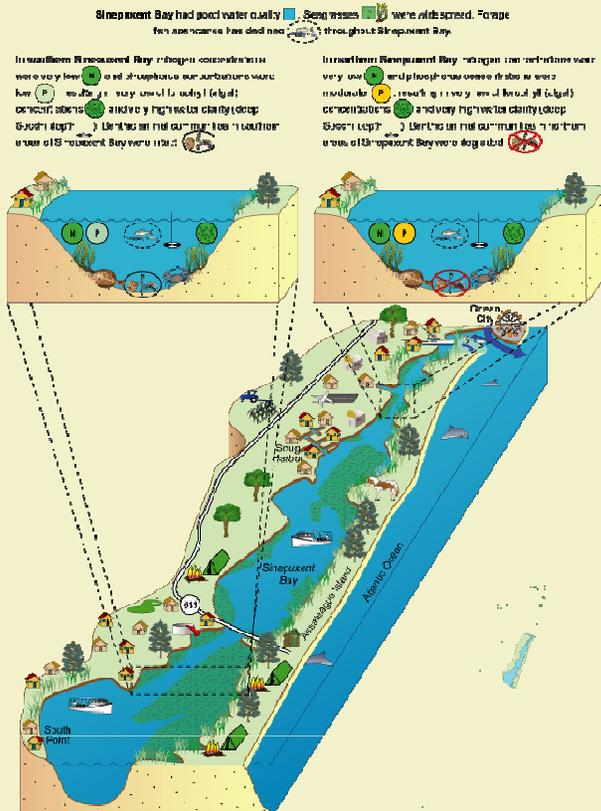


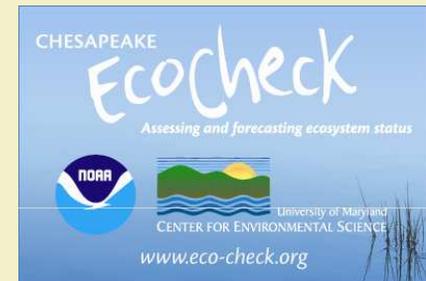
Conceptual diagrams and synthesis figures:

Tools for effective science communication



Caroline Wicks
 Science Communication Course
 Charleston, SC
 April 10, 2008

Caroline.wicks@noaa.gov
 www.ian.umces.edu



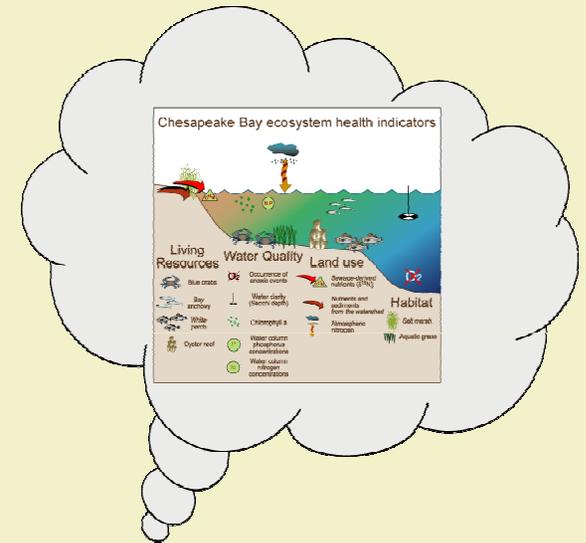
What is a conceptual diagram?

‘**Concept**’ from Latin ‘conceptus’ (meaning *thought*); something conceived in the mind (Webster’s 3rd Dictionary, 1986)

‘**Diagram**’ from Greek ‘diagramma’ (meaning *to mark out by lines*); a graphic design that explains rather than represents, a drawing that shows arrangement and relations (Webster’s 3rd Dictionary, 1986)

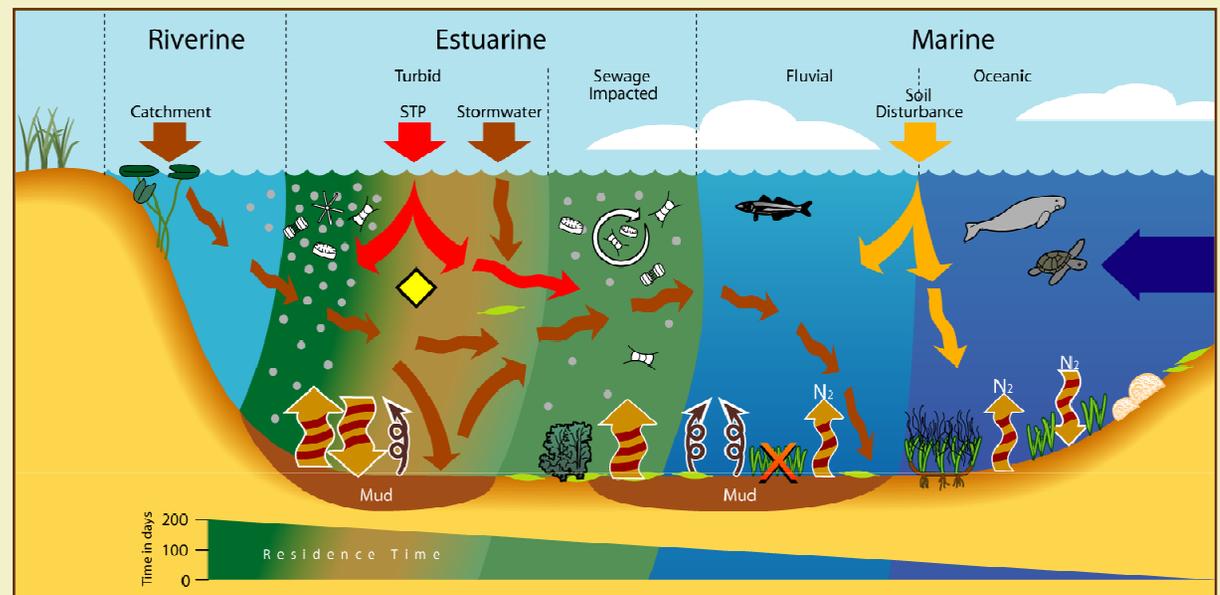
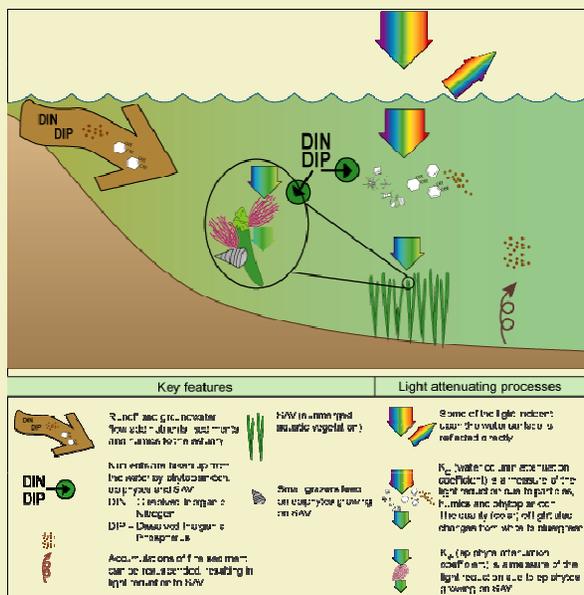
‘**Model**’ from Latin ‘modulus’ (meaning *small measure*); an abstract representation of a system or process (Turner, Gardner & O’Neill, 2001)

Conceptual diagram = A diagram using symbols that depicts the essential attributes of a system



Why use conceptual diagrams?

- Helps to clarify thinking (words can be ambiguous; an image commits to the message being portrayed)
- Communication (one-way and two-way – idea presentation and idea development)
- Identify gaps / priorities / essential elements
- Develop syntheses (or present synthesis)



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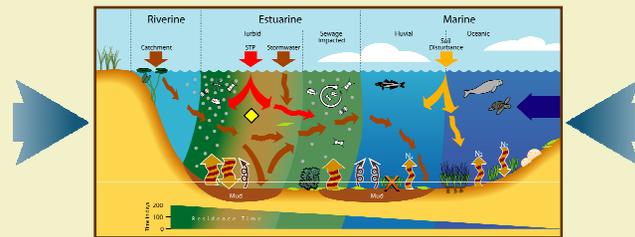
Conceptual diagrams provide an interface

Science

*Conceptual
diagram*

Community

Current
understanding



Priorities &
environmental
values

Credibility &
support

Shared vision

Commitment
& resources



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Good conceptual diagrams are used extensively

Z scheme of photosynthesis

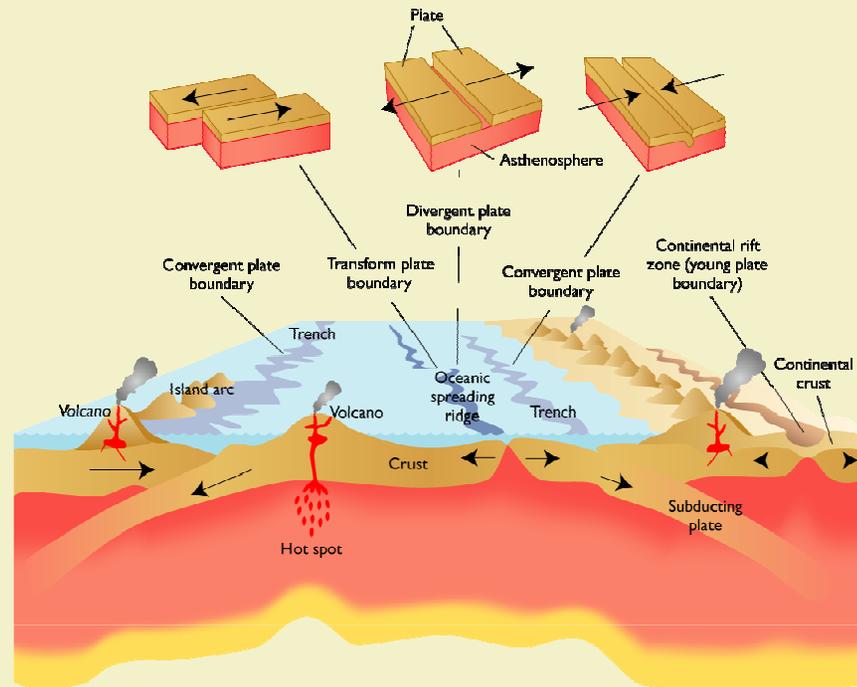
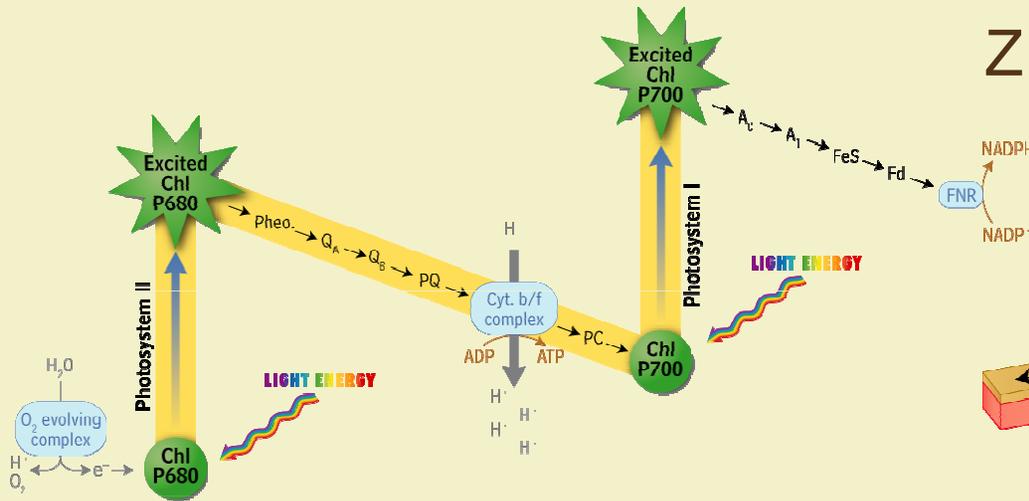
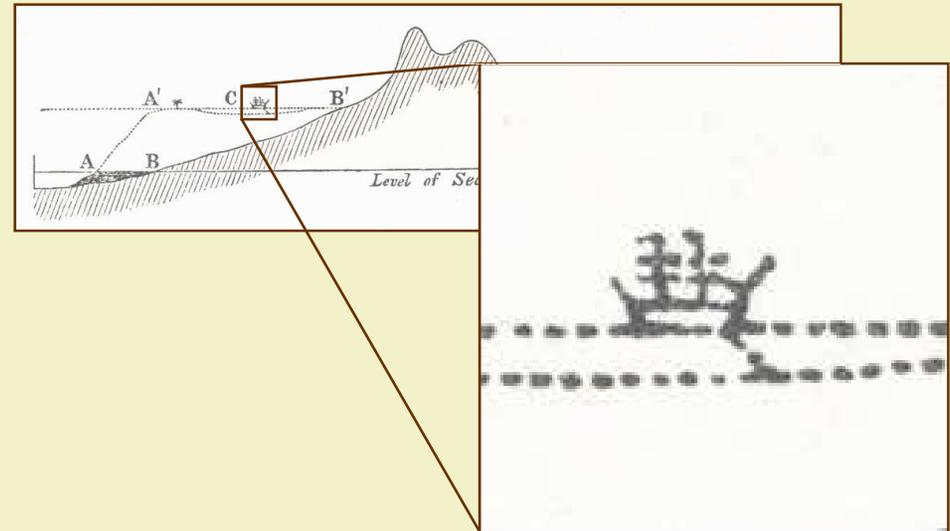


Plate tectonics

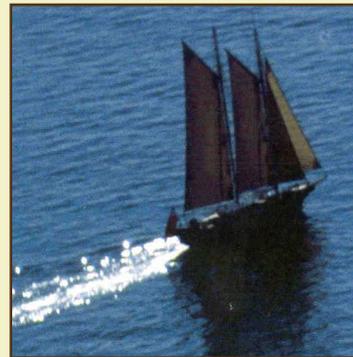
Conceptual diagrams use symbols: an ancient technique to depict unequivocal messages



Cave drawing
(Australian aborigines)



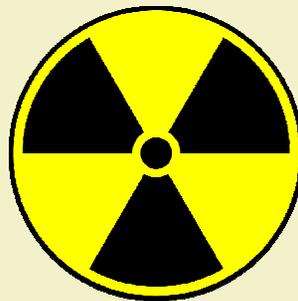
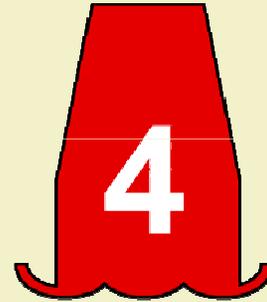
Darwin's conceptual diagram



Symbols (icons) are a key element of conceptual diagrams

- **‘Symbol’** from Greek ‘symbolon’ (*token of identity*) and Latin ‘symbolum’ (*token, sign*)
- **‘Icon’** from Greek ‘eikon’ (*to resemble*); pictorial representation
- A sign that signifies by virtue of sharing a property with what it represents
 - something that stands for or suggests something tangible 
 - a visible thing that stands for something invisible or intangible 
- Symbols used in mathematics (e.g. π), chemistry (e.g. ^{210}Pb), music (e.g. ) , weather (e.g. ) , religion (e.g. ) , corporations (e.g. ) , and organizations (e.g. )
- Symbols can be universal; language independent 
- Symbols are scalable; size of symbol can represent relative importance (e.g.  vs. )
- Symbols can be information-rich: size, shape, color and position of symbols can convey information

Both **shape** and **color** of symbols can be important for recognition



In conceptual diagrams, as in maps, symbols need to be explained in a legend

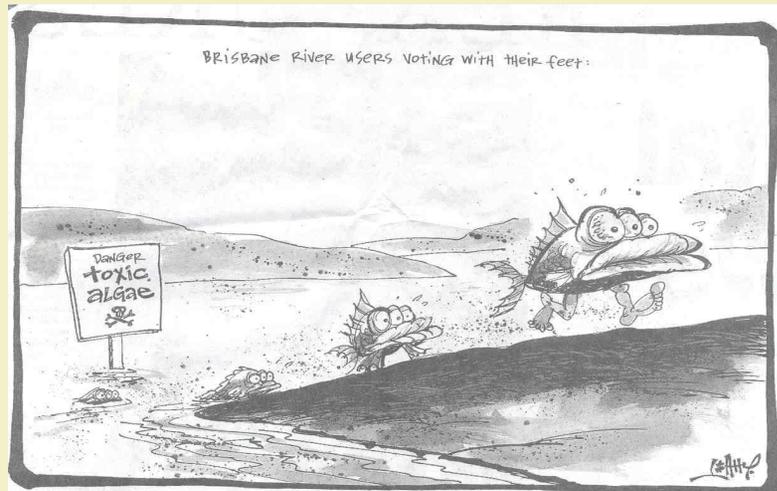
Map legend

	Hiking trail		Parking
	Steep trail; arrows point uphill		Ranger station
	Overlook		Picnic area
	Horse trail		Wheelchair accessible
	Unpaved road		Public campground
	Group camp; check at park headquarters for availability		Private campground

Conceptual diagram legend

Mangrove region	Transition zone	Seagrass beds	Reef	Deep Edge
Landward: - nitrogen, phosphorous, & sediment input from land  - hypo-hyper salinity changes 	Mangrove - frequent inundation - epibiotic filters 	- <i>Thalassia spp.</i> are dominant  Diversity of limiting factors: - nutrients  - wave energy  - hard substrate 	Reef - hard substrate limiting seagrass growth  - wave energy 	Deep Edge - seagrass are light - limited  - small species present, e.g. <i>Halophila spp.</i> 
Middle: - phosphorous - limited  - high salinity 	Seagrass - desiccation  - high light penetration 			

Conceptual diagrams are not...

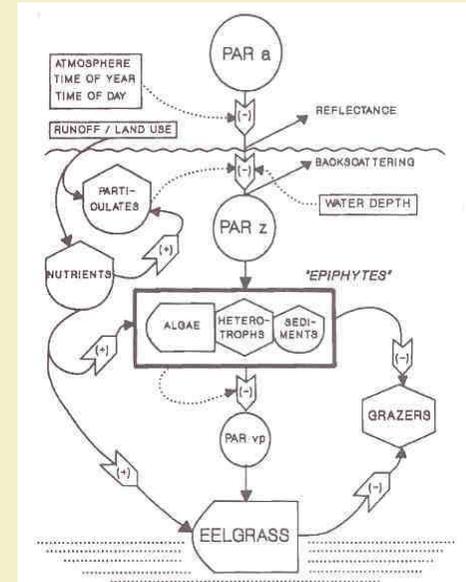


... cartoons

Conceptual diagrams are not...



... cartoons

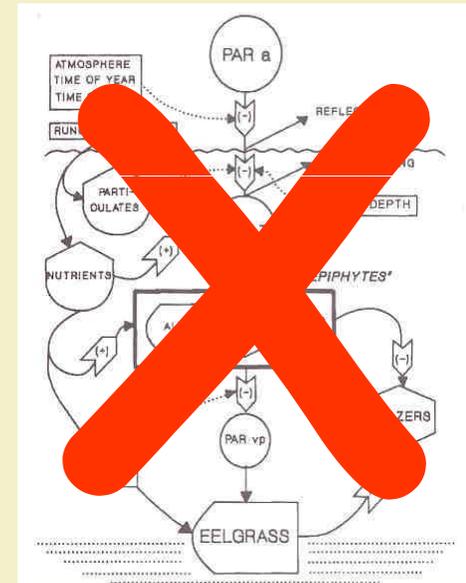


... model relationships

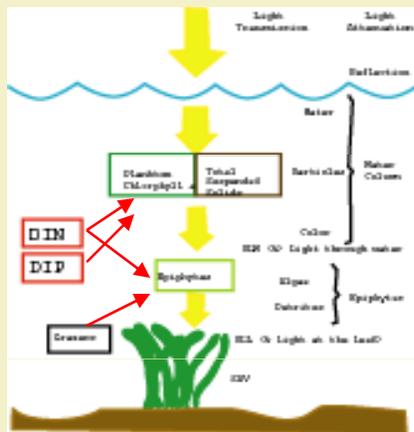
Conceptual diagrams are not...



... cartoons



... model relationships

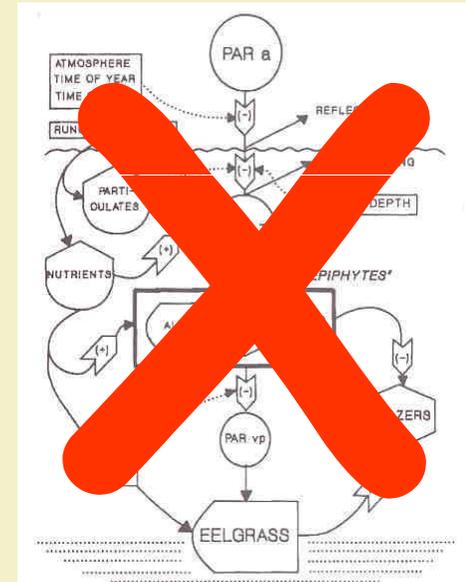


... colored box & arrow diagrams

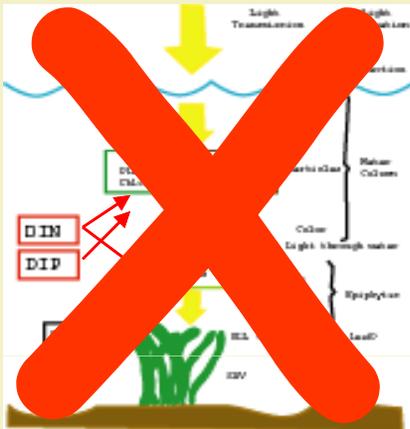
Conceptual diagrams are not...



... cartoons



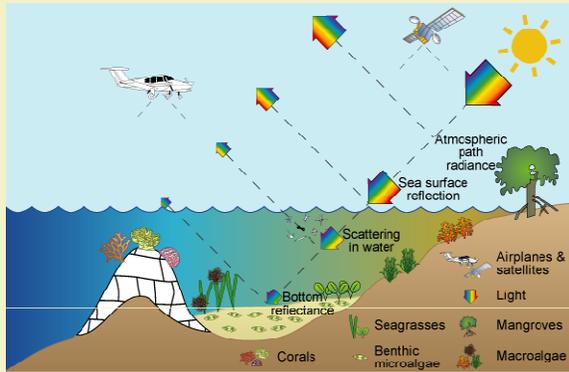
... model relationships



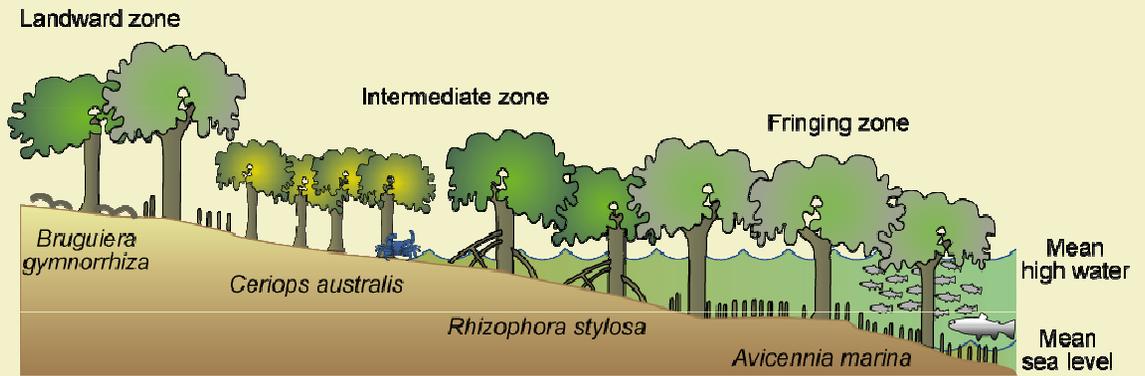
... colored box & arrow diagrams

... A REPLACEMENT FOR GOOD, WELL INTERPRETED DATA!

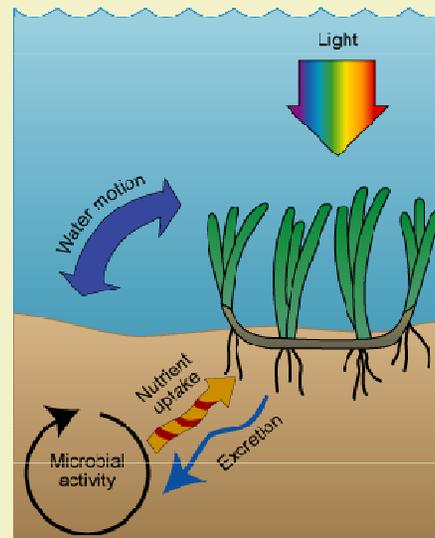
Conceptual diagrams and synthesis figures can depict processes at different scales



← kilometers →



← meters →



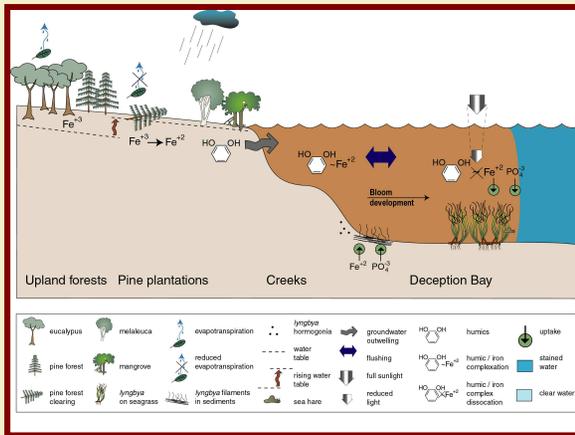
← centimeters →

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APPLICATION

NETWORK

Various applications of diagrams and figures

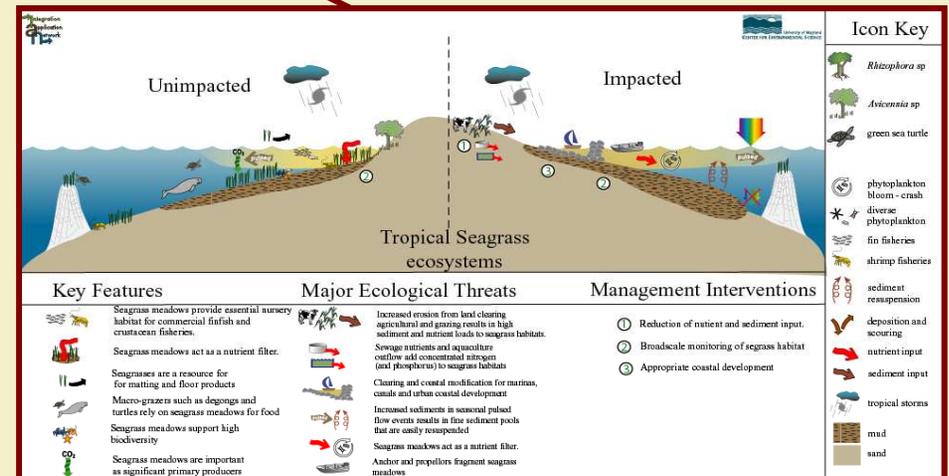
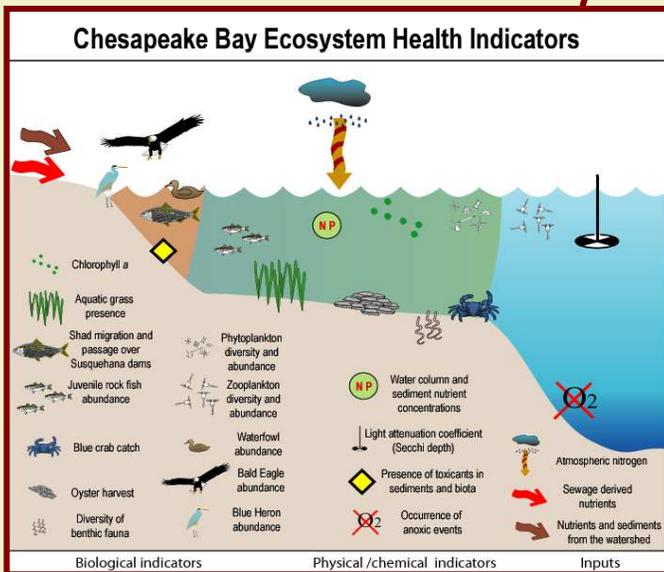
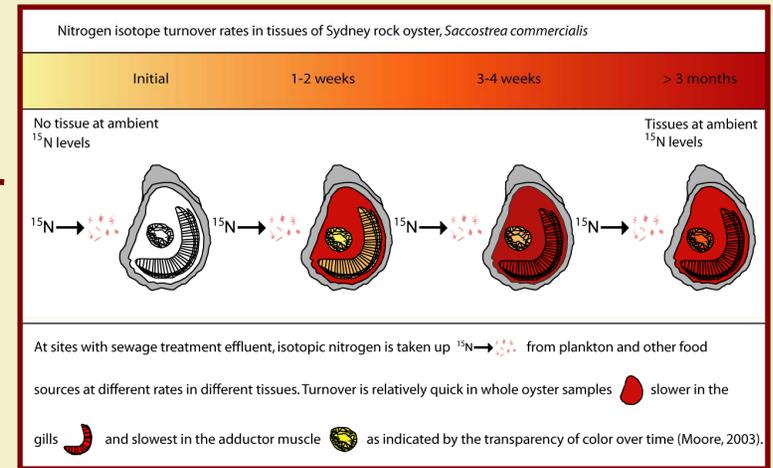


Research

Proposal

Public audience

Management



INTEGRATION &

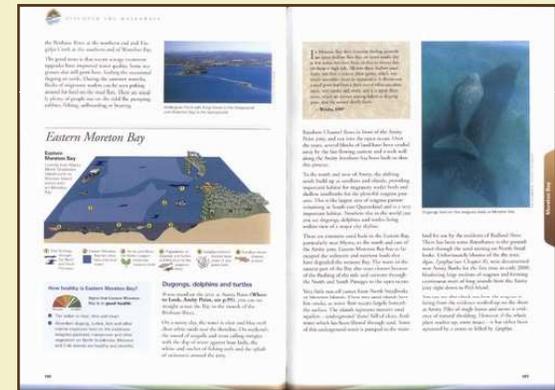
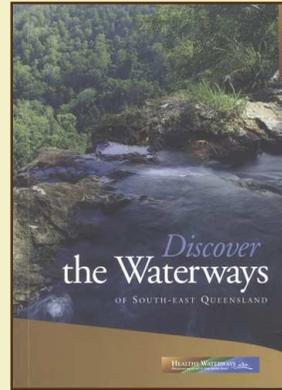
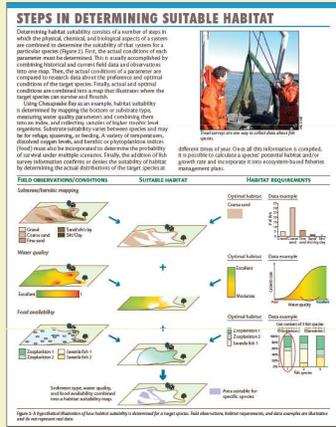
APPLICATION

NETWORK

Diagrams and figures can be incorporated into various publications

Newsletters

Books



Posters

Journal publications

BULLETIN OF MARINE SCIENCE, 71(3): 1153-11 69, 2002

SEAGRASS HABITATS OF NORTHEAST AUSTRALIA: MODELS OF KEY PROCESSES AND CONTROLS

T. J. B. Carruthers, W. C. Dennison, B. J. Longstaff, M. Waycott, E. G. Abal, L. J. McKenzie and W. J. Lee Long

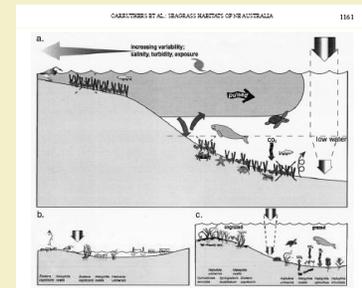


Figure 5. Model of Coastal habitat - major control-physical disturbance: a) general habitat processes; b) lateral seagrass processes; c) vertical seagrass processes, separating an on-grazed and ongrazed by macro-grazers.

grazes. While macro-grazers have a large influence on coastal seagrass meadows, they depend heavily on the maintenance of meadows. It has been estimated that one digging requires from 0.4 to 3.5 kg of seagrass per year (Herdson et al., 1977). Large declines of seagrass resulting from two large flood events in Hervey Bay were correlated with large scale digging, relocation and mortality (Pryor and March, 1995). Seagrass meadows in coastal environments have a wide range of nutrient cycling processes, differences occur both between species and with grazing. Ungrazed meadows tend to have high detrital nutrient cycling whereas grazed meadows continually rely on replenishment of external nutrient sources. Bacterial nitrogen fixation rates amongst seagrass roots and rhizomes are comparable to rates determined for terrestrial crops and legumes (O'Donohue and O'Donohue, 1995). Both bacterial *Thiobacillus* are important from the rhizosphere of the tropical seagrasses *Thalassia hemprichii*, *Cymodocea serrulata*, *C. rotunda*, *E. acoroides*, *H. uncinervis* and *Syringodium inaeifolium* (Kato, 1993). These microbial communities are supported by dissolved organic carbon released from the seagrass roots and rhizomes, up to 18% of the carbon fixed by *Z. capricorni* has been measured leaking into sediments surrounding the rhizosphere (Hansen et al., 2000). These sites are calculated to provide from a third to a half of the nitrogen required to support summer growth of *Z. capricorni* (O'Donohue et al., 1991). Digging grazing disturbs the surface sediments of the seagrass meadow, enhancing rates of nitrogen fixation in these meadows (Pryor and Dennison, 1999).

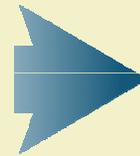
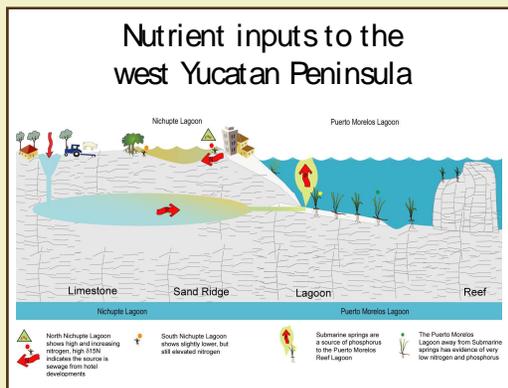
INTEGRATION &

APPLICATION

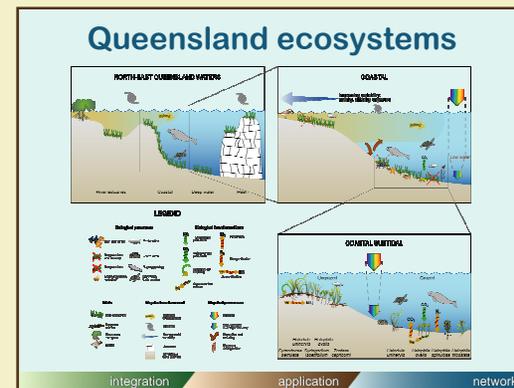
NETWORK

Diagrams and figures can be used in PowerPoint presentations

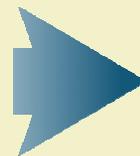
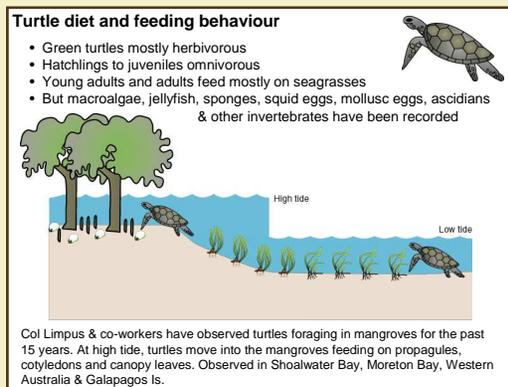
Overall summary



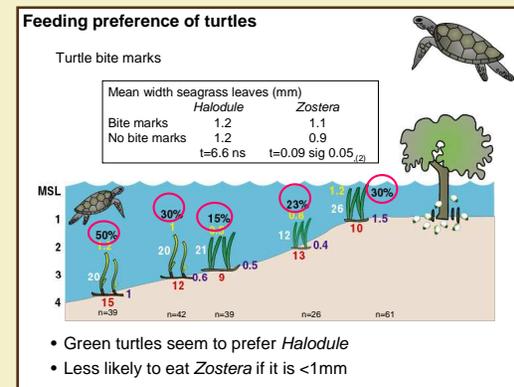
Component diagrams (nested)



Question statement



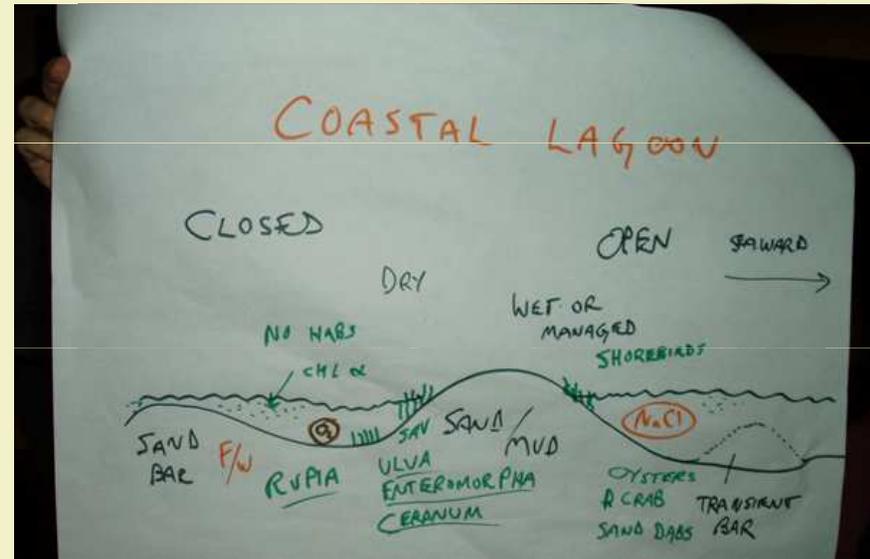
Question resolution



- Green turtles seem to prefer *Halodule*
- Less likely to eat *Zostera* if it is <1mm

Diagrams and figures can be produced in real time to synthesize main messages

Result of two day meeting about eutrophication in estuaries around the country



Major points to remember

- Remember your audience
- Simplify
- Think about colors
- Always have a legend
- Do not get stuck in a rut
- Do not make a box and arrow diagram
- Try making symbols
- Revise and revise and revise – then use it more than once
- Use diagrams for many audiences

