Project Status Report

Upper Mississippi River
Long Term Resource Monitoring Program
U.S. Geological Survey

Predicting the Effects of Water Level Management Options

Twenty-seven dams and hundreds of miles of levees affect floodplain habitat in the Upper Mississippi River floodplain. Predicting areas of the floodplain that may be wetted or dried has been difficult because water levels at the dams are managed as a function of discharge. This causes the slope of the water surface in the navigation pools to routinely vary over the year from less than a foot to over 8 feet. Environmental Management Technical Center staff have integrated hydraulic, statistical, and spatial models to predict the effects of management alternatives for Pool 25 on the Upper Mississippi River. Pool 25 has been the focus of an interagency committee on natural resources for the past 3 years.

The model framework, which includes options dealing with levee placement and water level management at the dams, can be easily applied to other areas on the system as data become available. For example, the spatial model is currently being used by the St. Paul District to predict the effects of management options on habitat in Pool 8. A report on that project is scheduled for this year.

The models 1) estimate how often a particular water level management plan may be practical based on the historical water surface elevation record and discharge estimates, 2) predict types and amounts of habitat affected by various water level and levee management alternatives, 3) estimate changes to the aquatic terrestrial transition zone (ATTZ) caused by dam operation and levee placement, and 4) estimate flood easement or ownership rights needed for various options.

Since 1939, discharge estimates for Pool 25 were used to compute exceedence frequencies on a weekly, monthly, and yearly basis. Water level measurements at five stations were used to calculate the percentage of time water levels were above specific elevations for the same three time scales. These data were also used to calibrate a one-dimensional hydrologic model (HEC-2), assuring that predicted water surfaces were within 0.3 feet of measured values. Bathymetric surveys in 1993 and 1994 provided transect data for the model at 1/2 mile intervals. The hydrologic model was used to predict water surfaces for four different discharge regimes, each for five water level management options. The present water level management plan was included as one option, with two options having higher water levels and two lower water levels than at present.

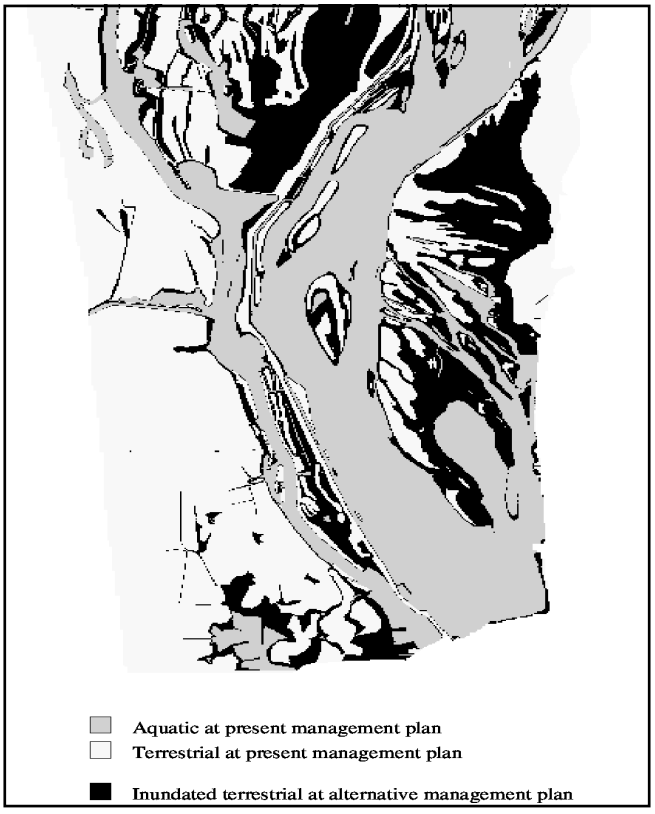

Figure. A map product from the Pool 25 model comparing the present water level management plan, at 95,000 cubic feet per second, and a plan to move the control point to the dam.

Geographic Information System (GIS) coverages were created for water surface elevations, land cover, floodplain elevations, land ownership, and levee locations. A water surface coverage for each of the 20 combinations of discharge and management plans was developed from the hydrologic model predictions. Twelve land cover classes were identified from color-infrared aerial photographs taken at a scale of 1:15,000: open water, submergents, submergents-rooted floating aquatics, rooted floating aquatics-emergents, emergents, emergents-grasses-forbes, grasses-forbes, woody terrestrial, agriculture, urban-developed, and sand-mud. Two additional classes were created to help display results because of changes in discharge or management, dewatered aquatics and flooded terrestrial. Floodplain elevations were obtained from bathymetric surveys measured in 1993 and 1994, contour data from United States Geological Survey 1:24,000 quadrangle maps, and estimates of elevation from river gages when photographs of the water and land interface were obtained. A land ownership coverage was developed by digitizing maps obtained from the St. Louis District of the U.S. Army Corps of Engineers. Levee locations were obtained from a team studying the flood of 1993. The GIS was then used to integrate all coverages, predicting the habitats affected for each scenario or the acreage needed for flooding easements. Quantitative estimates of each affected habitat class were tabulated and color maps were generated to illustrate spatial distribution of change. A black and white example of a map product is shown on the other side. Changes in aquatic areas ranged from a reduction of 8,000 acres to an increase of 22,000 acres under various scenarios. The area of greatest change was in the impounded reach closest to the dam.

The ATTZ, defined here as the amount of land area flooded between yearly average minimum and maximum water surface elevations, has been studied using the model. The ATTZ has changed considerably as a function of human activities on the floodplain. The areal extent of the ATTZ, both as it is now and as it would be if the dams and levees were not present, was calculated for three 2-mile wide bands representing the lower, middle, and upper reaches of the reservoir. In the lower reach of reservoir, the ATTZ is now only about 2/3 of its original size. In the other two reaches, the ATTZ is now only about 1/3 of its original size.

The model was also used to estimate the discharge representing ordinary high water and to predict additional lands that would be flooded as a result of alternative plans. One of the water level management options from the above study is presently being further investigated by the St. Louis District. It involves allowing a flexible control point (a specific location in the reservoir where a water level target is maintained). The major negative impact from this option would be the need for the St. Louis District to purchase additional land or flood easements. The model predicted that no lands would need to be purchased under any discharge for 13 miles immediately upriver of the dam. The maximum amount of land needed would be approximately 740 acres when water levels are maintained at their highest level at the discharge creating ordinary high water. This new plan would not have a detrimental effect on the 9-foot navigation channel and it would provide the management option of allowing for up to 4.3 feet of water level fluctuation for improvement of habitat for some organisms. To quantify the benefits that might be obtained from alternate water management strategies will require appropriate investigations.

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