California Water Plan Update 2013

California Water Sustainability Indicators

Workgroup Meeting
July 21, 2011

Why Are We Doing This?

A Recurring Question:

"How can we ascertain that the resource management strategies and objectives of the CA Water Plan are sustainable for the State and its various hydrologic regions?"

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CA Water Sustainability Indicators Objective

Develop an analysis framework and identify, compute, and evaluate a set of sustainability indicators to monitor progress towards water sustainability through meeting the objectives of California Water Plan

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CA Water Sustainability Indicators Work Plan

- Develop analytical framework:
  - Identify goals and objectives.
  - Identify indicators, including water footprint.
  - Identify targets or desired future conditions.
  - Ensure vision and vision alignment.
  - Describe analytical and interpretation methods.
- Conduct analysis:
  - Calculate condition/status and trends of indicators.
  - Calculate water footprint to track sustainable use of water.
  - Report indicators relative to desired future conditions.
  - Evaluate indicators compared to sustainability goals.
- Identify issues and data gaps.

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CA Water Sustainability Indicators
Who Are We Working With?

- DWR, UCD, USEPA, SGC, DSC, other agencies : Content
- Water Plan Statewide Water Analysis Network: Technical review
- Sustainable Water Resources Roundtable: Latest perspectives in methods and practices
- Regional Forums: Regional coordination
- State Agency Steering Committee: Overall State government coordination
- Water Plan Tribal AC: Tribal perspective
- Water Plan Public AC: Seek final input

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CA Water Sustainability Indicators
Where Are We Going to Implement It?

- The Framework provides a toolbox, useful templates, and illustrative examples for IRWM regions to conduct water sustainability analysis for local and regional water management.
- Agencies may improve their water sustainability through an evaluation of condition/trends of suitable indicators.
- The process could help identify issues and data gaps to inform future data monitoring needs on a local and regional scale.
- Local and regional scale indicator analyses could highlight policy needs for ensuring local and regional water sustainability.

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Proposed Approach

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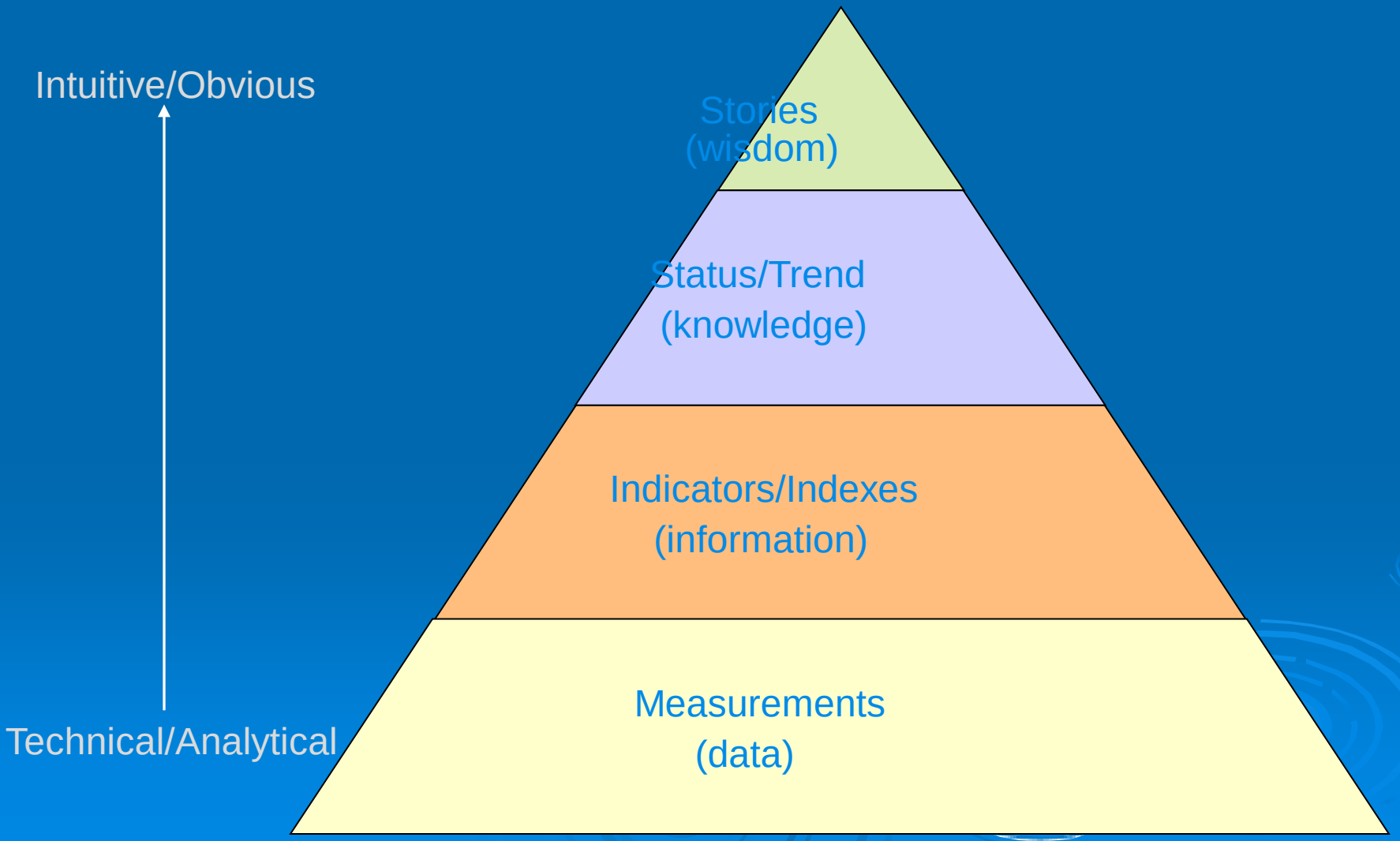


Sustainability and others terms

- What does sustainability mean and how do we measure it?
- Goals, objectives
- Themes, domains
- Index, indicators, metrics
- References and targets
- Report card and evaluation

Steps

Step 1 Define water sustainability and related terms

Step 2 Describe the overall vision for sustainability, goals corresponding to the vision, and measurable sustainability objectives; describe themes (e.g., water supply) and system processes

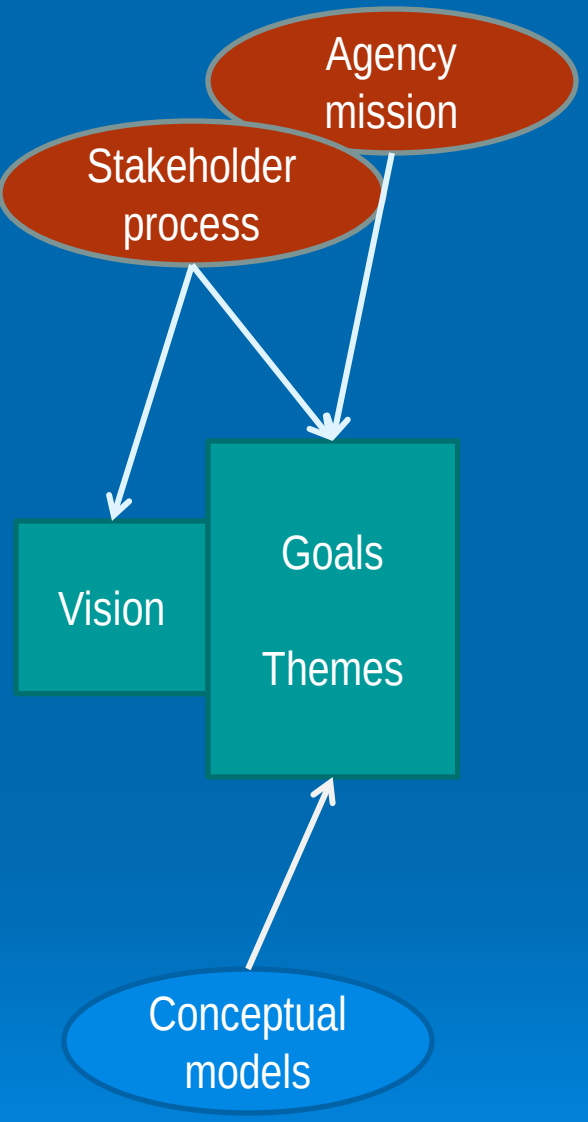
Step 3 Select indicators corresponding to the objectives and covering all themes and processes; define targets for each indicator; describe potential causes of change in indicator condition

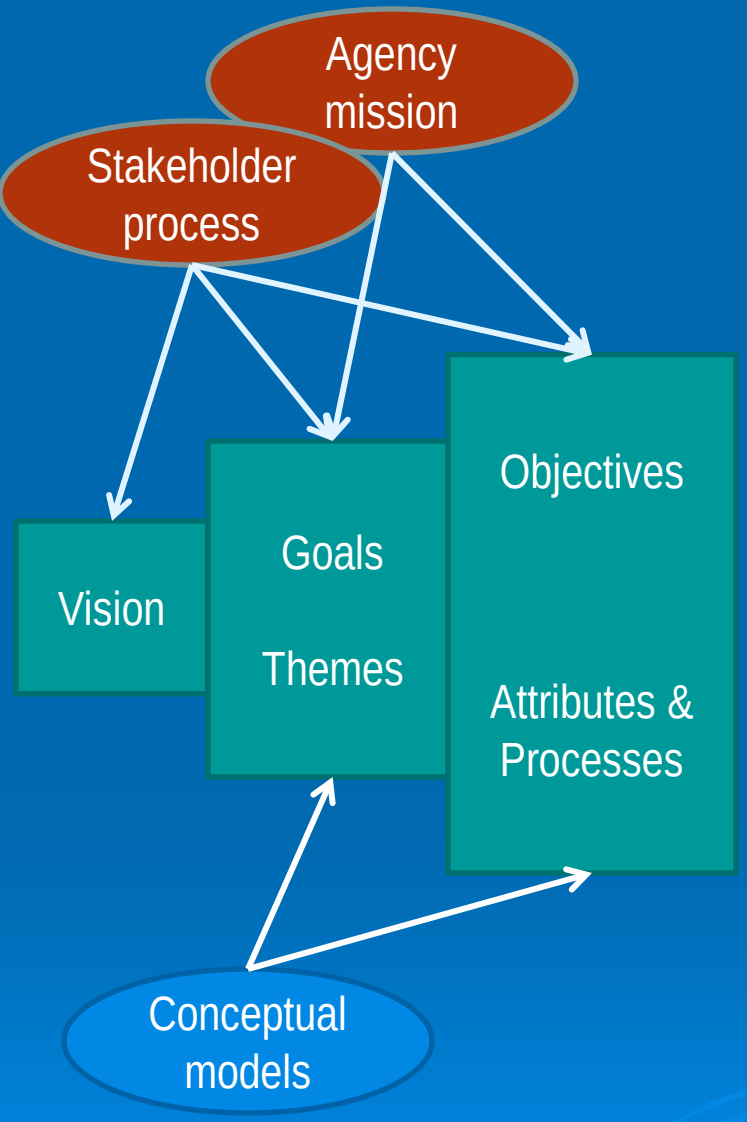
Step 4 Collect data for each indicator, maintain and describe data provenance; analyze data according to distance from current state from target state and describe analytical steps; measure trend in condition and significance of trend

Step 5 Describe summary condition and trend in condition in report card; evaluate performance of system sectors

Step 6 Evaluate causes of condition departure from target condition and individual and programmatic actions that could maintain good conditions and repair poor conditions

Step 7 Describe contribution of evaluation to change in knowledge, policy effectiveness, and public education


Agency mission
Stakeholder process
Vision
Goals
Themes
Conceptual models


Agency mission
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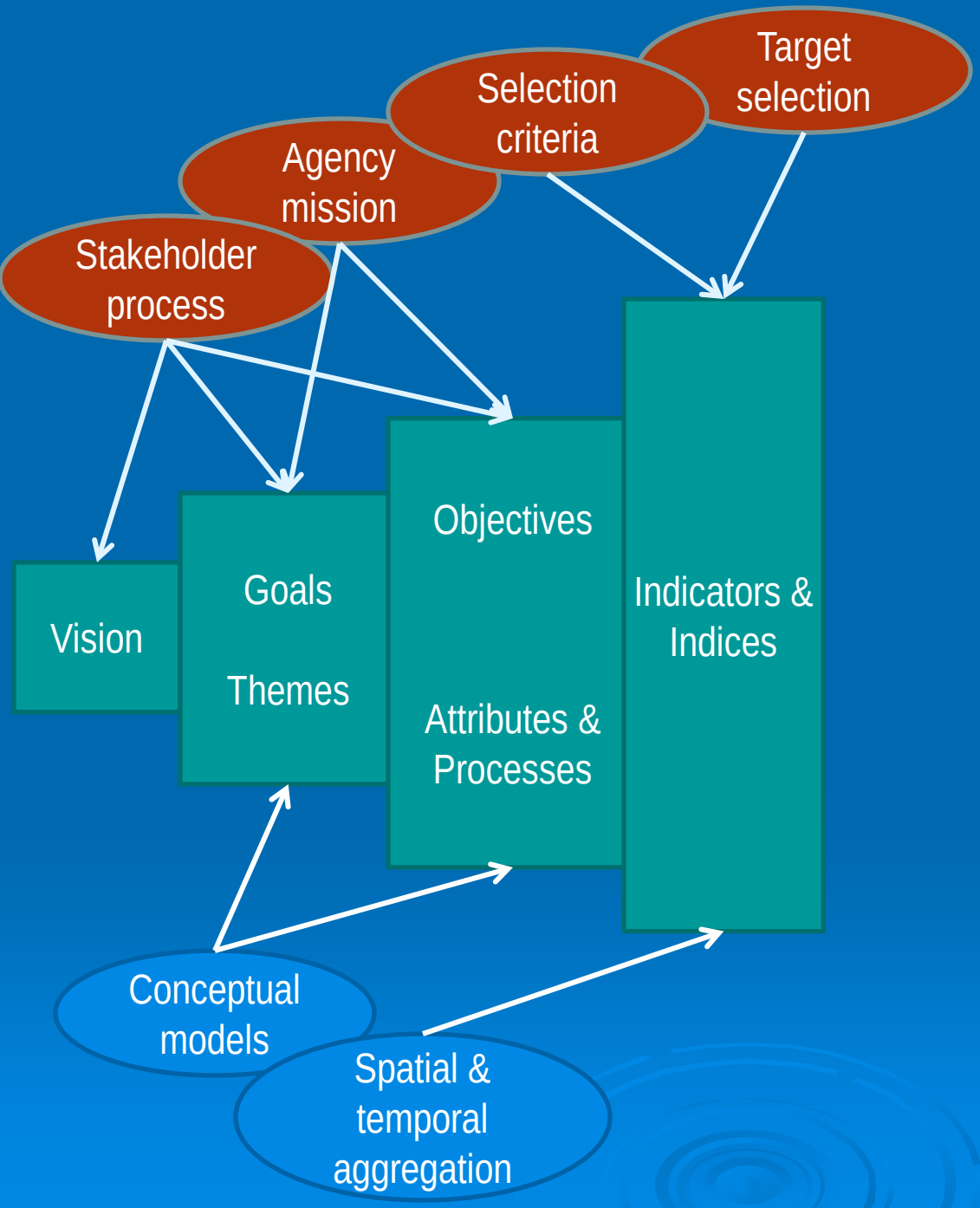
Conceptual models

Proposed Sustainability Objectives	Relationship to Water Plan 2009
1. Improve water use efficiency, increase water recycling, and increase water conservation in order to improve water supply reliability, reduce energy demand, and restore and maintain aquatic ecosystems and processes.	CWP Objective 2, 9; RMS Reduce demand
2. Improve regional water movement operations and efficiency and investigate new water technologies to contribute to social and ecological beneficial uses and reduce impacts associated with inter-basin water transfers. .	CWP Objective 1, 2, 7, 11, RMS Operational efficiency
3. Increase conjunctive management of new and recycled water from multiple sources to increase quantity, quality, and reliability of drinking water, irrigation water, and in-stream flows.	CWP Objective 3, 12, 13; RMS Increase water supply
4. Protect and restore surface water and groundwater quality and the natural systems that maintain these services in order to safeguard human and environmental health and secure California water supplies.	CWP Objective 4; RMS on water quality; chapter 4 discussion of water quality sustainability indicators
5. Practice, promote, improve, and expand environmental stewardship to protect and enhance environmental conditions by improving watershed, floodplain, and aquatic condition and processes.	CWP Objective 5, 12, 13; RMS Natural Resources
6. Integrate flood risk management with other water and land management and restoration activities.	CWP Objective 1, 6, 12, 13; RMS Improve flood
7. Improve and expand monitoring, data management, and analysis to support decision-making, especially in light of uncertainties, that support integrated regional water management and flood and water resources management systems	CWP Objective 10; various RMSs; CWP Vol. 1 Chapter 6 Integrated Data and Analysis


Target selection
Selection criteria
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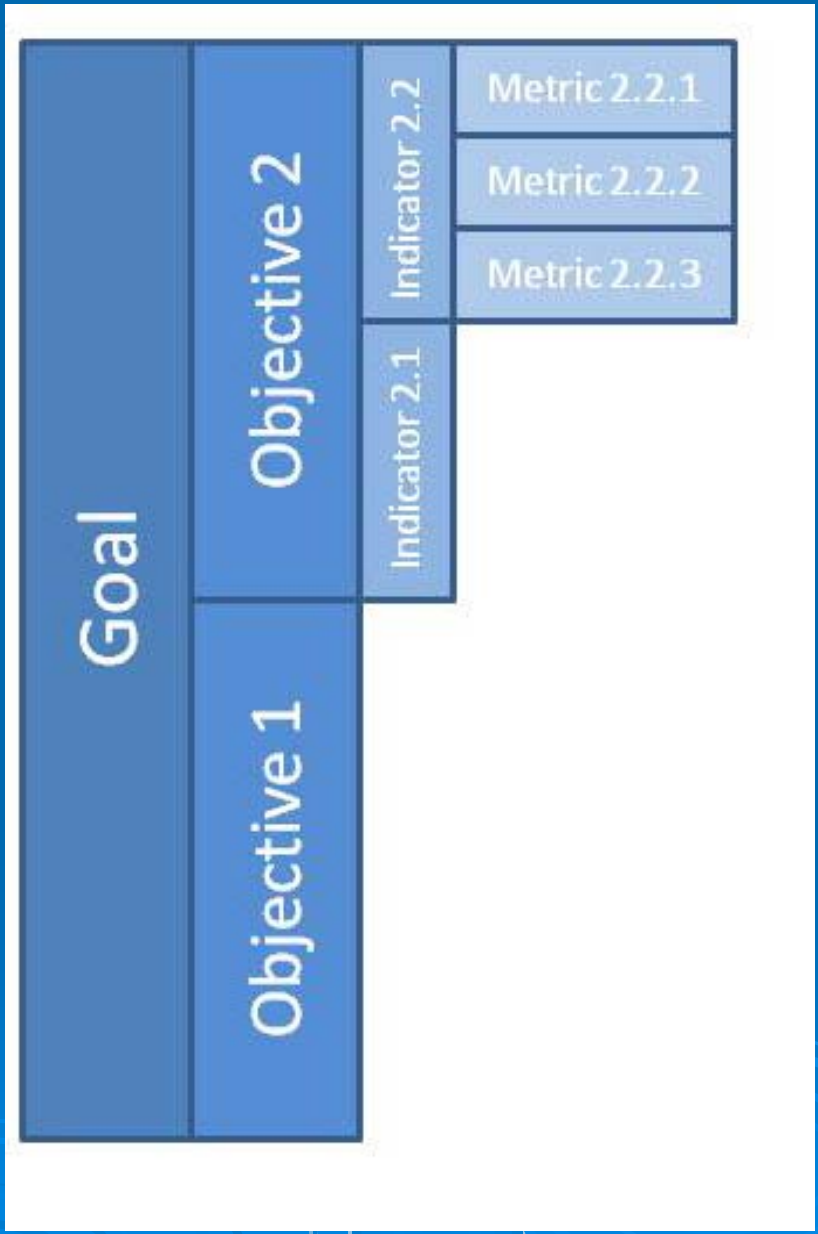
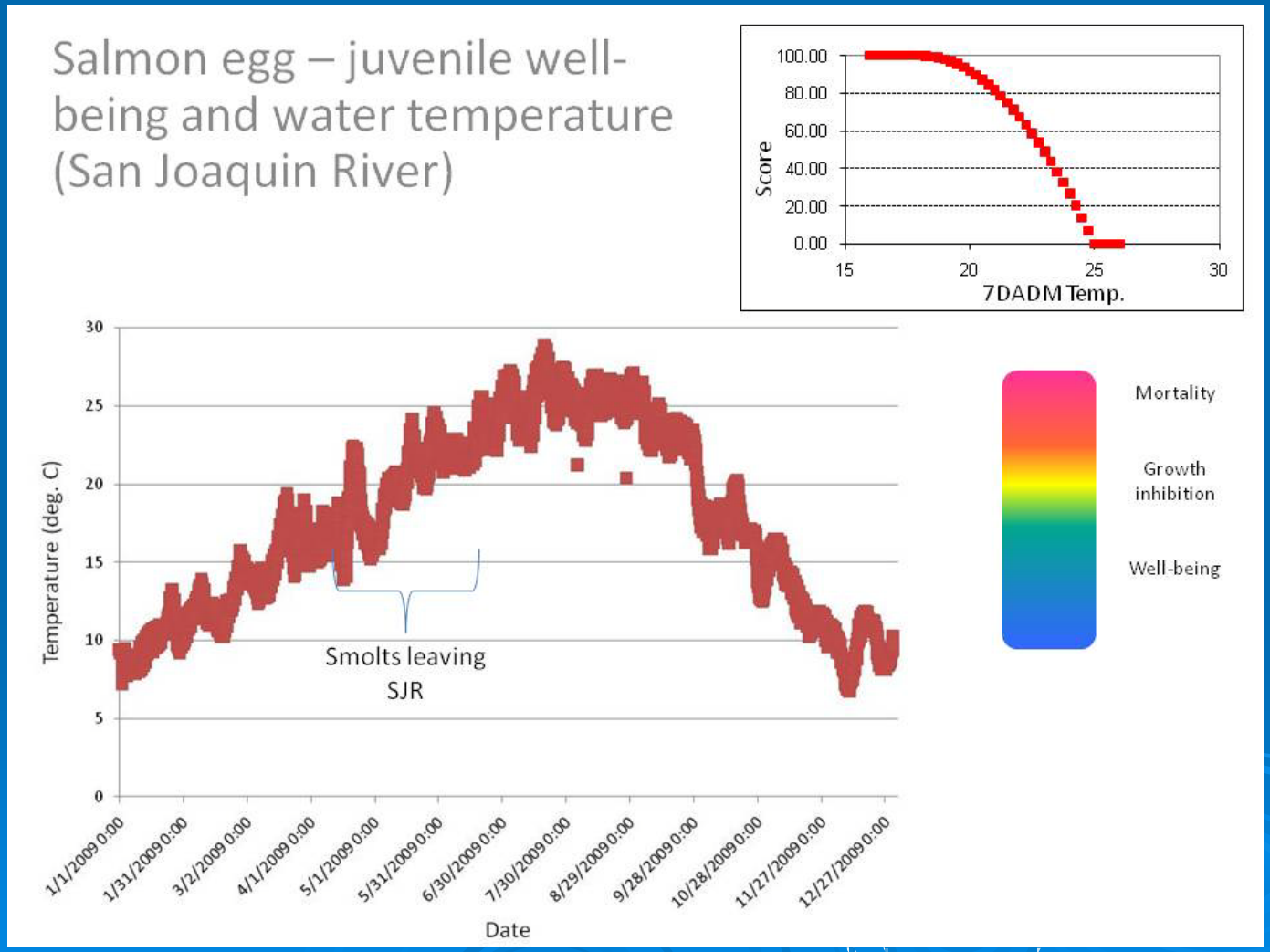
Conceptual models
Spatial & temporal aggregation

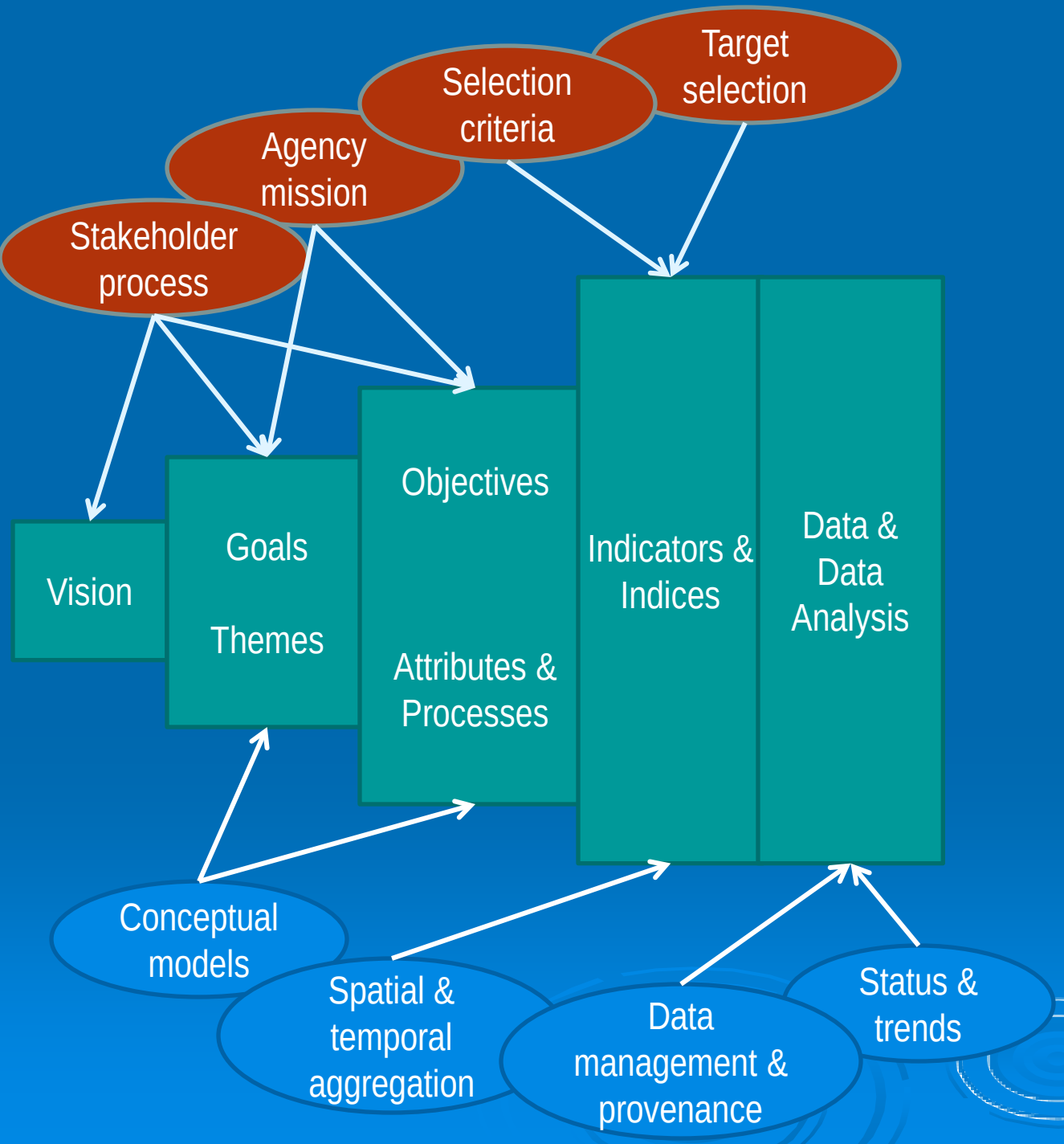
Organizing indicators



Sustainability Objective	Related CWP Objective and RMS	Example Indicators	Relevance to Sustainability Objective
4. Protect and restore surface water and groundwater quality and the natural systems that maintain these services in order to safeguard human and environmental health and secure California water supplies.	CWP Objective 4; RMS on water quality; chapter 4 discussion of water quality sustainability indicators	Ratio of observed to expected native aquatic species	Protect and restore water quality for environmental health
		Surface-water Water Quality Index	Surface water quality to safeguard human and environmental health
		Groundwater Water Quality Index	Ground water quality to safeguard human health

How do we measure condition?

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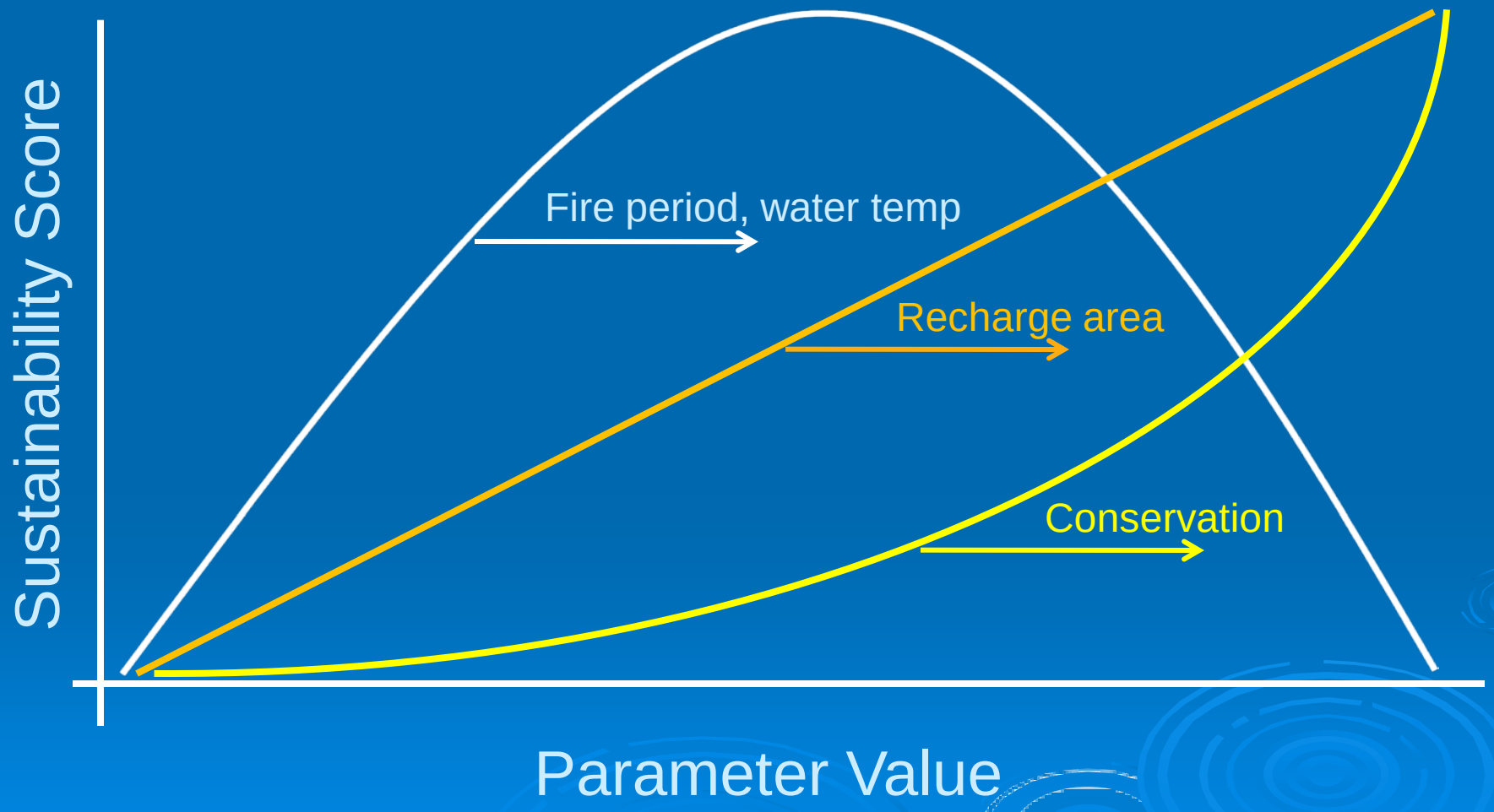
Data & Data Analysis
Conceptual models
Spatial & temporal aggregation
Data management & provenance
Status & trends

Possible Normalization Approaches

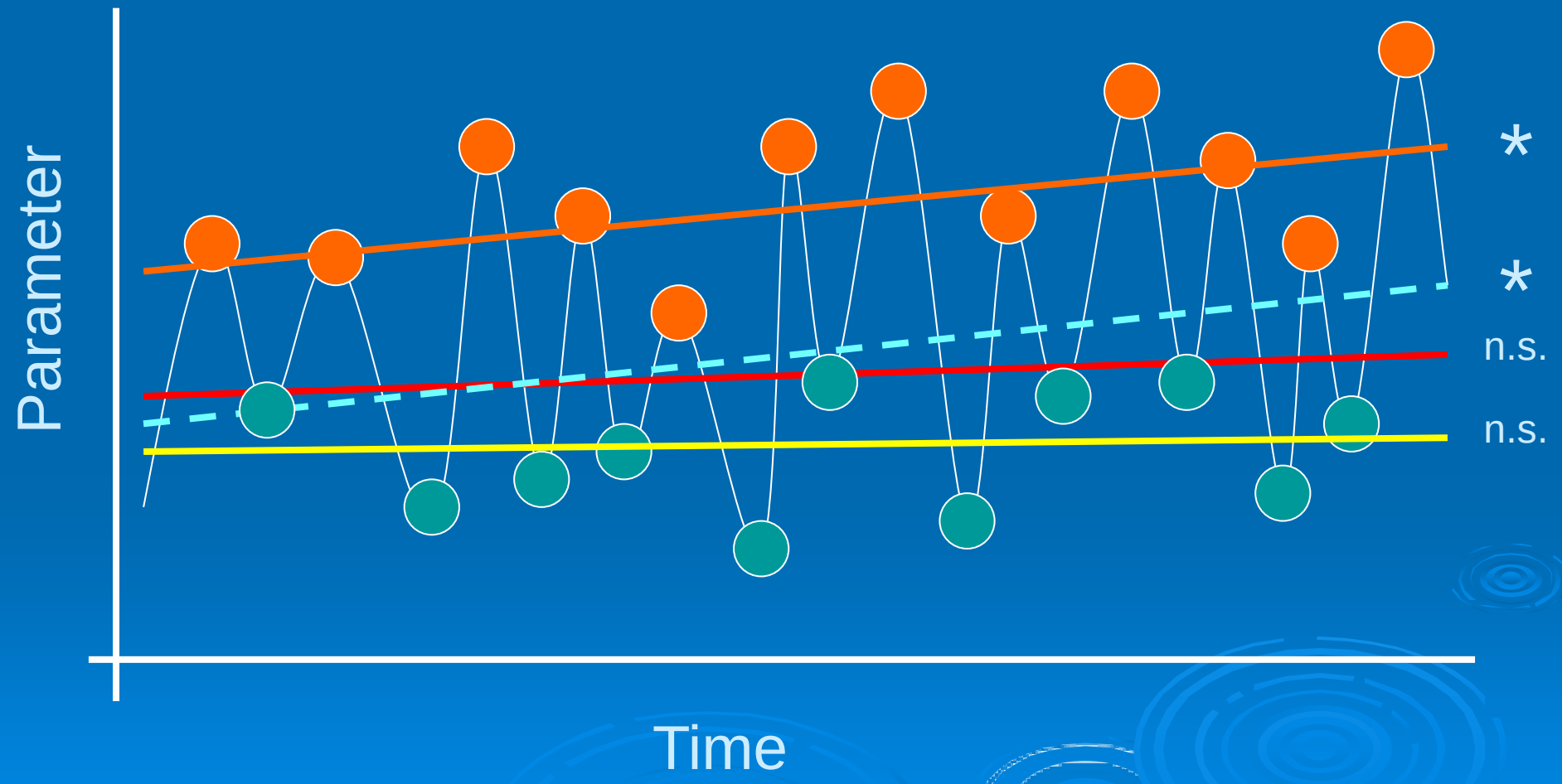
Comparison with Targets/References

The limits are chosen based on the undesirable situation, which receives the “0” value, and on the ideal situation, which may or may not correspond to a strategic objective and which receives the value “1”.

The relationship between normalized score and raw parameter value can vary in shape among parameters

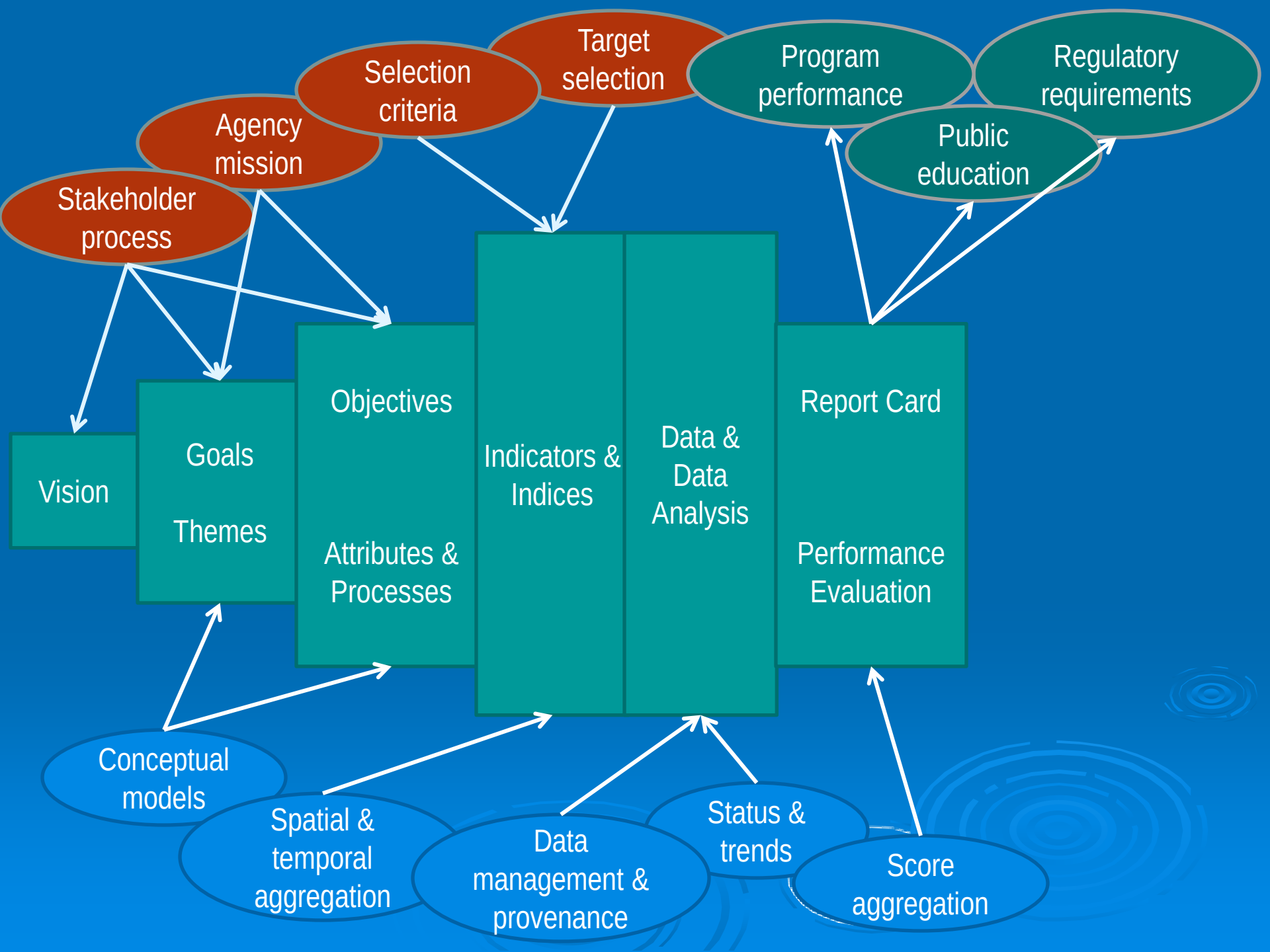


Trends analysis using statistical tests to control for environmental or other periodicity.
Trends in what?



Trends and Confidence

- Trends analysis (Seasonal Kendall)
  - Seasonal correction
  - Trend quantification
- Confidence and certainty
  - Quantitative and qualitative


Target selection
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Program performance
Regulatory requirements
Public education
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Goals
Themes
Objectives
Attributes & Processes
Indicators & Indices
Data & Data Analysis
Report Card
Performance Evaluation
Conceptual models
Spatial & temporal aggregation
Data management & provenance
Status & trends
Score aggregation

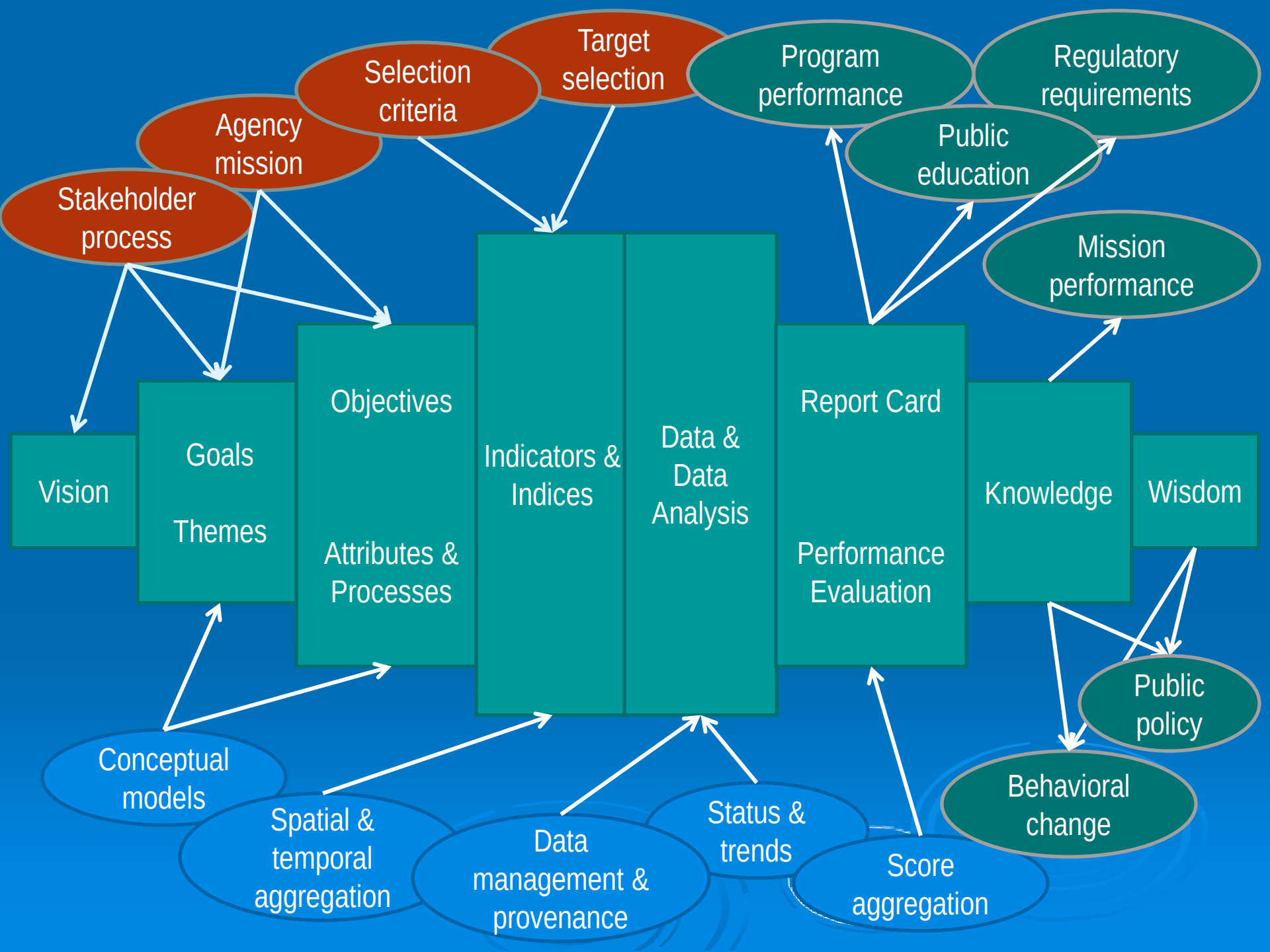
Summarizing condition and performance

Aggregation

- Normalized values for individual parameters are combined into single values for indices, for sustainability objectives, or for themes (e.g., water quality, water supply)
- Combination can be via calculation of average condition
- Another possibility is to use the lowest and highest normalized parameter values within a group to capture the range
- Range and standard deviation for averaging approaches are useful information to report

Example: “The mean score for Sustainability Objective 2 was 37, with a range of 23 to 65 and SD of 9 (n = 5)”

Goals	Measurable Objective	Condition	Trend	Confidence
Water quality and supply for natural and human communities	Water quality for aquatic health	50	↔	Medium-high
	Maintain natural stream flows	55	n/a	Medium
Protect and restore native animals and plants	Native birds	100	↔	Medium
	Native invertebrates	46	↔	High
	Native fish	49	↔	High
	Agricultural/urban development	90	n/a	Medium
Protect and enhance habitats, ecosystems, and watersheds	Protect aquatic connections	77	n/a	Medium-high
	Protect landscape connections	33	n/a	High
	Maintain natural production and nutrient cycles	82	↓	Medium
Maintain and restore natural disturbance	Restore natural fire regimes	9	↔	Medium
	Encourage natural flooding, while protecting people	50	n/a	Low
Improve social and economic conditions & benefits from healthy watersheds	Enhance wildlife-friendly agriculture	83	↑	Medium-high
	Improve community economic status	51	↓	High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Mission performance
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Themes
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Indicators & Indices
Data & Data Analysis
Report Card
Performance Evaluation
Knowledge
Wisdom
Public policy
Behavioral change
Conceptual models
Spatial & temporal aggregation
Data management & provenance
Status & trends
Score aggregation

Show connections between condition and changes needed to be sustainable

Sustainability Objective	Example Indicators	Value	Influences	Management Responses
4. Protect and restore surface water and groundwater quality and the natural systems that maintain these services in order to safeguard human and environmental health and secure California water supplies.	Ratio of observed to expected native aquatic species	47	Invasive weeds, water temperature, migration barriers, inadequate flows	Weed abatement, increased summer flows, fish ladders or barrier removal
	Surface-water Water Quality Index	63	Discharge to waterways, inadequate summer flows, invasive weeds, water withdrawals/transfers, climate change	Improved discharge treatment, weed abatement, incentives for regional water supply and against inter-basin
	Groundwater Water Quality Index	82	Agricultural chemicals, irrigation and drinking water withdrawals, inadequate septic, impermeable surface development	Best management practices for agriculture, conjunctive water management, wastewater treatment, improve regional development and redevelopment standards

Water Footprint

- Proposed index within Framework to track sustainable use of water (part of Phase II)
- Originates from “ecological footprint” concept. For example, the land-area required to supply an average US resident with food is ~2.4 acres
- Example: In the US, the per capita water footprint is 2,480 m^3/yr, the largest in the world (Hoekstra, 2009).

Regional (IRWM) and Local Scales

- Utility and scale transition
  - "Region" are important planning, operational, and reporting scales
  - The Framework is scale-insensitive
  - How do we encourage its use in the IRWM and similar regional processes?
  - How do we make sure it is useful to local entities who collect data, are concerned about changing conditions, and want to be sustainable?

Partner across scales and disciplines

- Coordinate with state partners (DSC, SGC, SWRCB, DFG, others)
- Coordinate with local/regional partners (Bay IRWM, SDRWQCB, Sonoma Water Agency, others)
- Share approach with SWRR, USEPA, and others at nation-scale
- Coordinate with tribes

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- Where are we going next?:
  1. Tribal Perspective - Water Plan Tribal AC:

     August 5, 2011; 10:45 am – 11:45 am; CALEPA, Sacramento
  2. Present Framework to Public AC and State Agency Steering Committee:

     August 24, 2011; 12:45 pm – 4:30 pm; CALEPA, Sacramento
  3. Technical Review at SWAN Workshop:

     August/September 2011

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- Where are we going next?:

5. Regional Coordination - Regional Forums: TBD
6. Revise Framework: September 2011
   - Identify targets for a set of recommended indicators
   - Identify data types and possible sources
   - Describe appropriate analytical approaches
   - Describe reporting system
7. Workgroup Framework Review Meeting:

   September 2011/ ?? / ??
8. Present Framework to Sustainable Water Resources Roundtable Fall Meeting: December 6, 2011

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Thank You!
Questions?

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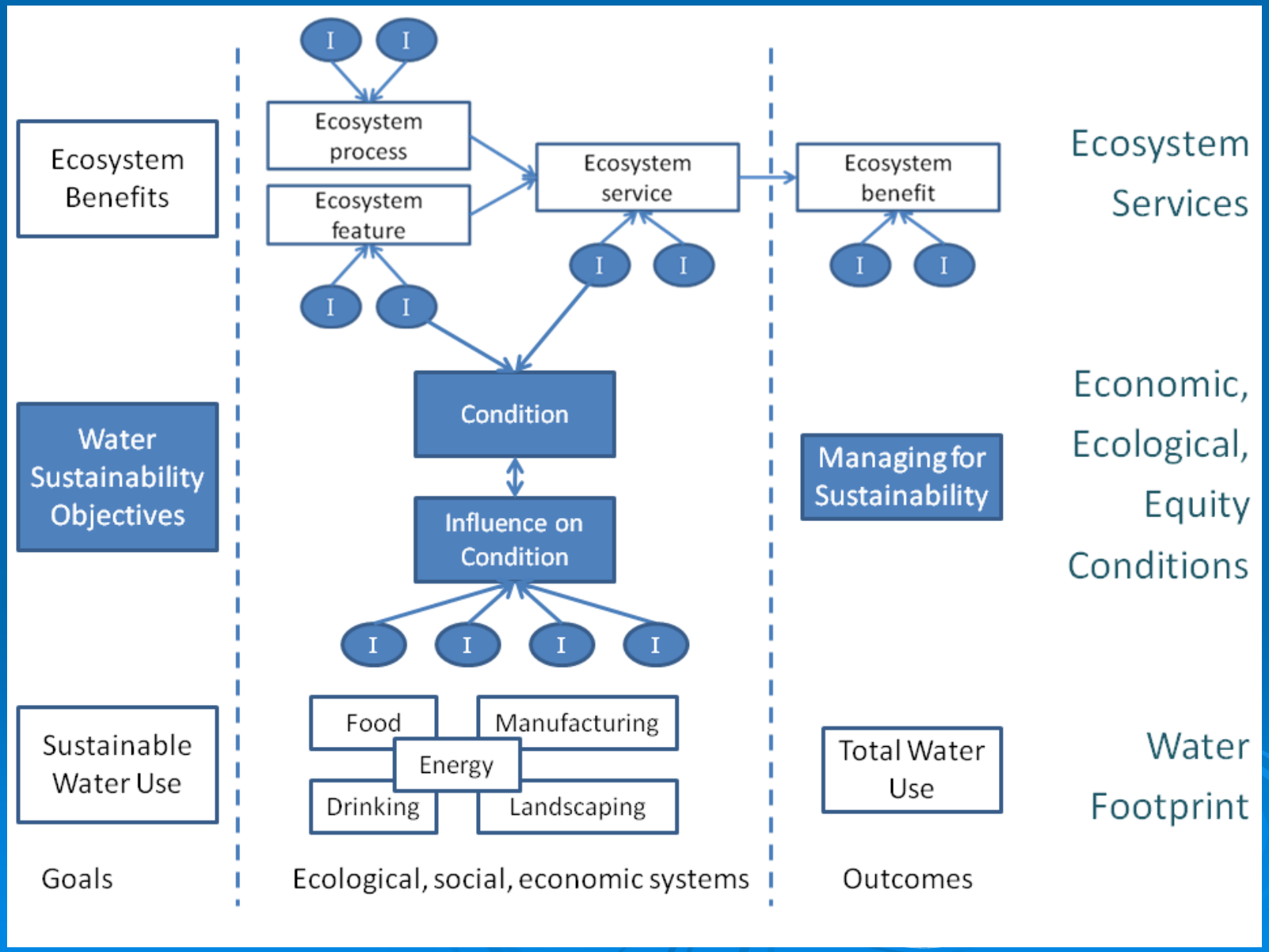
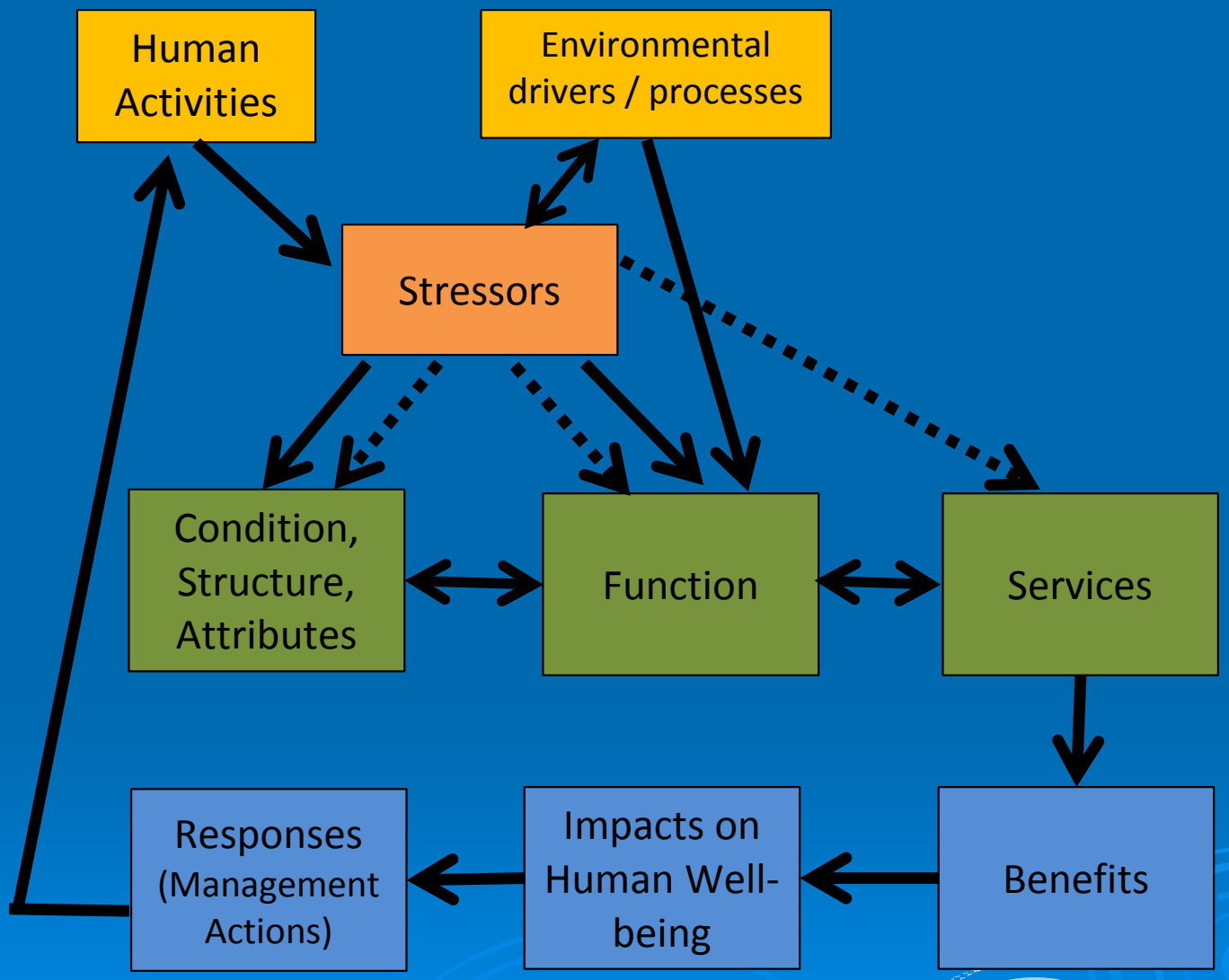
Summary

- Vision
- Definitions
- Framework
- Water Sustainability Objectives
- Water Footprint
- IRWM regions use of the developed Framework

Relationship to ecosystem services and water footprint



Model of ecosystem services provision



Based on Wright and Johnson 2011, UNEP-WCMC & WRI 2009

Discussion Topics

- Definition of water sustainability (page 9)
- Water sustainability objectives (pages 10/11)
- Candidate indicators (pages 12/13)

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Where are we going next?

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CA Water Sustainability Indicators
Project Schedule

Phase 1:

- Workshop 1: Draft Framework:
  Goals/objectives/indicators review — Fall/2011
- Water sustainability indicator analysis framework — Fall/2011

Phase 2:

- Detailed scoping for quantitative analysis — Fall/2011
- Workshop 2: Proposal on a Pilot analysis — Late/2011
- Workshop 3: Pilot results &
  a proposal for extended analysis — Summer/2012
- Workshop 4: Results from extended analysis — Summer/2013
- Final analysis and documentation — Fall/2013

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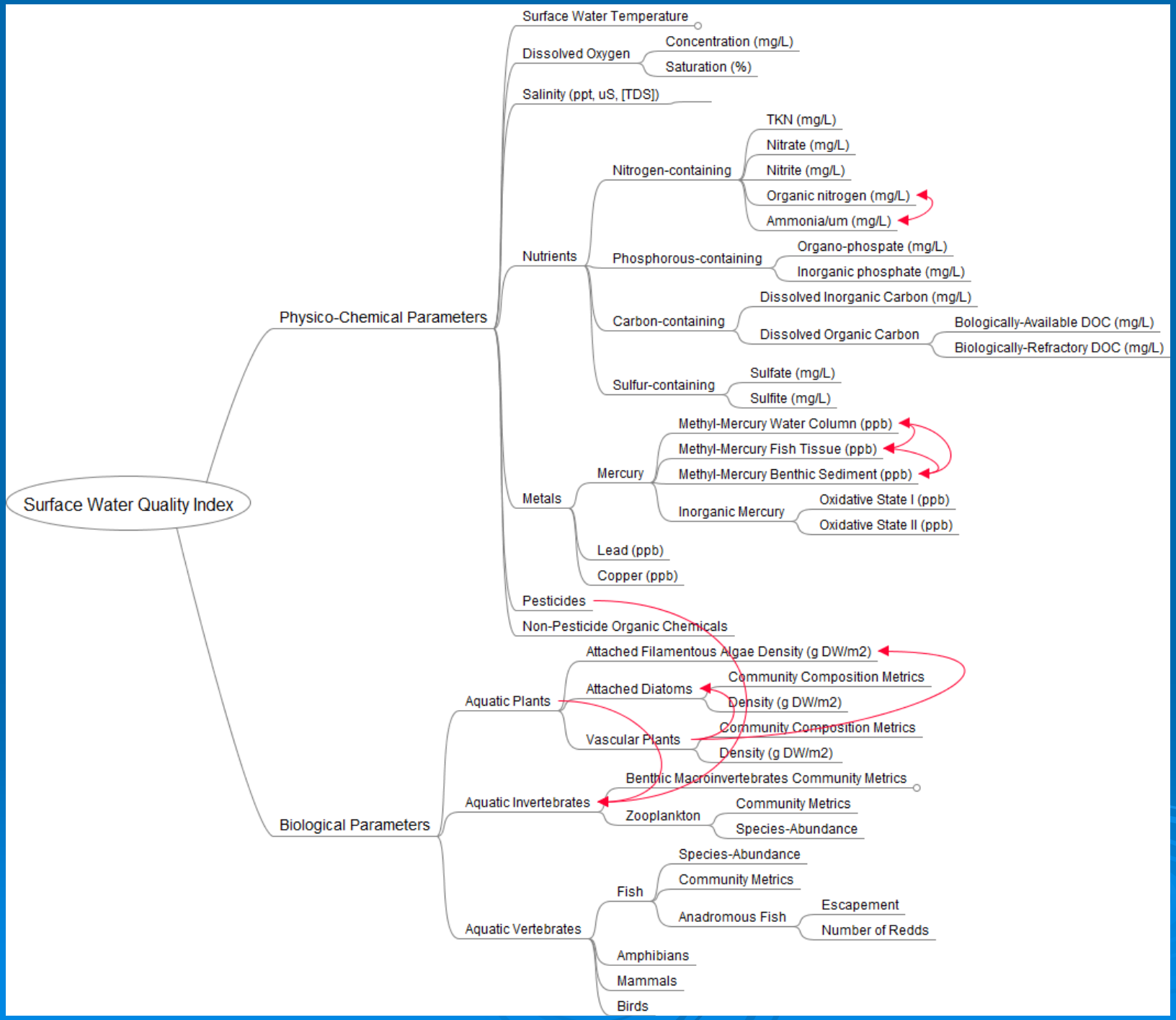
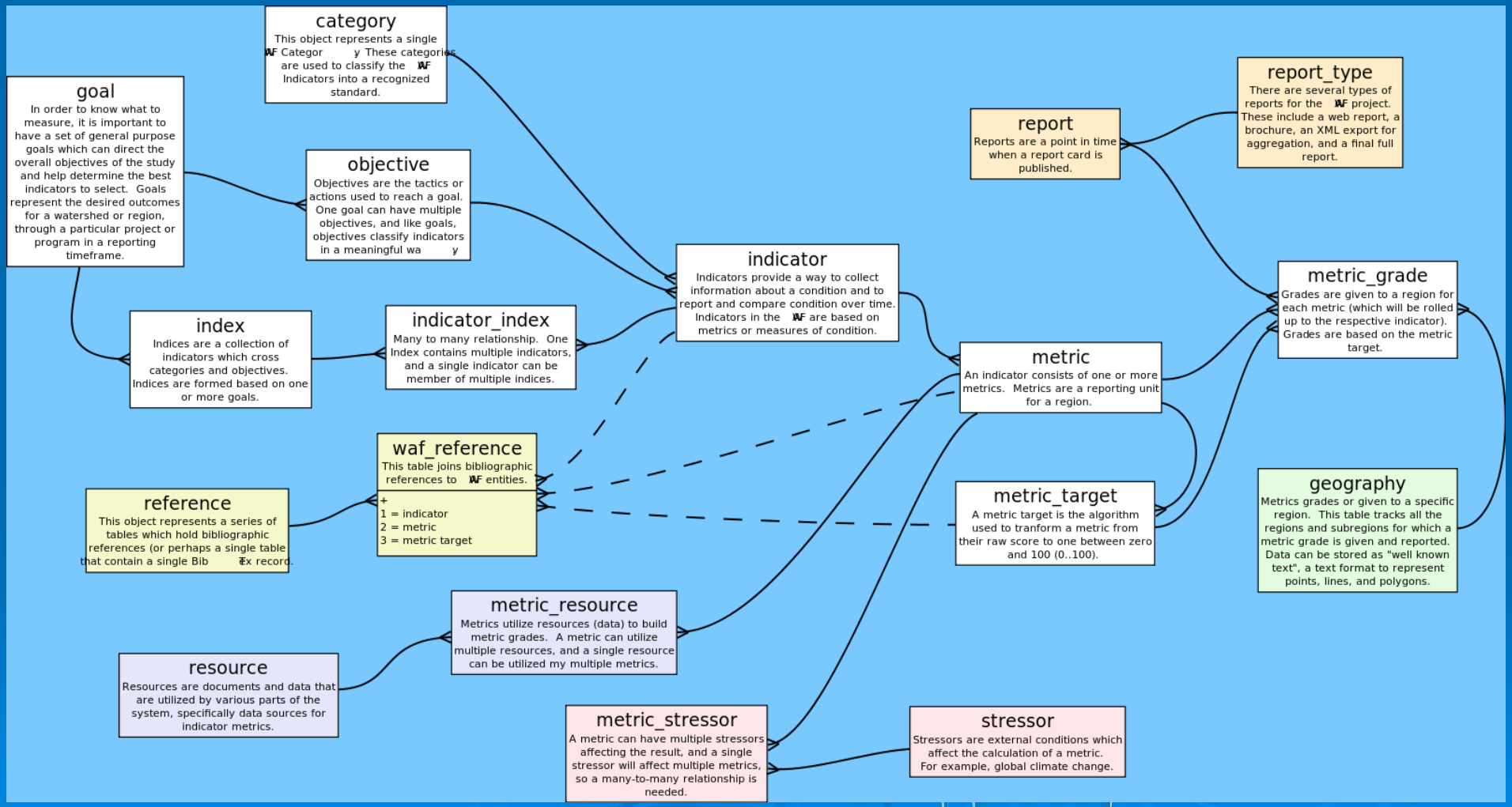
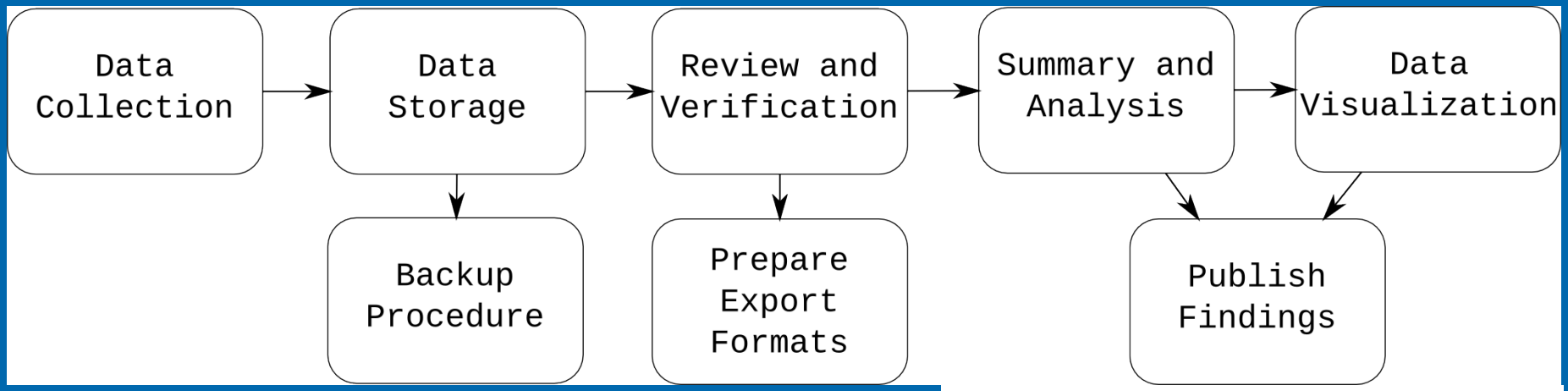

Surface Water Quality Index
Physico-Chemical Parameters
Surface Water Temperature
Dissolved Oxygen
Concentration (mg/L)
Saturation (%)
Salinity (ppt, uS, [TDS])
Nutrients
Nitrogen-containing
TKN (mg/L)
Nitrate (mg/L)
Nitrite (mg/L)
Organic nitrogen (mg/L)
Ammonia/um (mg/L)
Phosphorous-containing
Organo-phospate (mg/L)
Inorganic phosphate (mg/L)
Carbon-containing
Dissolved Inorganic Carbon (mg/L)
Dissolved Organic Carbon
Bologically-Available DOC (mg/L)
Biologically-Refractory DOC (mg/L)
Sulfur-containing
Sulfate (mg/L)
Sulfite (mg/L)
Metals
Mercury
Methyl-Mercury Water Column (ppb)
Methyl-Mercury Fish Tissue (ppb)
Methyl-Mercury Benthic Sediment (ppb)
Inorganic Mercury
Oxidative State I (ppb)
Oxidative State II (ppb)
Lead (ppb)
Copper (ppb)
Pesticides
Non-Pesticide Organic Chemicals
Biological Parameters
Aquatic Plants
Attached Filamentous Algae Density (g DW/m2)
Attached Diatoms
Community Composition Metrics
Density (g DW/m2)
Vascular Plants
Community Composition Metrics
Density (g DW/m2)
Aquatic Invertebrates
Benthic Macroinvertebrates Community Metrics
Zooplankton
Community Metrics
Species-Abundance
Aquatic Vertebrates
Fish
Species-Abundance
Community Metrics
Anadromous Fish
Escapement
Number of Redds
Amphibians
Mammals
Birds

Reporting can be automated or manual across wide range of time intervals (15 minute to annual)



Scientific workflow



Bowers and Ludascher, 2005; Howe et al., 2009

- Certain steps can be automated and online
- Provides a provenance pathway for findings, so people can drill backwards and build trust