System-Wide Water SWWRP Resources Program

Aquatic Plant Growth Models

Description: A dynamic simulation modelling approach to plant biomass dynamics has been developed by the U.S. Army Engineer Research and Development Center's Environmental Laboratory to provide a tool for water resources managers to evaluate key environmental conditions in which vegetation would persist or produce excessive biomass with ensuing consequences for the system in which it grows, either or not affected by management measures. Currently four models for submersed plants are available (hydrilla, Eurasian watermilfoil, American wildcelery, and sago pondweed). The models are based on carbon flow through the vegetation in a meter-squared water column with light and temperature as driving variables, and include descriptions of plant responses to current velocity, climate, and human influences such as management measures (changes in water turbidity, water level, mechanical control, nutrient limitation). Users can easily modify the plant community and site characteristics. Reports, user manuals, and executables can be downloaded via the Internet through URL: http://el.erdc.usace.army.mil/products.cfm?Topic=model&Type=aquatic.

Application: Users include U.S. Army Corps of Engineers Districts, water management agencies, consultancies, and universities. The wildcelery and sago pondweed models have been used in the past in planning studies of the 'Upper Mississippi River – Illinois Waterway (UMR-IWW) System Navigation Study', in which an ecological risk assessment of the potential effects of navigation increases on submersed vegetation were quantified. The same models are currently used in planning studies for the restoration of Lake Peppin, MN, and Marsh Lake, WI, as part of the Navigation and Ecosystem Sustainability Plan (NESP) study. The wildcelery model is currently used in a study on potential consequences of changes in water management of the Yangtze River, China, on wildcelery populations and Siberian cranes. All models are used by water management agencies and consultancies to evaluate habitat requirements and aquatic plant control needs, within the U.S. and abroad. For example, the hydrilla model is most frequently used in Florida and the Eurasian milfoil model in Wisconsin to evaluate aquatic plant control needs. All models are used for teaching purposes and as a basis for the design of experiments at universities within the U.S. and abroad.

Benefits: Simulation models for the metabolism and growth of aquatic plants are useful tools in managing large freshwater bodies that are the responsibility of the USACE. Users can save significant amounts of time and money by using plant growth simulation models to promote sound management of these systems.

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Data Requirements: Each model executable can be downloaded with the required files to run the model. An input data file provides plant-species characteristic input data and a weather file provides irradiance, air temperature, and latitude and longitude data for the documented calibration run. For user-specified runs at a particular site, default plant data contained in the input file can be used, but the site-specific data on daily changes in water depth, light extinction within the water column, water temperature (optional), and current velocity (optional) would have to be replaced in this input file. In addition, a weather file for the user-selected site would have to be prepared, for which usually irradiance and air temperature of a nearby airport are taken. The site-characteristic latitude and longitude data in the weather file provide the model with a trigger to use plant-developmental data appropriate for a temperate or a tropical climate. Initial biomass data for the plant species can also be entered in the input data file, if available. The latter would be conducive for the simulation that best describes the on-site behavior of the plant community.

Future Capabilities: A simulation model describing competition between submersed plant species for light at various nitrogen and phosphorus availabilities has been developed and recalibrated for American wildcelery and sago pondweed. This model will be available for users shortly. In addition, a model for emergent wetland plant biomass is under development, using arrowhead species for initial calibration. The latter model will not only predict plant biomass under prevalent freshwater environmental conditions, it will also include descriptions of vegetation responses to changes in salinity (as may occur by salt intrusion and as a result of storm surges in coastal wetlands) and of the role of vegetation in the cycling of nitrogen and phosphorus (preventing/mitigating the nitrogen loading of water bodies).

Point of Contact: Elly P. Best, Ph.D., Environmental Laboratory, U.S. Army Engineer Research and Development Center, (601) 634-4246, Elly.P.Best@usace.army.mil.

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