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BUILDING STRONG®

CEMCAT: Conceptual Ecological Model Construction Assistance Toolbox

by P. Soupy Dalyander and J. Craig Fischenich

CEMCAT Software Overview

The U.S. Army Corps of Engineers (USACE) Engineer Research and Development Center (ERDC), Environmental Laboratory (EL), has developed a software program to assist in the design and presentation of conceptual ecological models. The Conceptual Ecological Model Construction Assistance Toolbox (CEMCAT) offers a tiered structure tailored to the relative experience and knowledge of the user wherein the user can choose the level of support, information, or help required. For project developers who already incorporate conceptual models into the planning process, the software streamlines the process of designing and constructing conceptual models by providing a standardized structure. Straightforward step-by-step guidance allows those less familiar with conceptual ecological models to effectively and relatively simply incorporate this recommended element into the project planning and implementation process.

Two of the key functions of the software are to guide the user in the construction of an effective conceptual model and to aid the user in its visualization. To this end, several tools are available within the software to assist users at various experience levels throughout the process, including identifying objectives, considering which components are important to include in the model, and effectively representing the model. In addition, the software program provides an extensive library of visual icons and a convenient drag/drop platform that allows users to build representations of their models quickly and efficiently.

"On-the-fly" construction of models facilitates rapid development and construction that easily incorporates stakeholder input. For example, a manager can project the software build environment onto an overhead screen at a stakeholders meeting and construct a visual representation of a conceptual model that incorporates real time input and guidance from all involved parties. In this manner construction of the model is a transparent process, effectively and instantaneously taking into consideration the wide range of feedback which may come from across the range of interested parties.

Conceptual Ecological Models: An Overview

A conceptual ecological model (CEM) is a description of how an ecological system operates, including both the key components as they relate to ecosystem function and how those components relate to one another. Essentially, a CEM tells "how the system works" (Fischenich 2008). The development of a CEM is considered an essential first step in ecosystem restoration planning.

CEMs that are used as part of ecosystem restoration projects are typically targeted at identifying those features and processes of importance and relevance to the specific goals of a particular project. In addition, the model may address possible restoration actions and how they would affect the system, and/or what attributes (metrics) could or should be used to measure "success." For example, a model to reduce coastal wetland loss in a specific region would include the various factors contributing to loss in the first place (e.g., hurricane/storm erosion, subsidence, sediment starvation, etc.), anthropogenic factors that may be influencing the system (e.g., previously constructed seawalls, river channelization), endangered or sensitive species that might be affected by restoration action (e.g., wetland birds, mangroves), and metrics for tracking specific items that the project is trying to improve (e.g., acres of marsh).

There are multiple reasons for developing conceptual models for ecosystem restoration projects. Early in the planning process, a conceptual model allows managers and stakeholders to reach consensus on what problems need to be addressed, how the system evolved to reach the point of needing restoration, and what concerns need to be considered in choosing the best restoration action.

A complex system can be simplified and distilled down to its fundamental components as related to the project, allowing for easier communication between interested parties who may have widely varying backgrounds, experience, and goals (stakeholders, for example, may include fishermen, farmers, federal agencies, state and local authorities, and so forth). As the project develops, the CEM provides a concrete point of reference as restoration options are considered and implemented, the success of those projects is evaluated, and (if feasible and necessary) adaptive management strategies are undertaken. For this reason, many agencies including the U.S. Army Corps of Engineers and the U.S. Environmental Protection Agency recommend the use of conceptual models in ecological restoration projects and provide guidance for their development and use (Fischenich 2008; Suter 1996).

A conceptual ecological model itself is fundamentally an understanding of how the ecosystem of interest operates; however, there are many ways in which the model

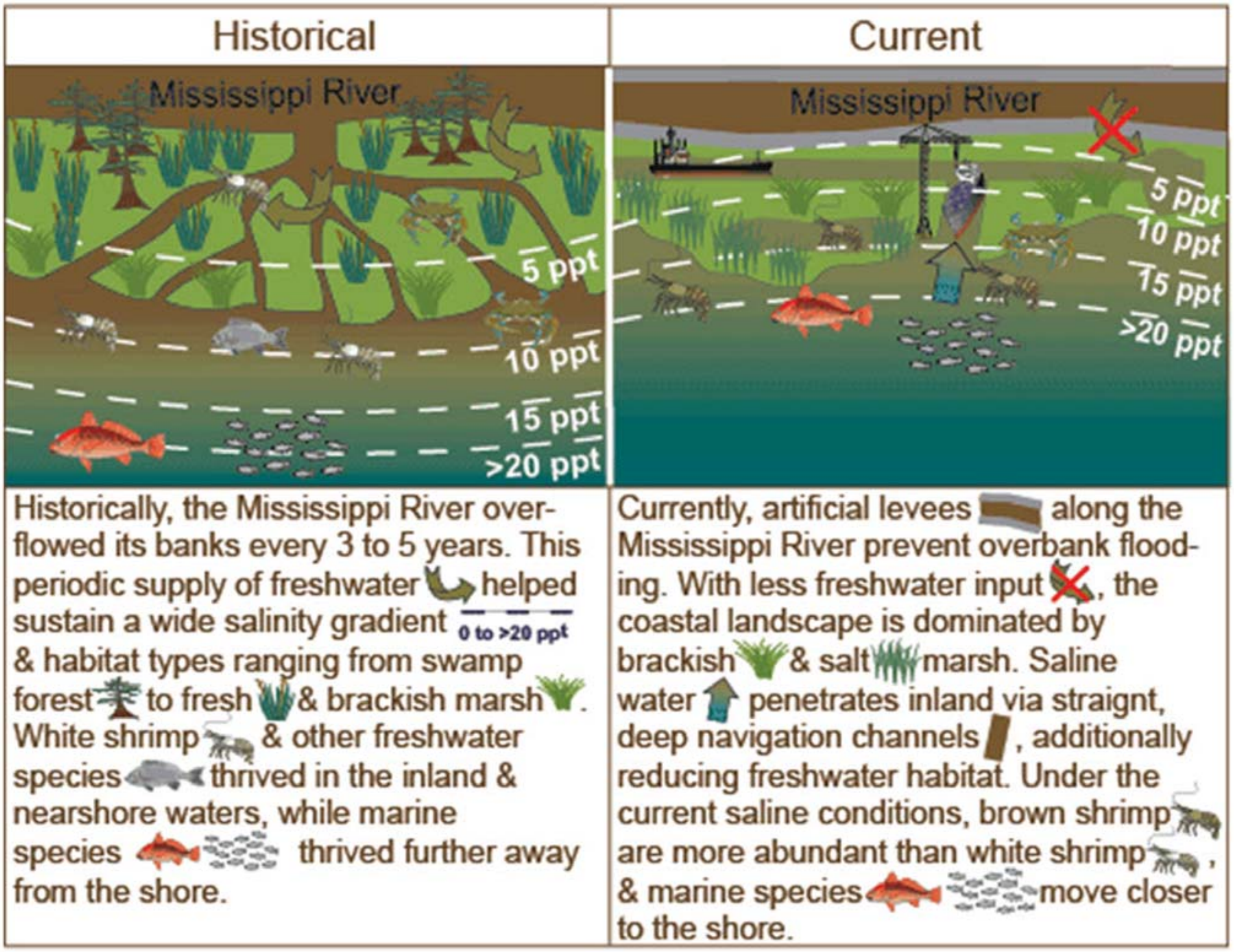

Figure 1. Conceptual model of coastal Louisiana (Coastal Louisiana Ecosystem Assessment and Restoration 2010).

itself may be communicated or visually represented. Most commonly, a conceptual model may consist of a verbal description of the site, a tabular expression of relationships among system components, or a graphical or pictorial representation.

Graphical or visual representations themselves may fall into one of several categories, most commonly a pictogram or rich picture diagram (essentially, a cartoon or image-based representation of the system, Figure 1), or a box/arrow display, which connects multiple components of the model to define the relationships between components (Figure 2). Each of these representations has differing strengths and weaknesses, and on any given project it may be necessary to include multiple representations to fully capture and communicate the model. For example, a pictogram of the mouth of the Mississippi River can be combined with a narrative description; the picture allows for a convenient visual point of reference, whereas the narrative provides more depth and detail on the processes themselves (Figure 1). Fischenich (2008) provides details on the different types of model representations, including pros and cons and criteria that should be used in selecting the best representation for any given situation.

Software User Guidance: Designing an Effective Model

The software program allows a user to select from three experience levels: Novice, Experienced, or Expert. The experience level dictates which tools are automatically provided by the software package, although any of the tools may be turned off or on by any level user at any time. For the novice user, the software program includes a wizard that provides basic information on the use of conceptual models, their purpose, and where to look for additional information. For both novice and experienced users, the software provides a checklist that guides the user through the various steps of constructing a model, including stating the objectives, defining the system, identifying components, and constructing a visual and narrative representation (Figure 3). Although users are advised to conduct

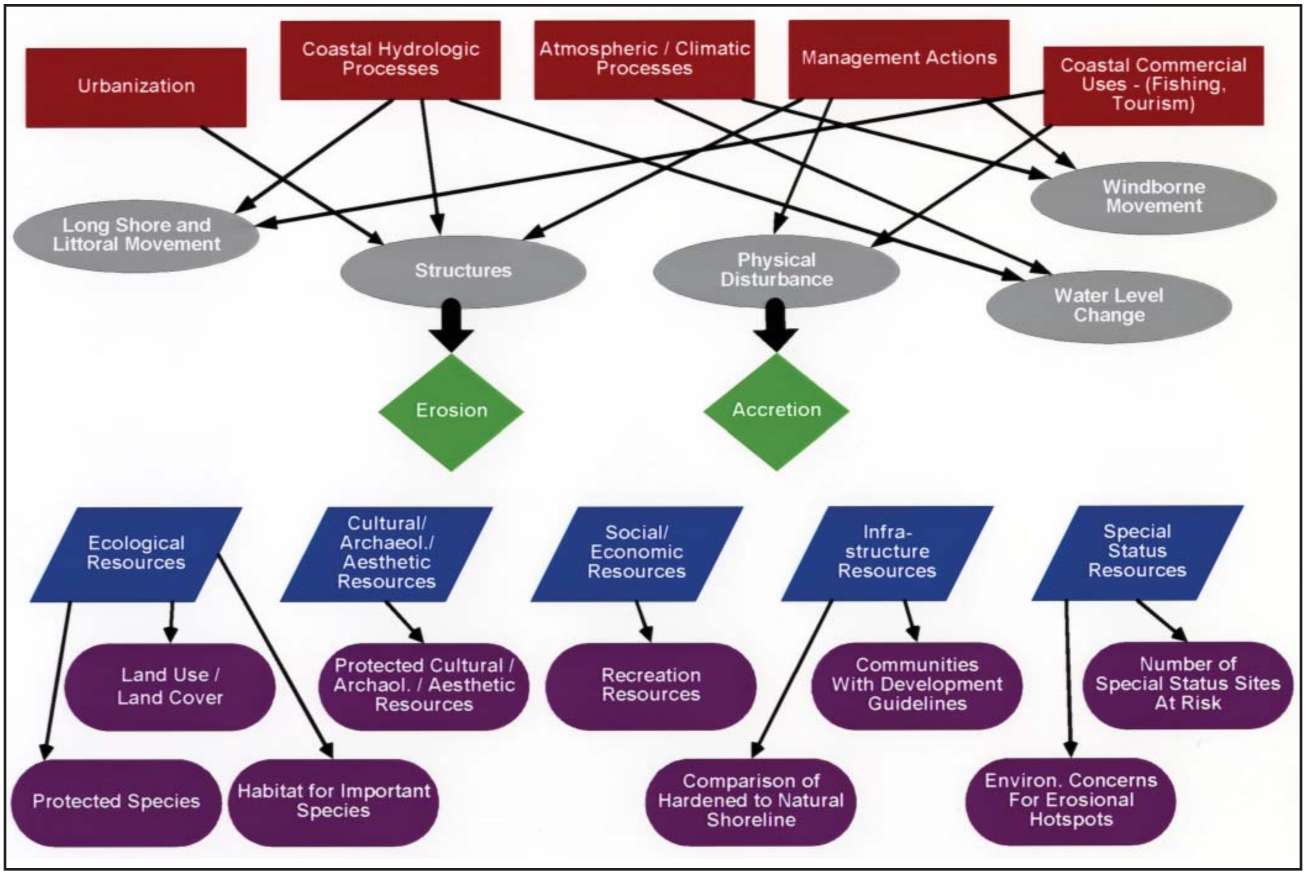

Figure 2. Indicators of environmental implications for erosion and accretion (adapted from Figure 6, Henderson and O'Neil 2007).

the steps of the process nominally in order, the checklist format does allow users to 'skip' a component as needed and return to complete it at a more convenient or appropriate time.

In addition to providing guidance on the construction of the conceptual model, CEMCAT also provides comprehensive guidance on the use of the software program itself. A searchable HTML help document may be opened and queried for help with specific tasks, and pop-up guidance may be turned on or off at any time to provide insight into the various software features, all of which are also accessible through a "Help" menu within the program.

Constructing a Conceptual Model Representation

As previously mentioned, there are many ways to represent a conceptual ecological model, two of the most common of which are included in the CEMCAT software. The CEMCAT software provides support for a narrative description in the form of a rich text editor that can be opened within the program, and allows import from and export to text files which may subsequently be opened and edited in other programs as required. For example, portions of the narrative description may be useful for incorporation in project reports. In addition, CEMCAT allows the construction of visual representations of multiple types, including both pictograms and box/arrow displays. Within a single project, the user may save more than one visual representation of varying types along with the narrative description, allowing for a single project to be represented in whatever forms may be necessary to completely capture and communicate the conceptual model.

Because of their highly visual nature, a pictogram or rich picture style display (see Figure 1) is often extremely useful in communicating the conceptual model to interested parties across a range of disciplines. However, constructing this type of representation can be a time-consuming and expensive process requiring the user to purchase expensive and proprietary editing software to build the representation in addition to locating appropriate icons to use for the visualization. CEMCAT provides a library of icons (courtesy of the University of Maryland Integration and Application Network, *http://ian.umces.edu/*), which the user can conveniently drag and drop into the provided workspace for the quick and efficient construction of pictogram style representations (Figure 4). These icon sets include 2- and 3-D representations of various ecosystem

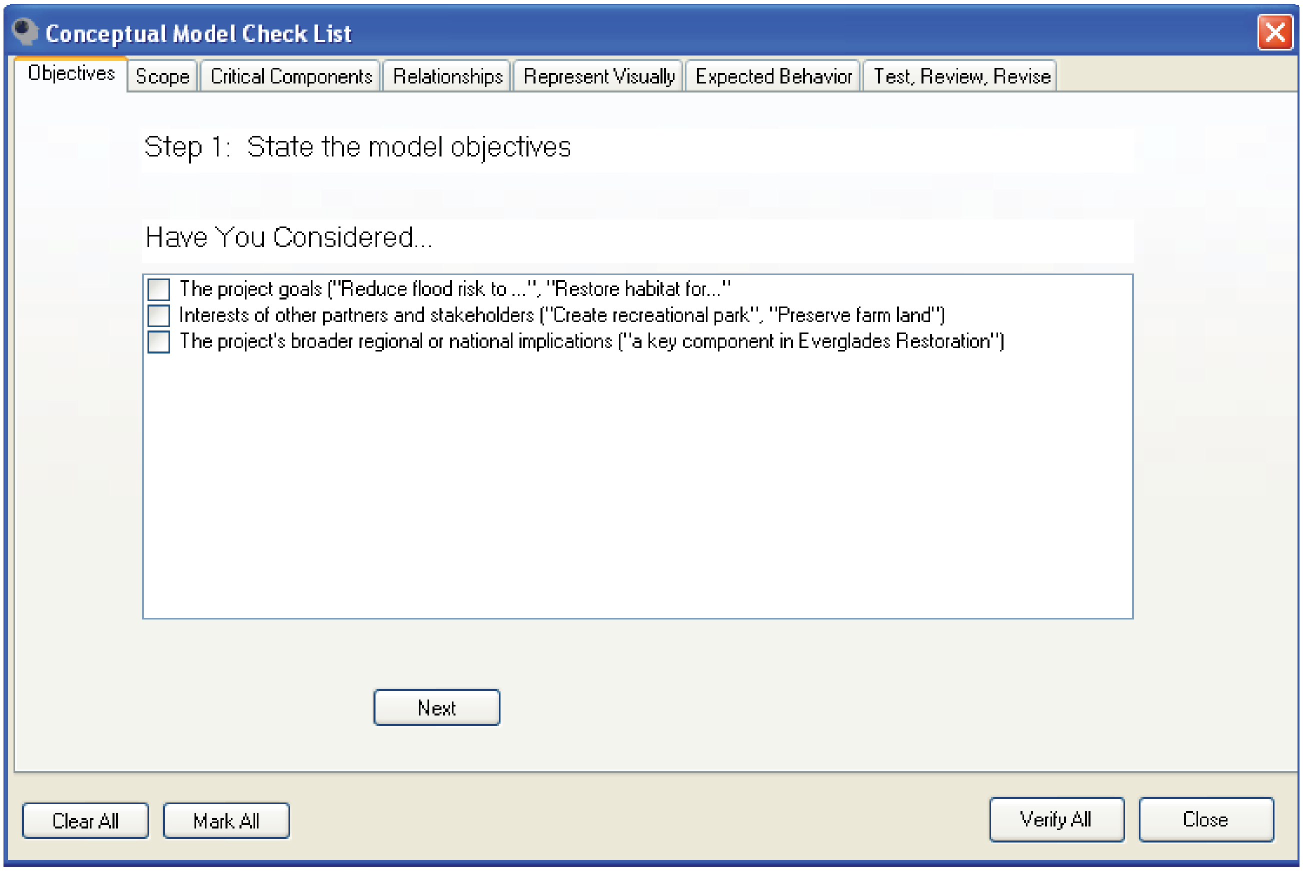

Figure 3. CEMCAT checklist provided automatically for novice and experienced users.

types that can be used to represent the project site. Alternatively, CEMCAT allows the user to import several common graphic formats, so a satellite image, aerial photo, or oblique digital photo of the actual site can be used as the backdrop.

CEMCAT also supports construction of box/arrow style visual representations (Figure 5). Formats for these representations are built into the CEMCAT framework, allowing a user to identify the type of model to be used and then simply label the appropriate boxes. The software then automatically formats the boxes in a consistent manner (e.g., all driver boxes in a Driver/Stressor model will be visually consistent, which allows a viewer of the model to rapidly understand the model components via visual association). Alternatively, users may develop and incorporate their own style of box/arrow model within the software program that will also carry automatic formatting capability. In this manner, the user can customize the appearance of the model after it has been constructed without individually reformatting each of the boxes. For example, if the user develops a custom layout of a State/Transition model and wishes to reformat all of the “state” boxes to a different shape or color, it can be done in a single step. The appearance of the arrows may also be modified within the program to delineate properties of the various connections. For example, a different line weight might indicate the importance of the connection, whereas a different line style (solid vs. dashed) might indicate relative certainty about the level of connection.

Summary

Conceptual ecological models are an essential component of ecosystem restoration project planning, though relatively few tools have emerged that provide guidance in model development or allow for visual representations of the models themselves to be constructed rapidly and efficiently. CEMCAT has been developed by the ERDC EL to fulfill this need, providing a software program that both outlines the process of constructing the model itself and offers tools to facilitate the development of a visual representation of the finished product. It is hoped that this tool will enable more planners and managers to incorporate conceptual models into all phases of ecosystem restoration projects. The model is posted on the Environmental Benefits Assessment website and is available for download during this testing period (*http://cw-environment.usace.army.mil/eba/cemcat.cfm*). Based upon comments received from users during this initial release period, CEMCAT will be revised in September 2010.

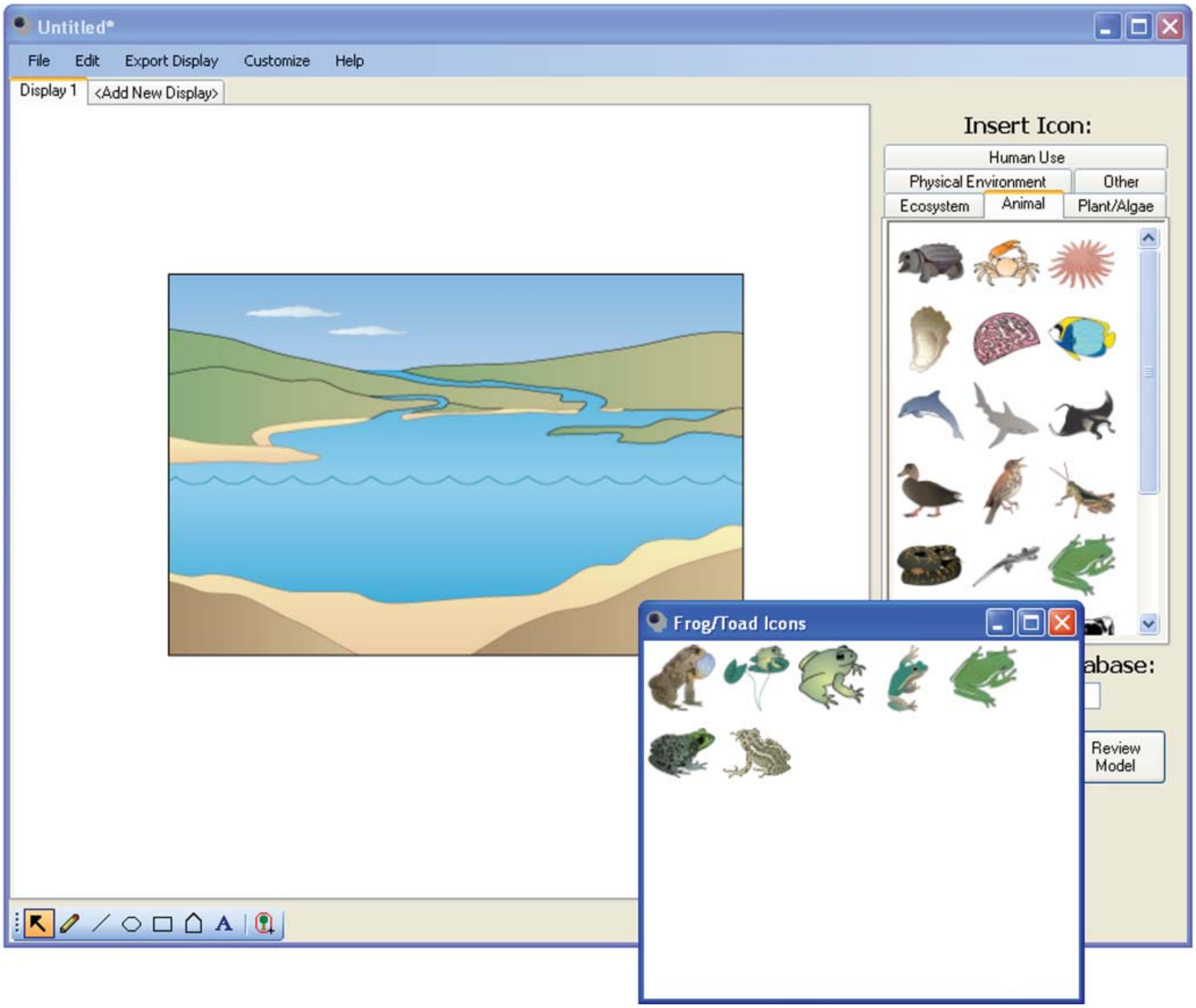

Figure 4. Construction of a pictogram-style model representation in CEMCAT.

Points of Contact

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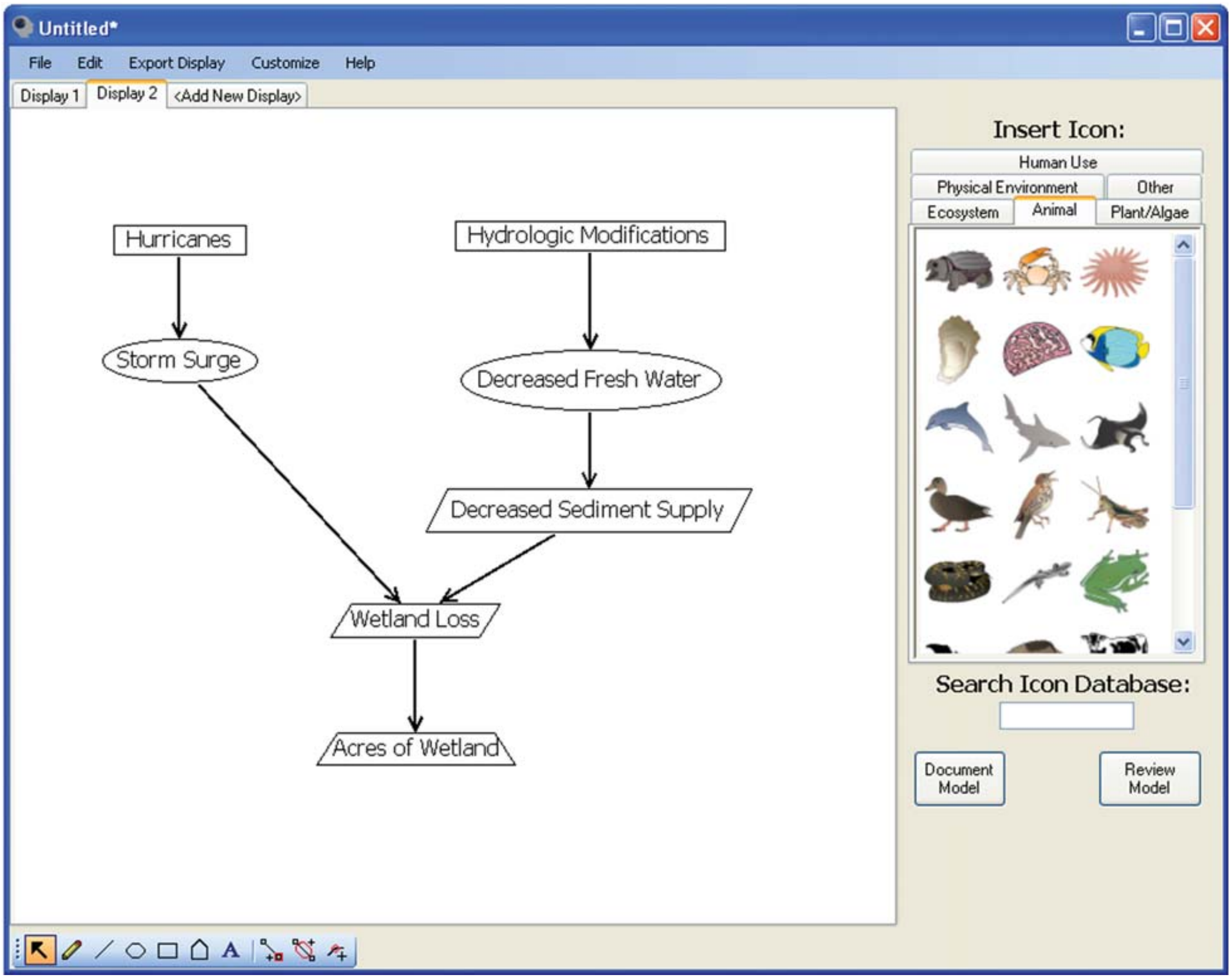

Figure 5. Construction of a box/arrow diagram in CEMCAT.

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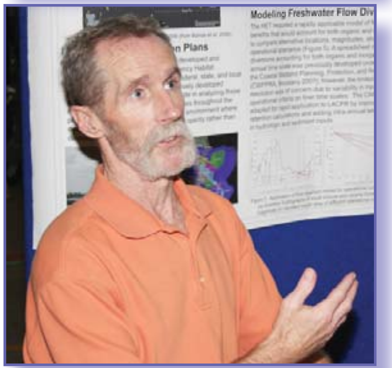

Dr. Fischenich is the Technical Leader for Ecosystem Restoration at ERDC-EL, and Dr. Dalyander develops desktop tools for planners and numerical models for ecosystem assessment.

Calendar of Upcoming Events

13-17 November 2010 -- Restore America's Estuaries
16 November 2010 -- Webinar - Fish Passage
30 November 2010 -- Webinar - Hydraulics (ADH) Applications for Restoration Planning on the Upper Miss
14-18 March 2011 -- Training: Statistics/Analysis for Ecological Problems
1-5 August 2011 -- National Conference on Ecosystem Restoration (NCER) 2011

EMRRP Technical Notes -- 2010

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Related Research Published by ERDC -- 2010

ERDC/EL TR-10-11. Operational Draft Regional Guidebook for the Functional Assessment of High-gradient Ephemeral and Intermittent Headwater Streams in Western West Virginia and Eastern Kentucky. U.S. Army Corps of Engineers

ERDC/EL TR-10-12. A New Nonmonetary Metric for Indicating Environmental Benefits from Ecosystem Restoration Projects of the U.S. Army Corps of Engineers. Richard A. Cole

ERDC/EL TR-10-13. Incidence and Management Costs of Freshwater Aquatic Nuisance Species at Projects Operated by the U.S. Army Corps of Engineers. Richard A. Cole, Paul F. Scodari, and Monica A. Franklin

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