



FFI: A software tool for ecological monitoring

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Abstract

A new monitoring tool called FFI (FEAT/FIREMON Integrated) has been developed to assist managers with collection, storage and analysis of ecological information. The tool was developed through the complementary integration of two fire effects monitoring systems commonly used in the United States: FIREMON (Lutes 2006) and the Fire Ecology Assessment Tool (Sexton 2003). FFI provides software components for: data entry, data storage, data query summary reports and analysis tools. In addition to a large set of standard FFI protocols, the Protocol Manager lets users define their own sampling protocol when custom data entry forms are needed. The standard FFI protocols and Protocol Manager allow FFI to be used for monitoring in a broad range of ecosystems. FFI is designed to help managers fulfill monitoring mandates set forth in land management policy. It supports scalable (project to landscape scale) monitoring at the field and research level, and encourages cooperative, interagency data management and information sharing. Though developed for application in the U.S., FFI can potentially be used to meet monitoring needs internationally.

Introduction

FFI (FEAT/FIREMON Integrated) is a software tool developed in the United States and designed to assist managers with collection, storage and analysis of ecological monitoring information. This tool was developed through a complementary integration of two fire effects monitoring systems commonly used in the U.S.: FIREMON (Lutes et al. 2006) and the Fire Ecology Assessment Tool (FEAT) (Sexton 2003). The National Interagency Fuels Coordination Group sponsored development of FFI and the National Park Service (NPS) was the managing partner.

FEAT was developed from the NPS, Fire Monitoring Handbook (FMH) (USDI 1992, USDI 2003) and associated software (Sydoriak 2001). This handbook was initially developed by the Pacific West Region of the NPS to guide fire related ecological monitoring in California, Oregon and Washington. The handbook provides detailed descriptions for establishing a sampling strategy based on levels of monitoring activity relative to fire and resource management objectives. FMH had a DOS-based software package for entering data into a Microsoft® FoxPro database. Beginning in 1995 the NPS conducted a series of regional workshops to examine user needs for fire and ecological monitoring throughout the entire NPS, then in 1996 FMH was adopted by all NPS regions across the U.S. The handbook was updated first in 2001 and again in 2003 to reflect the national scope of the system. The FMH software was replaced in 2005 with a Windows-based system that became known as the Fire Ecology Assessment Tool. FEAT used a Microsoft SQL Server database that was much more flexible than the original DOS-based program, allowing data from a greater variety of field sampling procedures to be stored in the database, greater ability to query data and export data, provided GIS tools, and supported PDA use.

The FIREMON fire effects monitoring system was developed by the U.S. Forest Service (USFS), Missoula Fire Sciences Laboratory through a grant from the Joint Fire Science Program in 2000. Many of the protocols in FIREMON were taken from the ECODATA ecological monitoring program used in Region One of the USFS (Keane, et al 1990). ECODATA used an IINFOS data management system and FORTRAN-77 based data analysis package called ECOPAK. FIREMON used Java™-based data entry software and Microsoft Access database. The FIREMON software package included report and analysis software, and a handbook with sampling strategy and detailed field sampling procedures.

FEAT and FIREMON both facilitate fire ecology monitoring and have similar procedural characteristics and database architecture. Their integration results in an enhanced ecological monitoring tool. FFI includes an extensive list of sampling protocols and users are able to define their own protocols in Protocol Manager, if necessary. While the core fire ecology components are still part of FFI the new flexibility means FFI can be used more broadly for monitoring a wide variety of ecosystem attributes. FFI is now better suited to assist managers in meeting the monitoring mandates set forth in land management policy (for example, the U.S. National Environmental Policy Act). It eases data collection; supports cooperative, interagency data management and information sharing; and supports scalable (site specific to landscape level) monitoring for both field application and research needs.

FFI provides data entry and storage for a set of ‘standard’ protocols delivered with the software. Protocol Manager – described in more detail below - is an FFI component that allows design of new sampling protocols thus making the FFI database capable of storing data in not just the standard protocols delivered with the FFI software but also any protocol designed by the user.

FFI is designed for Microsoft Windows operating systems. Data is stored in a Microsoft SQL database and accessed with SQL and Microsoft Visual Basic .NET programs. The system is designed for the varying Information Technology requirements of the USFS, NPS, Bureau of Land Management (BLM), Bureau of Indian Affairs (BIA) and the U.S. Fish and Wildlife Service (FWS).

The relationship of the three FFI software components is shown in Figure 1. The FFI Database Administration component interfaces with SQL Server Express 2012 or 2016 and is used for general database management functions like creating and deleting databases. The SQL databases in FFI have either a ‘Protocol Manager’ or ‘Data Capture’ schema. Protocol Manager databases contain the design criteria for each protocol and provide the list of data fields viewed in the FFI Data Entry software. Data capture databases store field data the user enters in the FFI Data Entry software.

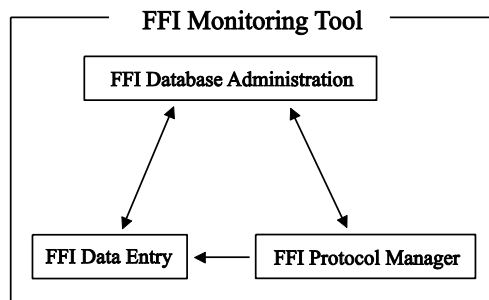


Figure 1. Relationship of the three FFI software components.

Development and testing

Like FEAT and FIREMON before it, FFI incorporates the evolutionary improvements of the systems it was borne from. In addition, FFI has benefited from its own testing and improvement process. Many hours were spent considering use cases and system architecture, testing the user interface and checking coded procedures. This work was done in cooperation with employees from numerous U.S. land management agencies. An FFI Testing Workshop was held in August 2007 to intensively test the FFI software, again with agency cooperation. After the August workshop, nine additional versions of FFI were built and tested before it was finally released in November 2007. We continue to update FFI to meet agency requirements, maintain compatibility with associated systems (e.g., Windows operating system and SQL Server), fix bugs and make user suggested changes. FFI is approved software in the U.S. Departments of Agriculture and Interior.

Species lists

FFI incorporates the U.S. Department of Agriculture, Natural Resource Conservation Service, PLANTS database (USDA 2008). Users query the PLANTS database to populate a 'local' species list using the FFI species management utility. Species in the local list appear in species dropdown menus on the data entry screens. Species or items not available in the PLANTS database can be included in the FFI local list by adding a 'user species'. For example, if a user is interested in sampling pine cone density then 'pine cones' can be added as a user species and it will be included on the species list dropdown menus on the data entry screens. The FFI local species list will also accommodate an unlimited number of 'unknown' species. This option is useful when field crews do not have the expertise to identify all the species encountered. In that case they can record the species as an unknown on the data collection form (for example, UNK01) and collect a sample. When the sample is identified by a botanist, the FFI species management utility can be used to replace the unknown species with its appropriate species name in the FFI local species list and FFI database. The FFI species management utility can also be used to replace a species name if the species was misidentified in the field or when species names and symbol codes change. The FFI local species list can be exported from one FFI database and imported to another.

The master species list included with FFI is the component most likely to limit the use of FFI; however, with a minimum amount of development any master species list can be incorporated in FFI allowing it to be used outside the U.S. Interested parties can build their own 'user species' list and test FFI before making the commitment of incorporating a new master species list. Further, when used in conjunction with the protocol manager, a new master species list and sampling protocols will allow FFI to be used for sampling other life forms such as terrestrial wildlife.

Data entry and storage

Data entry screens have built-in flexibility to accommodate data from a wide variety of plot-based sampling schemes. The data entry fields represent a combination of those in the FEAT and FIREMON so data can be collected using the methods described in the FMH (USDI 2003) or FIREMON (Lutes, et al 2006) field manuals and stored in an FFI database. In most cases the FFI database will also accommodate data collected with field sampling protocols from other publications.

Sampling protocols

The 'standard set' of sampling protocols delivered with the FFI software is listed in Table 1 as well as the source of the protocol, where applicable. The protocols were developed from the existing, recognized methods previously available in FEAT and FIREMON and supplemented with new protocols suggested during FFI development. Protocols that require unit data are available in metric and English unit versions. While FFI was developed from fire effects systems the wide array of protocols make the system applicable for monitoring rangeland, forest and other ecosystems regardless of the presence or absence of fire as a disturbance.

Table 1. Standard protocols delivered with FFI. Protocols not available in FIREMON or FEAT are listed as ‘New’ and, when applicable, the source of the protocol is provided.

Protocol	Source
Biomass – Fuels	New
Biomass – Plants	FEAT
Composite Burn Index	FEAT and FIREMON
Canopy – Densiometer	New
Cover – Line Intercept	FEAT and FIREMON
Cover – Species Composition (Ocular Macroplot)	FEAT and FIREMON
Cover – Individual Points	FEAT
Cover – Individual Points (ARS)	New ^A
Cover – Points by Transect	FIREMON
Cover/Frequency (Daubenmire)	FEAT and FIREMON
Density – Belts	FEAT and FIREMON
Density – Quadrats	FEAT and FIREMON
Fuel Characteristic Classification System	New ^B
Fire Behavior	FIREMON
Logs – Fixed-area	New
Photoload	New ^C
Plot Description (biotic, abiotic variables, fire behavior, photo links)	FIREMON
Post-Burn Severity	FEAT
Rare Plant Species	FIREMON
Surface Fuels (down woody material, duff, litter)	FEAT and FIREMON
Surface Fuels – Alaska Duff and Litter	New ^D
Surface Fuels – Piles	New ^E
Surface Fuels – Vegetation	FIREMON
Tree Data – Fixed-area	FEAT and FIREMON
Tree Data – Variable radius	New

^A Herrick et al. 2005^B Ottmar et al, 2007^C Keane and Dickinson 2007^D Alaska Interagency Fire Effects Task Group, 2007^E Hardy, 1996

Protocol Manager

Protocol Manager is a unique extension to FFI that lets users design new protocols that can then be imported for use in FFI. A protocol is defined as a set of methods implemented separately to perform a certain task. The user defines methods and combines them in Protocol Manager to build a protocol that will facilitate a comprehensive assessment of ecosystem attributes important to the user. User defined methods can be highly varied ranging from new methods to monitor vegetation to methods to monitor mammals, birds, amphibians, reptiles, insects or aquatic species. Protocol Manager also records metadata for each protocol (e.g., plot size, plot shape, quadrat size, etc.). The data recorded with user defined protocols is stored in the same database as data collected with the standard FFI protocols.

Queries, reports and analysis

FFI includes the query features found in FEAT with added functionality to allow data to be queried from user defined protocols designed in the Protocol Manager. The Query screen lets the user retrieve method data in a flexible, ad hoc manner in which values are filtered and parameters are defined through the user interface. The data summary reports and analysis tools are an expanded set of those provided in FIREMON. The FFI summary reports provide plot-by-plot summaries or grouped summaries of measured attributes such as trees per acre, down woody material biomass, frequency, cover and density. The FFI analysis tools program can perform grouped or ungrouped summary calculations of a measured attribute, or statistical comparisons of grouped or ungrouped plot data taken at different sampling periods. For statistical comparisons the analysis tools assume data was collected in a randomized block design with each time point structured as a block. Parametric analyses are made using analysis of variance. If a significant difference in means is noted, Dunnett's multiple comparison procedure is used to compare treatment groups to a designated control group to identify which means are different. Friedman's test is provided for non-parametric analyses. A minimum of four plots per group is required for statistical analysis. Reports and graphs can be saved to a file, printed, or cut-and-paste into other documents. Statistical testing procedures were developed with guidance of station statisticians at the U.S. Forest Service, Rocky Mountain Research Station. As an additional feature, tree and fuels data can be exported to build files necessary to run the Forest Vegetation Simulator (Dixon 2002), First Order Fire Effects Model (Lutes 2018) and FuelCalc (Lutes 2018).

Computer configuration

Computer configurations used for implementation of FFI fall into three categories: isolated computers, desktop as server and a limited access server (Figure 2). The configuration chosen by users depends upon individual needs and available computer and IT resources.

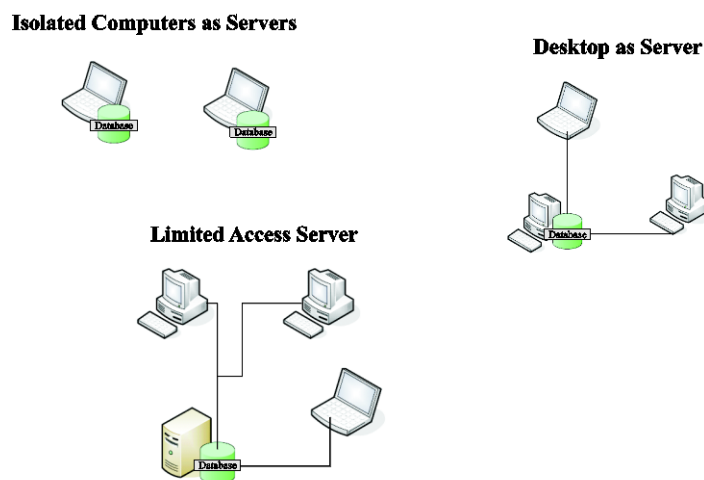


Figure 2. The three main computer configurations used with FFI.

Isolated Computer as Server

The stand-alone computer has no other computers attached to it that share its internal databases. This configuration has both the FFI software and SQL Server installed.

Desktop as Server

One computer with FFI and SQL Server installed is connected via network to other computers that have only FFI installed on them. Data entry can be accomplished on any of the computers. Database storage and management occurs on the desktop server.

*Limited Access Server**

A database server is a dedicated computer running a database engine that can be either accessed directly from a server or client computer with password protection or via intranet access. This configuration has SQL Server only installed on the database server and only FFI installed on the connected computers. **This configuration is not fully supported at this time and requires support of a dedicated SQL Server manager.*

FFI Requirements

The FFI software requires Microsoft Windows 7, 8 or 10 operating systems. Data must be stored in a Microsoft SQL Server Express 2012 or 2016, or SQL Server 2012 or 2016 full edition database. Recommended minimum random access memory is 4GB.

FFI-Lite

FFI-Lite was added in 2015 to be used on field data computers and as an easier to maintain application for smaller monitoring programs. It uses SQL-CE, which doesn't require installation or management like SQL Server. The application runs on desktop, laptop and tablet PCs running the Windows 7, 8, or 10 operating system. FFI-Lite does not support SQL password security or multiple simultaneous users, but, otherwise, the user experience is the same as FFI.

Electronic field data collection

Electronic field data collection is facilitated using FFI-Lite on a Windows-based ruggedized laptop or tablet. The user first creates a new sample event in the master database for each macro plot that will be sampled in the field, then the new sample events are exported to a USB drive and imported to the field computer using the FFI/FFI-Lite import/export utility. When field data collection is complete the new data are moved to the master computer, again using an USB drive and the import/export utility. Data may be imported for macro plots (e.g. plot location) and/or protocols (e.g., tree data). The user has the option to import each individual macro plot and sample event into the master database using no change, append or replace options.

Comma delimited (CSV) data import is supported at the protocol level. Comma delimited files can be created in any application and with any device that supports that format. This electronic

data collection option is not as sophisticated as the functionality built into the FFI-Lite input and output utilities but allows programs to use lower cost devices for data collection.

Technology transfer

FFI is supported with annual training workshops and on-line presentations. User assistance is provided through the FFI Website, help desk and Google group. Training schedules, software installation packages, documentation and technical support contacts are provided on the FFI Website: <https://www.frames.gov/ffi>

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