It takes many letters, words, sentences and paragraphs to describe the processes that make up an ecosystem. In short, a picture is worth a thousand words.

Watershed Characteristics
Urban landuse
Large sewage discharges
Clearing of riparian vegetation
Numerous sediment rich stormwater discharges

River Use
Prawn trawling
Dredging

River Characteristics
High turbidity
Light limited
Tidal flushing
Sediment resuspension

Science communication is an essential component of problem solving. Effective scientific communication requires synthesis, visualization and appropriate context. Conceptual diagrams, or “thought drawings,” are an excellent means of providing these requirements. A conceptual diagram uses symbols to convey the essential attributes of a system.

There are four important reasons for using conceptual diagrams: 1) To clarify thinking and avoid ambiguities. 2) To provide a unique communication interface between scientific disciplines or between scientists and non-scientists. 3) To identify gaps, establish priorities and solicit an agreed synthesis. 4) Recent technological advances have made it possible to generate conceptual diagrams without graphic art training or specialized equipment.

Conceptual diagrams can be applied in: a) setting research agendas, b) developing scientific syntheses, c) designing monitoring programs and d) identifying management priorities.

One of the key aspects of conceptual diagrams is the use of symbols. Symbols are one of the most ancient forms of human communication and remain a common feature of everyday life. They are very useful at depicting unequivocal messages that can transcend cultures, languages and times. The size, shape, color and position of symbols all convey meaningful information, and when arranged into a diagram, they can augment or replace words. For example, Charles Darwin’s diagram depicting his theory of coral reef formation has been reproduced thousands of times since it was first published in 1842. Yet the depiction of a sailboat is unequivocal, as is the image of a sailboat created centuries ago in a cave painting by an indigenous Australian.

a) A conceptual diagram by Charles Darwin, first published in England in 1842.2
b) Enlargement of the sailboat that appears in the above figure.
c) Cave art by an indigenous Australian, discovered in north Queensland.
Runoff and groundwater flow add nutrients, sediments and humics to the estuary. Nutrients are taken up from the water by phytoplankton, epiphytes and SAV. DIN = Dissolved Inorganic Nitrogen. DIP = Dissolved Inorganic Phosphorus. Accumulations of fine sediment can be resuspended resulting in light reduction to SAV. Small grazers feed on epiphytes growing on SAV. Some of the light incident upon the water surface is reflected directly. Kd (water column attenuation coefficient) is a measure of the light reduction due to particles, humics and phytoplankton. The quality of light (color) also changes from white to blue/green. Ke (epiphyte attenuation coefficient) is a measure of the light reduction due to epiphytes growing on SAV.

The difference between conceptual models and conceptual diagrams is apparent. The original conceptual model on the left took two pages of text to explain. In comparison, the adapted conceptual diagram is self-explanatory, it stands alone, and it also includes “process.”

**Message:** Effects of a particular process on seagrass beds

**Audience:** Scientific peers, resource managers

**Key Features:**
- Self-contained legend
- Inset showing greater detail

**Web:** [http://www.chesapeakebay.net/pubs/sav/index.html](http://www.chesapeakebay.net/pubs/sav/index.html)

This conceptual diagram was designed for publication in a peer-reviewed scientific journal. It demonstrates that symbols can be just as meaningful when printed in black and white or gray-scale. The diagram depicts the biological and physical processes of a tropical seagrass ecosystem.

**Message:** Processes affecting seagrass beds on a local scale

**Audience:** Scientific peers

**Key Features:**
- Effective use of gray-scale (adapted from a color diagram)
- Footnotes, referred to in the text

The symbol libraries created by the Integration & Application Network use “click & drag” technology. This advanced technology makes it easy for anyone to assemble a conceptual diagram quickly and easily. This particular diagram, showing an oblique view of a coastline, was created to depict an evolving view of an ecosystem and its processes for the broader community.

**Message:** Key impacts and processes in the river and the bay

**Audience:** General public

**Key Features:**
- Section headings
- Symbols incorporated into legend text
- Oblique view

**Web:** [http://www.healthywaterways.org/](http://www.healthywaterways.org/)

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**ECOSYSTEM COMPARISONS**

This series of comparative conceptual diagrams were created for use in the Land-Ocean Interactions in the Coastal Zone (LOICZ) Project.

**Message:** General processes affecting different ecosystem types on a global scale

**Audience:** Scientific peers, managers and general public

**Key Features:**
- Detailed legend contained within base
- Three comparative diagrams with a similar layout and scale
- Section headings

**Web:** [http://www.nioz.nl/loicz/](http://www.nioz.nl/loicz/)
Conceptual diagrams are an important communication tool for both studying and solving environmental problems. Based on the idea that a picture can say a thousand words, they provide diagrammatic representations of ecosystems in which key features and major impacts can be illustrated, communicating concepts, summarizing information and indicating key processes and stresses within an environment. They serve to highlight the most important ecosystem features, depicting the processes and biota, and can provide focus for research or monitoring efforts. Good conceptual diagrams have many lives in many places.

On a technical level, the term ‘conceptual diagram’ comes from the Latin word conceptus meaning “thought” and the Greek word diagramma meaning “to mark out by lines.” Essentially, it is a diagram depicting the arrangement and relationships of key attributes within a system, by using a variety of appropriate symbols that are easily understood.

Generation of a conceptual diagram involves: 1) Identifying the message, 2) Identifying the audience, 3) Listing structural and functional elements, 4) Experimenting with different ways to visualize the structural and functional elements and 5) An editing process involving feedback from the intended audience.

Further Resources:

The DVD, Powerpoint Presentation and Conceptual Diagram Creator are also available on the website: http://ian.umces.edu/

References: