Tell a compelling story

Combining killer graphics and narrative for effective science communication

William C. Dennison
Charles Darwin University

15 Sept 2017

University of Maryland
Center for Environmental Science

ian

Narrative & visual communication are ancient

Albert Anker's *Der Grossvater erzählt eine Geschichte*, 1884 (The Grandfather tells a story). Image: Wikimedia Commons

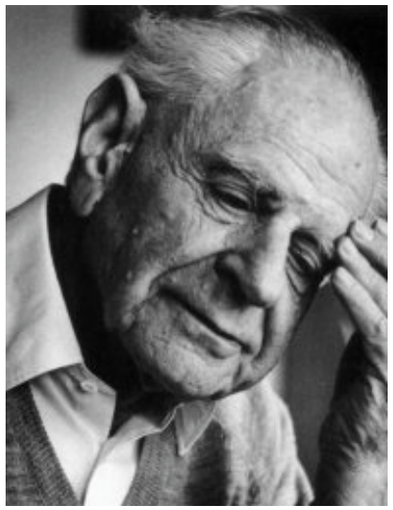
Stone age painting depicting man riding on horse found in the Bhimbetka rock shelters in India. Credit: Creative Commons

Why combine narrative and visuals for science communication?

- *Engage audience*; stories are more interesting than a string of facts, compelling visuals illustrate points
- *Improve retention*; easier to remember good stories and effective visual elements
- *Shorten reading time*; audience/reader can follow storyline and view visual elements quickly

Adapted from Dahlstrom, 2014

Science and storytelling are linked



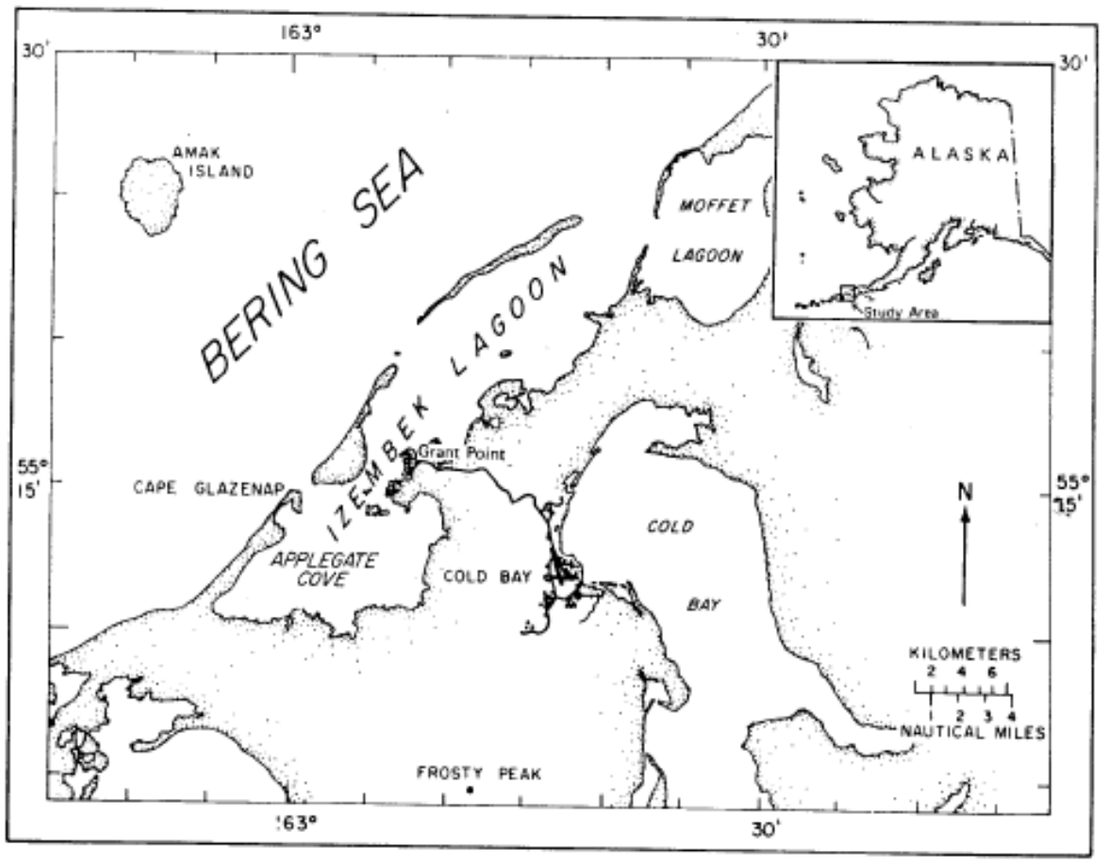
Karl Popper

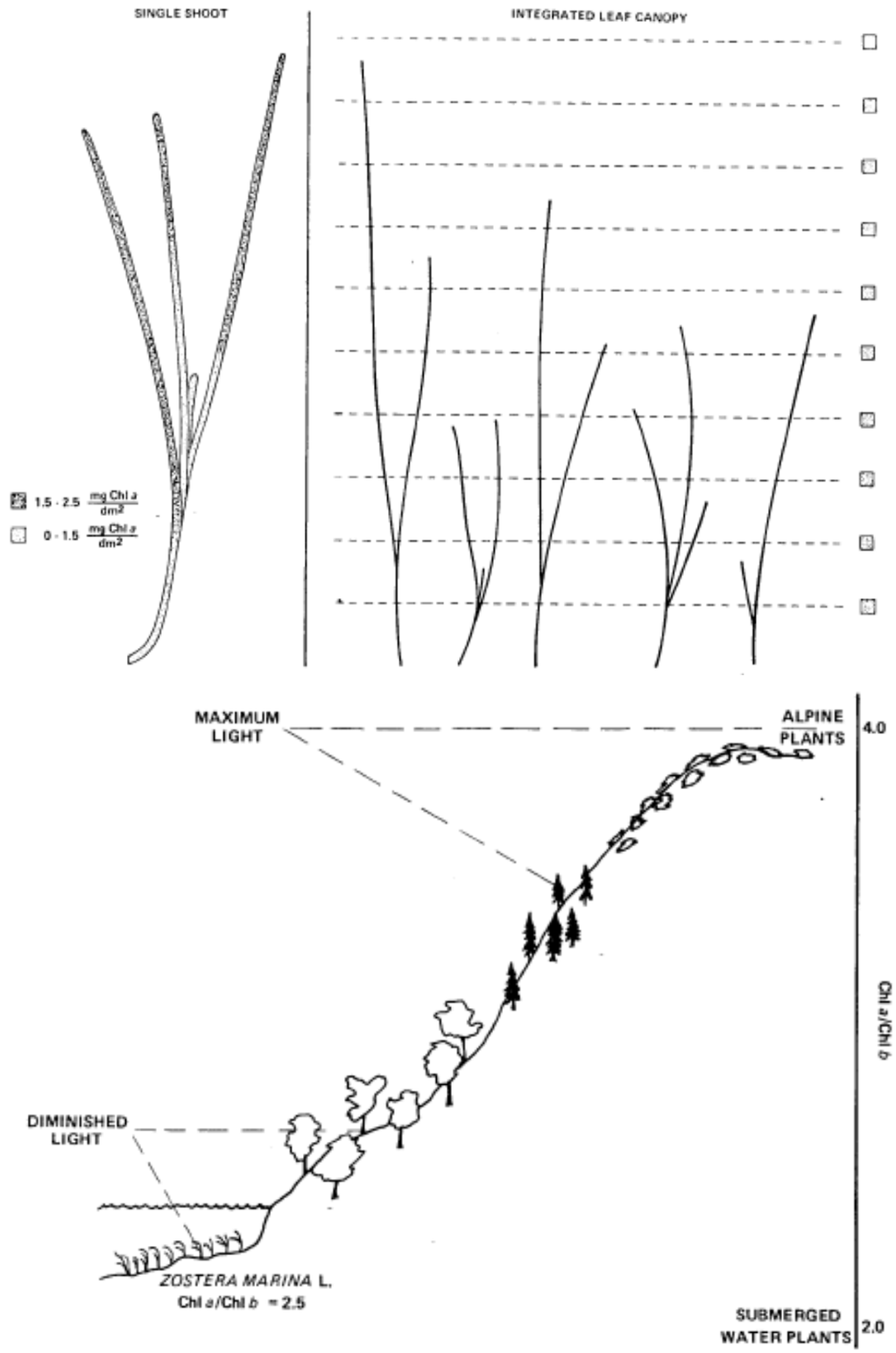
Peter Medawar

"It is one of the novelties of human language that it encourages story telling and thus *creative imagination*. Scientific discovery is akin to explanatory storytelling, to myth making and to poetic imagination."

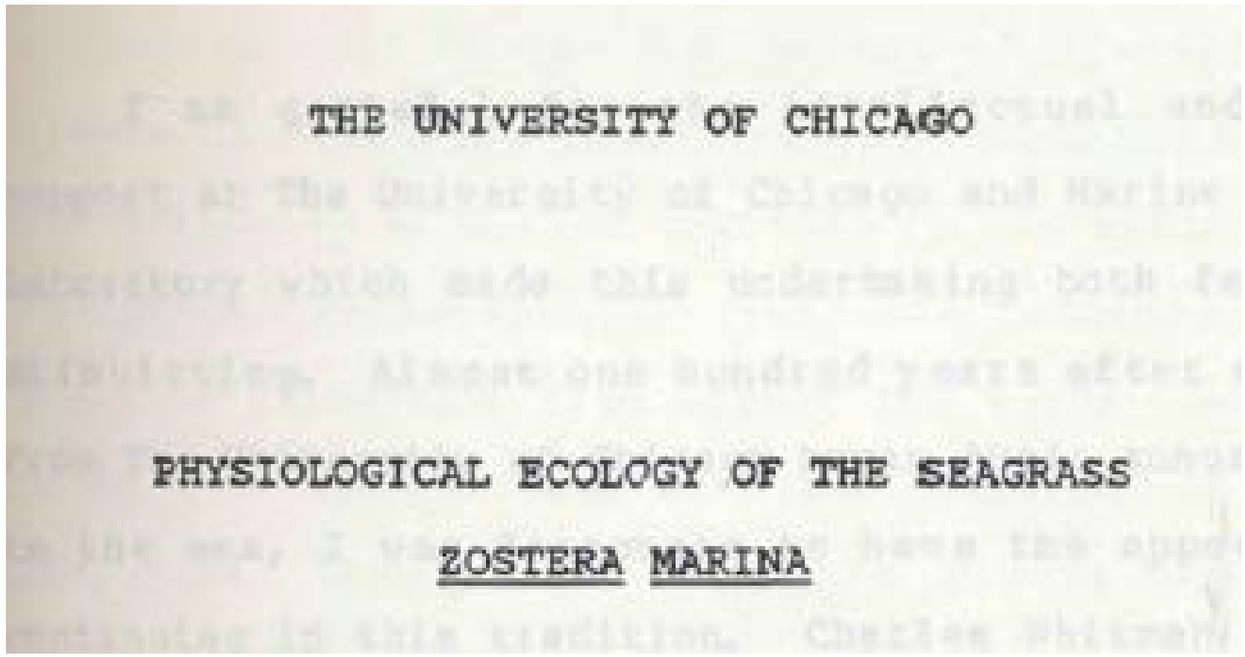
"Scientific theories … begin as imaginative constructions. They begin, if you like, as stories, and the purpose of the critical or rectifying episode in scientific reasoning is precisely to find out whether or not these stories are stories about real life."

Hand drawn sketches as part of M.S. thesis





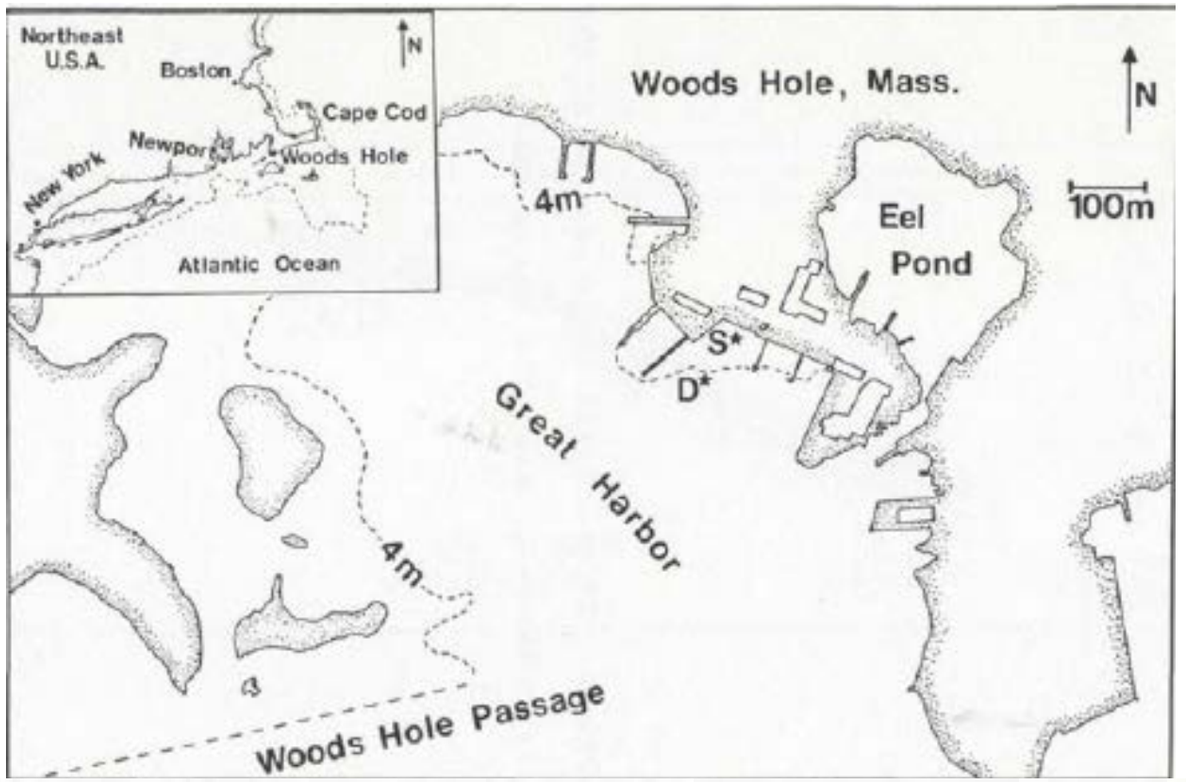
Hand drawn sketches as part of PhD

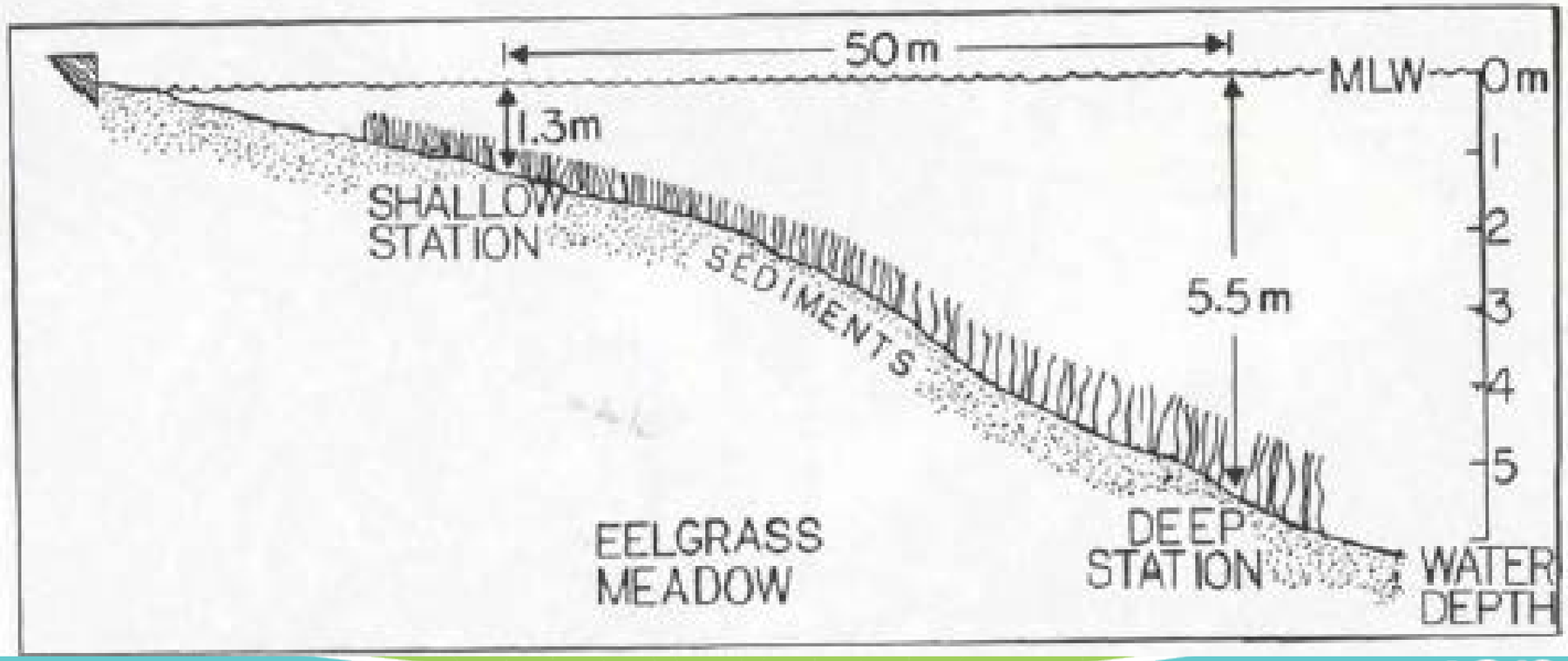


THE UNIVERSITY OF CHICAGO

PHYSIOLOGICAL ECOLOGY OF THE SEAGRASS

ZOSTERA MARINA

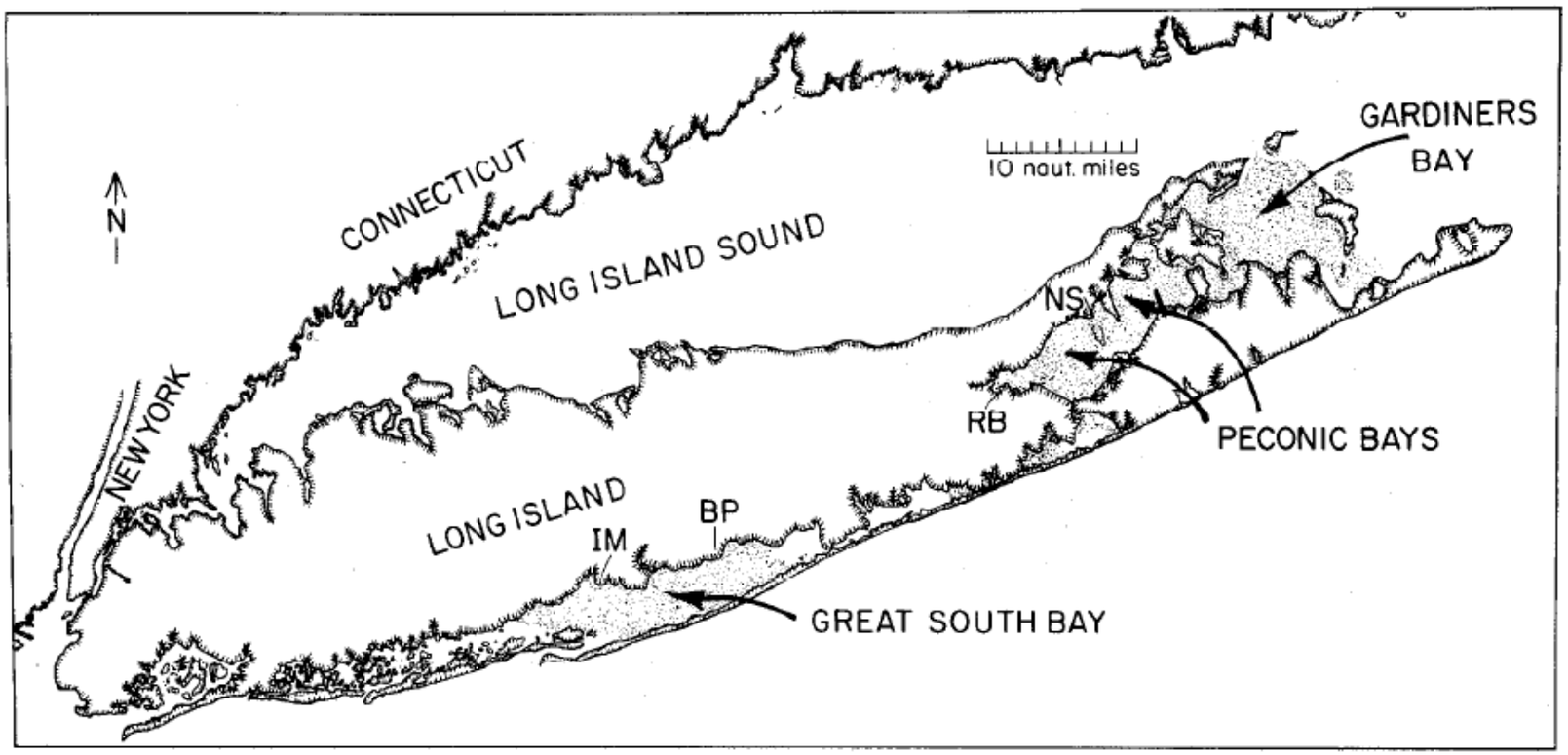


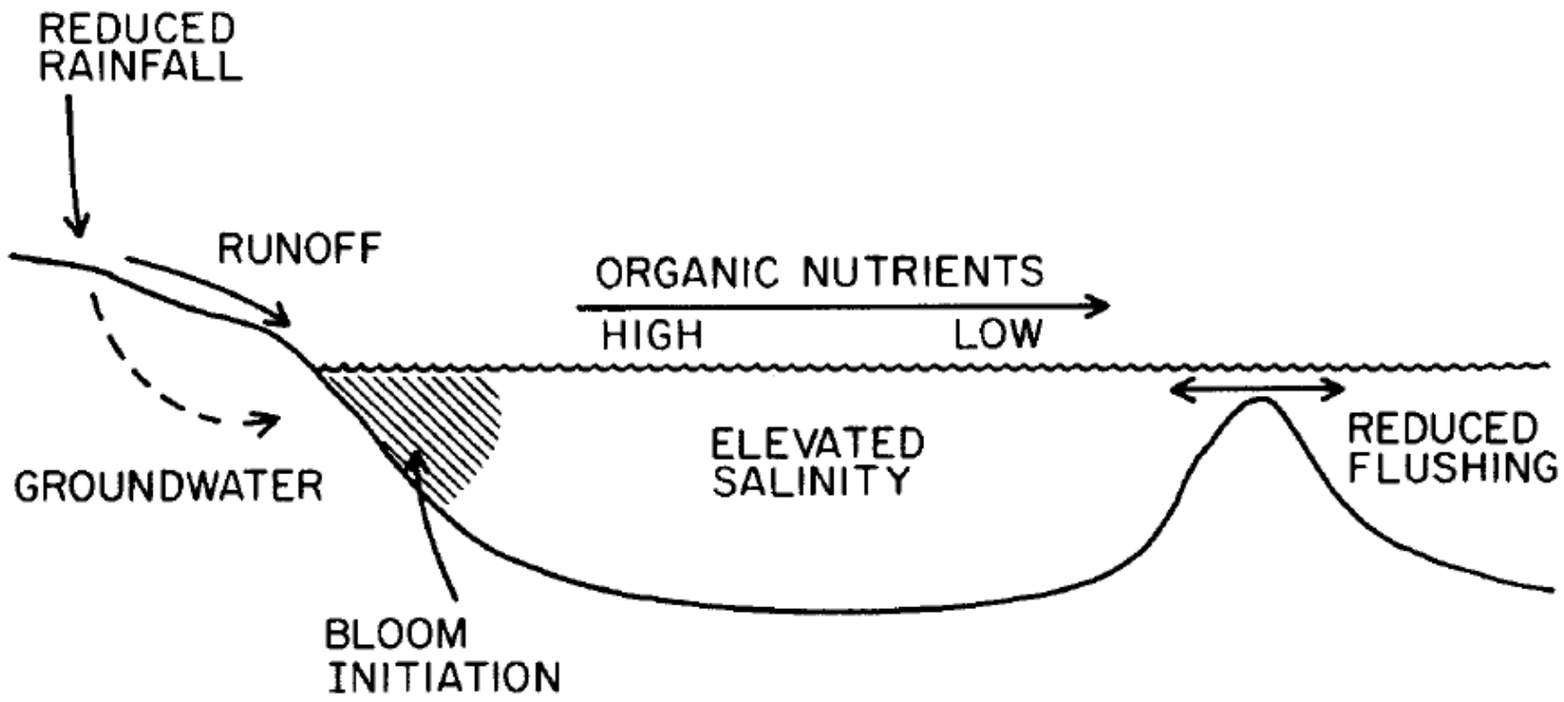


University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE

ian

Hand drawn sketches as part of postdoc



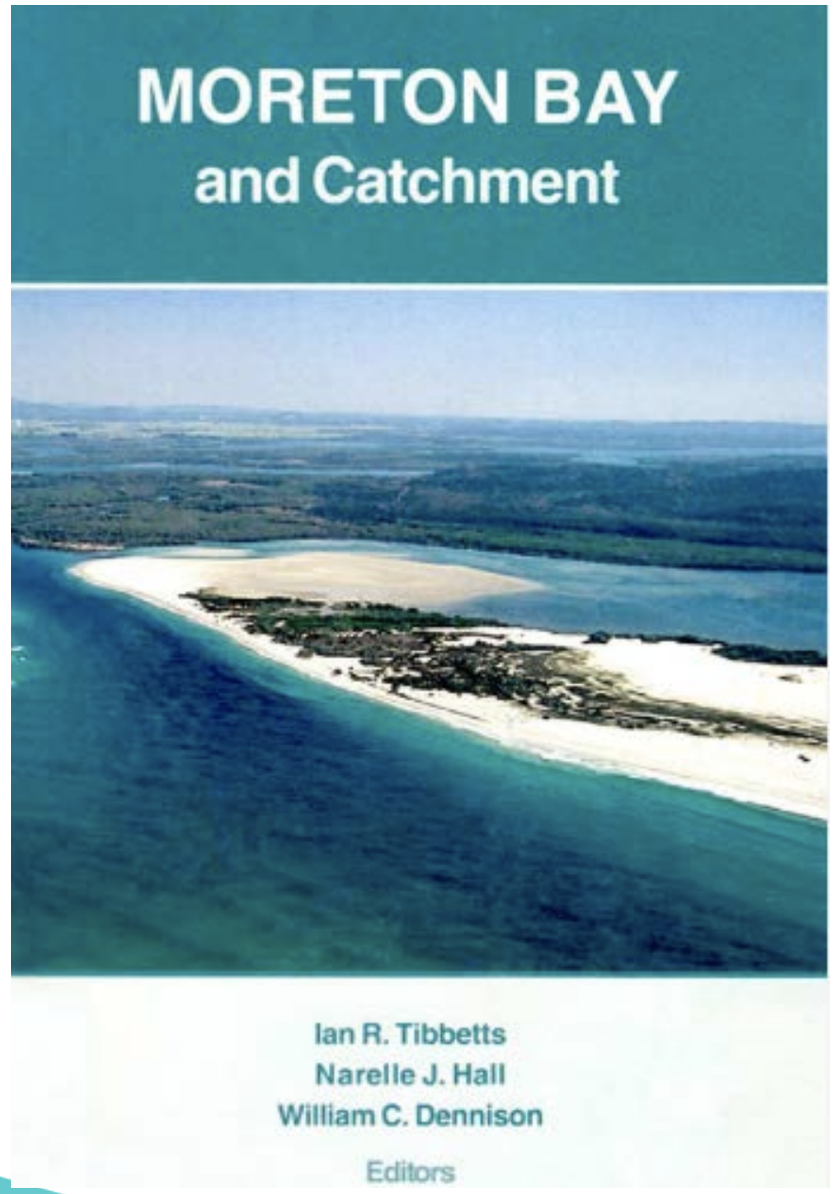


Marine Botany in Queensland, Australia

Marine Botany
The University Of Queensland

- Developed color graphics capacity
- Became involved in Healthy Waterways Campaign
- Used color graphics for communicating to broader audiences

Classic scientific book: B & W, dense, peer science audience



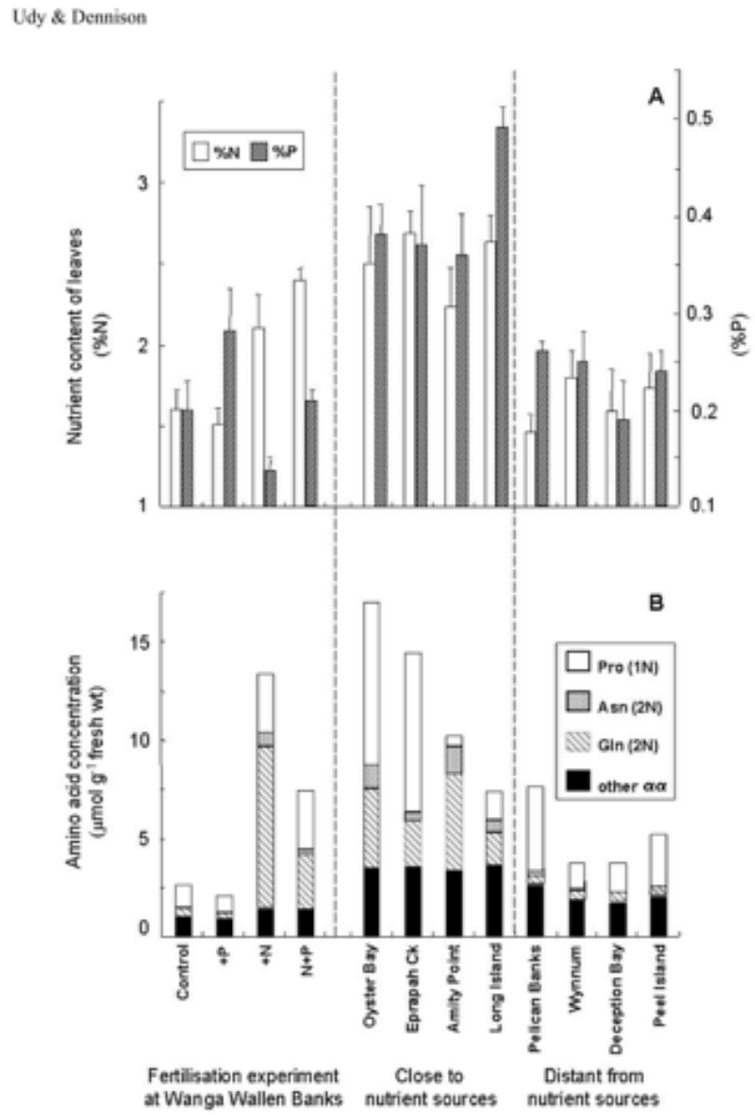


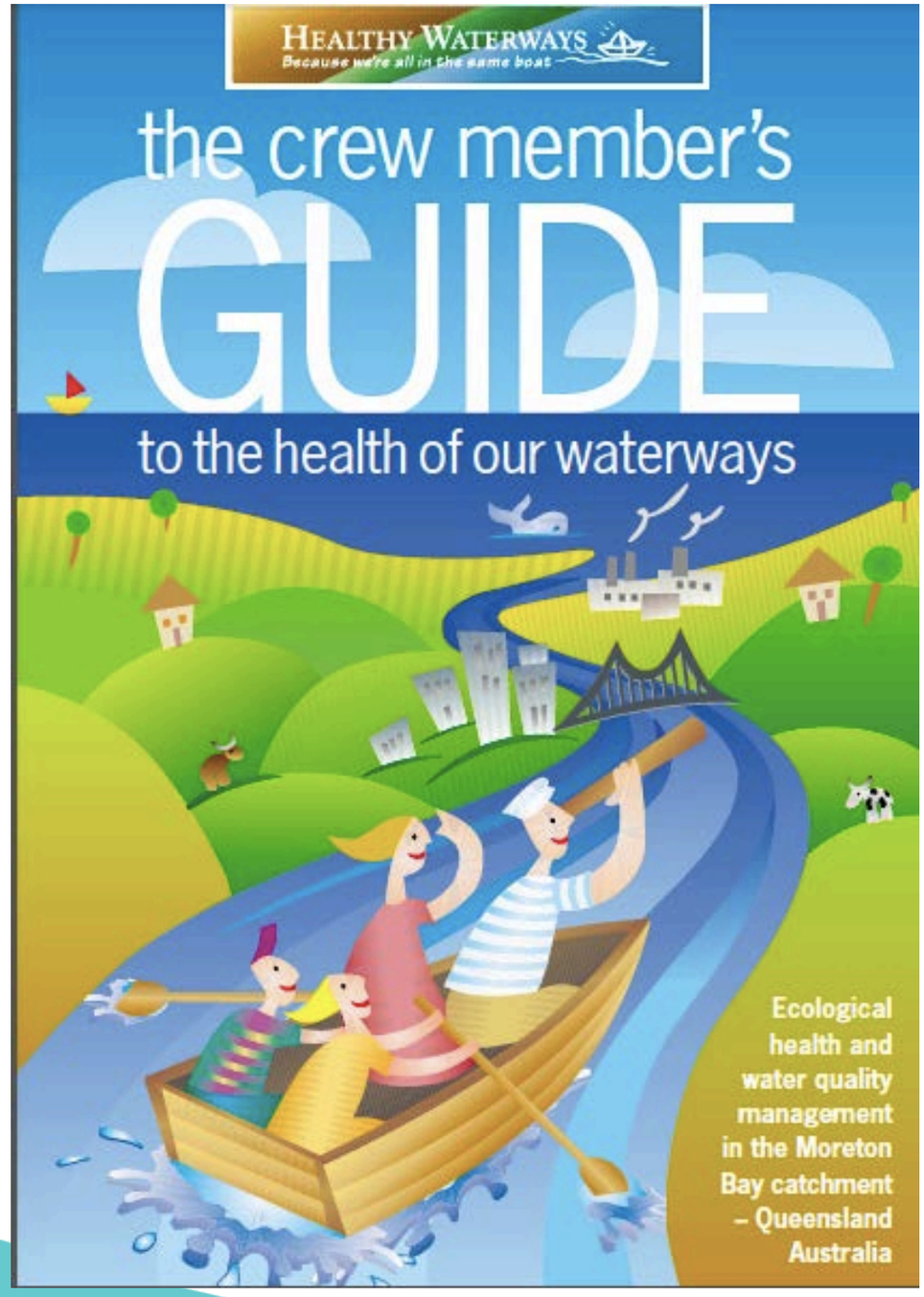
Figure 4. Characteristics of *Zostera capricorni* leaves which were influenced by both fertilisation and proximity to a nutrient source: (A) nutrient content, (B) concentration of amino acids; proline (Pro), asparagine (Asn), glutamine (Gln) and the other amino acids (other αα). (Combined data from Udy & Dennison, 1997a &1997b).

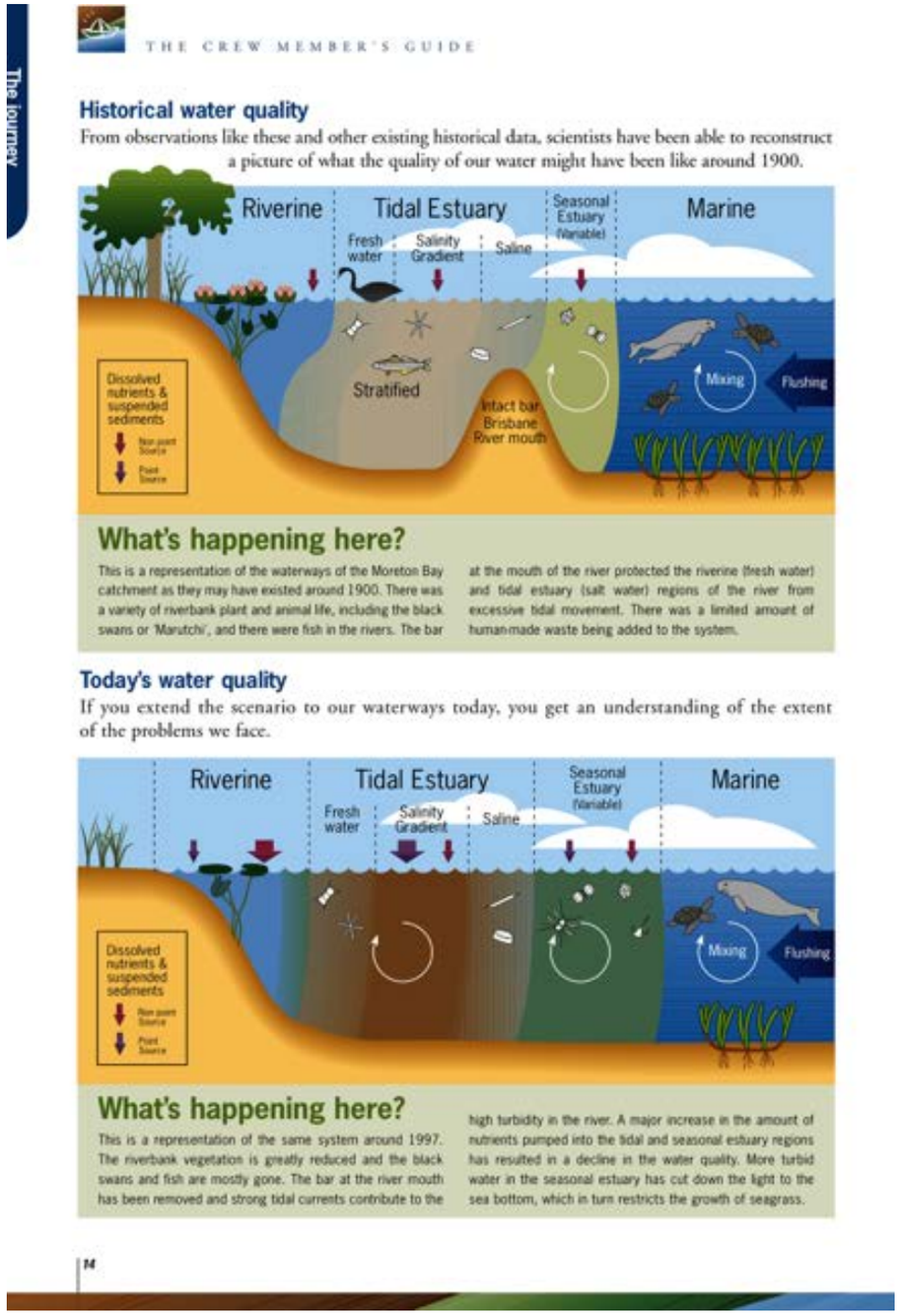
222 *Moreton Bay and Catchment*

University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE

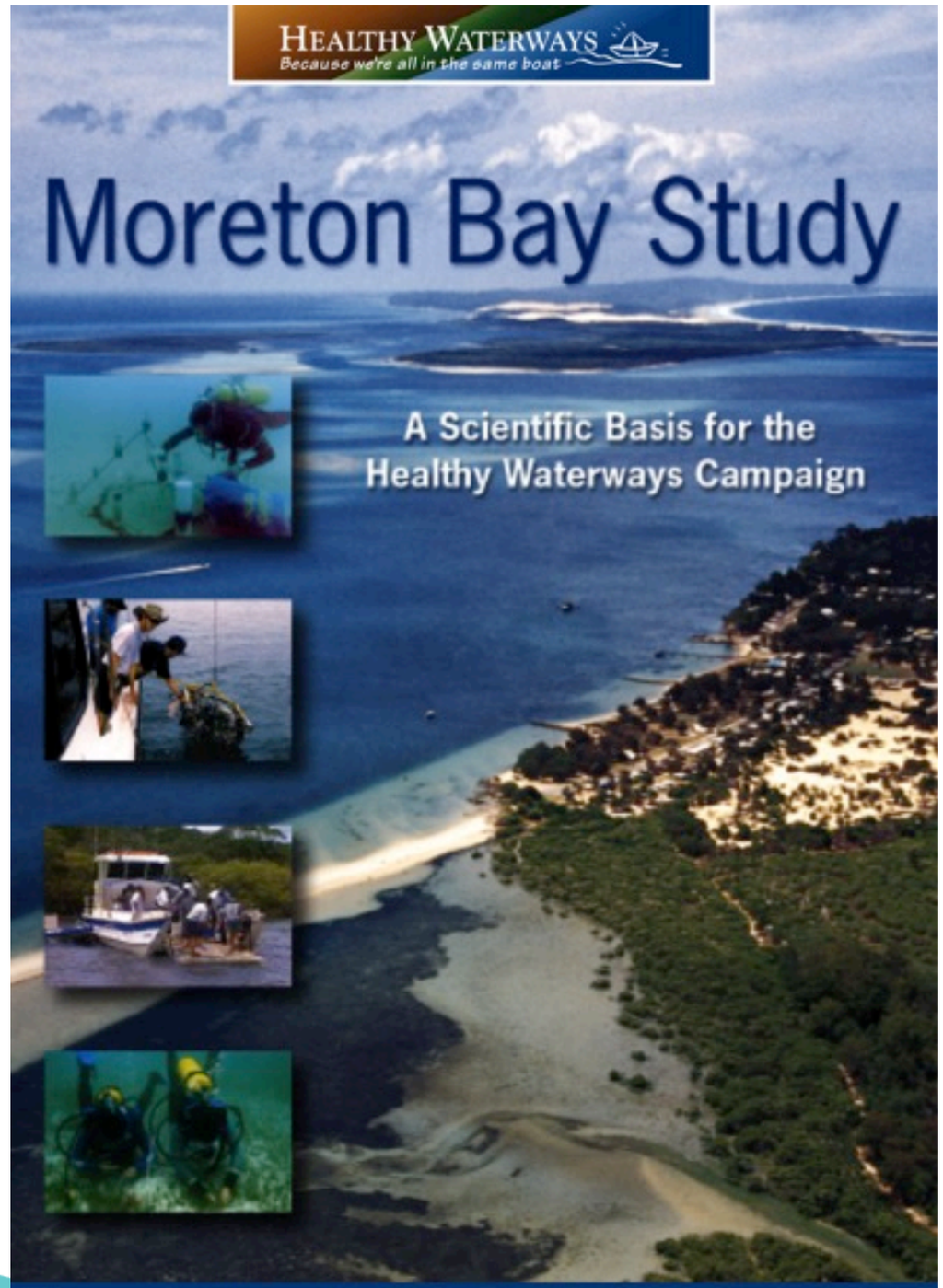
ian

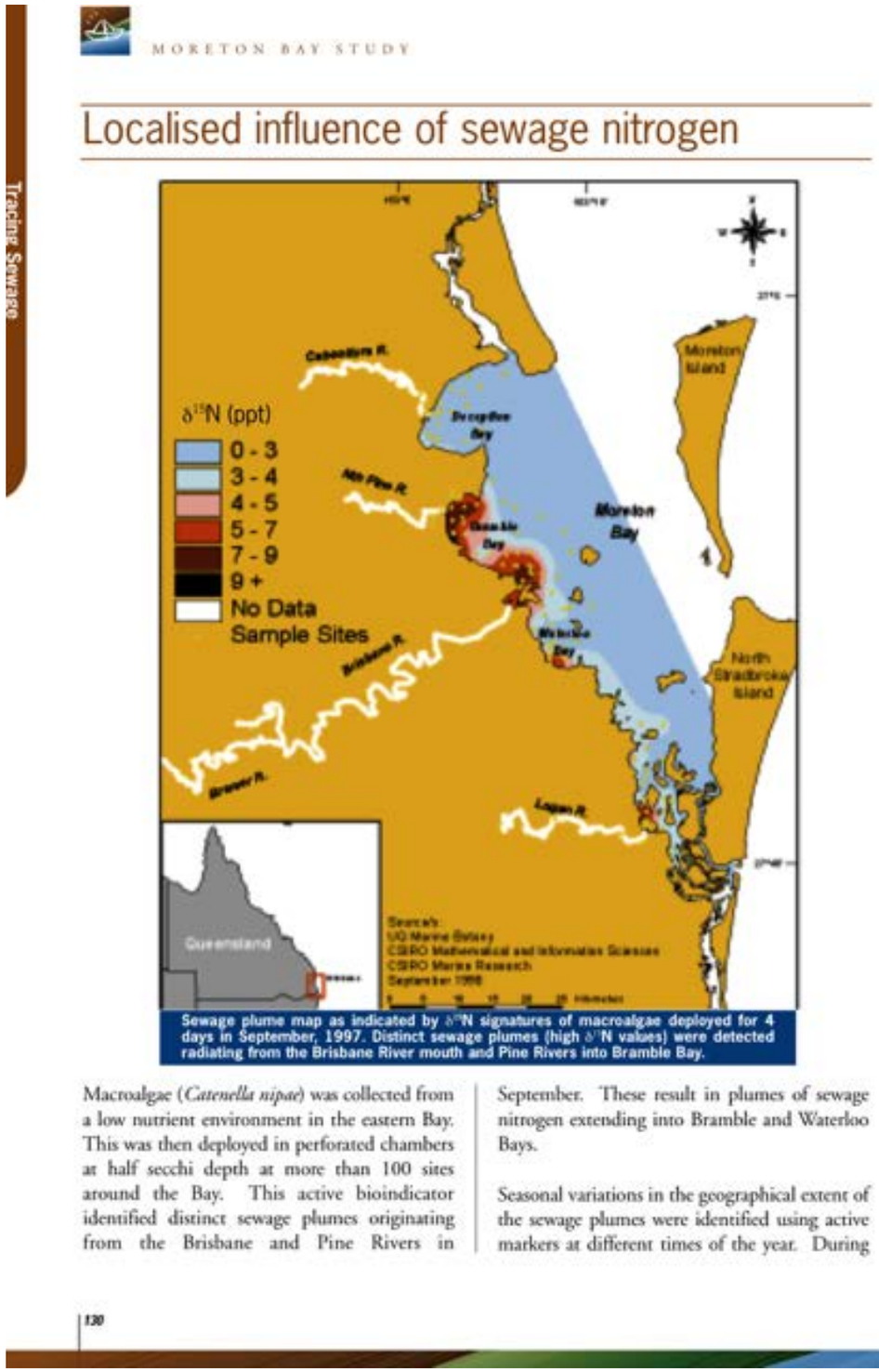
Published Crew Guide using color graphics





Scientific synthesis

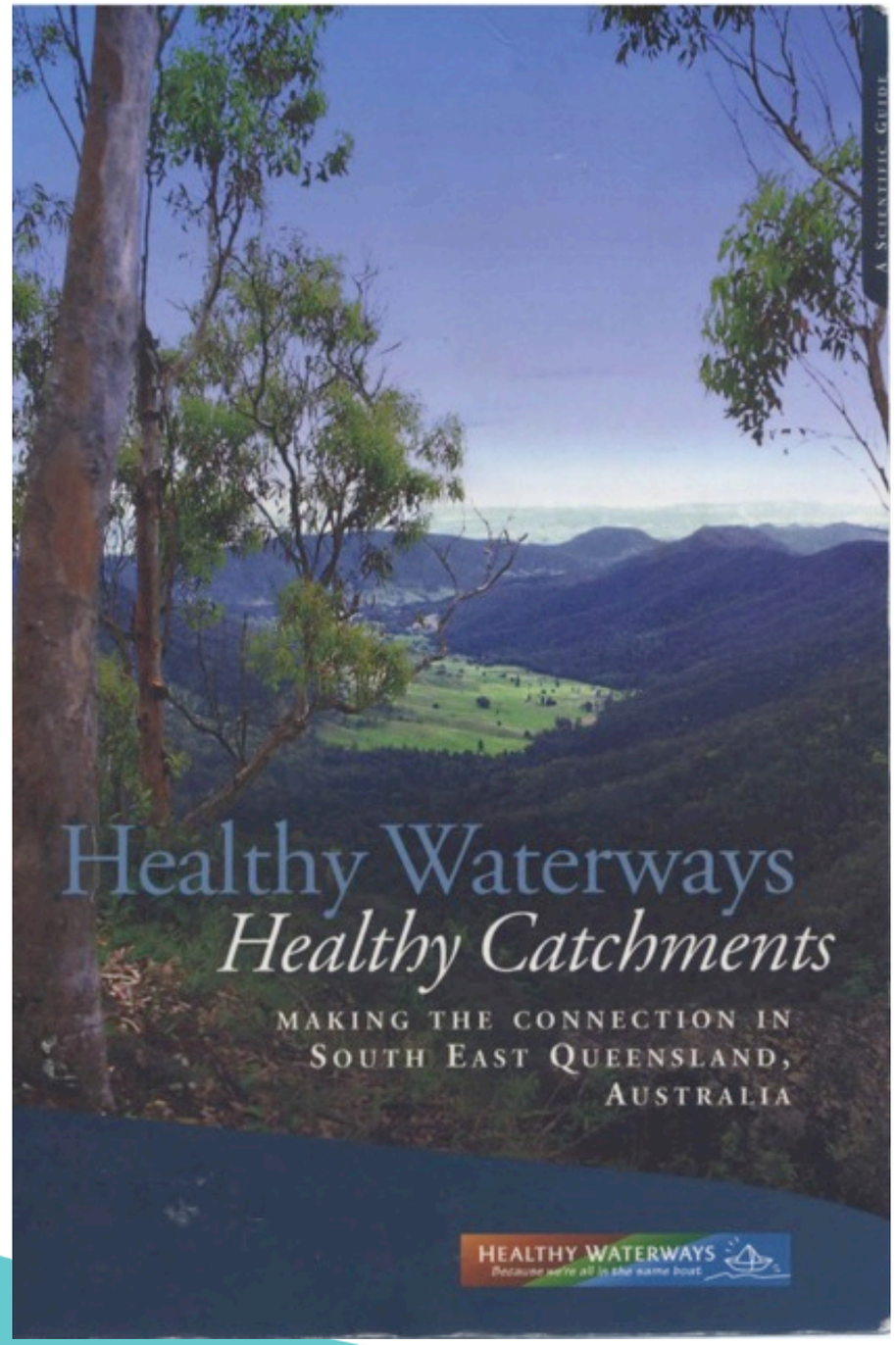




University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE

ian

Second scientific synthesis

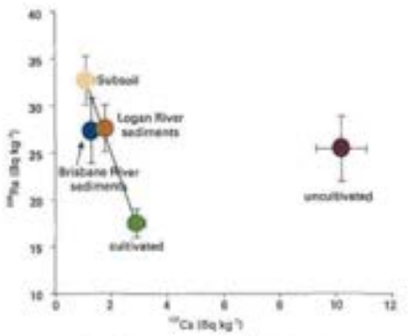


Erosion process tracing confirms model predictions

Sediment tracing methods provide us with an independent means of testing the model predictions. Surface soil samples were collected throughout the catchments from cultivated and uncultivated lands, and from subsoils in gullies and stream banks. These source types can be distinguished by measuring concentrations of cesium-137 (^{137}Cs) and radium-226 (^{226}Ra). ^{137}Cs is a product of atmospheric nuclear weapons testing that occurred in the 1950-70s. It accumulates in surface soil, and labels sediment eroded from topsoils. ^{226}Ra is a naturally occurring radio-nuclide that can occur in reduced concentrations in cultivated soils, possibly due to leaching. Together, these two radionuclides can give a good indication of the origin of sediment from the landscape.

Sediment samples collected from the lower reaches of the Brisbane and Logan Rivers upstream of the tidal estuaries, are likely to be well mixed during transport, and so should represent sediment delivered from many sources in their respective catchments. The mean ^{137}Cs and ^{226}Ra in the sediment sample values lie between the mean cultivated surface soil and subsoil values, while the mean uncultivated surface soil value lies well away from this group. Assuming that the mean sediment concentrations are a linear mix of the two primary sources, then we can estimate that 75 ± 25% of the sediments originate from subsoil (channel) erosion in the Brisbane and Logan catchments, while the remaining 25 ± 25% comes from cultivated surface soils. Note that these results have a relatively high statistical uncertainty (± 25%), which means that the variation in the contribution of surface soils and subsoils to river sediments is relatively high. On average, the subsoil contribution to the Logan and Brisbane Rivers will vary from 50-100%. These results do not exclude the likelihood that some sediment is also coming from uncultivated land, however, the contribution is relatively small.

Erosion processes were traced using the isotopes cesium (^{137}Cs) and radium (^{226}Ra). Used in combination, these two radionuclides can give a good indication about where sediment has originated from in the landscape.

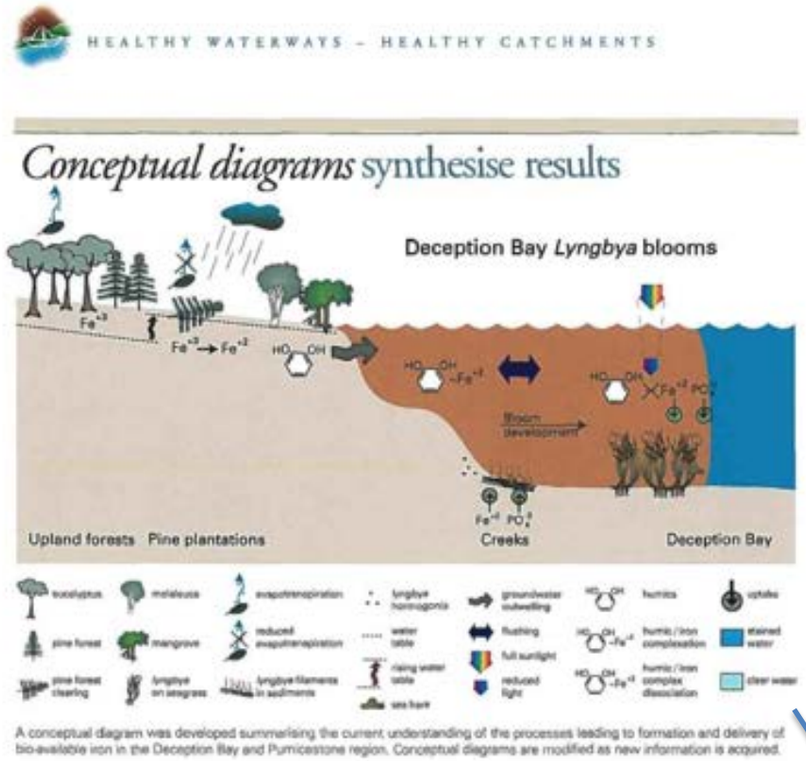


Average radium (^{226}Ra) and cesium (^{137}Cs) values from cultivated and uncultivated soils (hillslope erosion) and subsoils (channel erosion), compared with average values obtained from sediment in the lower Brisbane and Logan Rivers. These results show that the river sediments mainly originate from subsoil erosion (75%), with most of the remaining sediment coming from erosion of cultivated soil.

University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE

ian

Conceptual diagrams used to synthesize results



HEALTHY WATERWAYS – HEALTHY CATCHMENTS

Conceptual diagrams synthesise results

Deception Bay *Lyngbya* blooms

Upland forests Pine plantations Creeks Deception Bay

eucalypus melaleuca evapotranspiration *lyngbya* hormogonia groundwater outwelling humics uptake

pine forest mangrove reduced evapotranspiration water table flushing humic / iron complexation stained water

pine forest clearing *lyngbya* on seagrass *lyngbya* filaments in sediments rising water table full sunlight humic / iron complex dissociation clear water

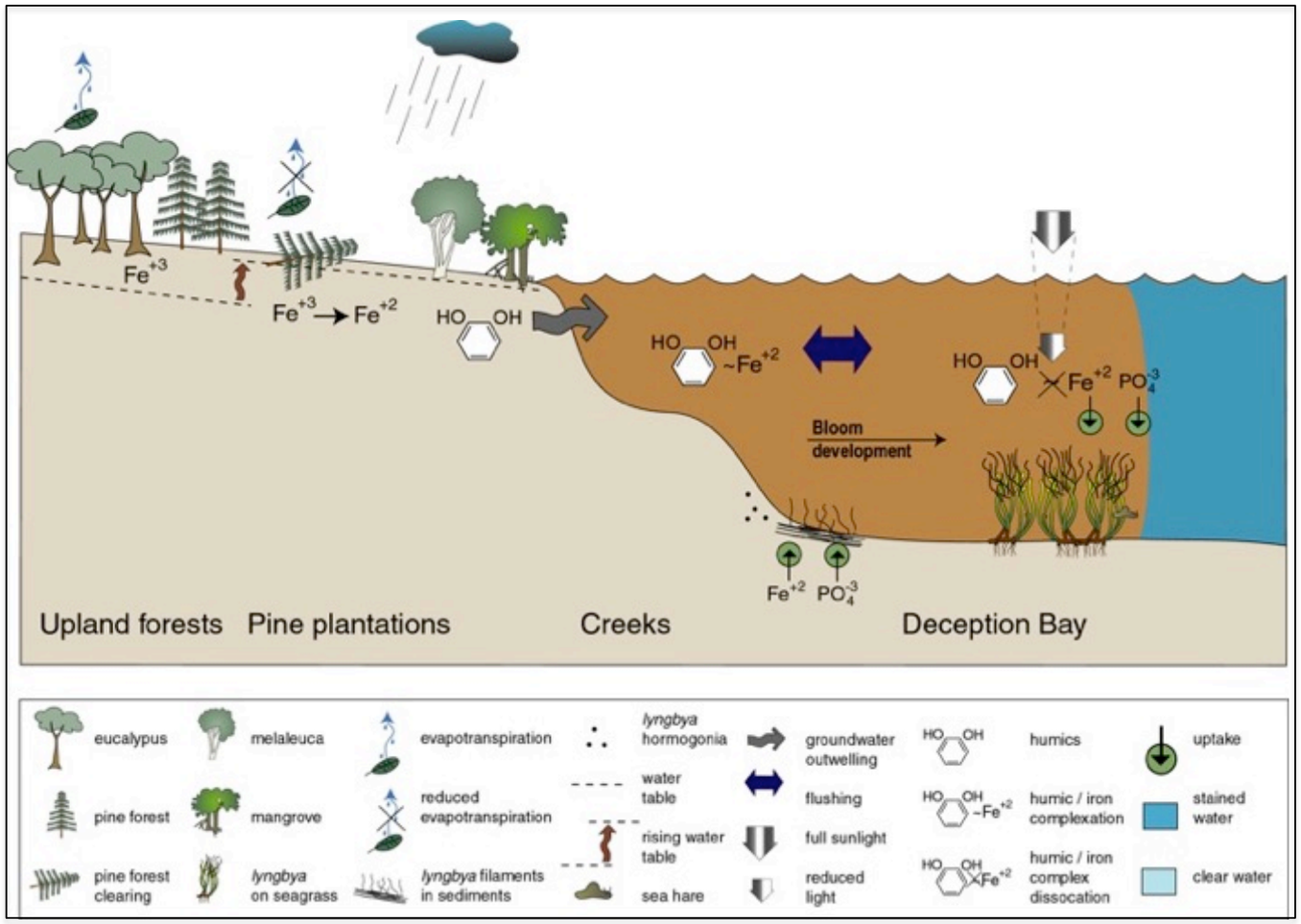
sea hare reduced light

A conceptual diagram was developed summarising the current understanding of the processes leading to formation and delivery of bio-available iron in the Deception Bay and Pumicestone region. Conceptual diagrams are modified as new information is acquired.

Deception Bay

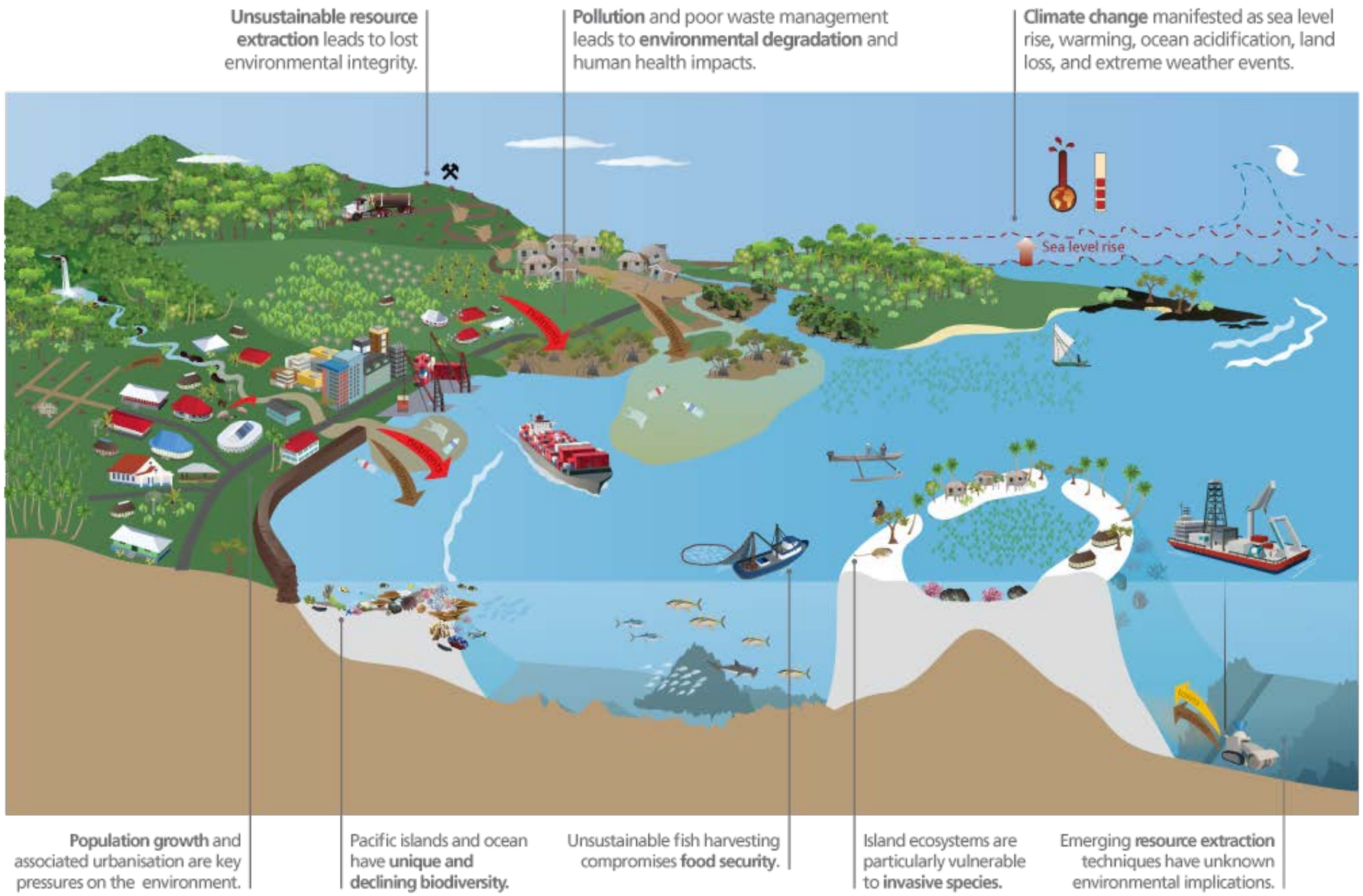
In the early phases of the bloom, *Lyngbya majuscula* cells (hormogonia) appear to develop into filaments in the sediments and grow on the sediment and on seagrass macroalgal substrates. For *Lyngbya majuscula* to proliferate, it requires sources of phosphorus and bioavailable iron (Fe). Nitrogen (N) is sourced from N fixation in the initial stages of a bloom, however, *L. majuscula* is capable of taking up NO_x and NH_3 if available. There are large sources of Fe in the catchment from the Landsborough sandstone, but a transport mechanism is required to deliver bioavailable Fe (dissolved Fe^{+3})to *L. majuscula* bloom sites. Reduced evapotranspiration resulting from large-scale catchment disturbance results in rising water table. Water-saturated soils become anoxic and the chemical reduction of dissolved Fe compounds leads to the formation of Fe^{+2}. Rainfall events carry organic-rich waters, which form complexes with Fe^{+3}. The humic/Fe^{+2} complexes are then flushed into northern Deception Bay. With sufficient light, photolysis (splitting by light) results in the dissociation (separation of the humic Fe^{+2} complexes), thus making Fe^{+2} available for uptake by *L. majuscula* probably by enzymes associated with the surface of *L. majuscula*. These particular sources and transport mechanism may be unique to Deception Bay blooms, however, casual factors may be similar in other areas where *L. majuscula* blooms have been observed.

144



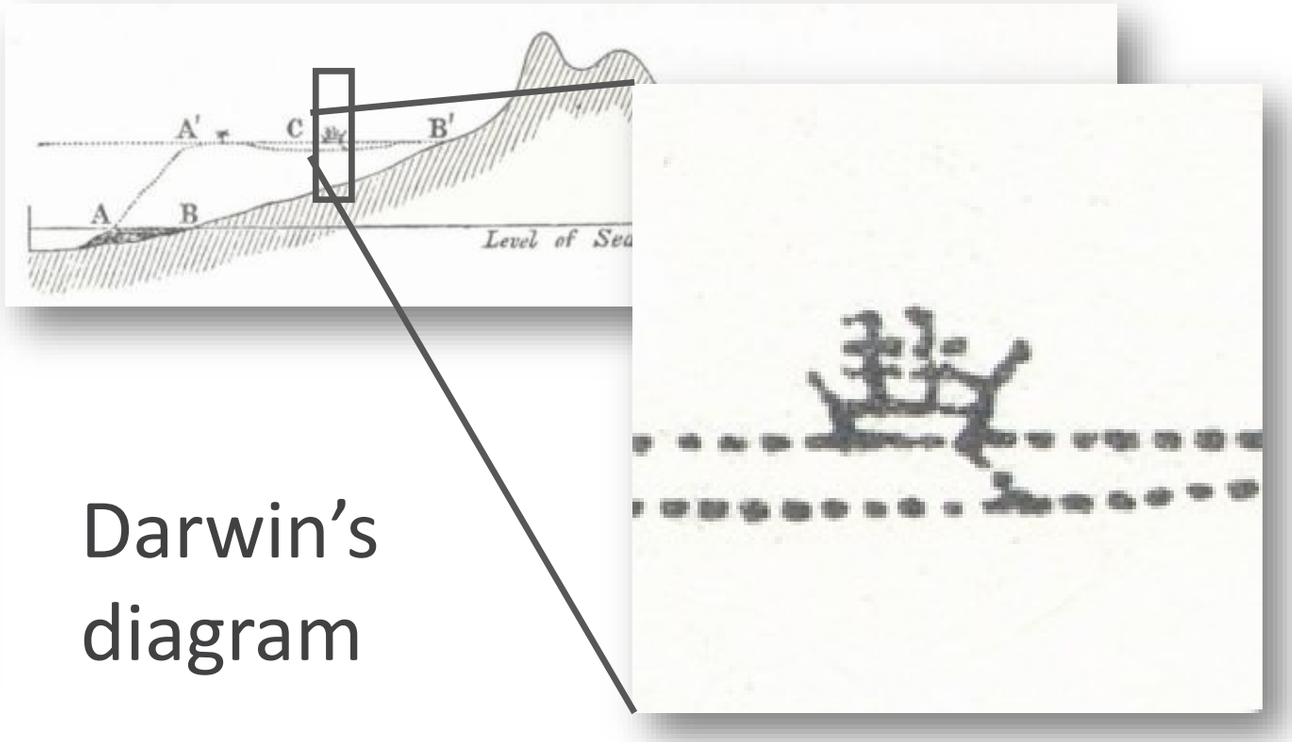
What is a conceptual diagram?

A diagram using symbols that depicts the essential attributes of a system: “thought drawing”



Conceptual diagrams use symbols depict unequivocal messages

Cave painting

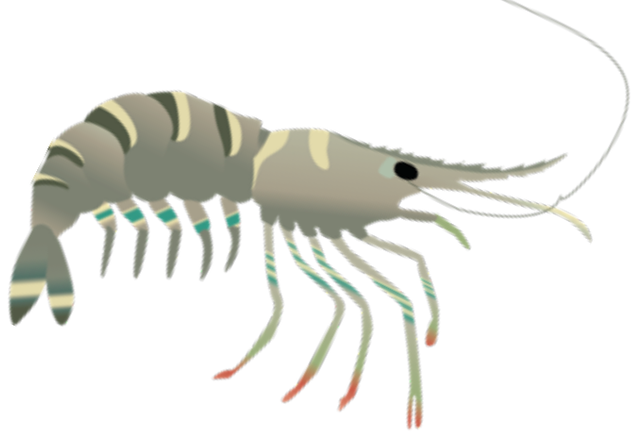


Darwin's diagram

Symbols are language independent and universal

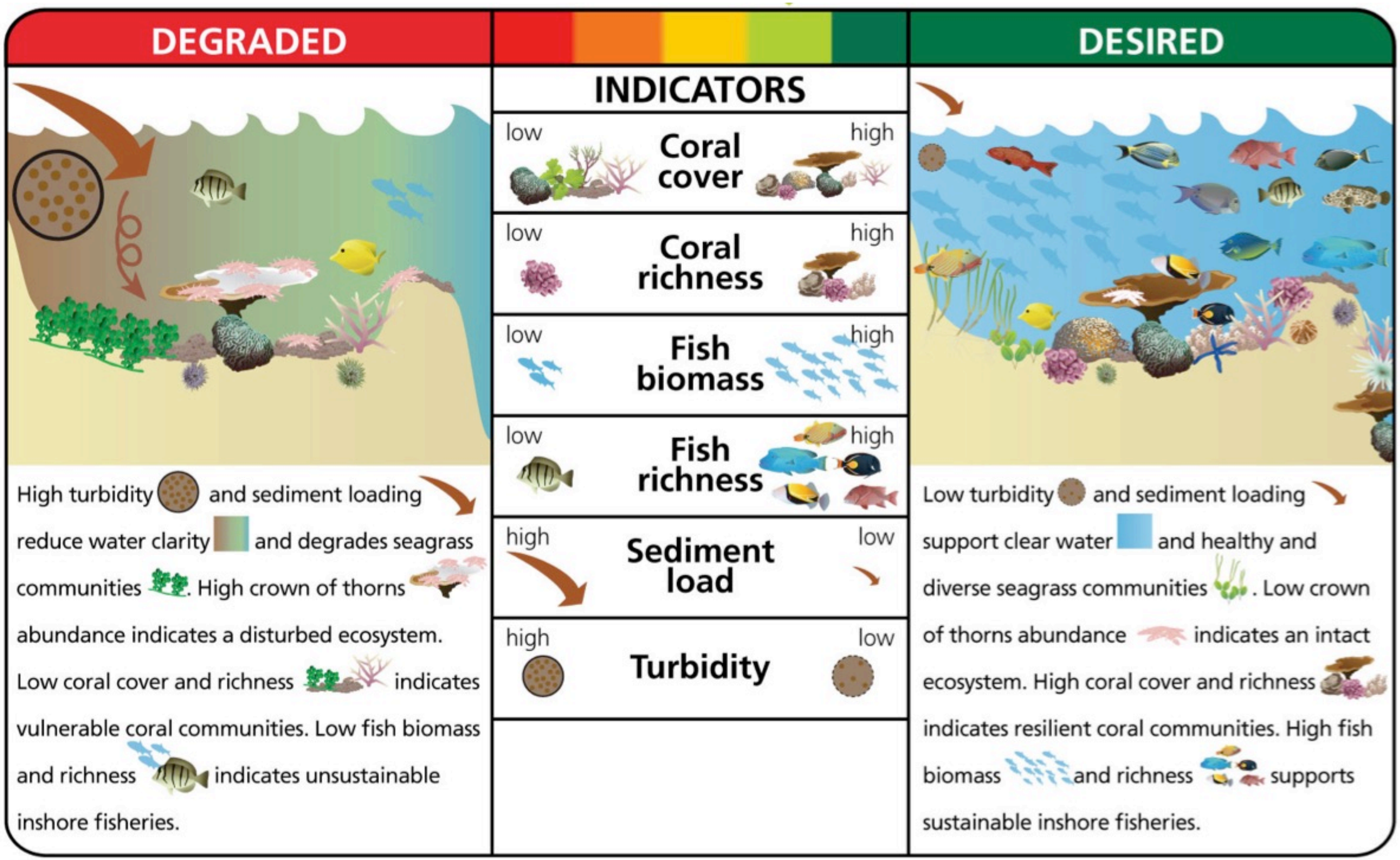
- Symbols are used and identified all over the world: mathematics π , weather , music , religion , corporate branding , signage , and organizations .

- Symbols can represent something tangible

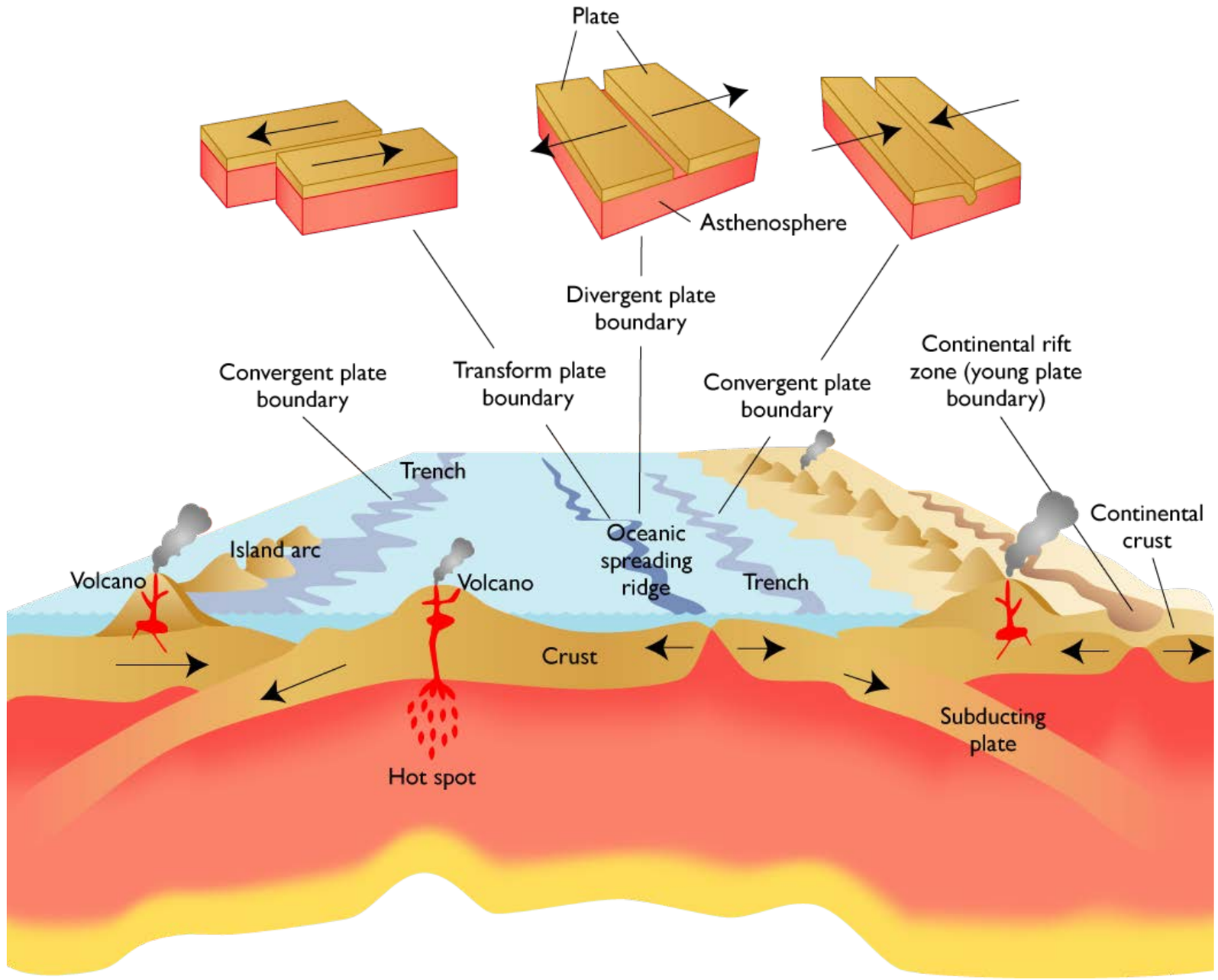


- Symbols can represent something invisible or intangible

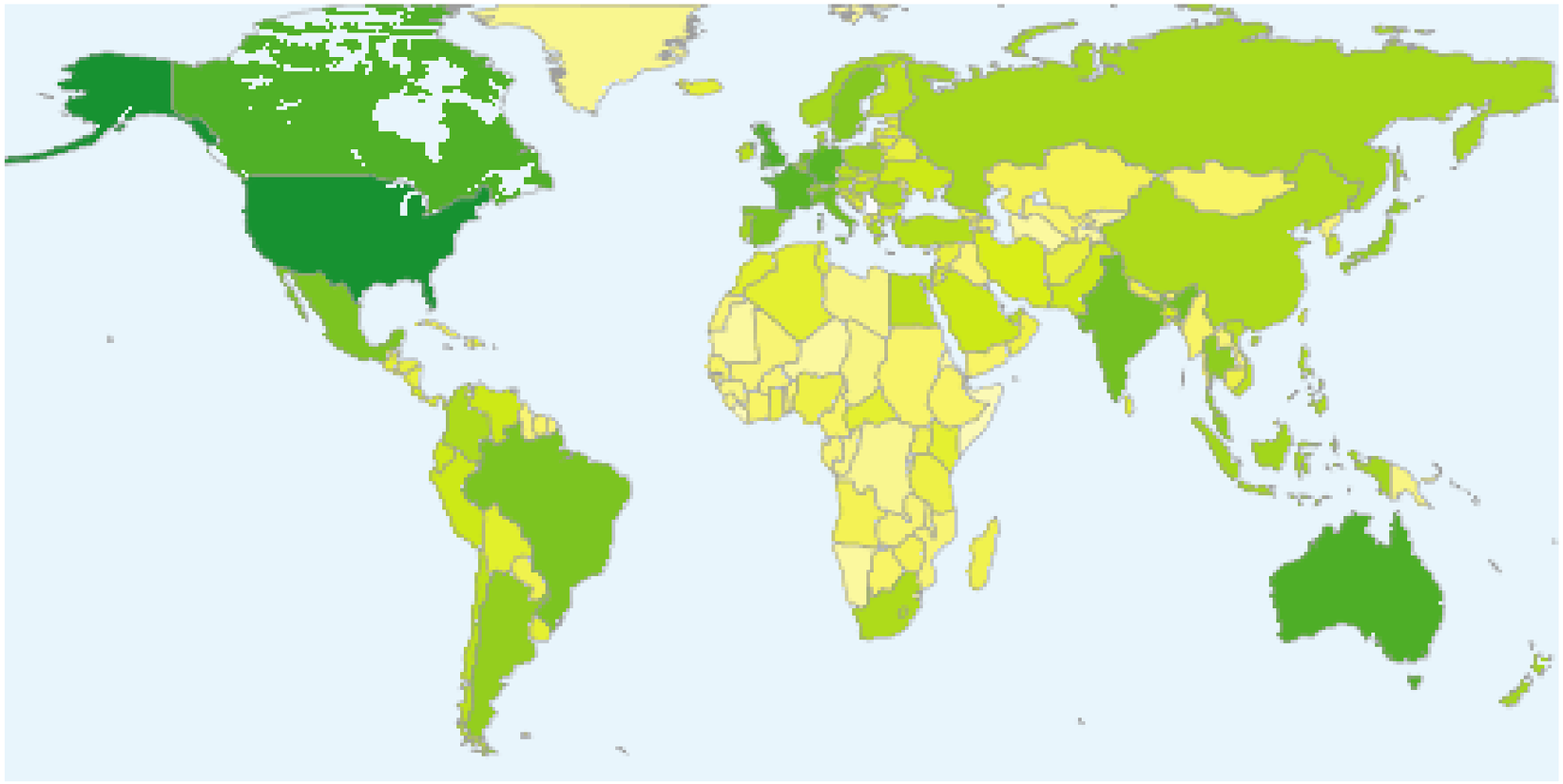
Size, shape, color, and position of symbols conveys information

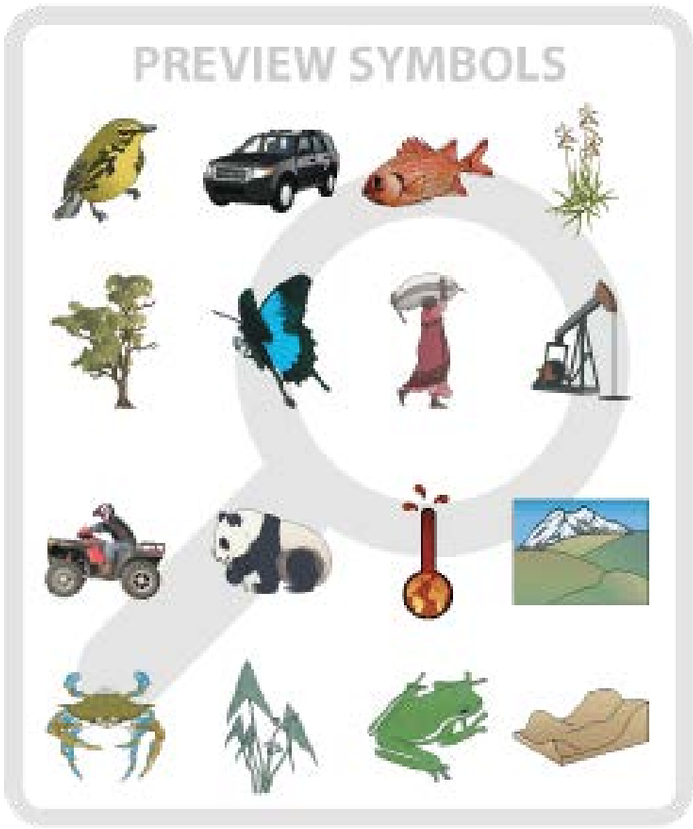


Good conceptual diagrams synthesize and present information clearly



IAN is creating a global symbol language



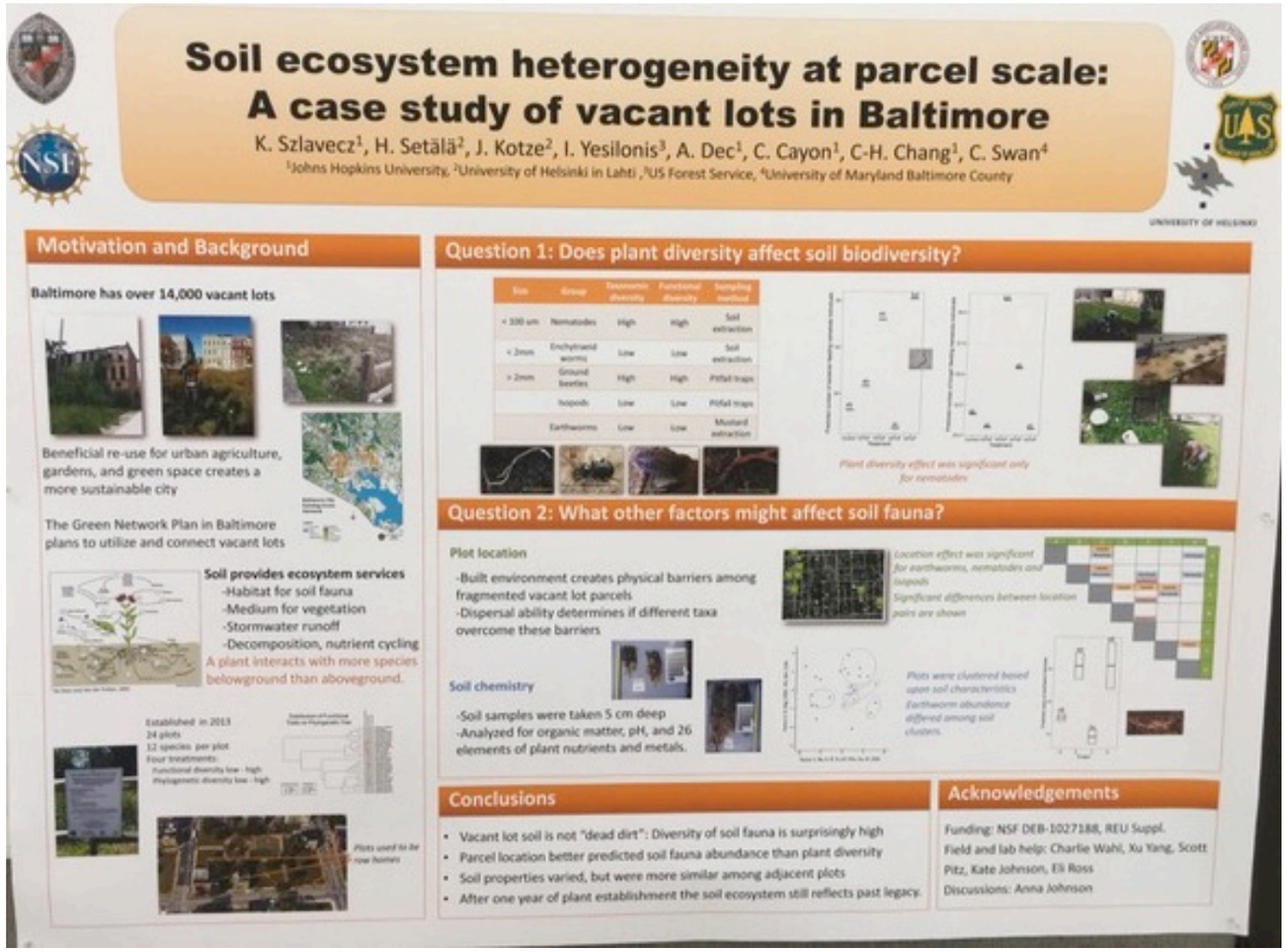


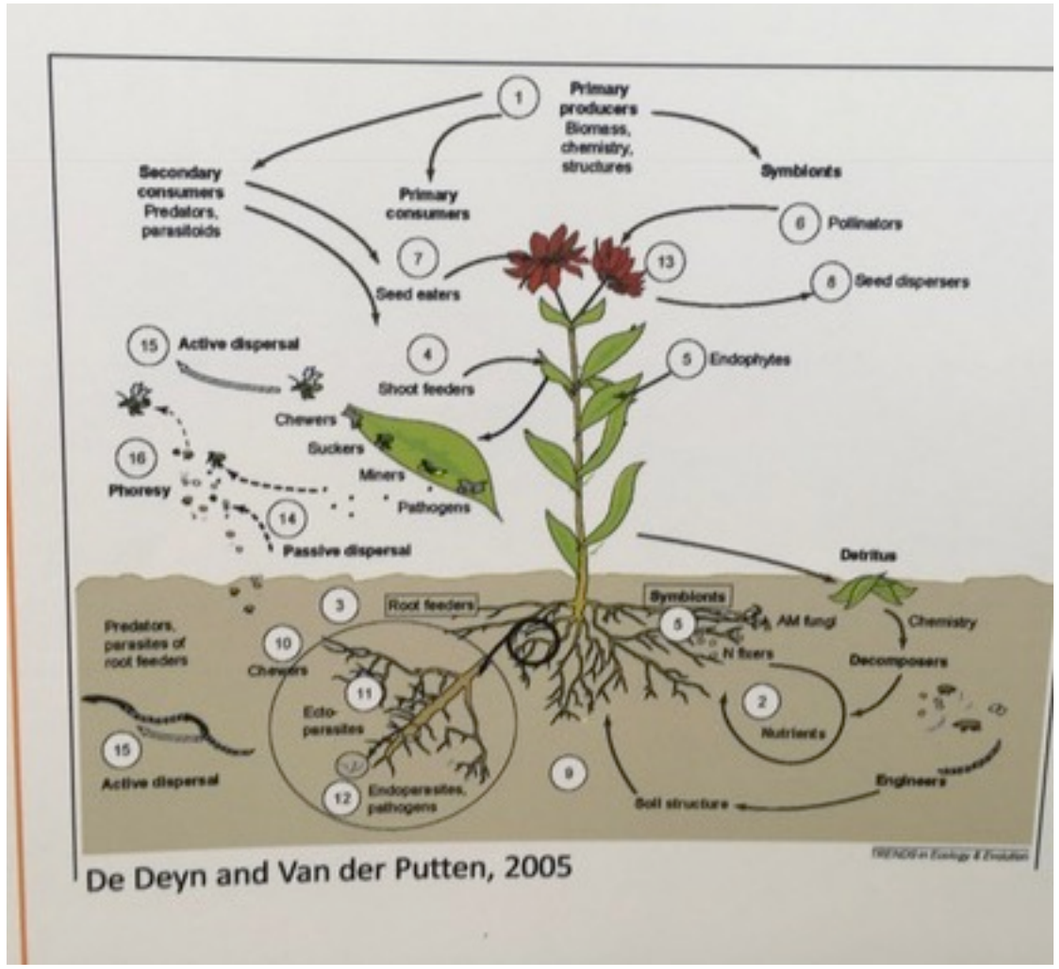
236 countries

2925 symbols

Over 92,000 users

You can make your own diagrams



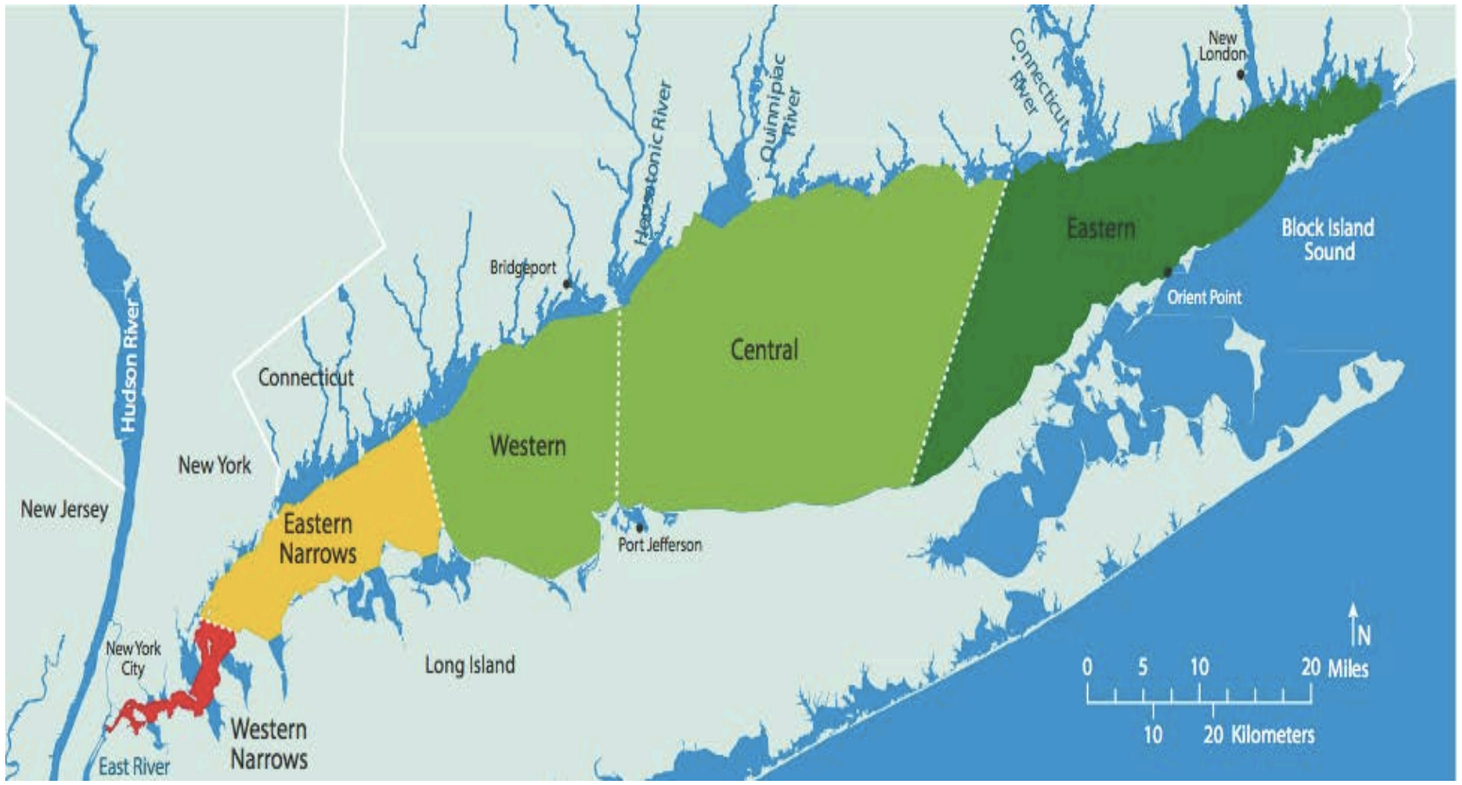


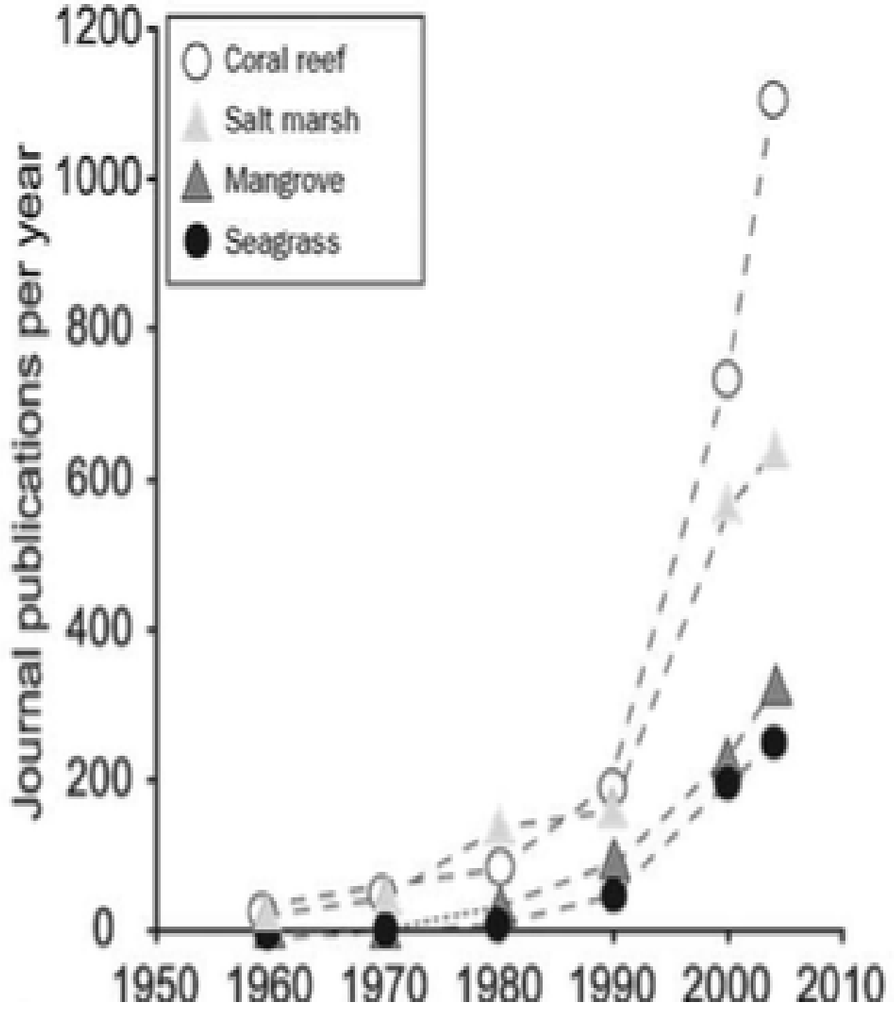
Visual literacy for science communication

1. There are many types of visuals that can be used
2. A diversity of visual elements enhances the appeal
3. Creation, selection, and editing of visual elements is important
4. Visual elements need to be fully integrated with text
5. Color selection = internally consistent & cognitively aware
6. Visual elements should be able to stand alone
7. Reduce extraneous information (e.g., chart junk, map junk)

There are many forms of visuals that can be used, including **photos**, **conceptual diagrams**, maps, graphs, videos

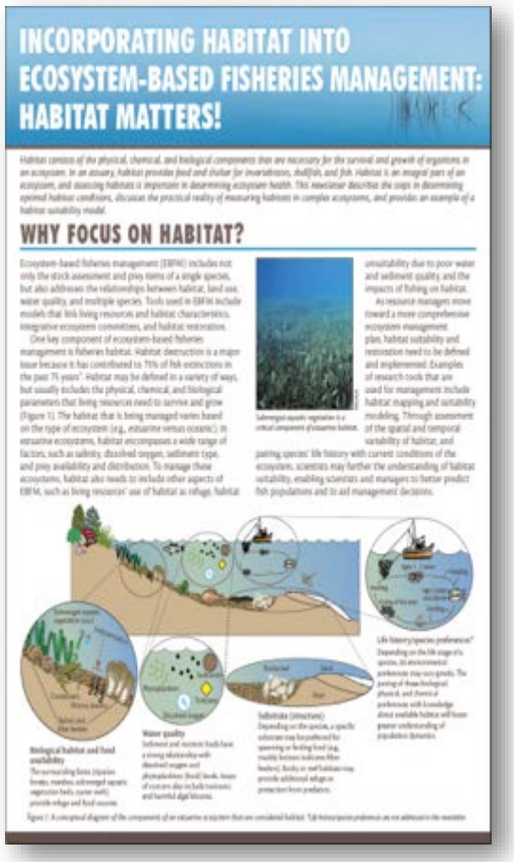
There are many forms of visuals that can be used, including photos, conceptual diagrams, **maps**, **graphs**, videos





There are many forms of visuals that can be used, including photos, conceptual diagrams, maps, graphs, **videos**

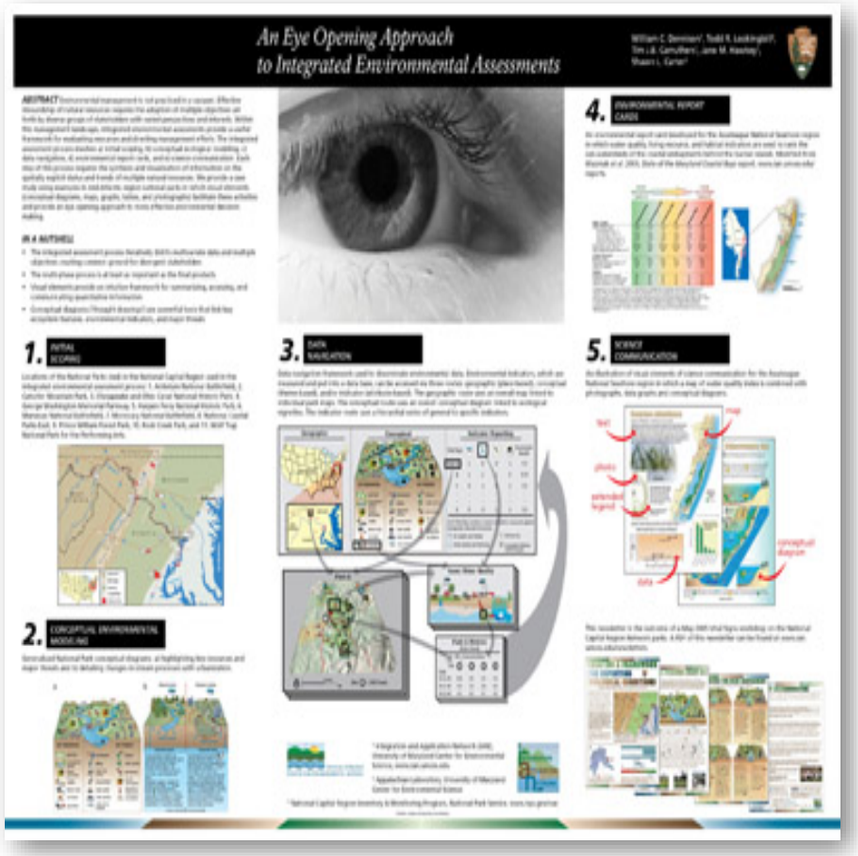
A diversity of visual elements enhances the appeal of science communication


INCORPORATING HABITAT INTO ECOSYSTEM-BASED FISHERIES MANAGEMENT: HABITAT MATTERS!

WHY FOCUS ON HABITAT?


Environmental problem solving in coastal ecosystems: A paradigm shift to sustainability

William C. Dennison


An Eye Opening Approach to Integrated Environmental Assessments

William C. Dennison¹, Todd R. Lookingbill², Tim J.B. Carruthers², Jane M. Wesley², Shawn L. Carter³

University of Maryland Center for Environmental Science

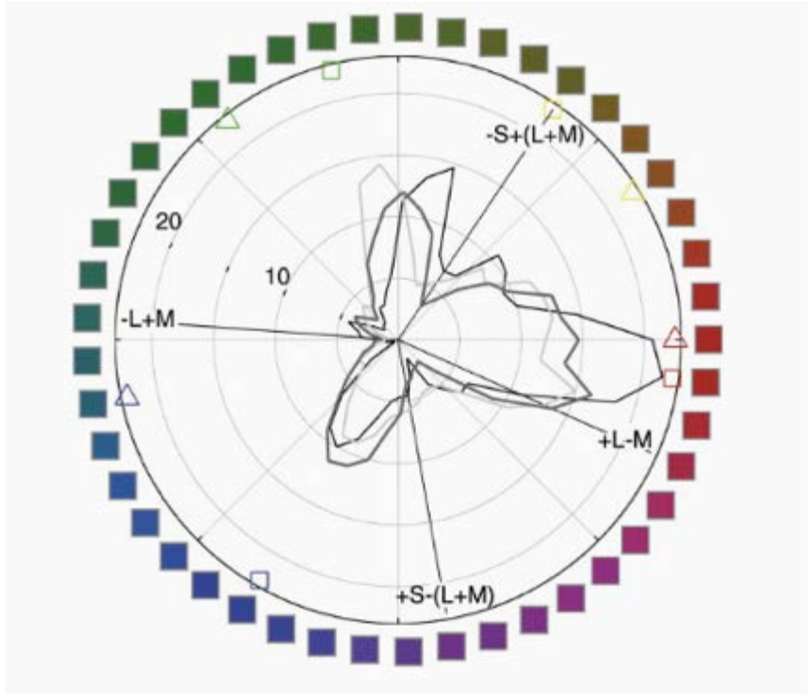
ian

Visual elements need to be fully integrated with text

University of Maryland
Center for Environmental Science

ian

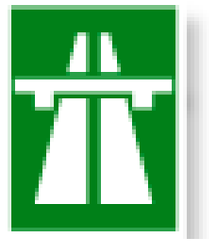
Color selection is crucial



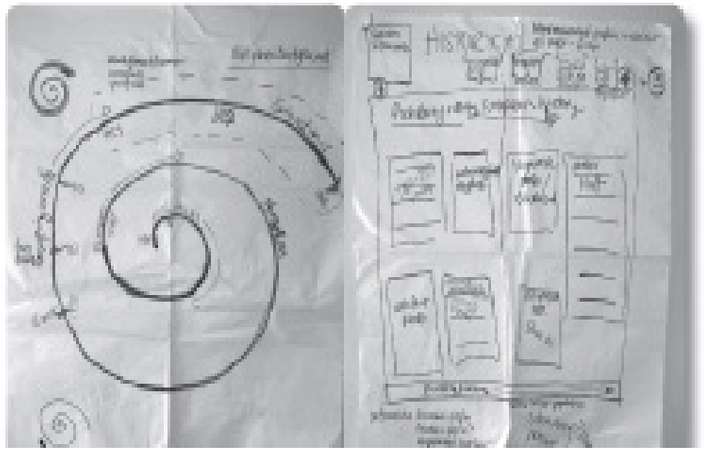
Neural basis for distinct hues

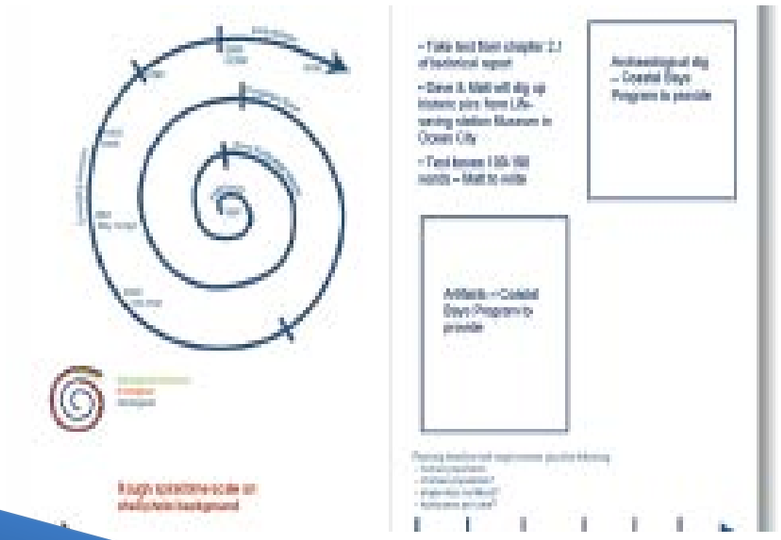
- Red hues lead to highest MRI brain responses
- Green and blue hues stimulate activity to lesser degree

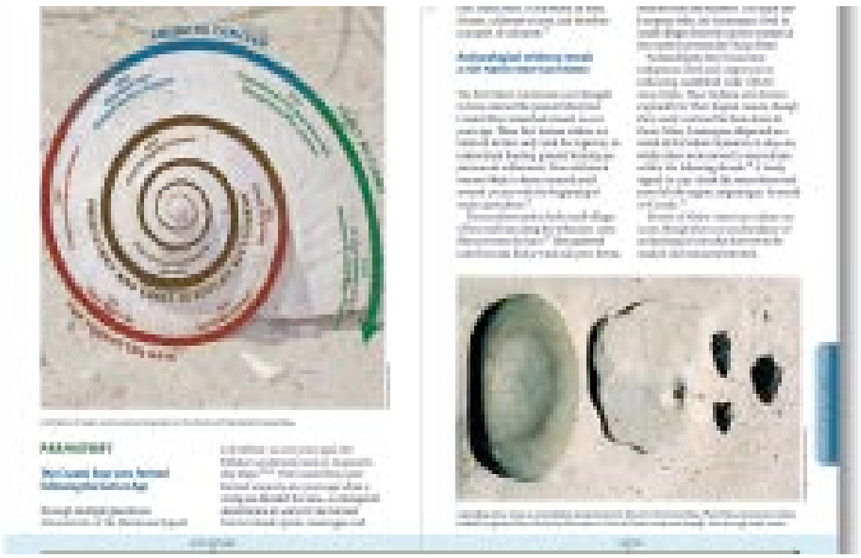
Stoughton and Conway 2008



Care should be given to the creation, selection, and editing of visual elements



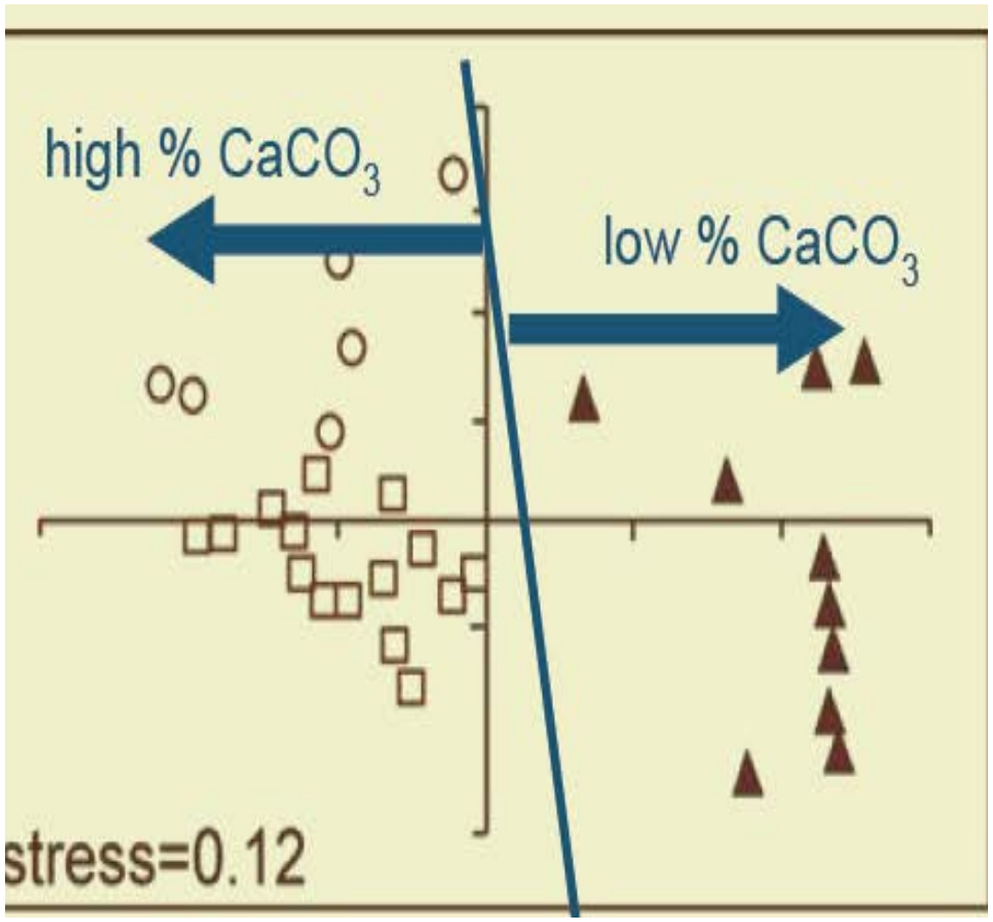




Visual elements should be able to stand alone (captions & legends)

Figure 1.1: Climate drivers, such as temperature and precipitation, influence many health issues. Health issues are likely to change or become exacerbated. Among those health concerns occurring across the State are water contamination or harmful algal blooms, which prevent swimming and fishing. Increases in temperature and changes to precipitation patterns are likely to influence air quality, heat stress, and vector-borne diseases across the State.

Reduce extraneous information (e.g., chart junk, map junk) to allow focus on content of interest



Narrative structure

- Evolution from key words → active titles →word clouds → narrative structure
- Good science narrative requires synthesis, audience awareness, elements of story, solid scientific basis
- Narrative structure is not facilitated by the standard scientific publishing format: Abstract, Introduction, Methods, Results, Discussion

Began using conclusions as titles

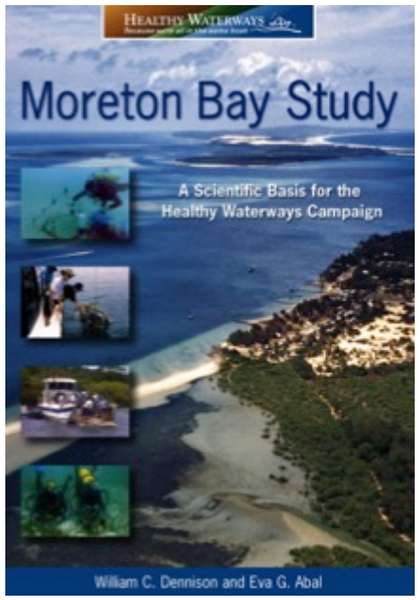


Table of Conclusions

Table of Conclusions

Conclusions evolved into 'active titles'

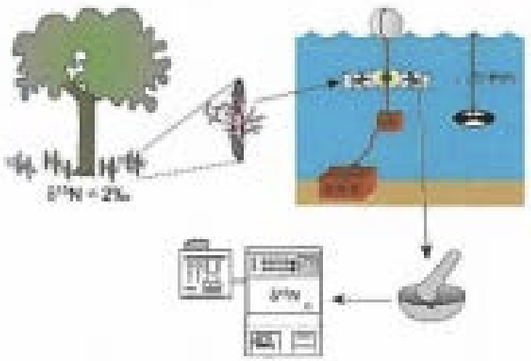
Typical page with active title

Sewage plumes track decrease in nitrogen loads from STP into Moreton Bay

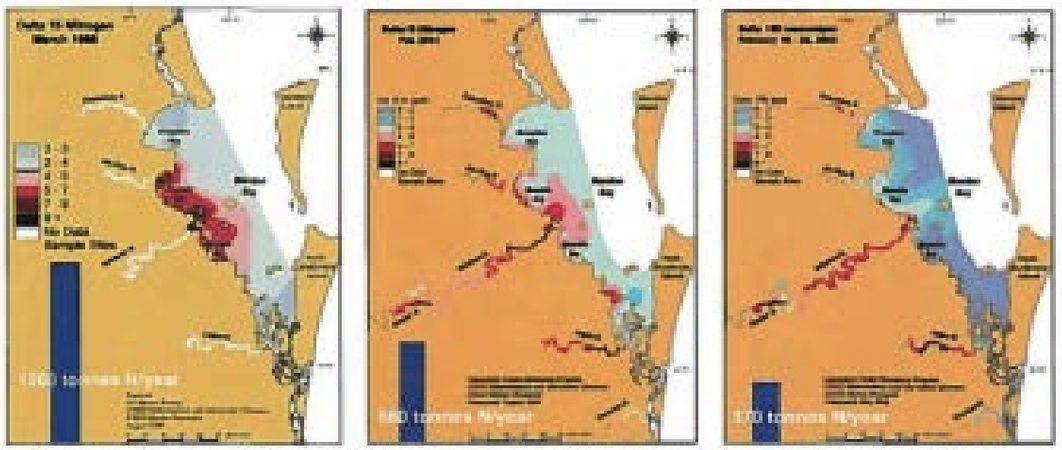
Sewage plumes in Moreton Bay and its river estuaries, although temporally variable (as previously reported in Dennison and Abal, 1999), can track the extent of nitrogen loads from sewage treatment plants. The intensity and distribution of sewage-derived nitrogen can be mapped using the gradient in $\delta^{15}N$ values of macroalgae with distance from sewage nutrient inputs.

The mapping of sewage plumes in South East Queensland estuarine and marine waters began in 1998 and since 2001 has been conducted annually. Sewage plumes extend into Moreton Bay from the many Sewage Treatment Plants on the Western side of the Bay. The Brisbane River was a major contributor to the Moreton Bay sewage plume in 1998, extending into Bramble and Waterloo Bay. However, since 1998, the spatial extent of the sewage plume in Bramble Bay has been significantly reduced, with the intensity of the sewage signal at the Brisbane River mouth also decreasing from 9 to 5-7‰. There also appeared to be little sewage extending southward into Waterloo Bay or into central Moreton Bay.

The reduction in the size and intensity of the sewage plume in Bramble may be due to significant upgrades that have occurred to sewage treatment plants in Redcliff and Brisbane City Councils. Natural variation in river flow and nutrient delivery to Moreton Bay between years is also likely to have contributed to observed pattern.

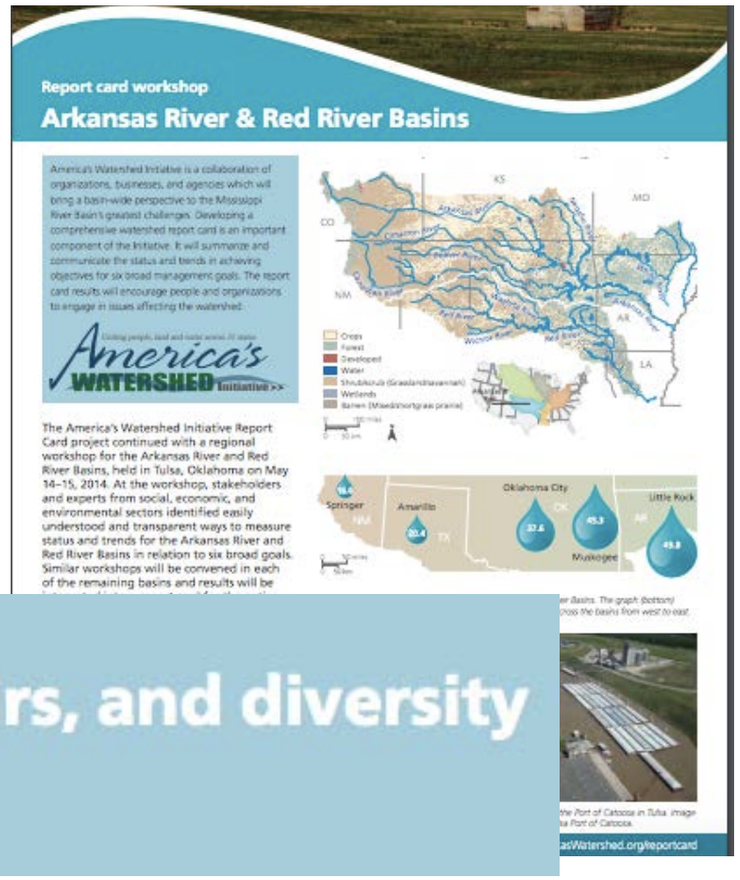


Methodology for tracing Sewage. The macroalgae *Caterpilla nipae*, is collected on mangrove pneumatophores and deployed in clear chambers at half seochi depth, and exposed to ambient water for four days. Samples are then collected, dried and analysed for $\delta^{15}N$ value on a mass spectrometer.



Sewage plume maps generated in 1998 (March), 2001, (February) and 2002 (February) showing that the extent of sewage plumes in Western Moreton Bay have decreased over the past five years. This coincides with Sewage Treatment Plant upgrades and the development of management actions to improve water quality in the Bay. Bars indicate the annual nitrogen load from Luggage Point and Redcliffe Sewage Treatment Plants.

Began soliciting key words

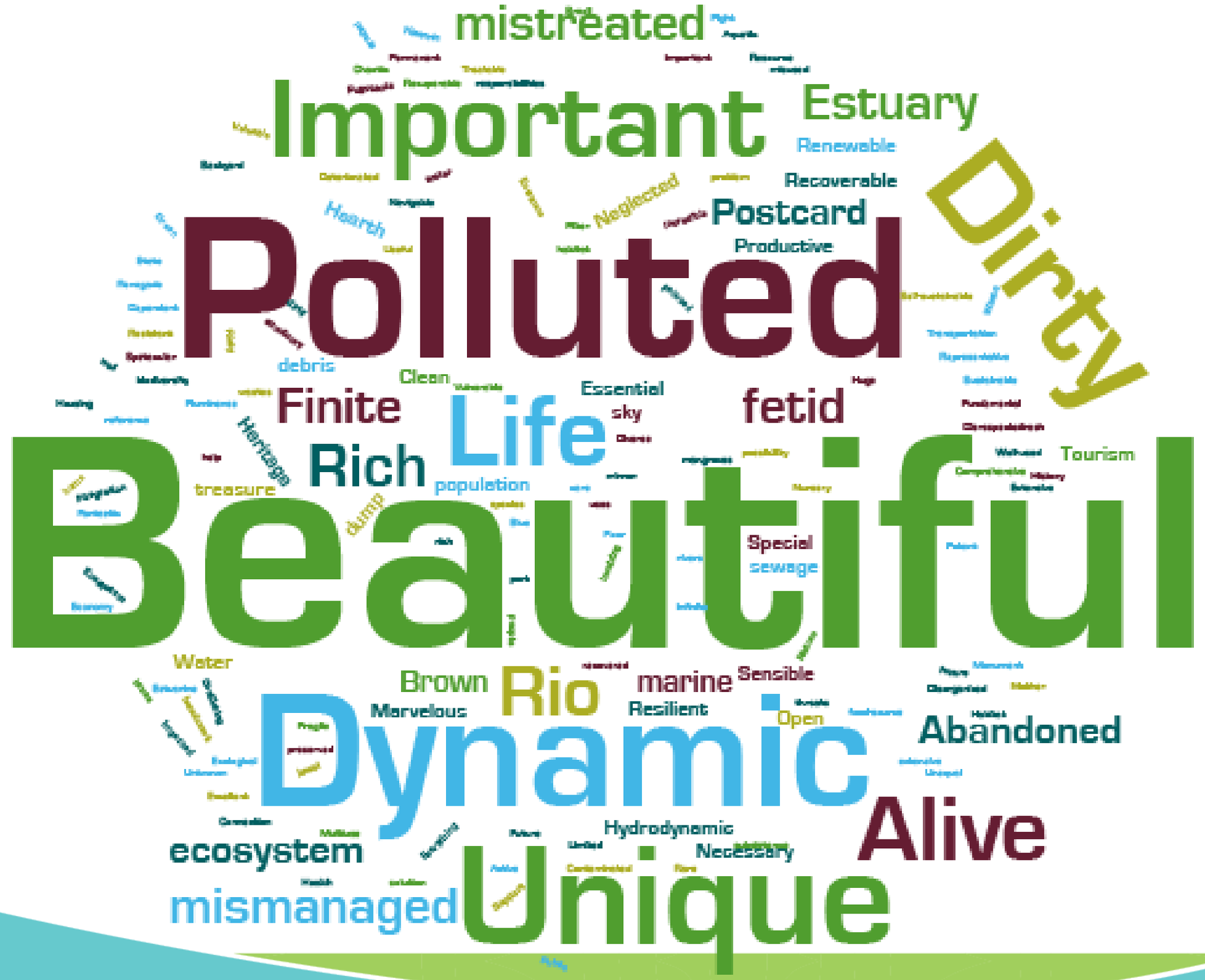


Droughts, reservoirs, and diversity

Beautiful, productive, abundant water

Started developing word clouds

Guanabara Bay is . . .



University of Maryland
Center for Environmental Science

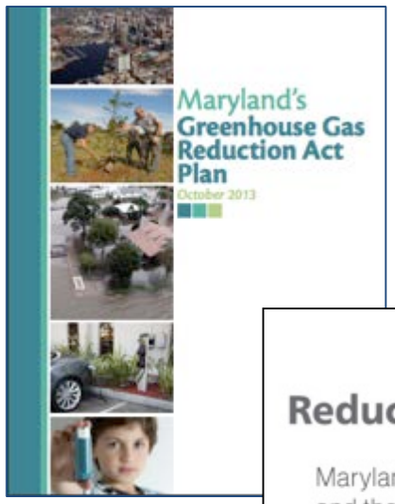
ian

Darwin Harbour is . . .

University of Maryland
Center for Environmental Science

ian

Made short declarative statements to accompany graphics



Randy Olson introduced the ABT format:
. . . and . . . but . . . therefore . . .

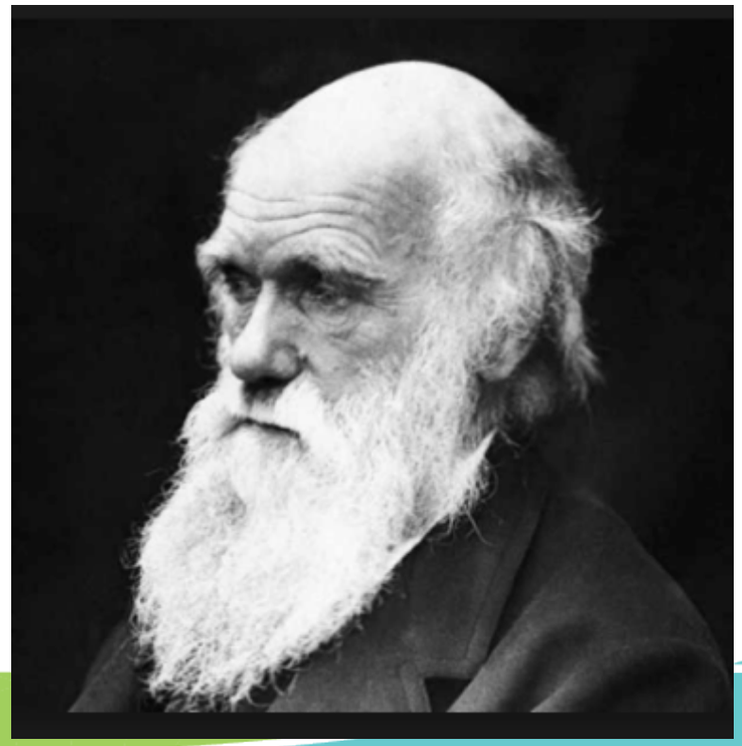
ABT . . . and . . . but . . .therefore. . .
AAA . . .and . . . and . . . and . . .
DHY . . . despite . . . yet . . . however . . .

Narrative Index = simple quantifiable assessment of narrative structure

- Number of ‘but’s vs. number of ‘and’s in text
- Narrative Index =(# ‘but’s / # ‘and’s) x 100
- Rationale; exclusive use of ‘and’ leads to AAA (boring, repetitious); adding ‘but’ into sentence creates tension and facilitates ABT (tension and resolution)
- Simple quantitative index

Charles Robert Darwin

- 1809 – 1882; English
- Influenced by Malthus (An essay on the principle of population), Lyell, Humboldt
- Made extended field trip; 5 years, S. America & Galapagos Islands
- Prolific author; numerous books & scientific papers



Alfred Russel Wallace

- 1823 – 1913; English
- Influenced by Malthus (An essay on the principle of population), Lyell, Humboldt
- Made extended field trips; 4 years S. America, 8 years Malay archipelago
- Prolific author; numerous books & scientific papers

Simultaneous publication in J Proc Linnean Society; 1858

Aug. 20. Price 2s.

JOURNAL OF THE PROCEEDINGS
OF THE
LINNEAN SOCIETY.

Vol. III. ZOOLOGY. No. 9.

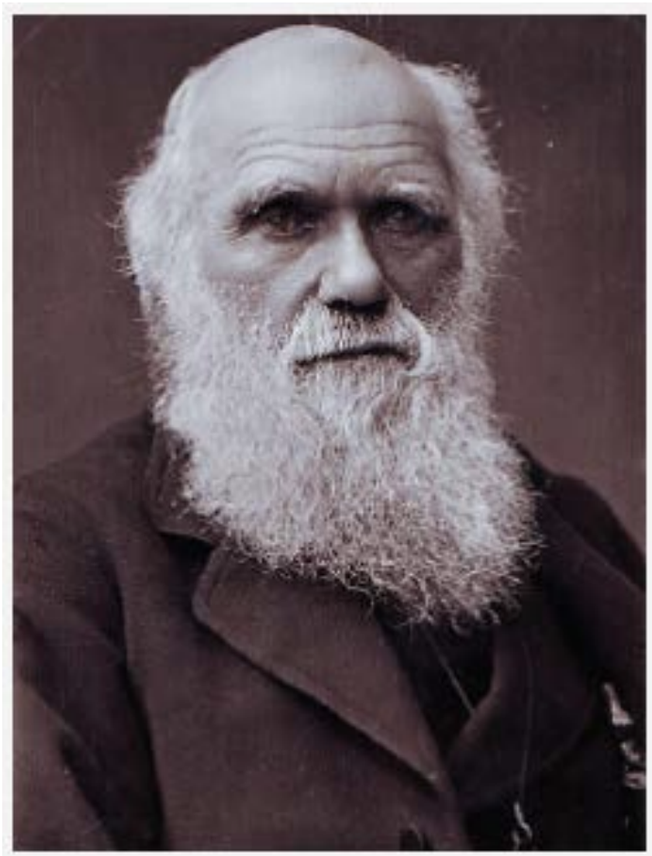
CONTENTS.

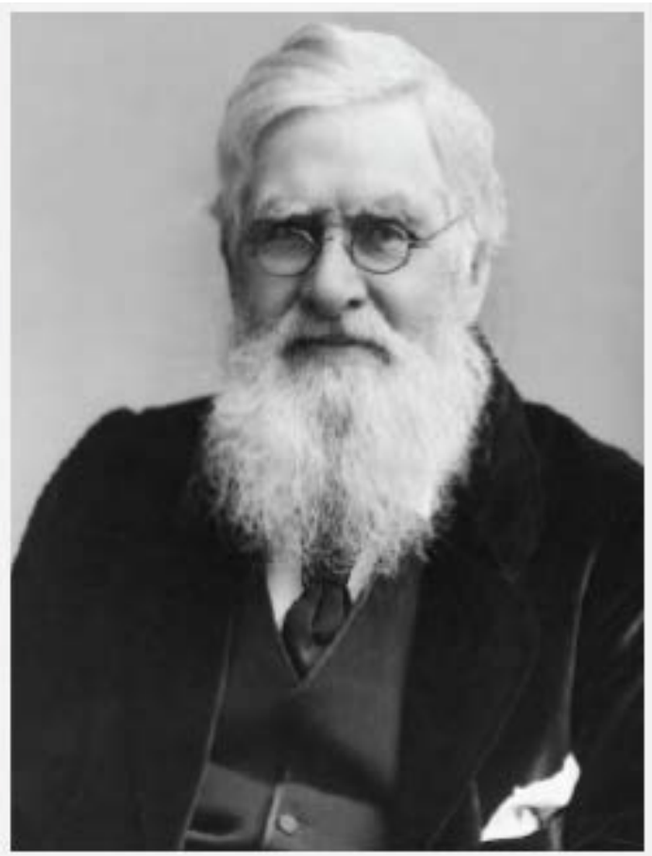
LONDON:
LONGMAN, BROWN, GREEN, LONGMANS & ROBERTS.
1859
WILLIAMS AND NORGATE.
1859.

VIII. On the Tendency of Species to form Varieties; and on the Perpetuation of Varieties and Species by Natural Means of Selection. By CHARLES DARWIN, Esq., F.R.S., F.L.S. & F.G.S., and ALFRED R. WALLACE, Esq. Communicated by Sir CHARLES LTELL, F.R.S., F.L.S., and J.D. HOOKER., M.D., V.P.R.S., F.L.S &c.

Controlled ‘experiment’

- Same theory (natural selection)
- Both Englishmen; similar age
- Similar influences (e.g., Malthus, Lyell, Humboldt)
- Similar observations (e.g., S. American flora & fauna)
- Published at the same time
- Published in the same journal
- Neither man was present when paper was originally read at the Linnean Society

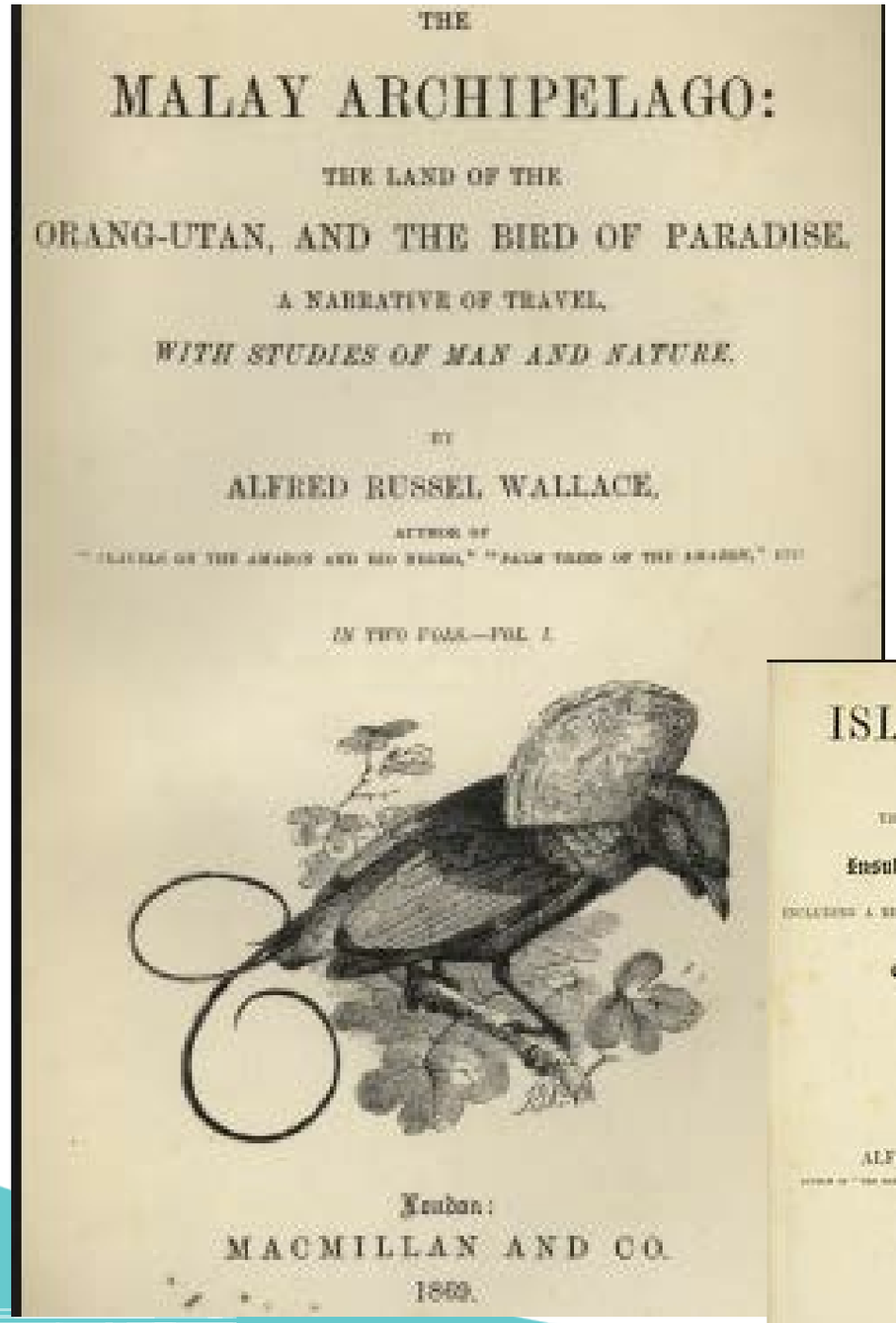




Wallace vs. Darwin narrative index

- Wallace: “On the Tendency of Varieties to Depart Indefinitely from the Original Type” Narrative Index = 19
- Darwin: "On the Variation of Organic Beings in a state of Nature; on the Natural Means of Selection; on the Comparison of Domestic Races and true Species” Narrative Index = 27
- Darwin: “Abstract from Letter 10/5/1857” Narrative Index = 26

Wallace: Narrative Index


THE

MALAY ARCHIPELAGO:

THE LAND OF THE

ORANG-UTAN, AND THE BIRD OF PARADISE.

A NARRATIVE OF TRAVEL,

WITH STUDIES OF MAN AND NATURE.

BY

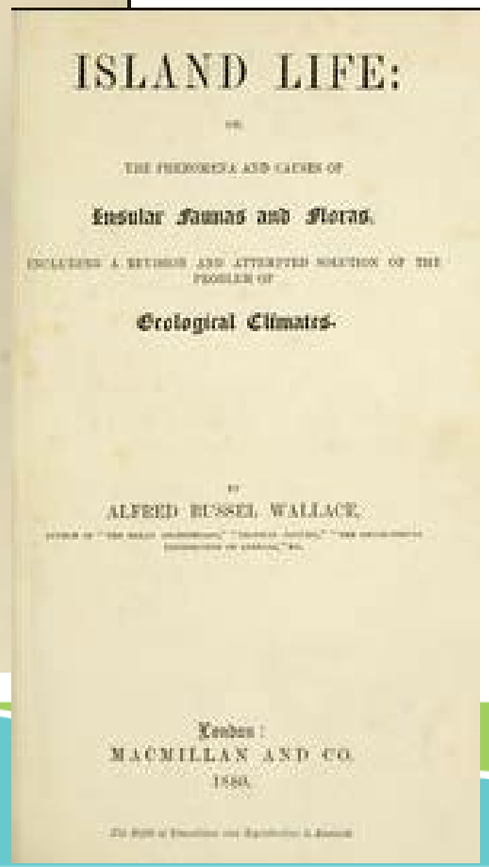
ALFRED RUSSEL WALLACE,

IN TWO VOLS.—VOL. I.

London:

MACMILLAN AND CO.

1869.


ISLAND LIFE:

OR,

THE PHENOMENA AND CAUSES OF

Insular Faunas and Floras.

INCLUDING A REVISION AND ATTEMPTED SOLUTION OF THE PROBLEM OF

Geological Climates.

BY

ALFRED RUSSEL WALLACE,

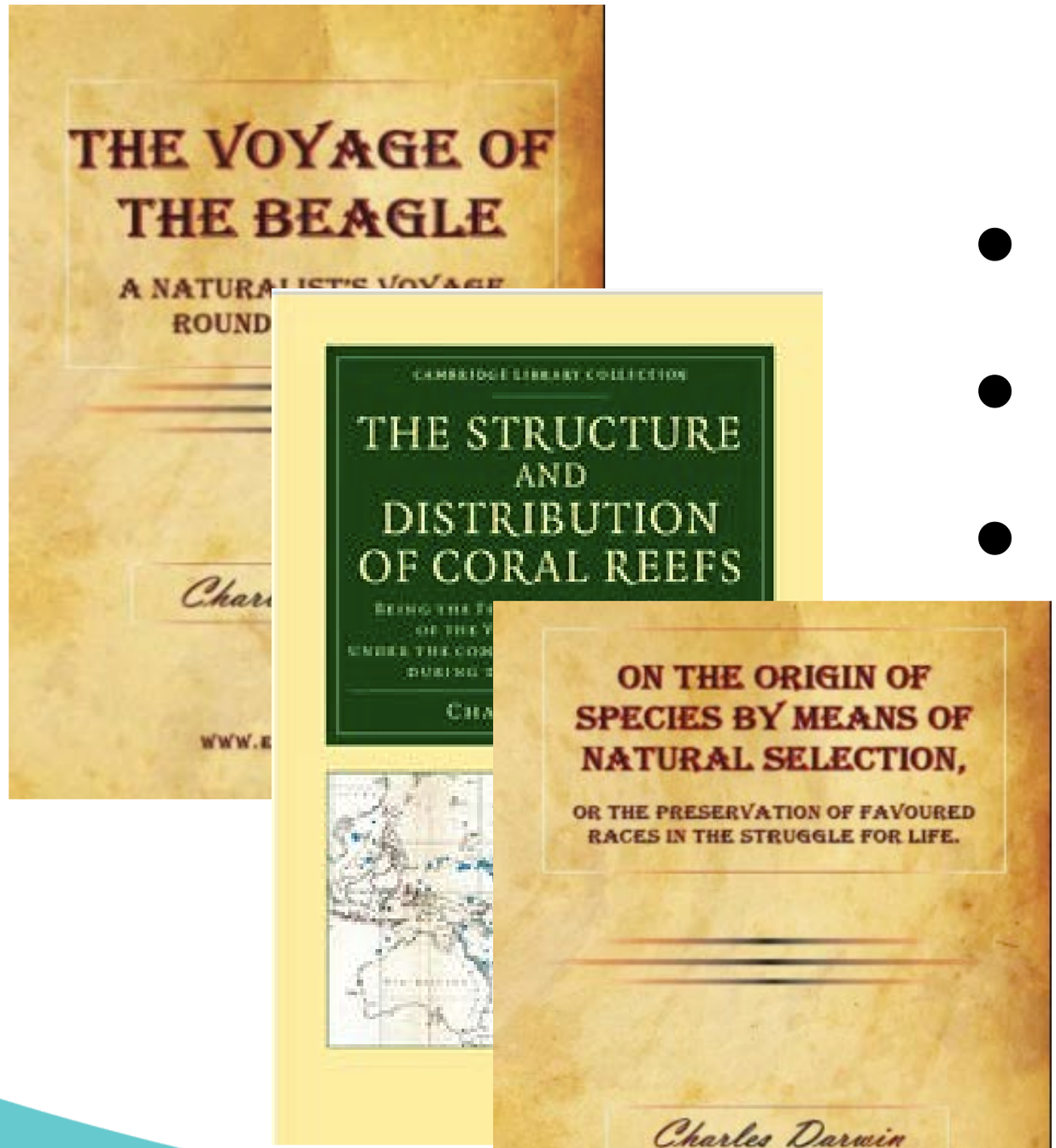
London:

MACMILLAN AND CO.

1880.

- Malay Vol 1 = 11
- Malay Vol 2 = 12
- Island Life = 14

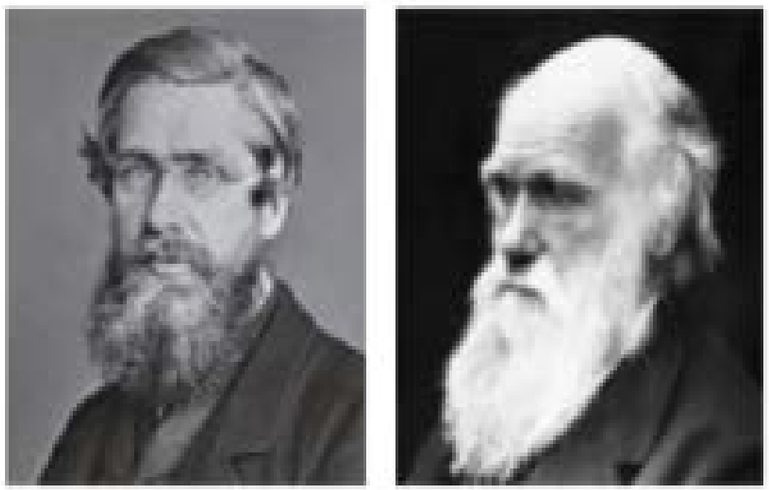
Darwin: Narrative Index



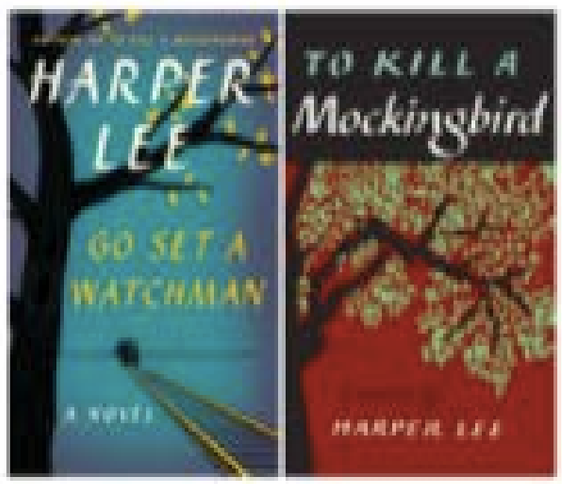
- Voyage = 17
- Coral Reefs = 17
- Origin = 20

Narrative structure applies to science, literature and politics

NARRATIVE MATCHUPS



14 vs 18

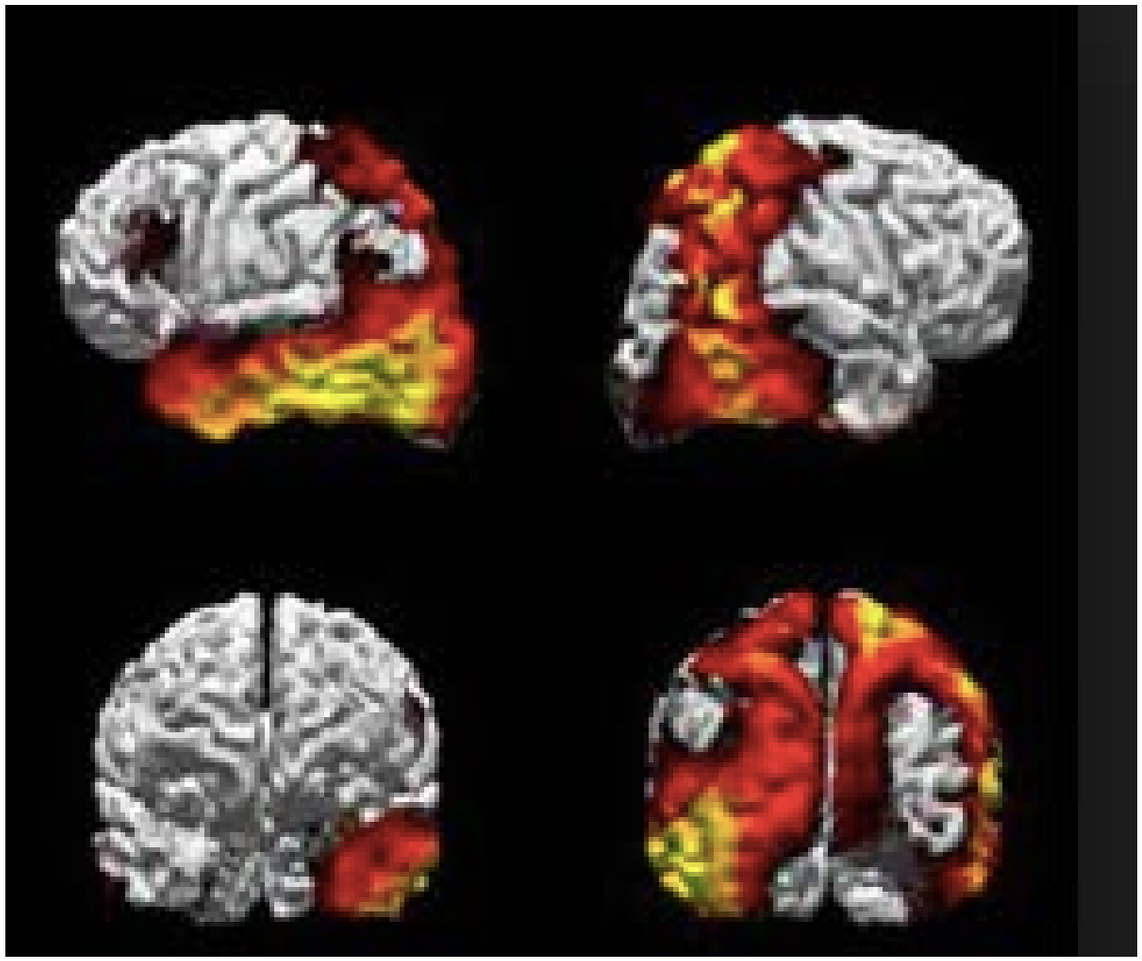


17 vs 24

14 vs 28

http://www.scienceneedsstory.com/blog/the-narrative-index/

Narrative affects neural activity

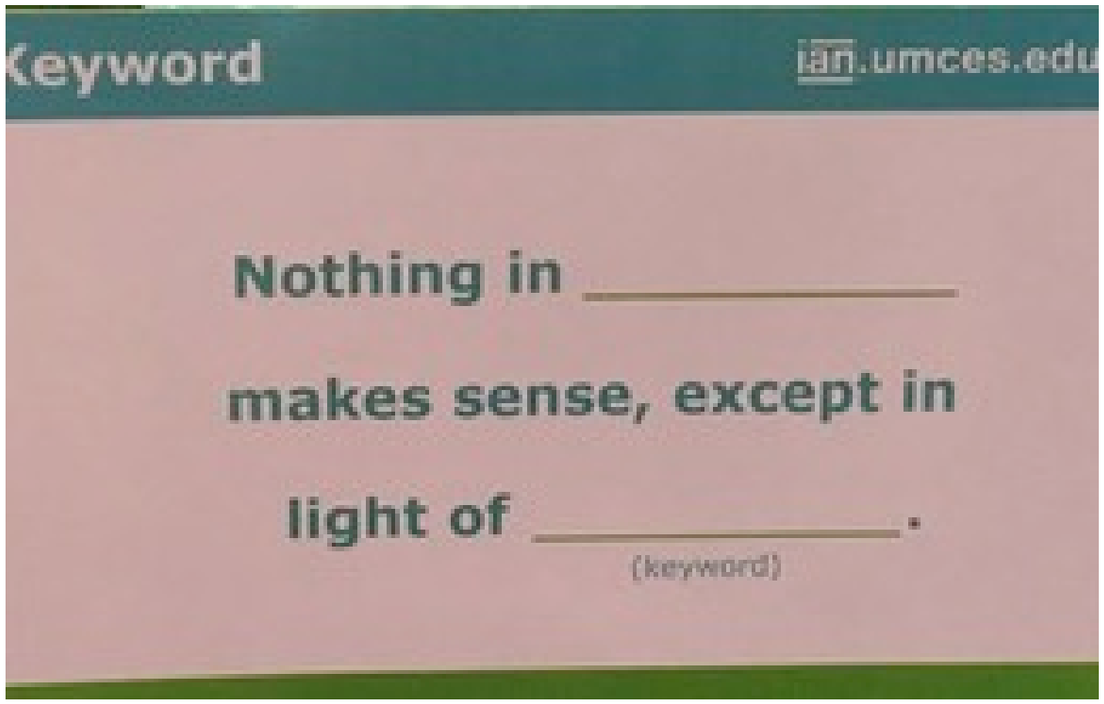


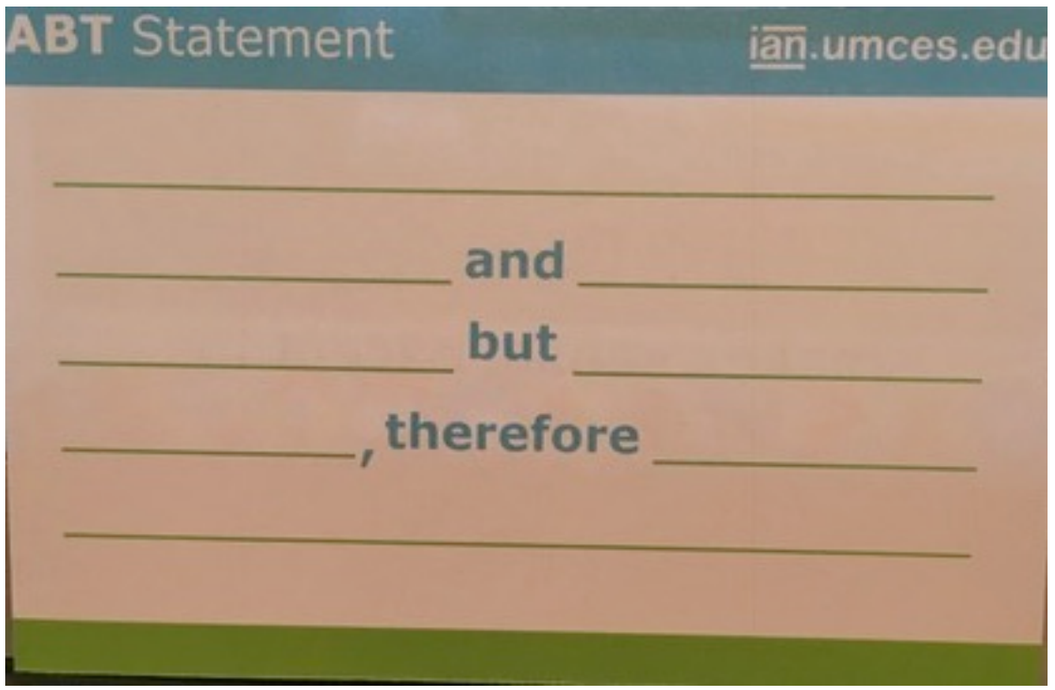
Neural basis for narrative

- Narrative activates the brain
- Narrative unifies the thinking of a group

Hasson in Olson 2015

ABT statements and key word identification



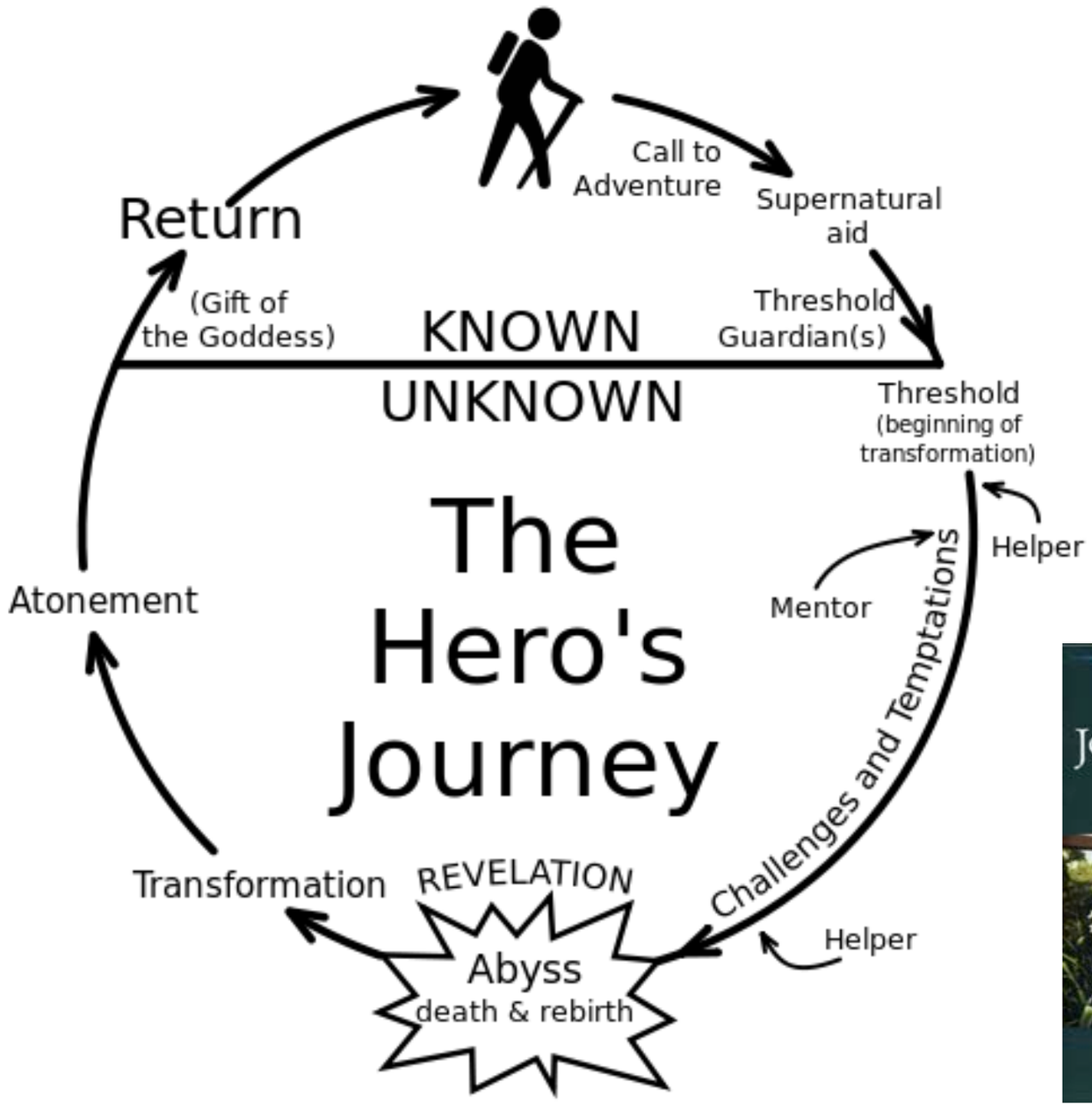


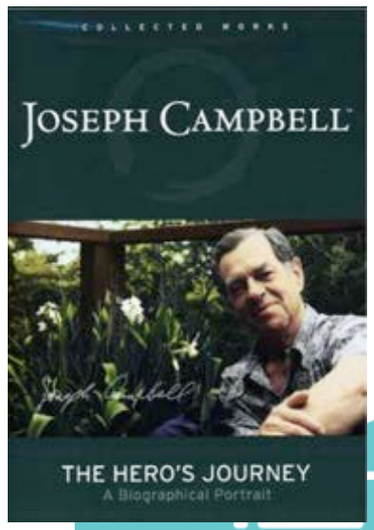
Narrative literacy for science communication

1. Storytelling can be a powerful tool for science communication
2. Selection of key words can enhance science communication
3. The ABT format provides compelling narrative structure
4. Active titles enhance comprehension
5. Science narratives should focus on informing, not persuading audience
6. Simplify & define terms, avoid jargon, but do NOT ‘dumb it down’ – instead, ‘raise the bar’
7. Provide context; ‘why should the audience care?’

Storytelling can be a powerful tool for science communication (using causality, temporality and character)

- **Causality**: Cause-effect relationships inferred
- **Temporality**: Timeline, context dependent
- **Character**: People involved





Selection of key words can enhance science communication

Randy Olson's Dobzhansky template:

Nothing in the _____ makes sense,
except in light of _____.

Nothing in geology makes sense, except in light of plate tectonics.
Nothing in ecology makes sense, except in light of evolution.

Transdisciplinary science is

_____,

_____,

_____ .

The ABT format (". . . and . . . but . . . therefore . . ." template) provides compelling narrative structure

"Stories are fun

And

may seem complex

But

they all have a similar structure

Therefore

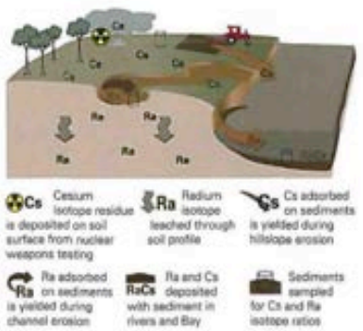
they lend themselves to templates."

Active titles enhance comprehension

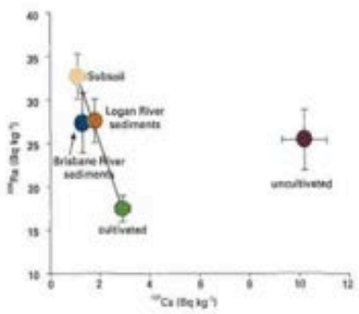
Erosion process tracing confirms model predictions

Sediment tracing methods provide us with an independent means of testing the model predictions. Surface soil samples were collected throughout the catchments from cultivated and uncultivated lands, and from subsoils in gullies and stream banks. These source types can be distinguished by measuring concentrations of cesium-137 (^{137}Cs) and radium-226 (^{226}Ra). ^{137}Cs is a product of atmospheric nuclear weapons testing that occurred in the 1950-70s. It accumulates in surface soil, and labels sediment eroded from top-soils. ^{226}Ra is a naturally occurring radio-nuclide that can occur in reduced concentrations in cultivated soils, possibly due to leaching. Together, these two radionuclides can give a good indication of the origin of sediment from the landscape.

Sediment samples collected from the lower reaches of the Brisbane and Logan Rivers upstream of the tidal estuaries, are likely to be well mixed during transport, and so should represent sediment delivered from many sources in their respective catchments. The mean ^{137}Cs and ^{226}Ra in the sediment sample values lie between the mean cultivated surface soil and subsoil values, while the mean uncultivated surface soil value lies well away from this group. Assuming that the mean sediment concentrations are a linear mix of the two primary sources, then we can estimate that 75 ± 25% of the sediments originate from subsoil (channel) erosion in the Brisbane and Logan catchments, while the remaining 25 ± 25% comes from cultivated surface soils. Note that these results have a relatively high statistical uncertainty (± 25%), which means that the variation in the contribution of surface soils and subsoils to river sediments is relatively high. On average, the subsoil contribution to the Logan and Brisbane Rivers will vary from 50-100%. These results do not exclude the likelihood that some sediment is also coming from uncultivated land, however, the contribution is relatively small.



Erosion processes were traced using the isotopes cesium (^{137}Cs) and radium (^{226}Ra). Used in combination, these two radionuclides can give a good indication about where sediment has originated from in the landscape.



Average radium (^{226}Ra) and cesium (^{137}Cs) values from cultivated and uncultivated soils (hillslope erosion) and subsoils (channel erosion), compared with average values obtained from sediment in the lower Brisbane and Logan Rivers. These results show that the river sediments mainly originate from subsoil erosion (75%), with most of the remaining sediment coming from erosion of cultivated soil.

Active titles

Report card design inspired by paddlewheel

ian.umces.edu

University of Maryland
Center for Environmental Science

ian

Science narratives should focus on informing, not persuading audience

Inform

- Instructs, explains, describes, etc.
- *Gives* something to audience
- *Tells* them
- Information can persuade

Persuade

- Changes attitudes, beliefs, etc.
- *Gets* something from audience
- *Sells* them
- Persuasion can inform

Simplify & define terms, avoid jargon, but do NOT ‘dumb it down’ – instead, ‘raise the bar’

What's Working

Upgrades in both nitrogen and phosphorus wastewater treatment result in rapid local water quality improvements

- Upgrades to wastewater treatment plants are effective restoration practices.
- Wastewater treatment plant upgrades result in decreased nitrogen and phosphorus loadings to the Chesapeake Bay.
- Reduced nitrogen and phosphorus loads lead to improved water quality and in some cases increased submerged aquatic vegetation.

Many practices provide initial water quality improvements in runoff; however, full benefits to stream conditions can be delayed

enges

- 'Lag time' is a delayed response time between implementing best management practices and observing full water quality improvements.
- Lag times are affected by groundwater age, sediment movement, phosphorus storage in sediments, and riparian buffer age.
- The effect of lag times will vary depending on the types of best management practices and where they are implemented.

Provide context; ‘why should the audience care?’

UCONN
COLLEGE OF AGRICULTURE, HEALTH AND NATURAL RESOURCES

People, Trees, and Power: Human Dimensions of Roadside Tree Management to Reduce Power Outages

Daniel C. Hale and Anita T. Morzillo
University of Connecticut, Department of Natural Resources and the Environment, Storrs, CT

STORMWISE
stormwise.uconn.edu

A tree fallen on power lines in Glastonbury, central Connecticut, after the 2011 October Snowstorm.

INTRODUCTION

Stormwise is a vegetation management program aiming to reduce the risk of tree-related storm damage to power lines. Tree trimming, removal, and planting directly affects places where people live. Therefore, this study seeks to understand **public attitudes** toward the program.

Past research suggests that attitudes toward natural resources vary from urban to rural areas. At a household level, trees can have a strong effect on people's experiences. Therefore, this study will evaluate how these **landscape factors** influence attitudes toward vegetation management.

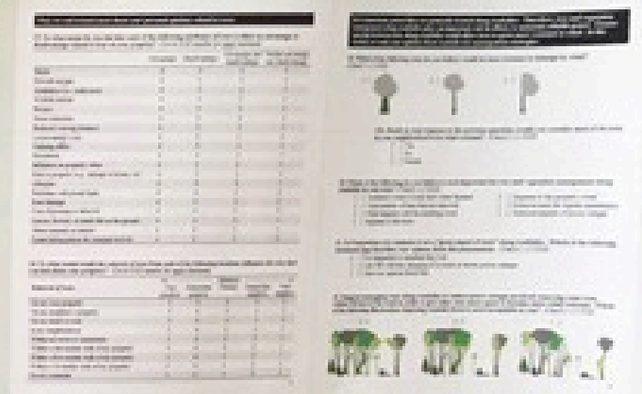
Stormwise envisions a roadside forest with widely spaced trees that can grow resistant to wind

SURVEY

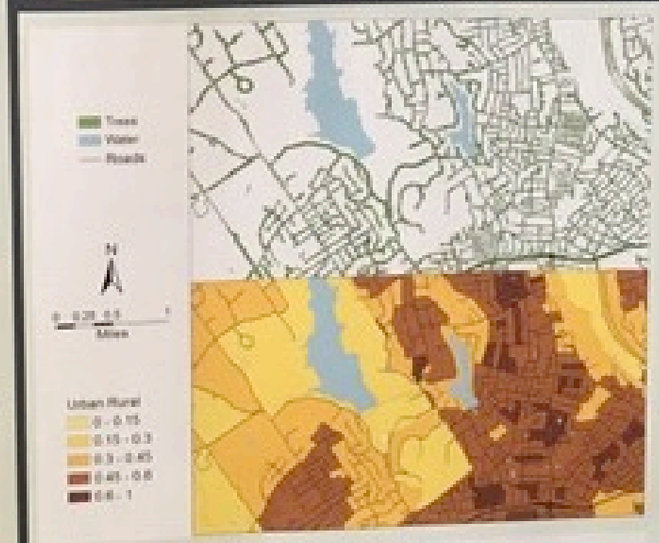
Self-administered surveys were used to measure attitudes toward Stormwise vegetation management. In February 2017, we mailed 3,600 surveys to a random sample of Connecticut residents in two areas, and across an urban-rural gradient. Questions address:

- Experience with storms and power outages
- Attitudes toward utility vegetation management
- Ecosystem services and disservices related to trees
- New roadside tree management strategies
- Sociodemographic information

So far, more than 750 surveys have been received (21%).



An excerpt from the survey mailed to Connecticut residents.



Top: Tree cover within 35 m of road centerlines.
Bottom: Census blocks by urban-rural index. 0 = rural; 1 = urban.

SPATIAL ANALYSIS

Neighborhood characteristics will be mapped and quantified around each survey respondent's address. We will evaluate trends in resident attitudes in relation to two landscape factors:

- **Trees** contribute to neighborhood character and may be altered by vegetation management. To show the roadside forest in a household context, tree cover will be mapped within various distances of from the household and road.
- Differences exist among humans, forests, and vegetation management along an **urban-rural gradient.** An index is being developed to assess attitudes along this gradient.

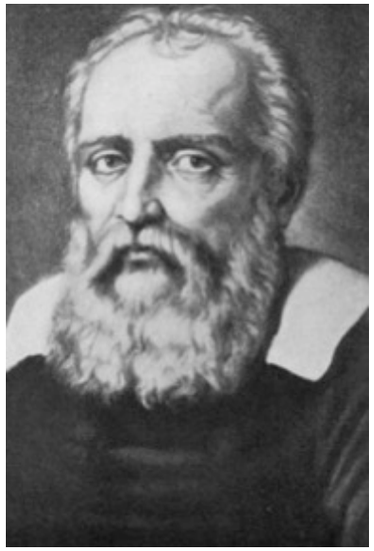
MANAGEMENT IMPLICATIONS

- **Survey data** will be used to explore pathways toward adopting Stormwise tree management strategies statewide.
- Combined with survey data, **spatial analysis** will provide insight for developing management strategies targeting people in urban versus rural locations.

This project is supported by the Eversource Energy Center and the University of Connecticut. Use of human subjects was approved by the University of Connecticut Institutional Review Board (#H16-007).

Paradigm shifts occur with good science communication

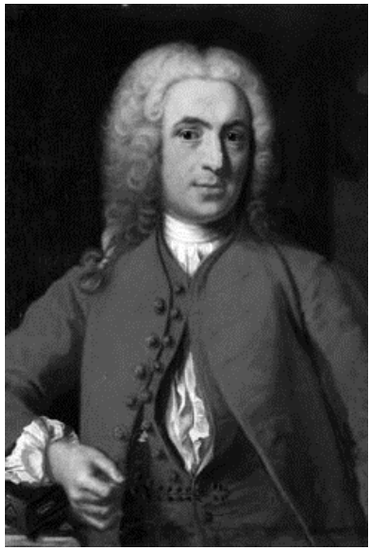
Astronomy



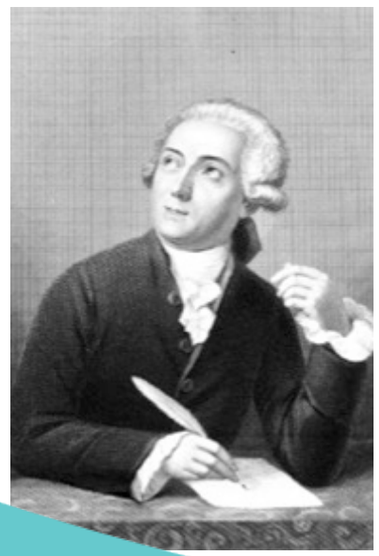
Physics

Astronomy

Physics

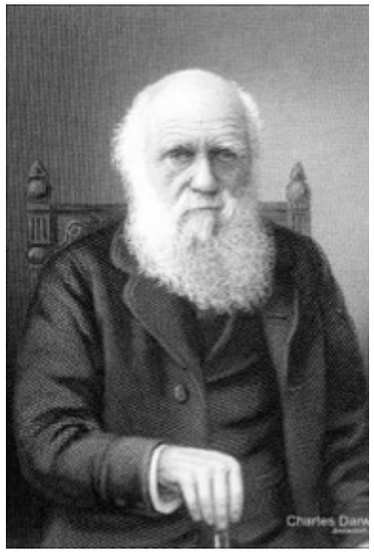


Biology

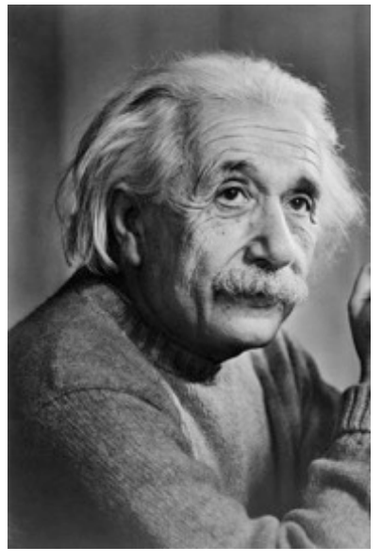


Chemistry

Geology



Evolution



Physics

Biology

Paradigm shift to sustainability leaders