Knowledge Networks and Science Data Ecosystems

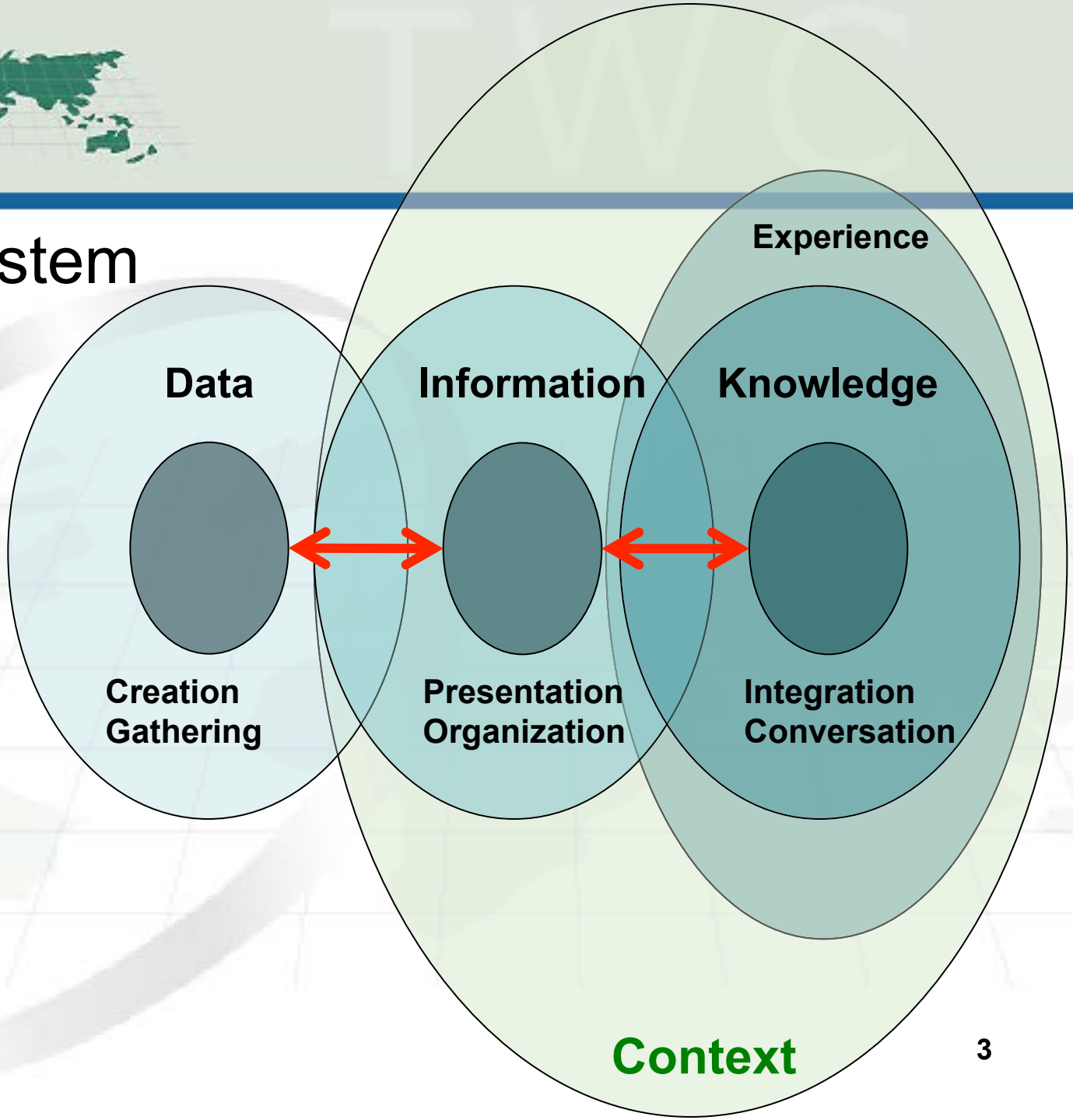
December 7, 2012, AGU12 IN54A-02.

Peter Fox (RPI/ Tetherless World Constellation and WHOI/AOP&E)
pfox@cs.rpi.edu

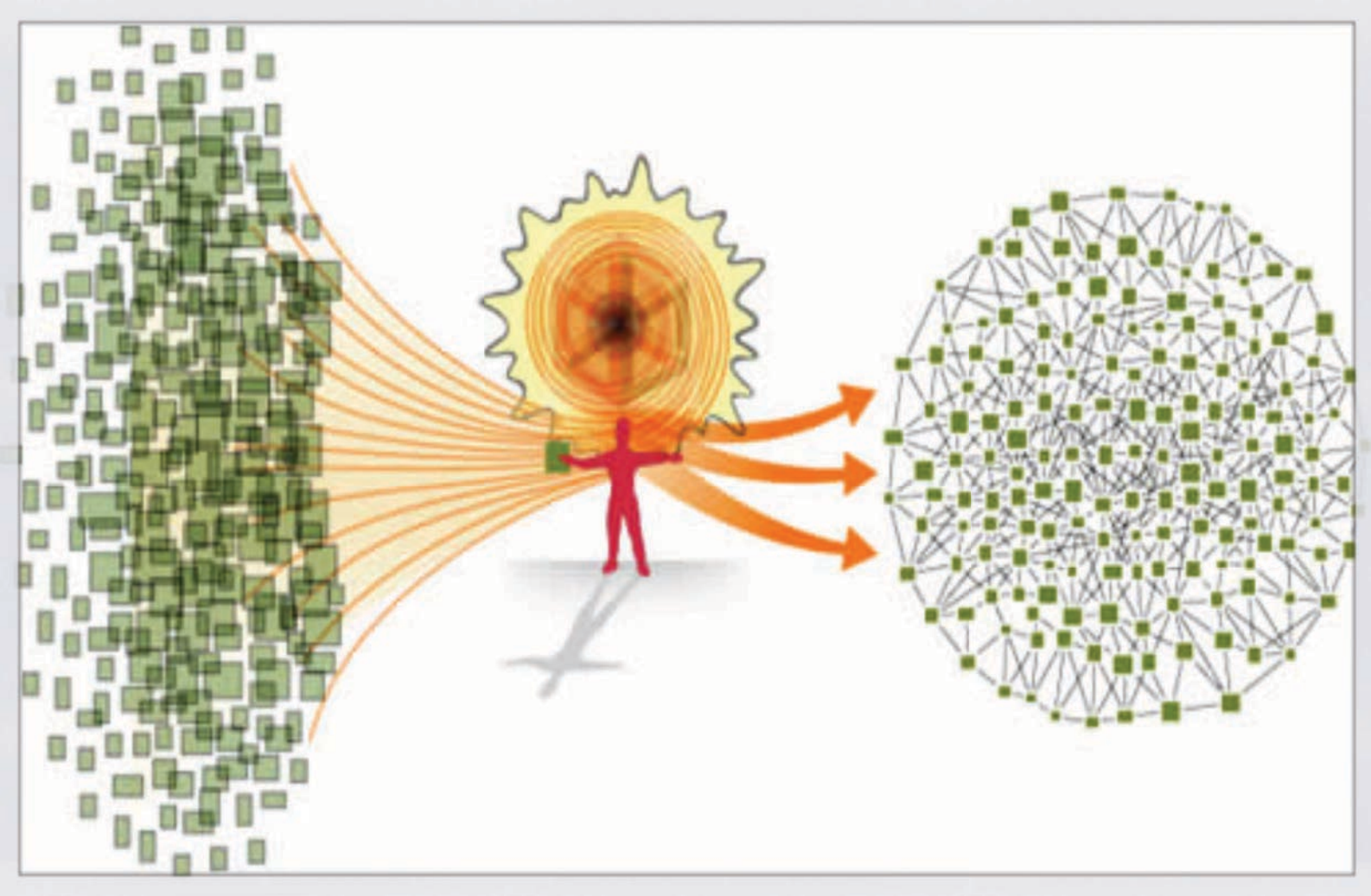
What's ahead/pre-summary

- Data ecosystems necessarily involve a variety of stakeholders
- Complex relations require us to move beyond 'simple' networks
- To do that, we:
  - Define the framework for a knowledge base, and populate it
  - Query and render the result

- Ecosystem


Experience
Data
Information
Knowledge
Creation
Gathering
Presentation
Organization
Integration
Conversation
Context

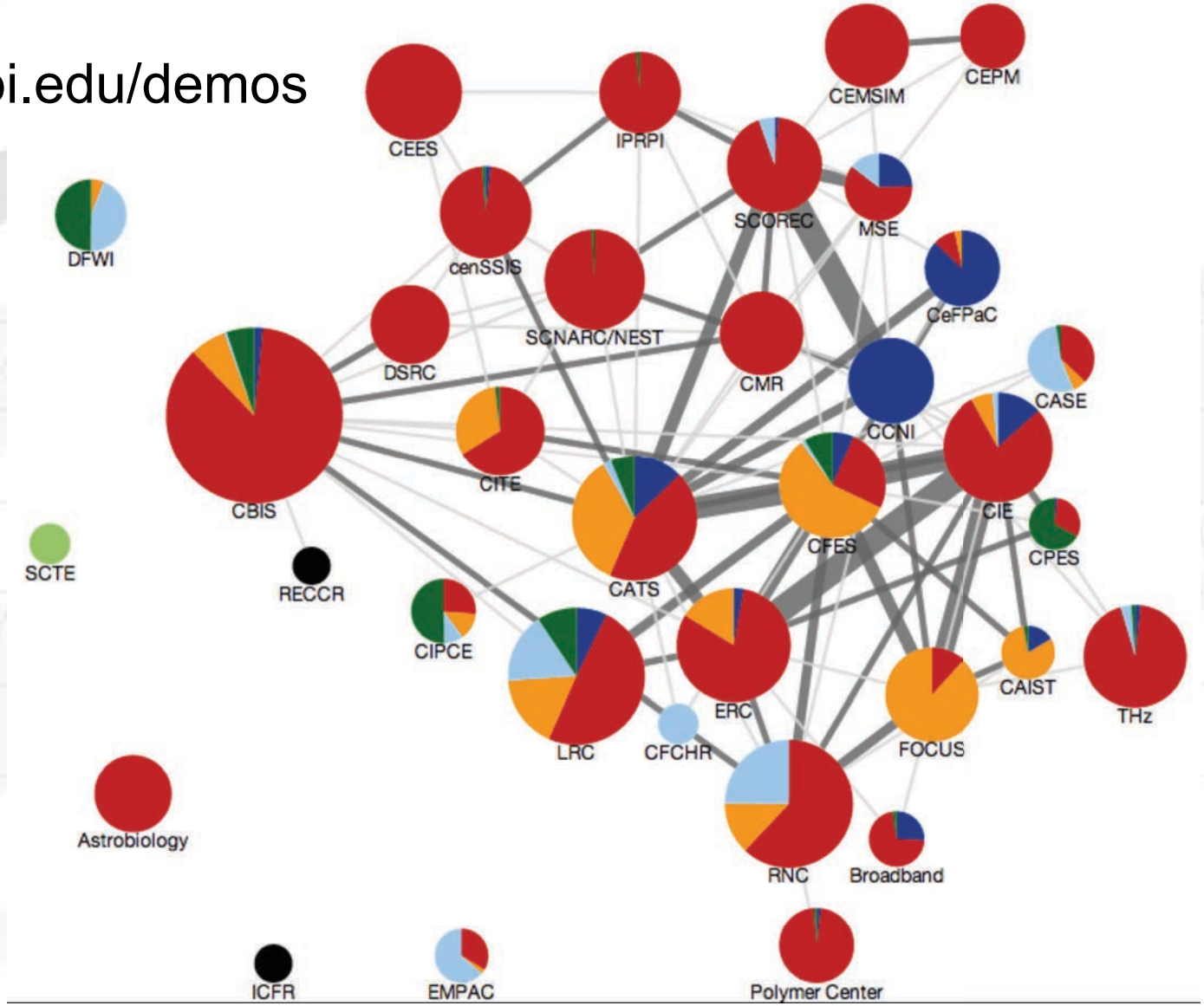
You mean, you want to know?



What is a Knowledge Network? How does it work?

Rendering of a network

logd.tw.rpi.edu/demos



Marine ecosystems

Science ecosystem

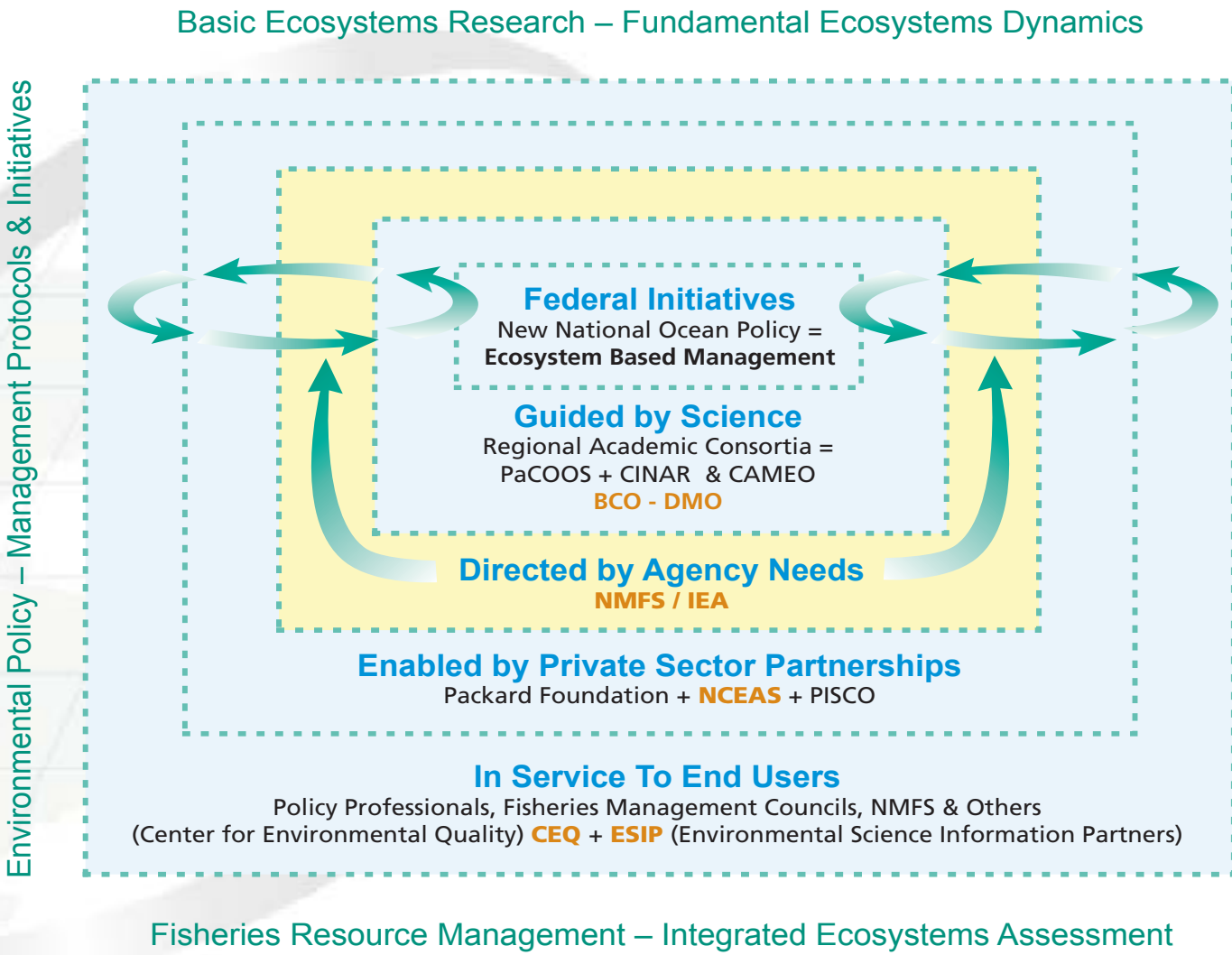
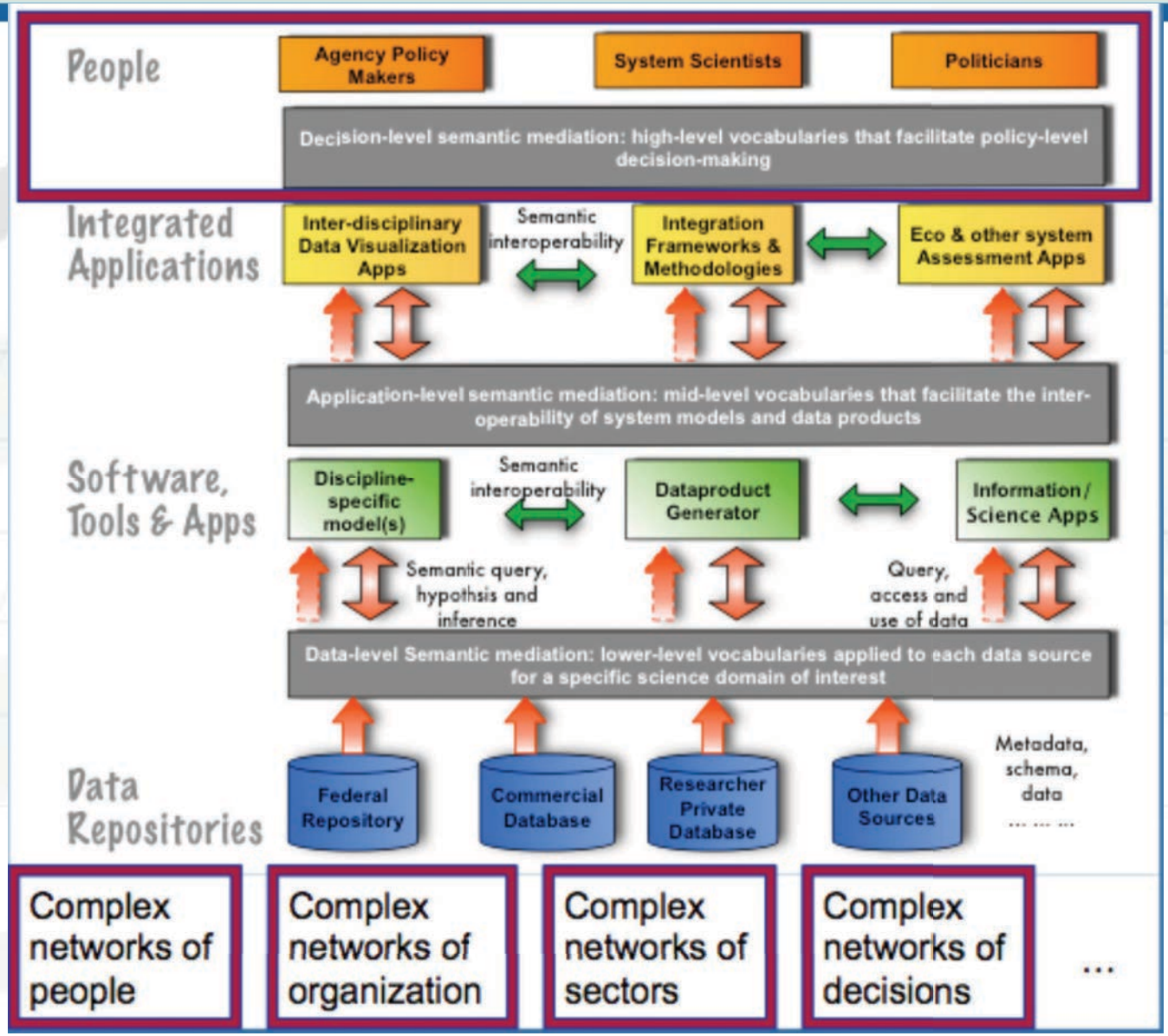


Figure Acknowledgement: Suzanne Lawrence

Complex networks



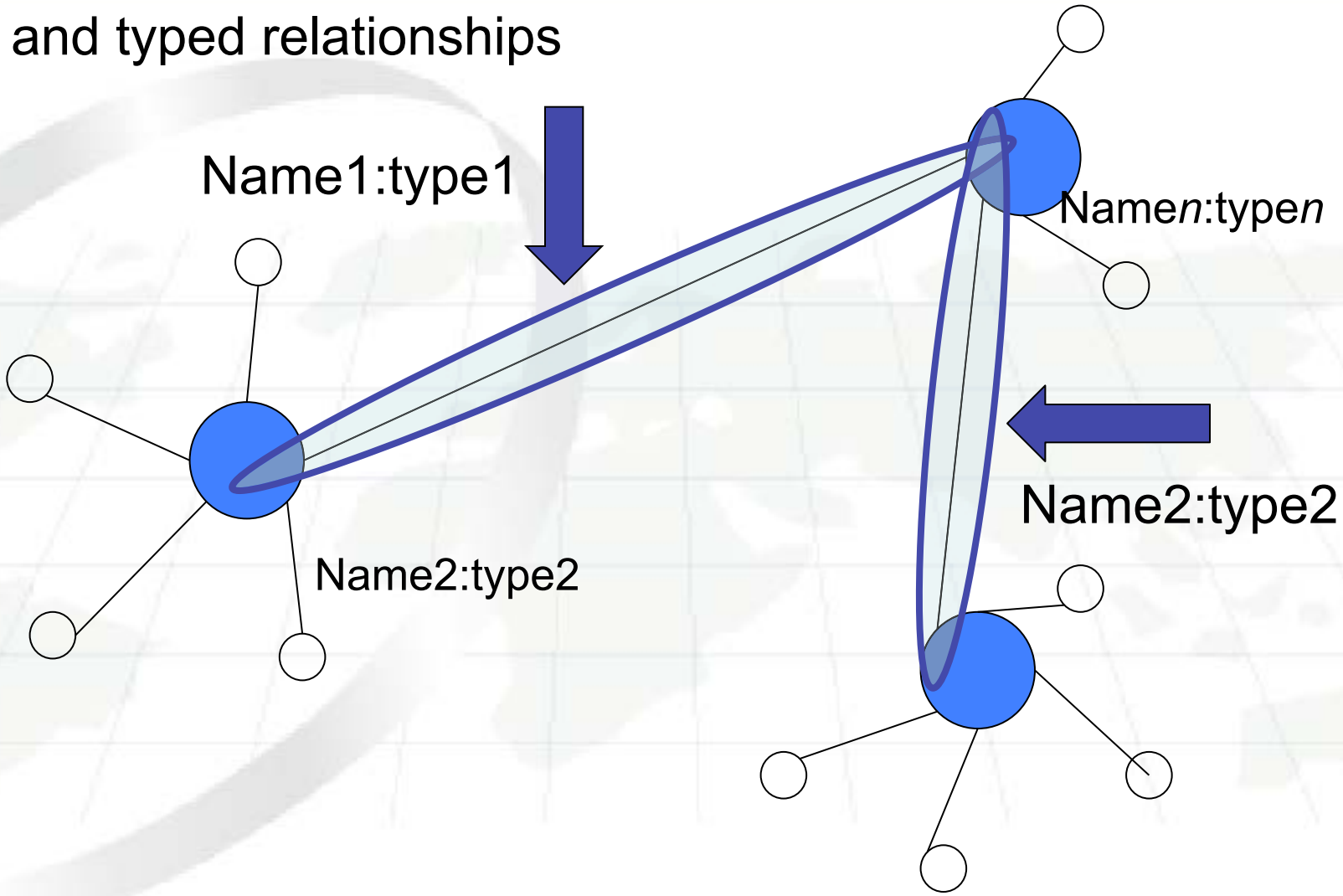
‘Complex’ networks

- Based on information content
  - Node count and number of links
  - Spanning height
  - ‘Width’
  - Etc.
- Or complexity metrics, cf. McCabe – number of linearly independent paths through the network
- *Open world* networks lead to differing node relations… (or not)

- Complex :== Meaning in context
- Semantic networks are ones where the nodes and relations are ‘named and typed’

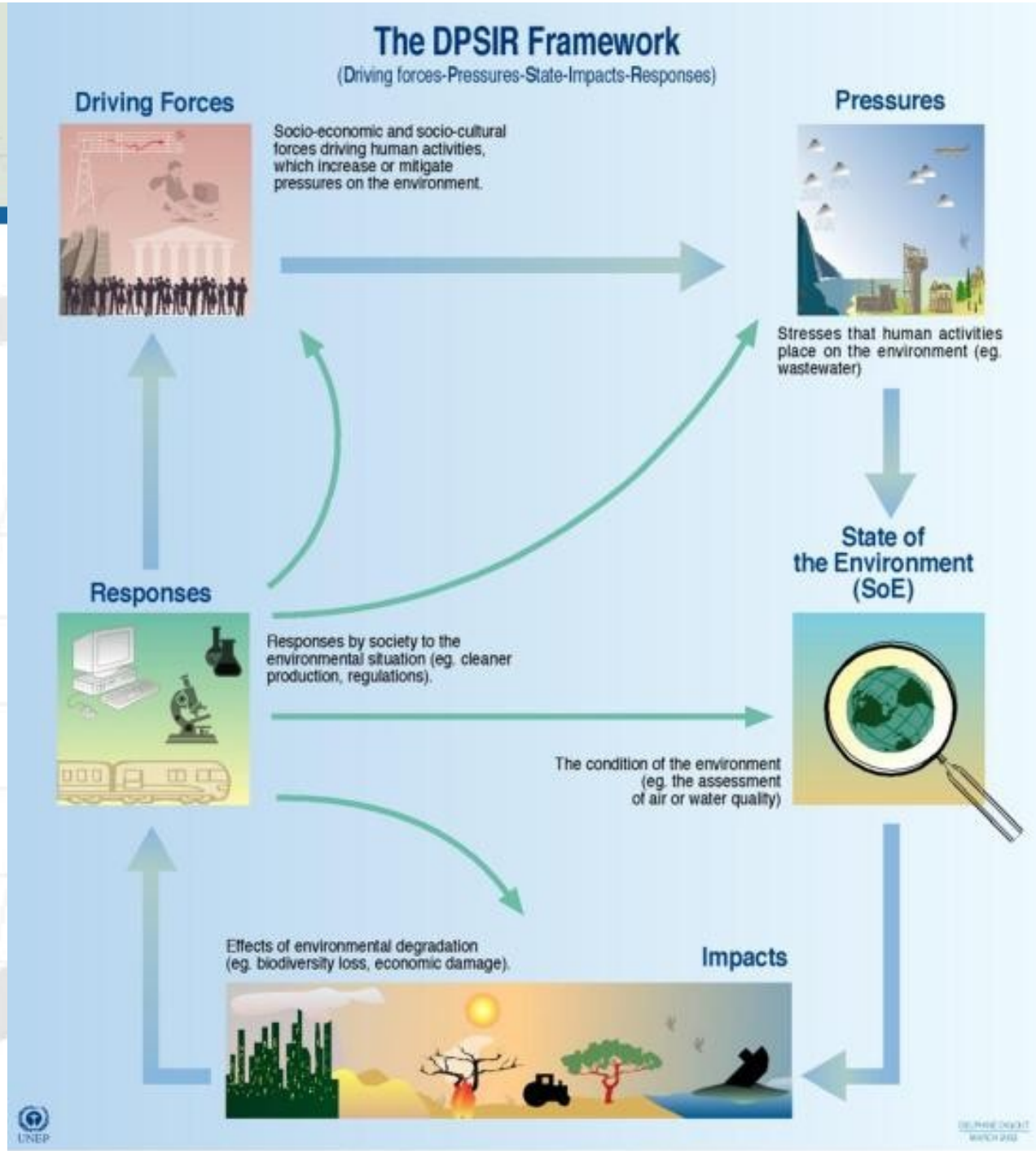
What about meaning

Named and typed relationships

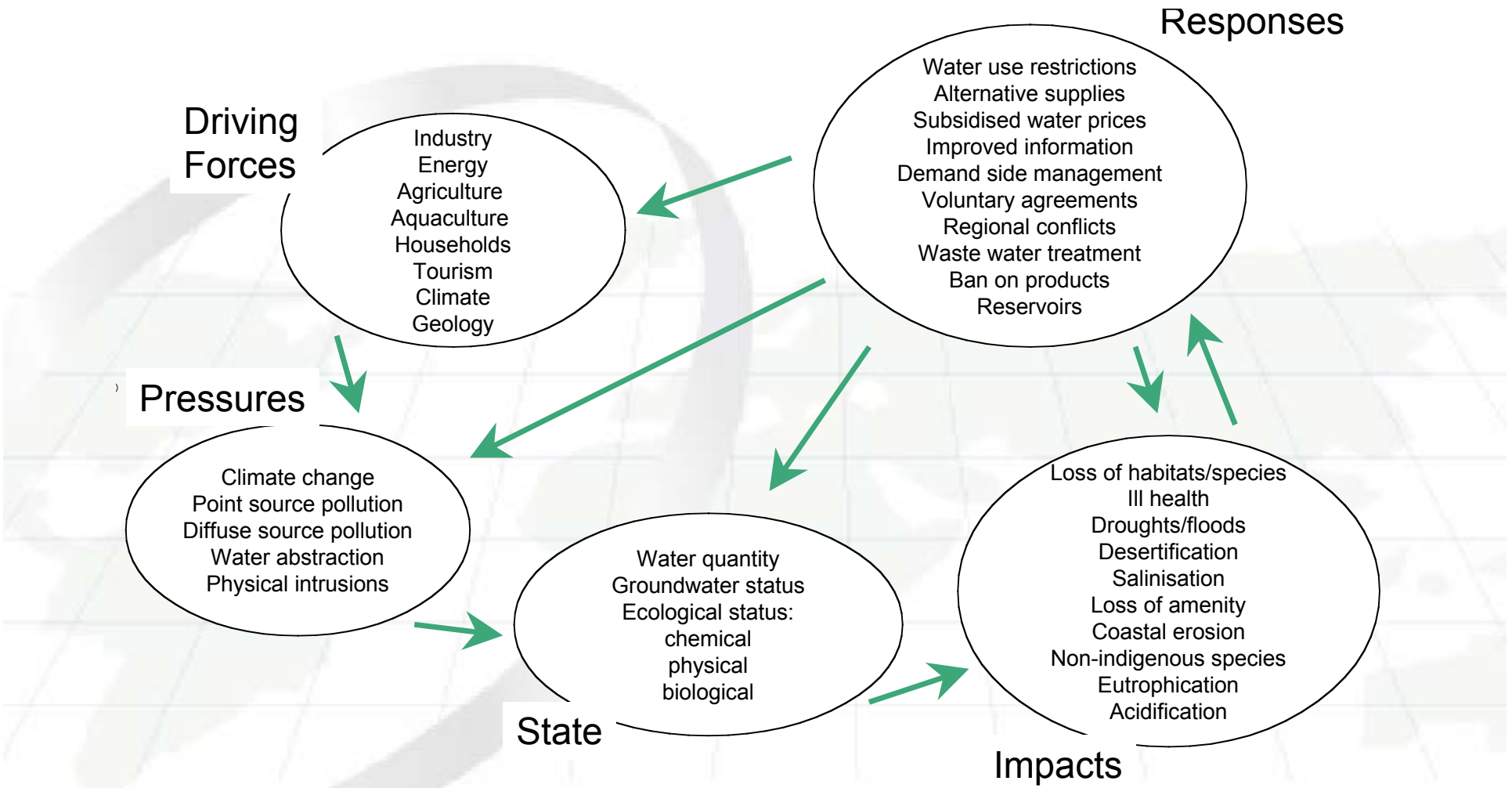


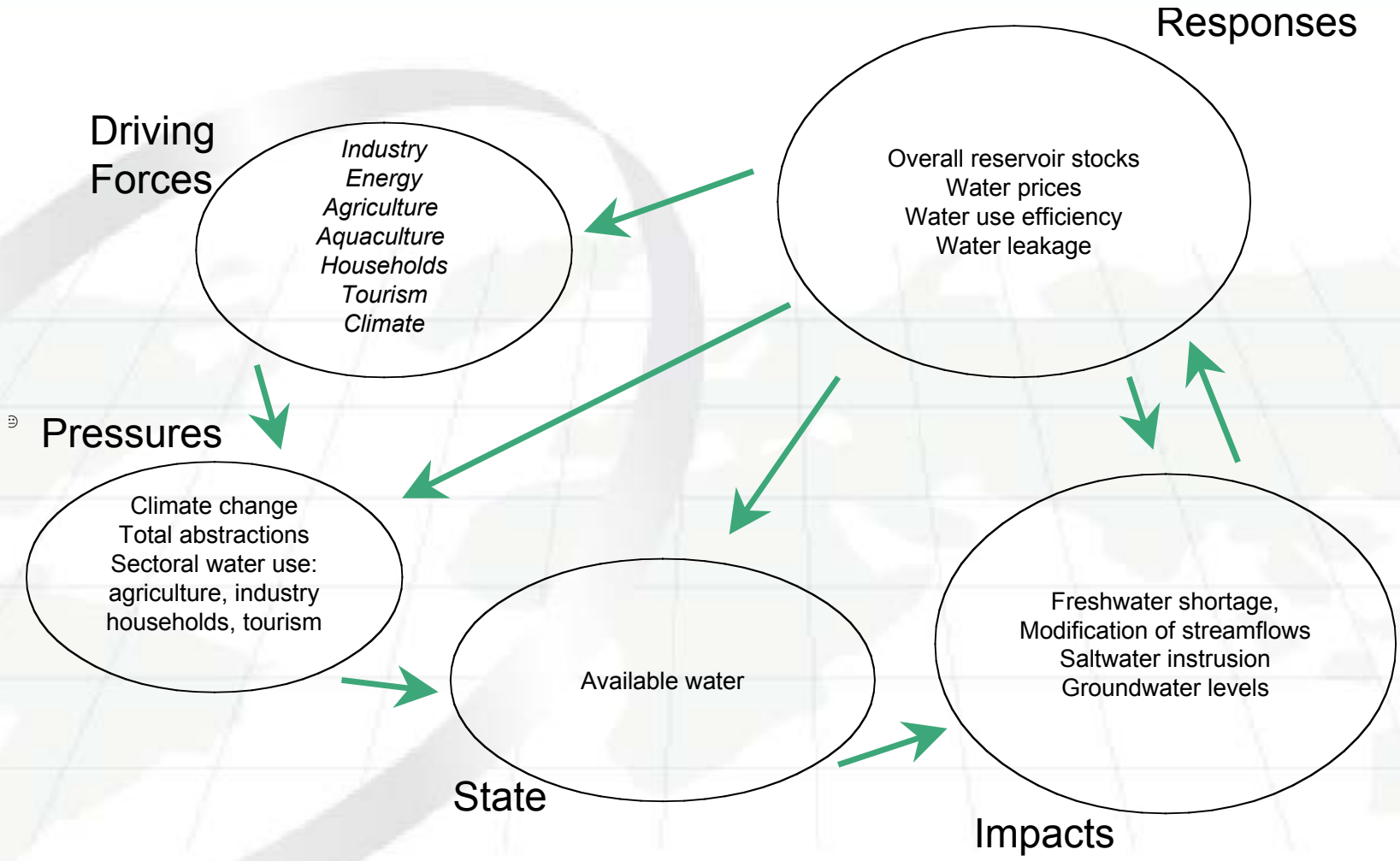
The DPSIR Framework

(Driving forces-Pressures-State-Impacts-Responses)



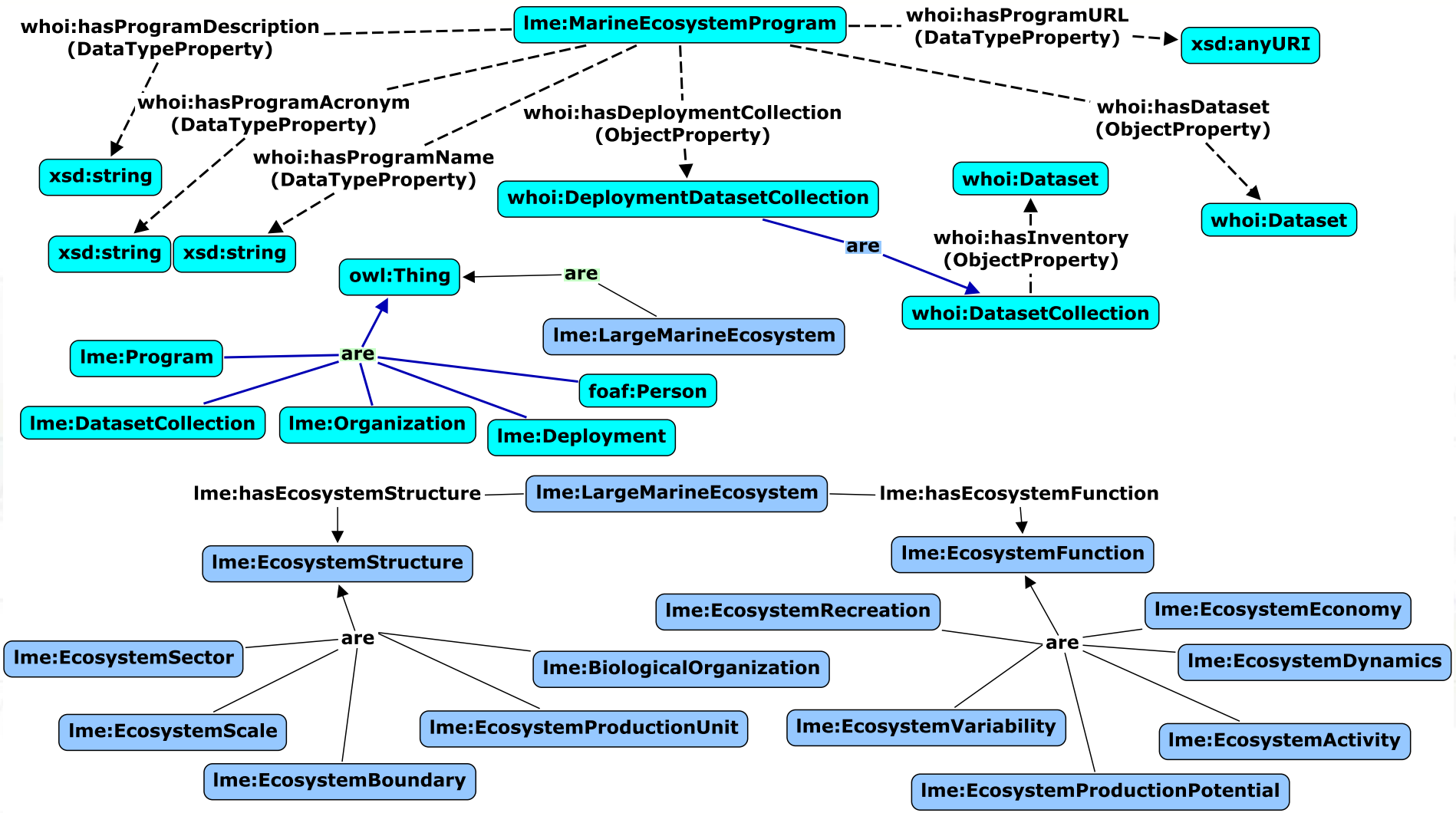
Source : Global International Water Assessment (GIWA), 2001; European Environment Agency (EEA), Copenhagen.


Responses
Water use restrictions
Alternative supplies
Subsidised water prices
Improved information
Demand side management
Voluntary agreements
Regional conflicts
Waste water treatment
Ban on products
Reservoirs
Driving Forces
Industry
Energy
Agriculture
Aquaculture
Households
Tourism
Climate
Geology
Pressures
Climate change
Point source pollution
Diffuse source pollution
Water abstraction
Physical intrusions
State
Water quantity
Groundwater status
Ecological status:
chemical
physical
biological
Impacts
Loss of habitats/species
Ill health
Droughts/floods
Desertification
Salinisation
Loss of amenity
Coastal erosion
Non-indigenous species
Eutrophication
Acidification

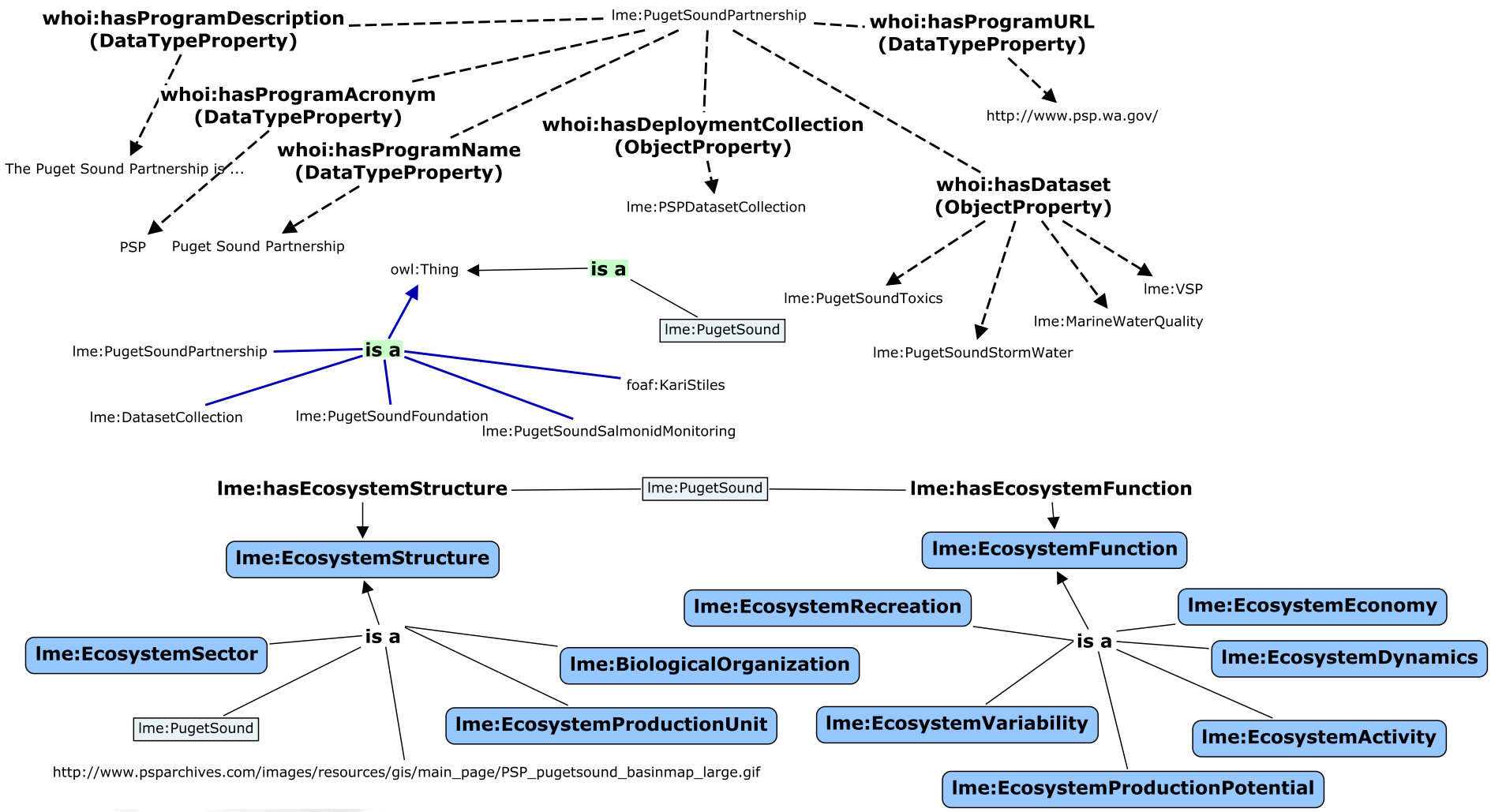


Water Quantity

Models for ecosystems



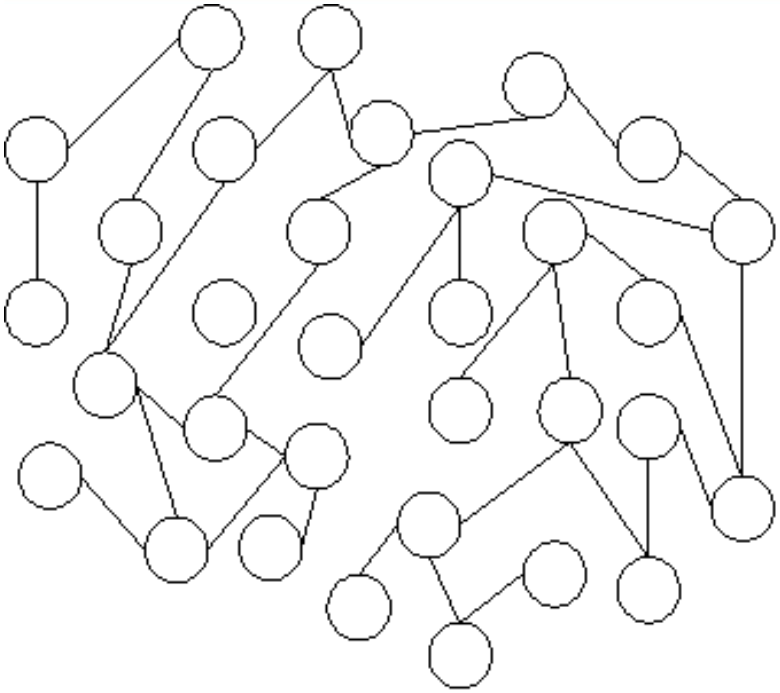
Instances


whoi:hasProgramDescription (DataTypeProperty)
lme:PugetSoundPartnership
whoi:hasProgramURL (DataTypeProperty)
whoi:hasProgramAcronym (DataTypeProperty)
http://www.psp.wa.gov/
whoi:hasProgramName (DataTypeProperty)
whoi:hasDeploymentCollection (ObjectProperty)
The Puget Sound Partnership is ...
lme:PSPDatasetCollection
whoi:hasDataset (ObjectProperty)
PSP
Puget Sound Partnership
owl:Thing
is a
lme:VSP
lme:PugetSoundToxics
lme:PugetSound
lme:MarineWaterQuality
lme:PugetSoundPartnership
is a
lme:PugetSoundStormWater
foaf:KariStiles
lme:DatasetCollection
lme:PugetSoundFoundation
lme:PugetSoundSalmonidMonitoring
lme:hasEcosystemStructure
lme:PugetSound
lme:hasEcosystemFunction
lme:EcosystemStructure
lme:EcosystemFunction
lme:EcosystemRecreation
lme:EcosystemEconomy
lme:EcosystemSector
is a
is a
lme:EcosystemDynamics
lme:BiologicalOrganization
lme:PugetSound
lme:EcosystemProductionUnit
lme:EcosystemVariability
lme:EcosystemActivity
http://www.psparchives.com/images/resources/gis/main_page/PSP_pugetsound_basinmap_large.gif
lme:EcosystemProductionPotential

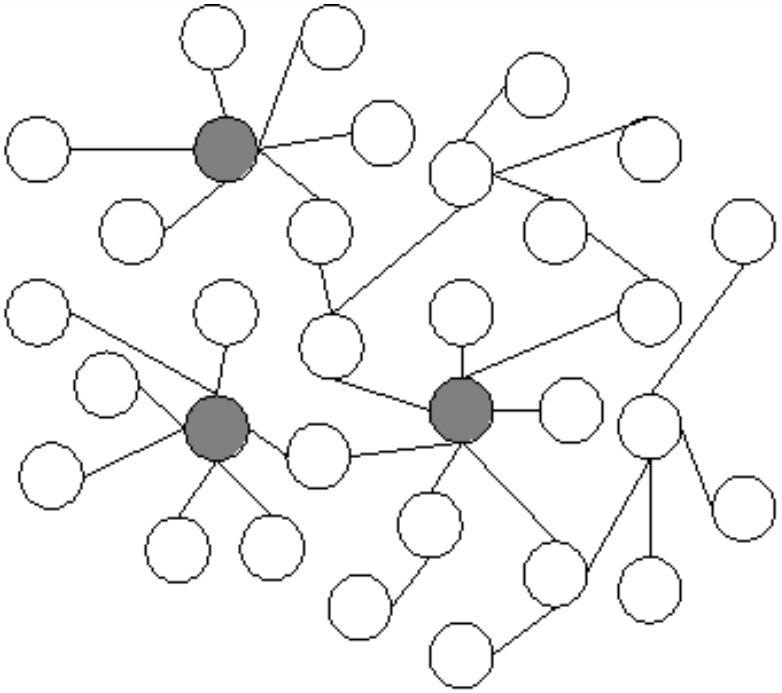
Network Scale(s)

- Complex :== Meaning
- Semantic networks are ones where the nodes and relations are ‘named and typed’
- Interesting property - scale-free
  - Citation networks
  - The Web
  - Semantic networks
  - Depend on super nodes

Scale free?



(a) Random network



(b) Scale-free network

More likely – multi-scale with some hierarchy …

Vision being implemented

- “Our vision is to develop, facilitate, and maintain sustained multi-way engagement of natural and social scientists and many practitioners in multi-scale local to global networks for Large Marine Ecosystems (LMEs)”.

- Goal: Perform routine assessments of LMEs involving all (or as many) stakeholders and we want robust science data presented in forms that various end-users can consume…

Discussion

- We have the tools to explore these networks, collaboratively…
- Now looking at network rendering, i.e. queries and visualizations
- Current limit is: base information models upon which to develop the initial knowledge base(s) (i.e. ontologies)
- Next: Compute deductive closure, iterate… ?
- Thanks for listening. Questions?