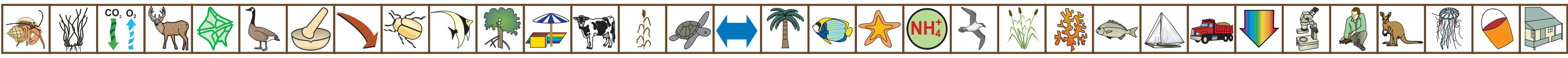
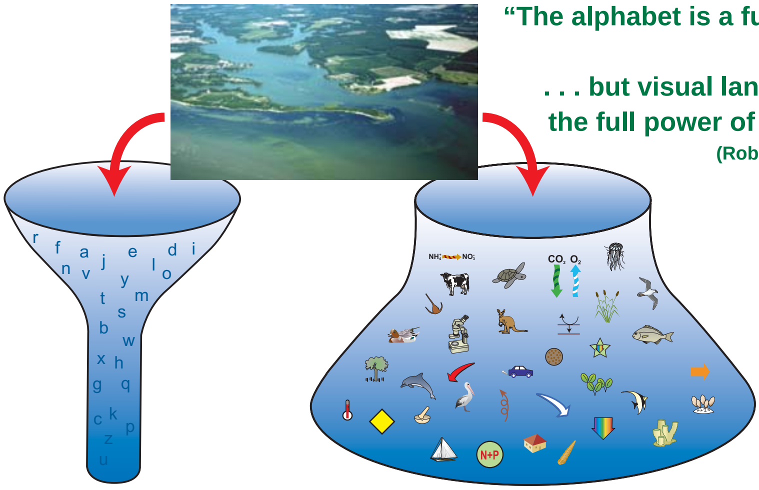
CONCEPTUAL DIAGRAMS:

TOOLS FOR SCIENCE COMMUNICATION





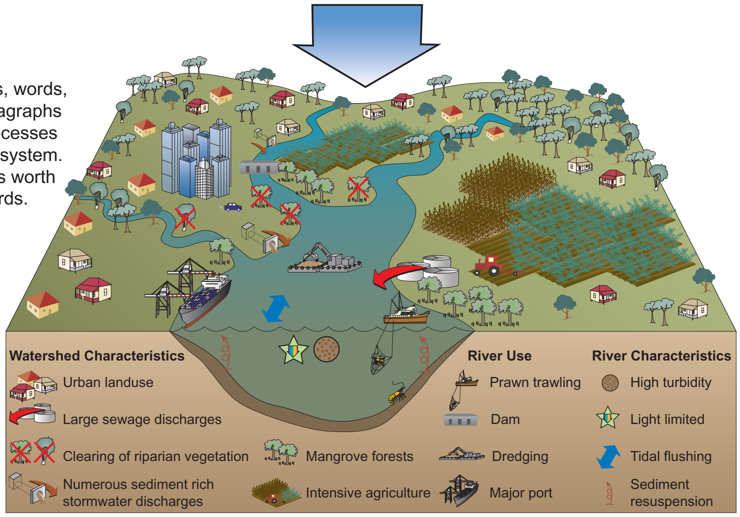
"The alphabet is a funnel. . .

(John Culkin)

. . . but visual language unleashes the full power of communication"

(Robert E. Horn, 1999)[1]

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.



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:

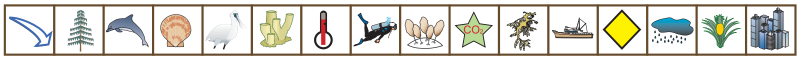
a) setting research agendas,

b) developing scientific syntheses,

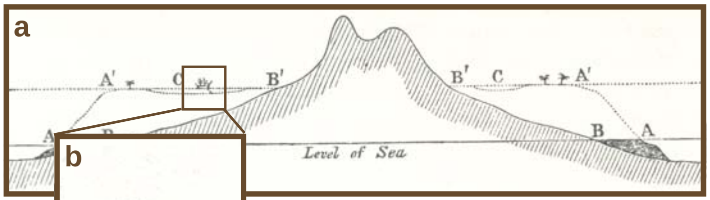
c) designing monitoring programs and

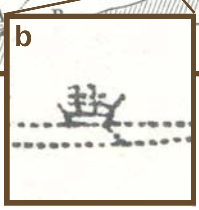
d) identifying management priorities.

SYMBOLS FORM A VISUAL LANGUAGE



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.

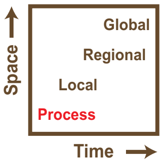




a) *A conceptual diagram by Charles Darwin, first published in England in 1842.*[2]

b) *Enlargement of the sailboat that appears in the above figure.*

c) *Cave art by an indigenous Australian, discovered in north Queensland.*



MODELS VS DIAGRAMS

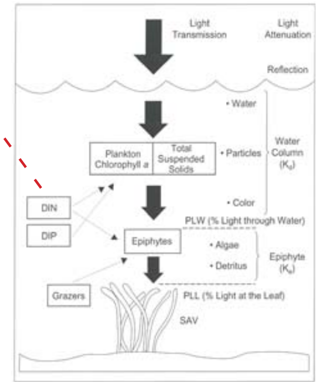
Conceptual Model [3]

Depicting process

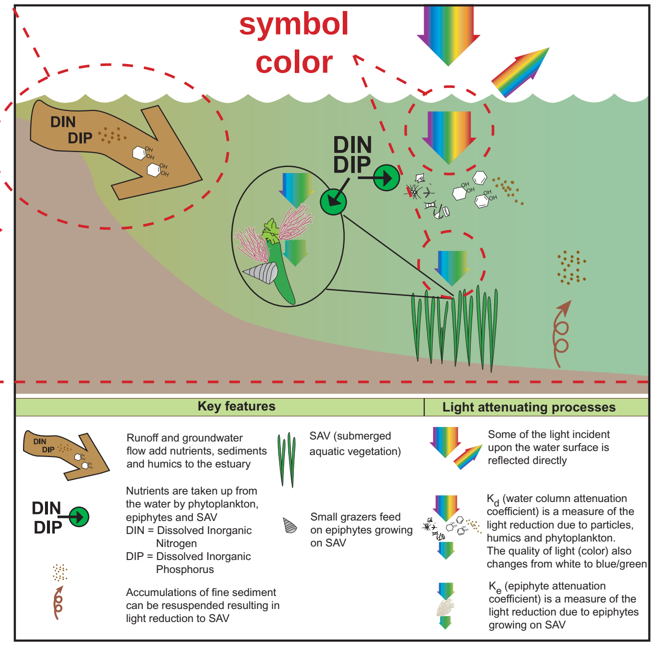
Conceptual Diagram

Uses boxes to represent processes

Requires accompanying text to explain diagram



Use of symbol color



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

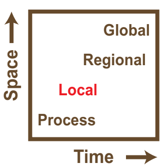
Audience: Scientific peers, resource managers

Key Features:

- Self-contained legend
- Inset showing greater detail

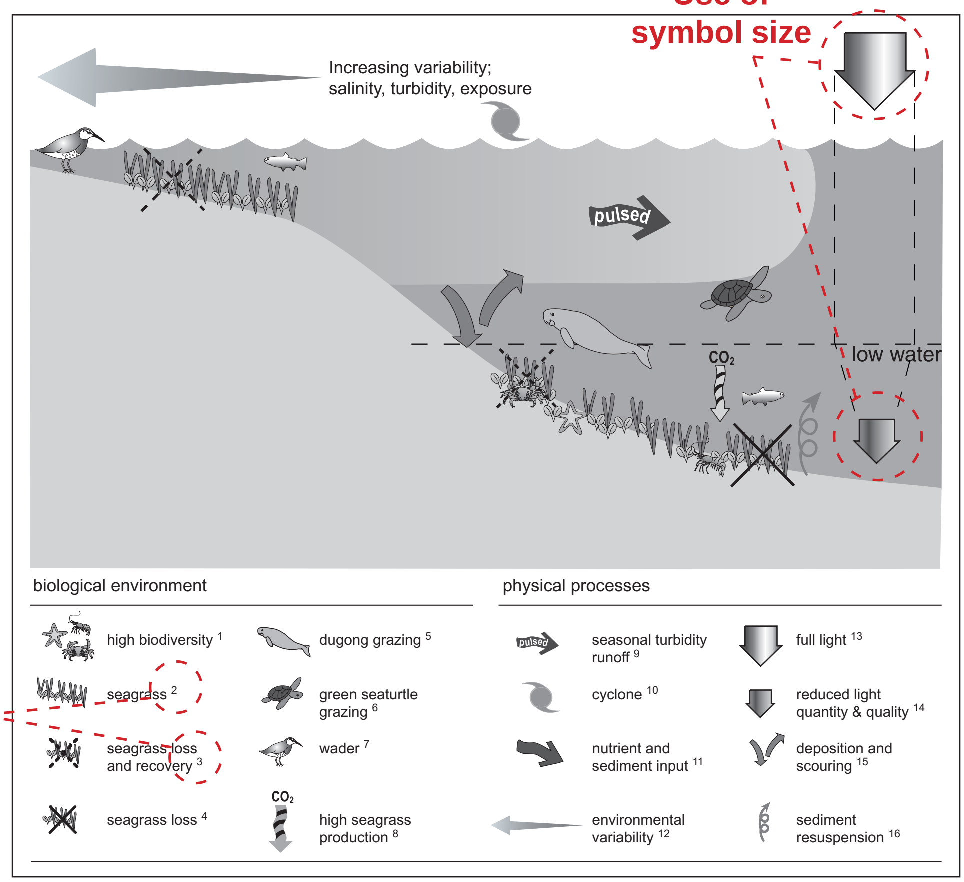
Web: http://www.chesapeakebay.net/pubs/sav/index.html

Self-contained legend



PEER REVIEW PUBLICATIONS

Use of symbol size



This conceptual diagram was designed for publication in a peer-reviewed scientific journal.[4] 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

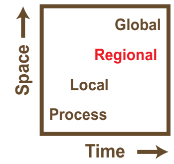
Key Features:

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

Web: http://www.marine.uq.edu.au/marbot/

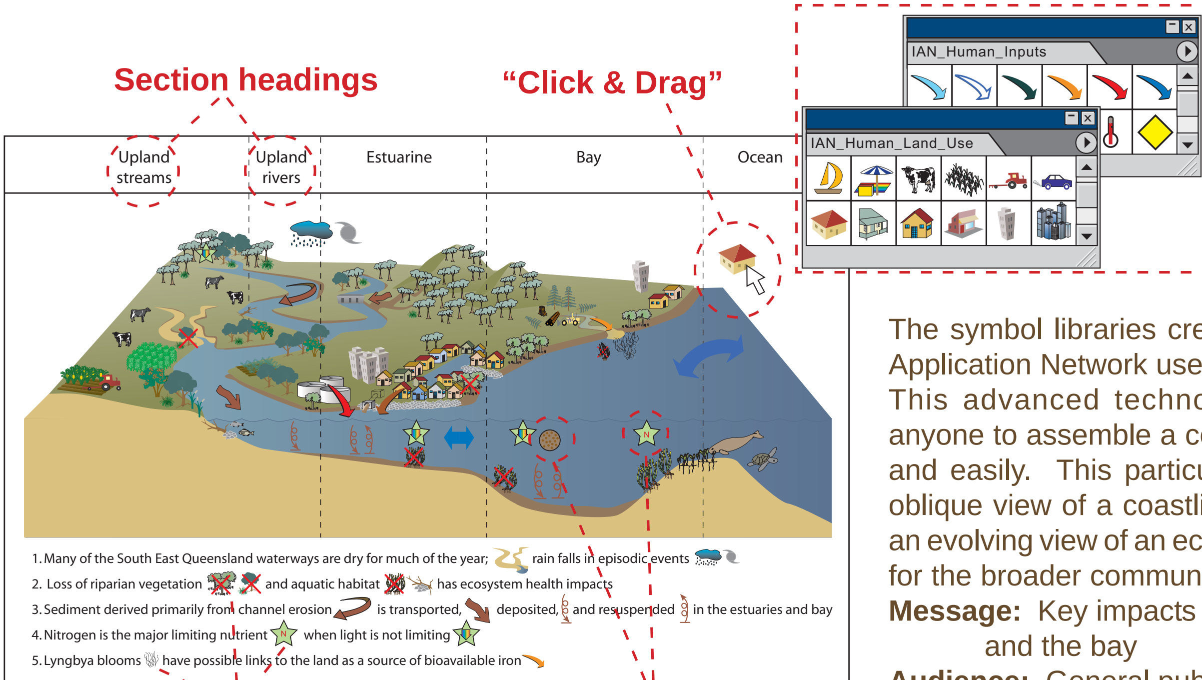
Scientific references

SCIENCE / MANAGEMENT INTERFACE



Section headings

"Click & Drag"



Symbol Libraries

Symbols incorporated into legend text

Use of symbol shape

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.

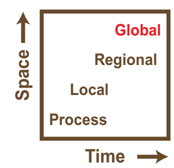
Message: Key impacts and processes in the river and the bay

Audience: General public

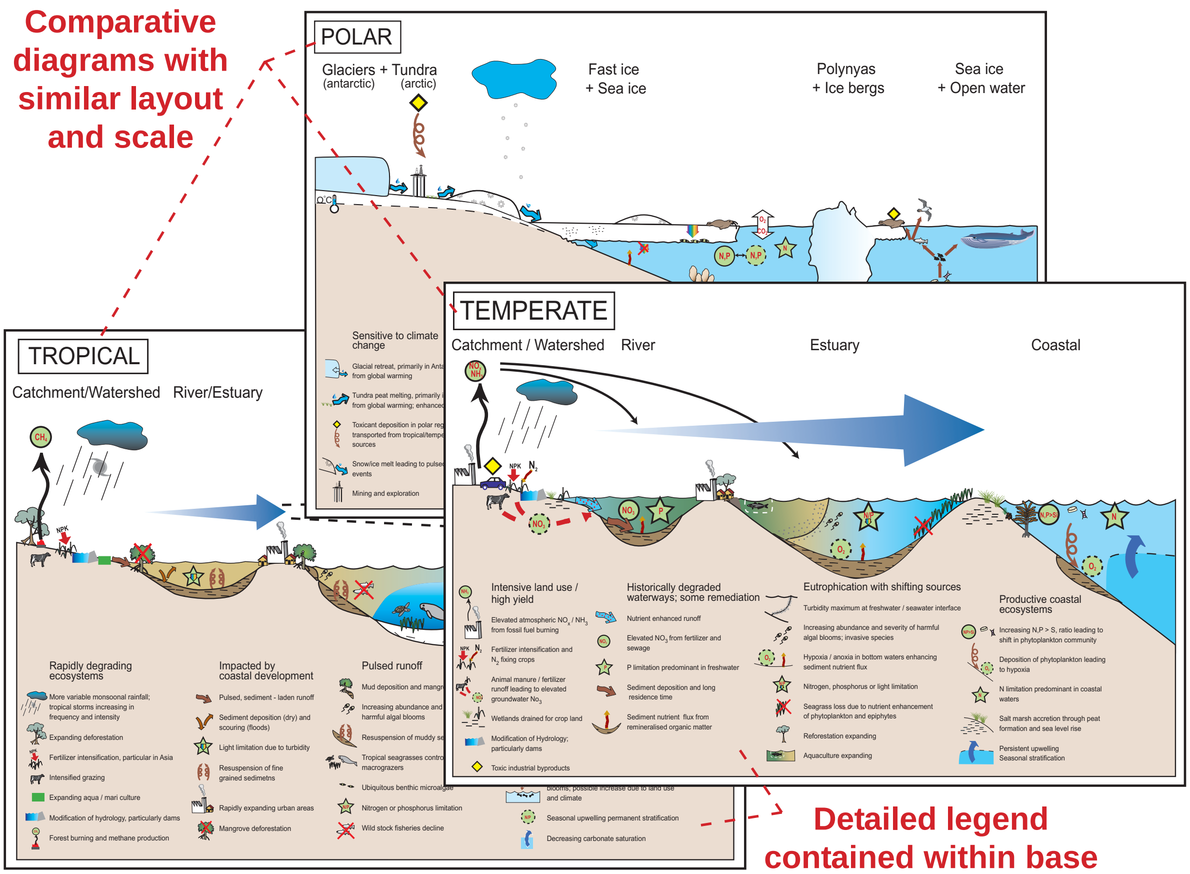
Key Features:
- Section headings
- Symbols incorporated into legend text
- Oblique view

Web: http://www.healthywaterways.org/

ECOSYSTEM COMPARISONS



Comparative diagrams with similar layout and scale



Detailed legend contained within base

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

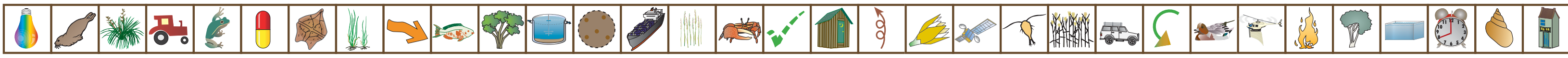
Message: General processes affecting different ecosystem types on a global scale

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/

CONCEPTUAL DIAGRAMS ARE "THOUGHT DRAWINGS"

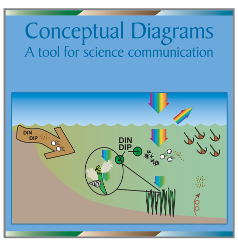


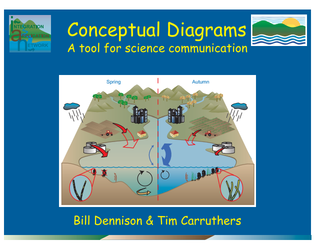
Conceptual diagrams are an important communication tool for both studying and solving environmental problems. Based on the idea that a picture can say a thousand words, they provide diagrammatic representations of ecosystems in which key features and major impacts can be illustrated, communicating concepts, 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.

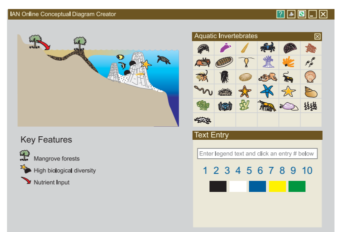
On a technical level, the term 'conceptual diagram' comes from the Latin word *conceptus* meaning "thought" and the Greek word *diagramma* meaning "to mark out by lines." Essentially, it is a diagram depicting the arrangement and relationships of key attributes within a system, by using a variety of 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:







Download the Symbol Libraries for free from the IAN Website: http://ian.umces.edu/

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

References:

1. Horn, R.E., 1998. Visual Language: Global Communication for the 21st Century. MacRovu Inc., Washington.
2. Darwin, C., 1874. The structure and distribution of coral reefs (2nd ed.). Smith-Elder, London.
3. Batiuk, R.A. *et al*., 2000. Chesapeake Bay: Submerged Aquatic Vegetation, Water Quality and Habitat-Based Requirements and Restoration Targets: A Second Technical Synthesis. United States Environmental Protection Agency for the Chesapeake Bay Program.
4. Carruthers, T.J.B., Dennison, W.C., Longstaff, B.J., Waycott, M., Abal, E.G., McKenzie, L.J. and Lee Long, W.J. (2002). Seagrass habitats of northeast Australia: Models of key processes and controls. Bulletin of Marine Science: Vol. 71, No. 3, pp. 1153-1169.

*The **I**ntegration and **A**pplication **N**etwork (IAN) is a collection of scientists interested in **solving**, not just studying environmental problems. The intent of IAN is to inspire, manage and produce timely syntheses and assessments on key environmental issues, with a special emphasis on Chesapeake Bay and its watershed. IAN is an initiative of the faculty of the University of Maryland Center for Environmental Science, but will link with other academic institutions, various resource management agencies and non-governmental organizations.*

PRIMARY OBJECTIVES FOR IAN

- **Foster** problem-solving using integration of scientific data and information
- **Support** the application of scientific understanding to forecast consequences of environmental policy options
- **Provide** a rich training ground in complex problem solving and science application
- **Facilitate** a productive interaction between scientists and the broader community

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INTEGRATION APPLICATION NETWORK