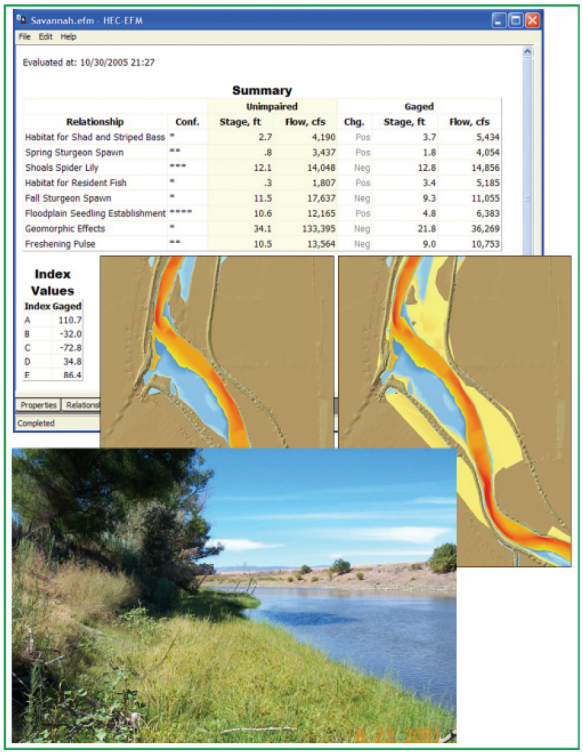
System-Wide Water SWWRP Resources Program

Hydrologic Engineering Center-Ecosystems Functions Model (HEC-EFM)

Description: The Ecosystem Functions Model (HEC-EFM) is a planning tool that aids in analyzing ecosystem response to changes in flow regime. The Hydrologic Engineering Center (HEC) of the U.S. Army Corps of Engineers is developing HEC-EFM to enable project teams to visualize existing ecologic conditions, highlight promising restoration sites, and assess and rank alternatives according to the relative change in ecosystem aspects.



Relationship	Conf.	Unimpaired Stage, ft	Unimpaired Flow, cfs	Chg.	Gaged Stage, ft	Gaged Flow, cfs
Habitat for Shad and Striped Bass	*	2.7	4,190	Pos	3.7	5,434
Spring Sturgeon Spawn	**	.8	3,437	Pos	1.8	4,054
Shoals Spider Lily	***	12.1	14,048	Neg	12.8	14,856
Habitat for Resident Fish	*	.3	1,807	Pos	3.4	5,185
Fall Sturgeon Spawn	*	11.5	17,637	Neg	9.3	11,055
Floodplain Seedling Establishment	****	10.6	12,165	Pos	4.8	6,383
Geomorphic Effects	*	34.1	133,395	Neg	21.8	36,269
Freshening Pulse	**	10.5	13,564	Neg	9.0	10,753

Central to HEC-EFM analyses are "functional relationships." These relationships link characteristics of hydrologic and hydraulic time series (flow and stage) to elements of the ecosystem through combination of four basic criteria: 1) season, 2) flow frequency, 3) duration, and 4) rate of change. There is no limit to the number or genre of relationships that may be developed and a user interface has been constructed to facilitate entry and inventory of criteria.

After relationships are developed, a statistic computations package (also managed by the interface) analyzes flow and stage time series for the specified criteria and produces a single flow value for each relationship. This process is repeated to assess a modified flow regime and resulting values for without and with project conditions are compared to indicate the direction of change of ecosystem health.

In addition to the statistical computations, EFM analyses typically involve hydraulic modeling which translates statistical results to water surface profiles and spatial layers of water depth, velocity, and inundated area, and Geographic Information System (GIS) programs to display these generated layers as well as other relevant spatial data (i.e., soils, vegetation, and land-use maps).

Application: The most recent application of HEC-EFM was developed to test a restoration scenario that involved adding meander back to a previously straightened stretch of the Truckee River at McCarran Ranch, Nevada. This was the first application of HEC-EFM that focused on analyzing the ecological effects of a change in channel topography; previous applications had focused on comparing different river flow regimes and water management scenarios.

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The McCarran Ranch application, completed in 2005, was a cooperative effort between HEC and the Desert Research Institute of the University of Nevada. It was supported by SWWRP and the Urban Flood Restoration Program, which is a research effort to apply and evaluate innovative approaches for assessing the impact of flood control and river restoration activities in arid lands.

Benefits: HEC-EFM has many strengths, most notably 1) it is capable of testing ecological change for any number of relationships for up to eleven flow regimes, 2) it links ecology with established hydrologic, hydraulic, and GIS tools, and 3) it can be applied quickly, inexpensively, and can incorporate expert knowledge. HEC-EFM is also a generic software tool, applicable to a wide range of riverine ecosystems and restoration projects.

Future Capabilities: Future enhancements focus on adding new statistical features to provide more flexibility in defining relationships and to strengthen EFM connections with GIS.

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