Introduction to Conceptual Diagrams
A tool for effective science communication

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Outline

• What are conceptual diagrams?
• Why are conceptual diagrams effective?
• How can conceptual diagrams be used?
What are conceptual diagrams?

**concept** /ˈkänsept/
Noun: Something conceived in the mind  
(Webster’s 3rd Dictionary, 1986)

**diagram** /ˈdīəˌgram/
Noun: A drawing that shows relations  
(Webster’s 3rd Dictionary, 1986)

**conceptual diagram**
A diagram using symbols that depicts the essential attributes of a system
Conceptual diagrams provide synthesis, visualization, and context.
What makes conceptual diagrams so effective?

- Help to clarify thinking
- Aid communication
- Can identify data gaps, management priorities, or key features and threats
Diagrams are an interface between scientists, government, and the community.
Conceptual diagrams can illustrate complex processes

nutrient loading: +N +P

Oligotrophic  Mesotrophic  Eutrophic  Hypertrophic
Conceptual diagrams can describe processes at different scales.

Consumers of detritus include sessile filter feeders, such as sponges and mangrove oysters.

The Protist, Halophytophthora produces zoospores that attach to leaves. Zoospores send out hyphae that penetrate leaf tissues and produce enzymes that break down organic compounds.

Yeasts absorb the water-soluble portion of decomposing leaves and are themselves consumed by filter feeders, such as sponges and copepods.

Consumers of detritus include benthic animals, such as crabs, shrimp, worms, and microcrustaceans.

meters → centimeters
Conceptual diagrams can communicate ecosystem relationships

How does the groundwater system work in north Kona?

North Kona has low rainfall, dark porous soils, abundant sun, and high evaporation. As a result, aquatic resources are highly dependent on groundwater.

Rainfall that seeps into the soil forms a layer of fresh groundwater that floats on the layer of brackish groundwater. The brackish water emerges in low anchialine pools and seeps into the fishponds, wetlands, and nearshore marine waters.
Conceptual diagrams can show ecosystem comparisons.
The components of a conceptual diagram: BASE
The components of a conceptual diagram: **SYMBOLS**

- Symbols are language independent and universal: mathematics $\pi$, weather ☀️, music 🎶, religion 🐳, corporate branding 🏆, signage 🍀, and organizations ✨.
The components of a conceptual diagram: SYMBOLS

• Symbols are language independent and universal: mathematics $\pi$, weather $\odot$, music $\triangledown$, religion $\varpi$, corporate branding $\circ$, signage $\square$, and organizations $\oplus$.

• Symbols can represent something tangible.
Symbols are language independent and universal: mathematics $\pi$, weather ☀️, music 🎶, religion 🕉️, corporate branding 🦅, signage 💼, and organizations 💕.

- Symbols can represent something tangible
- Symbols can represent something invisible or intangible

CO₂, O₂
IAN’s symbol libraries are a key tool for scientists and managers.
Use the size and color of symbols to convey information

<table>
<thead>
<tr>
<th><strong>DEGRADED</strong></th>
<th><strong>INDICATORS</strong></th>
<th><strong>DESIRED</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>High turbidity and sediment loading reduce water clarity and degrades seagrass communities. High crown of thorns abundance indicates a disturbed ecosystem. Low coral cover and richness indicates vulnerable coral communities. Low fish biomass and richness indicates unsustainable inshore fisheries.</td>
<td><strong>Coral cover</strong>&lt;br&gt;low&lt;br&gt;<strong>Coral richness</strong>&lt;br&gt;low&lt;br&gt;<strong>Fish biomass</strong>&lt;br&gt;low&lt;br&gt;<strong>Fish richness</strong>&lt;br&gt;low&lt;br&gt;<strong>Sediment load</strong>&lt;br&gt;high&lt;br&gt;<strong>Turbidity</strong>&lt;br&gt;low</td>
<td>Low turbidity and sediment loading support clear water and healthy and diverse seagrass communities. Low crown of thorns abundance indicates an intact ecosystem. High coral cover and richness indicates resilient coral communities. High fish biomass and richness supports sustainable inshore fisheries.</td>
</tr>
</tbody>
</table>
The legend is the key
Symbols can be used in data graphs.
Symbols can be used in tables

<table>
<thead>
<tr>
<th>Water quality &amp; habitat indicators</th>
<th>McHenry</th>
<th>Mid-lake</th>
<th>Southern lake</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DO</strong> Dissolved oxygen</td>
<td>93</td>
<td>79</td>
<td>93</td>
<td>87</td>
</tr>
<tr>
<td><strong>TP</strong> Total phosphorus</td>
<td>100</td>
<td>95</td>
<td>81</td>
<td>88</td>
</tr>
<tr>
<td>Water clarity</td>
<td>67</td>
<td>83</td>
<td>69</td>
<td>74</td>
</tr>
<tr>
<td><strong>Chlorophyll a</strong></td>
<td>64</td>
<td>73</td>
<td>65</td>
<td>68</td>
</tr>
<tr>
<td>pH</td>
<td>100</td>
<td>100</td>
<td>99</td>
<td>100</td>
</tr>
<tr>
<td><strong>Hg</strong> Mercury</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Aquatic grasses</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>

Grading scale:
- 0% very poor
- 100% very good
- Insufficient data

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Symbols can transform flow charts

- Habitat destruction
- Increased coastal erosion
- Decreased storm buffering
- Lost tourism revenue
- Loss of seagrass habitat
- Loss of coral reef habitat
- Decreased fisheries
- Declining human well-being in coastal populations
- Increased sediments and pollutants
Symbols can be used in infographics

Reducing Maryland’s carbon pollution

Maryland’s plan to reduce carbon pollution and the impacts of climate change will:

- grow Maryland’s green economy
- support thousands of jobs
- protect the environment
- improve public health
Diagrams can be produced in real time with all participants contributing.
Those key messages are synthesized into a shared vision.

**Science**
- Current understanding
- Credibility and support

**Community**
- Priority and environmental values
- Commitment and resources
...into synthesized cumulative impact visualizations
Use diagrams for public outreach
Conceptual diagrams can be used in websites and cell phone apps.
Solicit feedback

- Colleagues and collaborators
- Key stakeholders
- Recognized experts
Solicit feedback
Solicit feedback

**Physical features**
- Storms result in inlet formation, closure, and island overwash.
- Dynamic geomorphology includes longshore sand transport, island "rollover," and net westerly migration.
- Mainland groundwater discharges to the coastal bays and the ocean. Assateague groundwater is isolated.
- Removal of artificial structures is restoring natural processes such as dune building and overwash.

**Ecosystem features**
- Rare overwash habitat supports specialized and rare species such as piping plover and seabeach amaranth.
- Birds use the island for overwintering and a stop along a major Atlantic migration corridor.
- The absence of ambient noise allows for sensitive species to be unimpacted by human activity.
- Native white-tail deer and historically introduced horses and sika deer.

**Human use features**
- The bays and ocean provide important habitat for commercial and recreational fisheries.
- Aesthetic appeal and observation of unique fauna attracts millions of visitors every year.
- Increasingly rare on the US Atlantic coast, night darkness characterizes the sky.
- Hunting of native white-tail deer and introduced sika deer help control population size.

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In summary...

- You can quickly and effectively sketch complex scientific concepts
- No artistic talent is needed – click and drag our base and symbols
- Draft and revise
- Obtain stakeholder input and feedback

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Concept: Acid rain kills forests

Definition: Acidification of rainfall by emissions kills trees

Keywords: Air pollution
          Acid rain
          Tree death

Each person has to draw the concept for others to guess – all keywords must be written down to finish