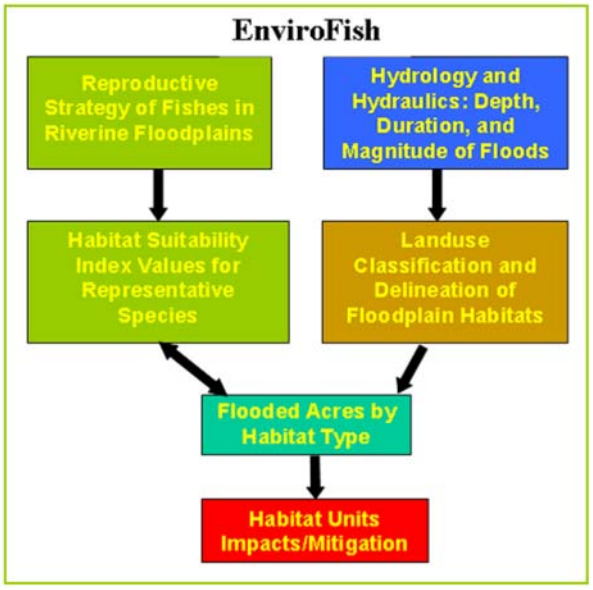
System-Wide Water SWWRP Resources Program

EnviroFish



Description: The timing, duration, and magnitude of flooding influence ecosystem functions of riverine floodplains, including reproductive success of fishes and other organisms. Flood-control projects alter the natural flooding regime resulting in environmental impacts that must be quantified. EnviroFish was developed to quantify impacts of flood control on fish habitat in large alluvial rivers of the United States. Once impacts are determined, specific floodplain restoration or mitigation techniques can be planned and benefits can be calculated. Overall, EnviroFish provides a tool to determine the appropriate amount of mitigation to offset adverse environmental impacts of large-scale flood-control projects on fish habitat. Other aquatic organisms, such as invertebrates and amphibians, can also be used in the evaluation. The conceptual basis of EnviroFish requires integration of hydroperiod, land use, and empirically-based knowledge of aquatic organism's use of inundated floodplains. The model has been applied to flood-control projects in the lower Mississippi River Valley and continues to be refined and updated.

Applications: EnviroFish is a hydraulic modeling procedure coupled to a spreadsheet that estimates acres of functional reproductive habitat for fishes in riverine floodplains. The hydraulic model is written in JAVA and is designed to directly accept data in direct storage system (DSS) file formats. EnviroFish calculates average daily flooded acres for an array of project alternatives. Acres are weighted using Habitat Suitability Indicies (HSIs), which reflect the biological value of water depth, duration of flooding, and land use to fish reproduction. The output of EnviroFish is Habitat Unites, typically used in the Habitat Evaluation Procedure to assess impacts and benefits of water resource projects. EnviroFish can calculate Habitat Units for specific floodplain habitats with each habitat providing different values for spawning and rearing fishes. In order of least to most preferred floodplain habitats, they include agricultural fields, fallow fields, bottomland hardwood forests, and permanent water bodies. The user of the software can define hydraulic criteria (magnitude, depth, and duration of flooding) for successful spawning and rearing of fishes, use any combination of land use categories, and calculate Habitat Unites for individual or groups of species providing that adequate biological data are available to support the analysis. Otherwise, default values are provided to guide the decision-making process of parameterizing the model. Overall, EnviroFish predicts a biological response to different flooding scenarios suitable for standard Federal planning processes.

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EnviroFish has been used on multiple flood-control projects and has provided a unifying method to determine impacts of a project on fish habitat, and using the same variables, identify numerical requirements of mitigation (e.g., number of acres to reforest) to fully compensate for impacts.

Benefits: Fish assemblages are often the primary resource impacted from flood-control projects. Other methods of impact calculation, such as Hydrogeomorphic (HGM) or simply mitigating each acre lost (or use ratios) without regard to quality or function, do not directly address fish habitat. EnviroFish can be used in conjunction with HGM models or other watershed-level assessment techniques to specifically evaluate the magnitude of environmental impacts to fish and other aquatic organisms, identify sensitive species that are most susceptible to altered hydroperiod, and quantify benefits of mitigation. Over 100 species of fish are represented in the current framework of EnviroFish, so this technique has applicability to a broad range of warmwater fish assemblages. There is no geographic limit to its applicability. Small or large watersheds can be modeled. The biological criteria (i.e., Habitat Suitability Index values) can be modified to account for site-specific factors that influence habitat preference of different fish species. Hydraulic engineers are familiar with the hydraulic modeling process used by EnviroFish, which allows rapid transfer of capability to the field. Most importantly, EnviroFish provides a unique capability to document benefits of mitigation based on sound scientific principles of fish and fluvial ecology, and is fully compatible with incremental cost analysis to justify expenditures.

Future Capabilities: The biological concepts of EnviroFish can be applied to numerous types of flood-control and restoration projects in riverine floodplains. Potential future capabilities include linking EnviroFish to other assessment methodologies, such as HGM or the Ecosystem Functions Model (EFM) developed by Institute for Water Resources-Hydrologic Engineering Center (IWR-HEC). More sophisticated hydraulic models can also be incorporated into the EnviroFish concept to better delineate surface topography (e.g., LIDAR) and hydraulic connections in floodplains, including Gridded Surface Subsurface Hydrologic Analysis (GSSHA). Advancements in our understanding on distribution and habitat preferences of spawning and rearing fish across a variable landscape will improve the predictive capability of EnviroFish and lead to better methods of watershed analysis.

Data Requirements: 1) Channel hydraulics and hydrology in the form of a stage/area relationship which can come from stage-area curves, usually maintained as direct storage system (DSS) files accessed by the Hydrologic Engineering Centers one-dimensional steady / unsteady flow model River Analysis System (HEC-RAS). Alternatively these can also be obtained from observation records (gauge data via Web Interface for USACE Water Levels of Rivers and Lakes or the USGS National Water Information System), Geographic Information System (GIS)-based modeling (land use and flooded area) or some mixture of two techniques, depending on criteria of the division, district or other agencies choice; 2) Land use designations and areas which can be acquired via project specific Global Positioning System (GPS) survey or, potentially, from a geospatial analysis based on a variety of GIS databases (USDA, USGS, Individual States) as long as these shape files/aerial photos are georectified to derive volume/area; 3) Habitat suitability index values for individual species or groups of species (guild). Obtained from a library /archive (e.g., USFWS) or, to ensure highest geographic fidelity and accuracy, are developed for the species-system combination of interest.

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