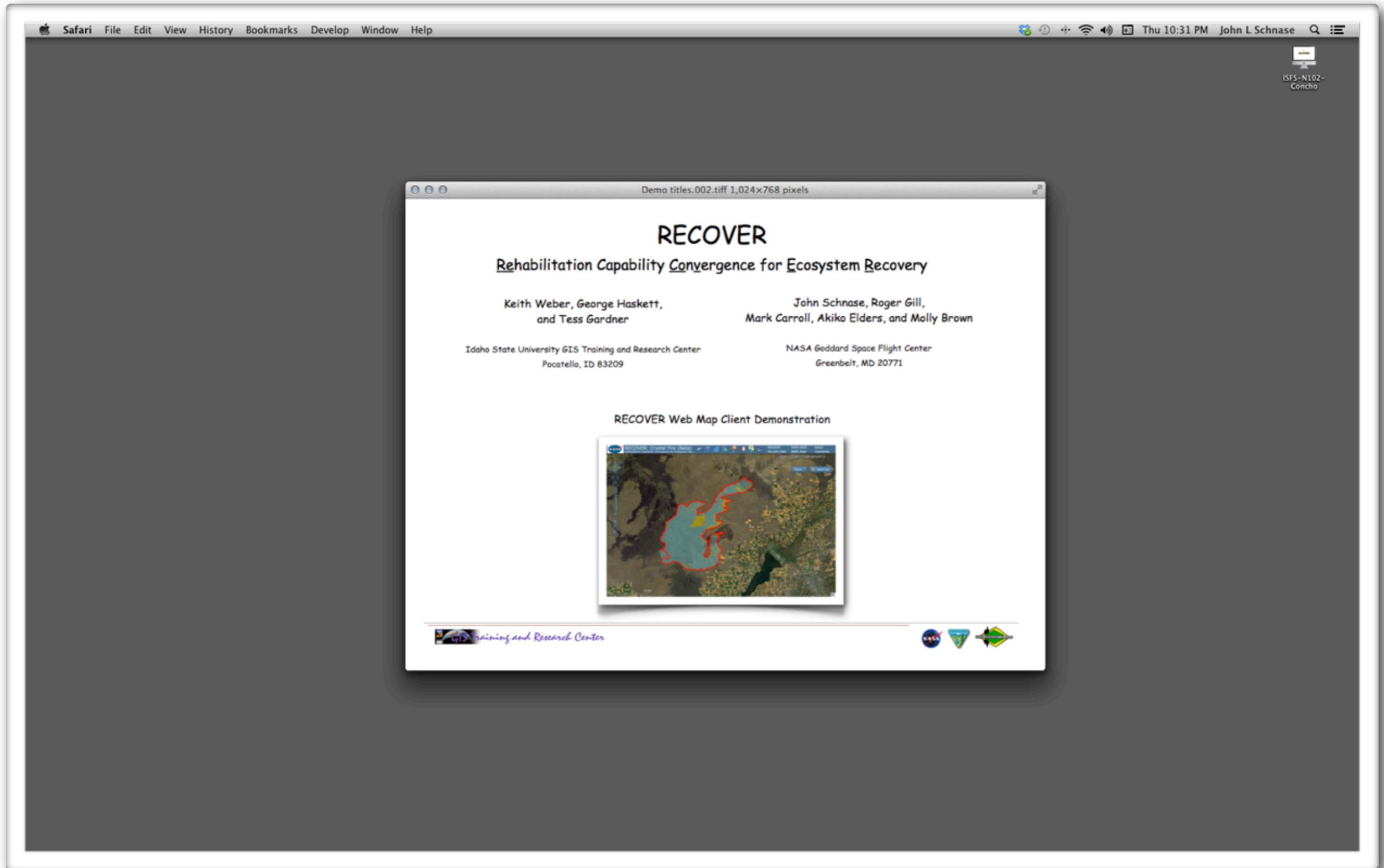
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### RECOVER Cloud-Based Server Demonstration



# RECOVER Client Demo



# RECOVER

## Rehabilitation Capability Convergence for Ecosystem Recovery

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### RECOVER Web Map Client Demonstration



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## What we need from you ...

Take a few minutes to become familiar with the system. Then simulate using RECOVER to build a fire rehabilitation plan for a new fire.

- Can you perform all the spatial assessments you need with the current RECOVER application?  
If not, what is missing from the client? What is missing from the server?

Do you want to work together to put this capability into operational use?

If so, then we'll need your help to develop a Phase II proposal:

- people who can help us finish system development and evaluation,
- people who can help us evaluate the system in actual use this fire season, and
- agency support to help us meet NASA's Applied Sciences Program requirements.