Examining Aquatic Indicators in Watershed Condition/Function Assessment

(*Beyond IBIs*)

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Definitions

- Indicators – things we can measure around us that can tell us about components of a natural or human system
- Performance Measure – similar to indicators, except often confined to management actions and other intentional human actions
- Index – an aggregation of indicators that convey a story about a system

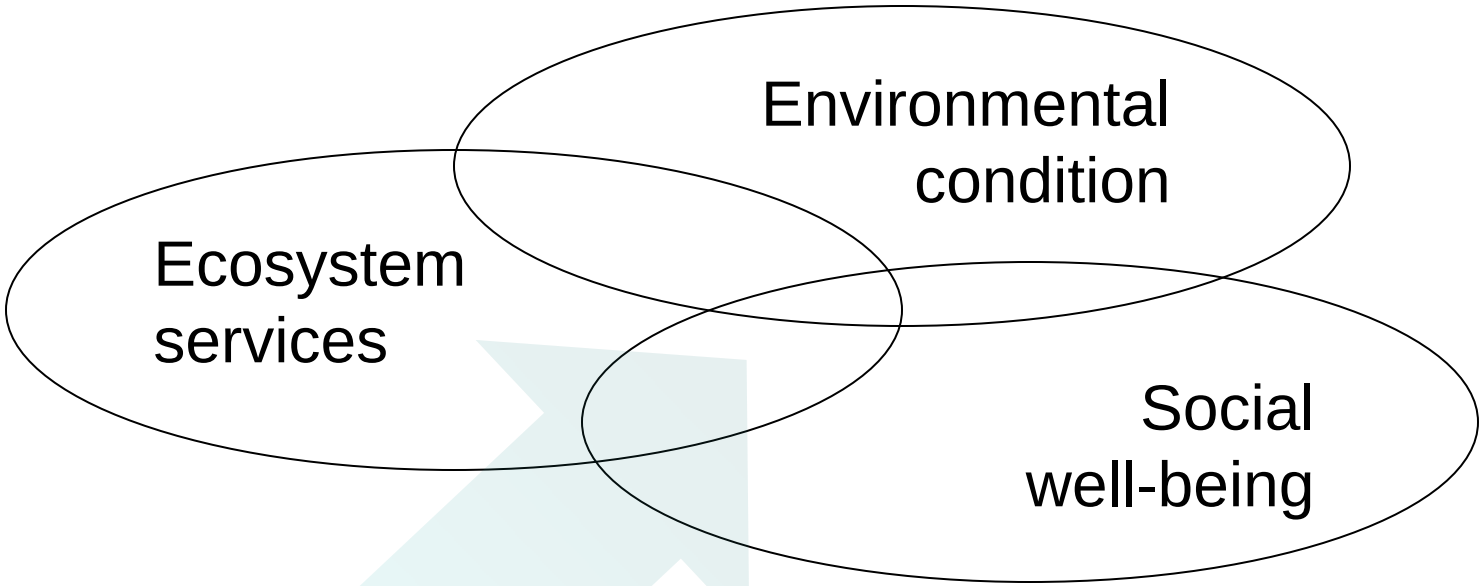
Watershed Assessment

California Watershed Assessment Manual

Volumes I and II

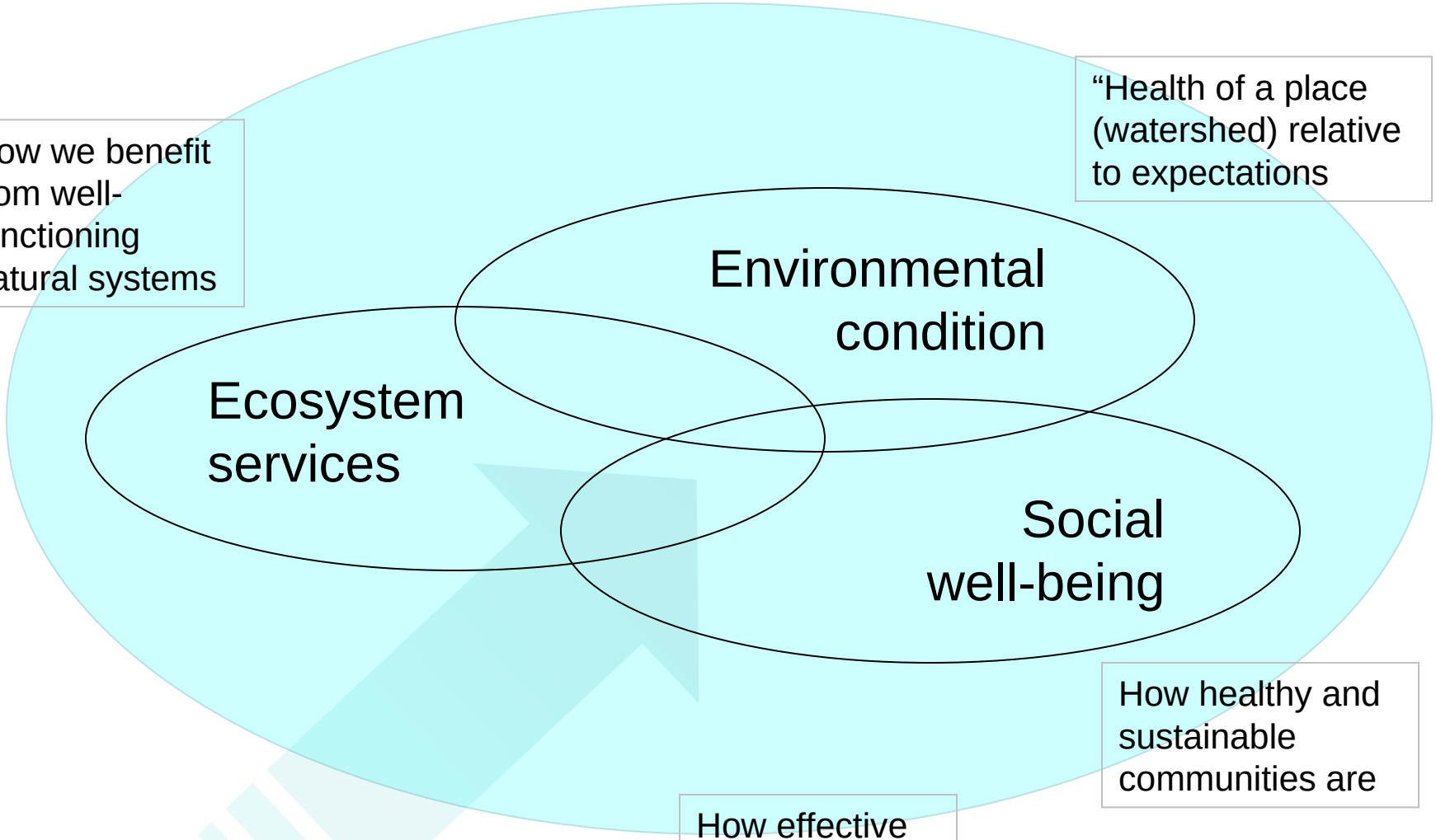
http://cwam.ucdavis.edu

Volume II: Indicators, Periphyton, Benthic macroinvertebrates, etc.



Management performance

Scale Independent!



How we benefit from well-functioning natural systems

"Health of a place (watershed) relative to expectations

How healthy and sustainable communities are

How effective our actions are in protecting and improving

Management performance

Global Effort

- Millenium Ecosystem Assessment
- United Nations sustainability and environmental indicators
- Genuine Progress Index
- USEPA SAB framework
- Government Accounting Office
- Heinz Center: State of the Nation’s Ecosystems
- USEPA Index of Watershed Indicators
- Water Quality Index (OR and BC)
- State of Puget Sound
- Chesapeake Bay Habitat Health Report Card
- Etc…..

California Effort

IBIs

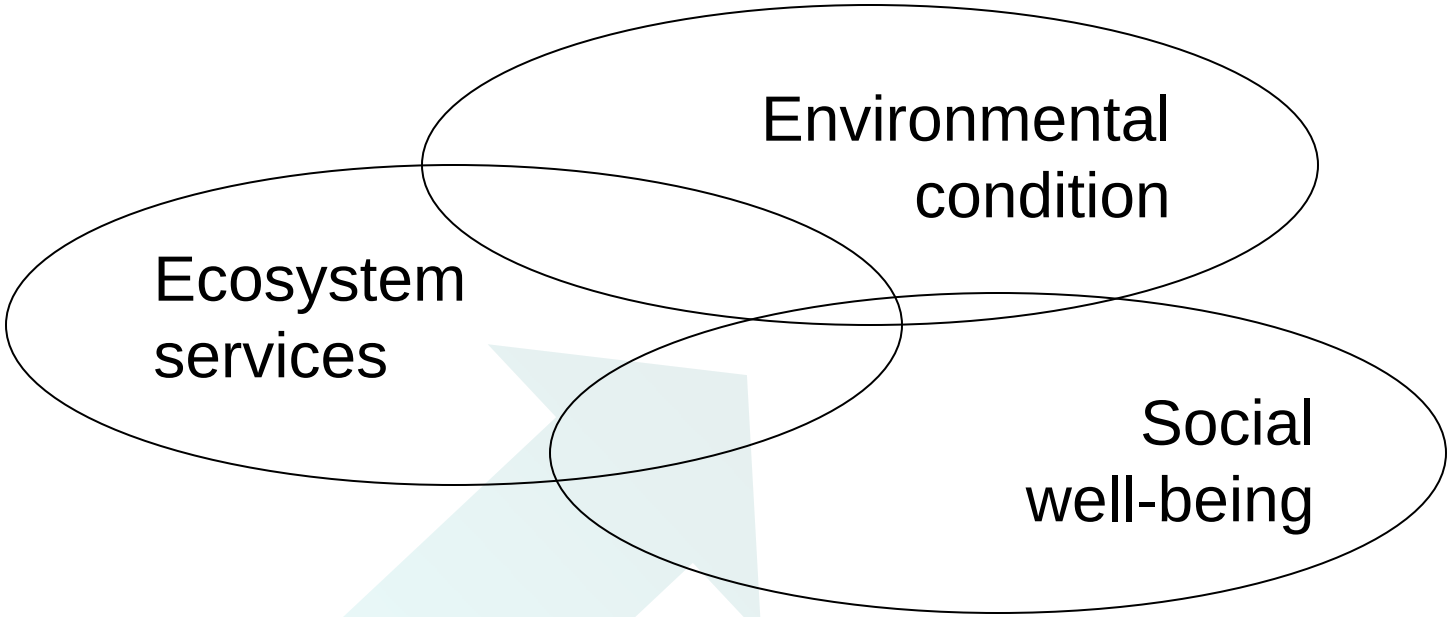
Caltrans – valuation of environmental impacts and services

Water agencies – performance in water supply and water quality (DWR, SWRCB?)

Ecosystem restoration (DFG, CALFED)

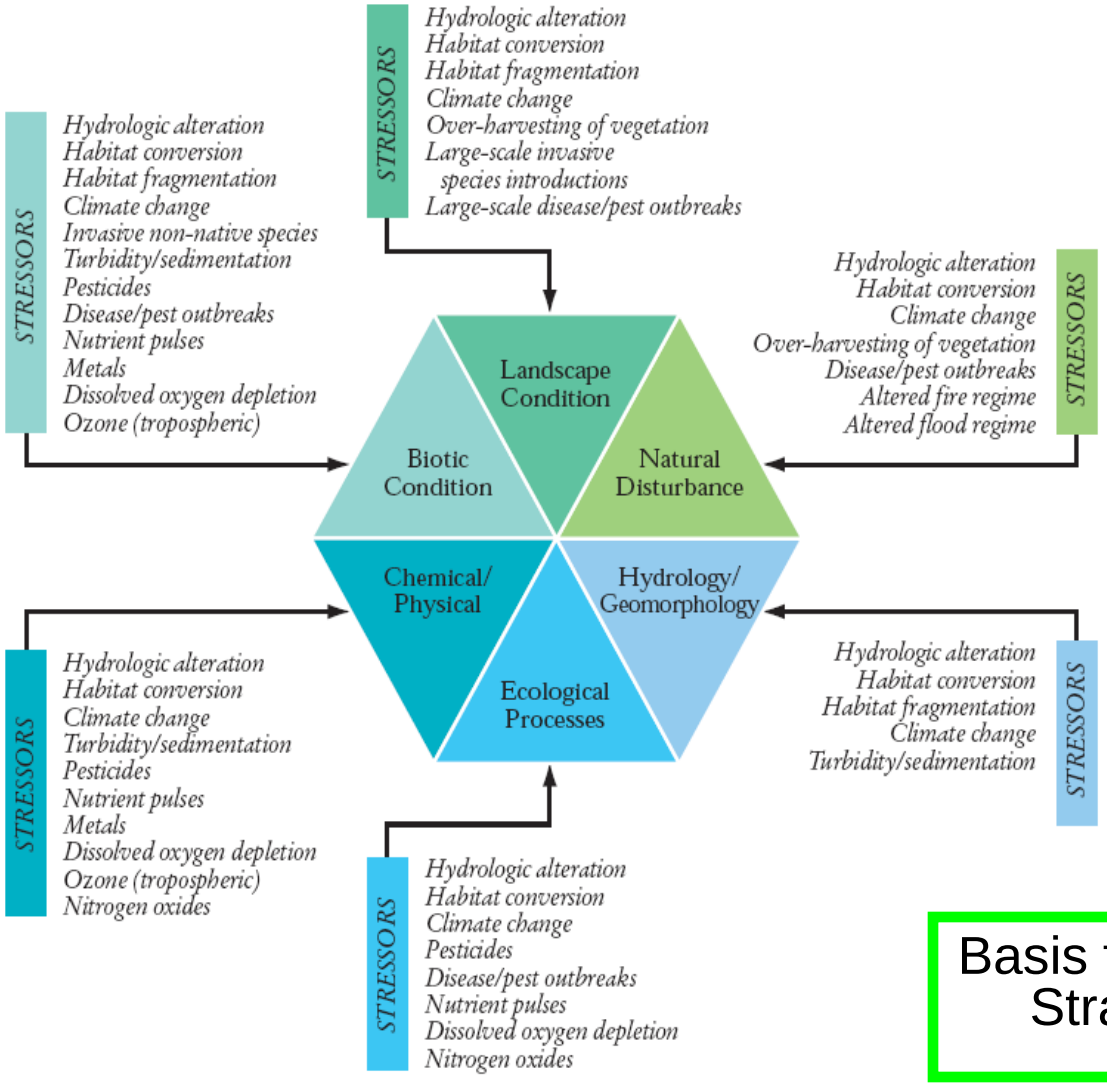
Watershed Assessment Framework (DWR, CALFED)

Statewide Goal: Systematize Integrated Approach – Watershed Assessment Framework



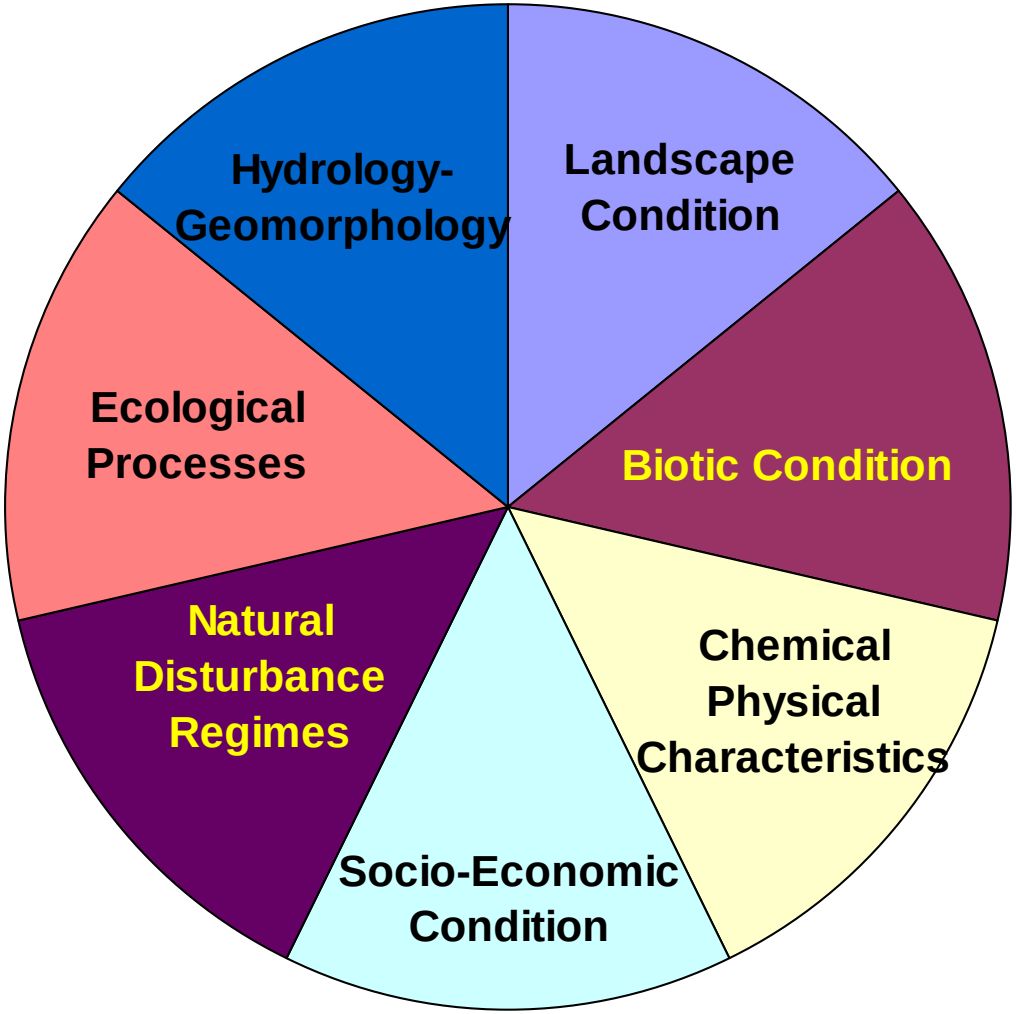
Management performance

USEPA-SAB

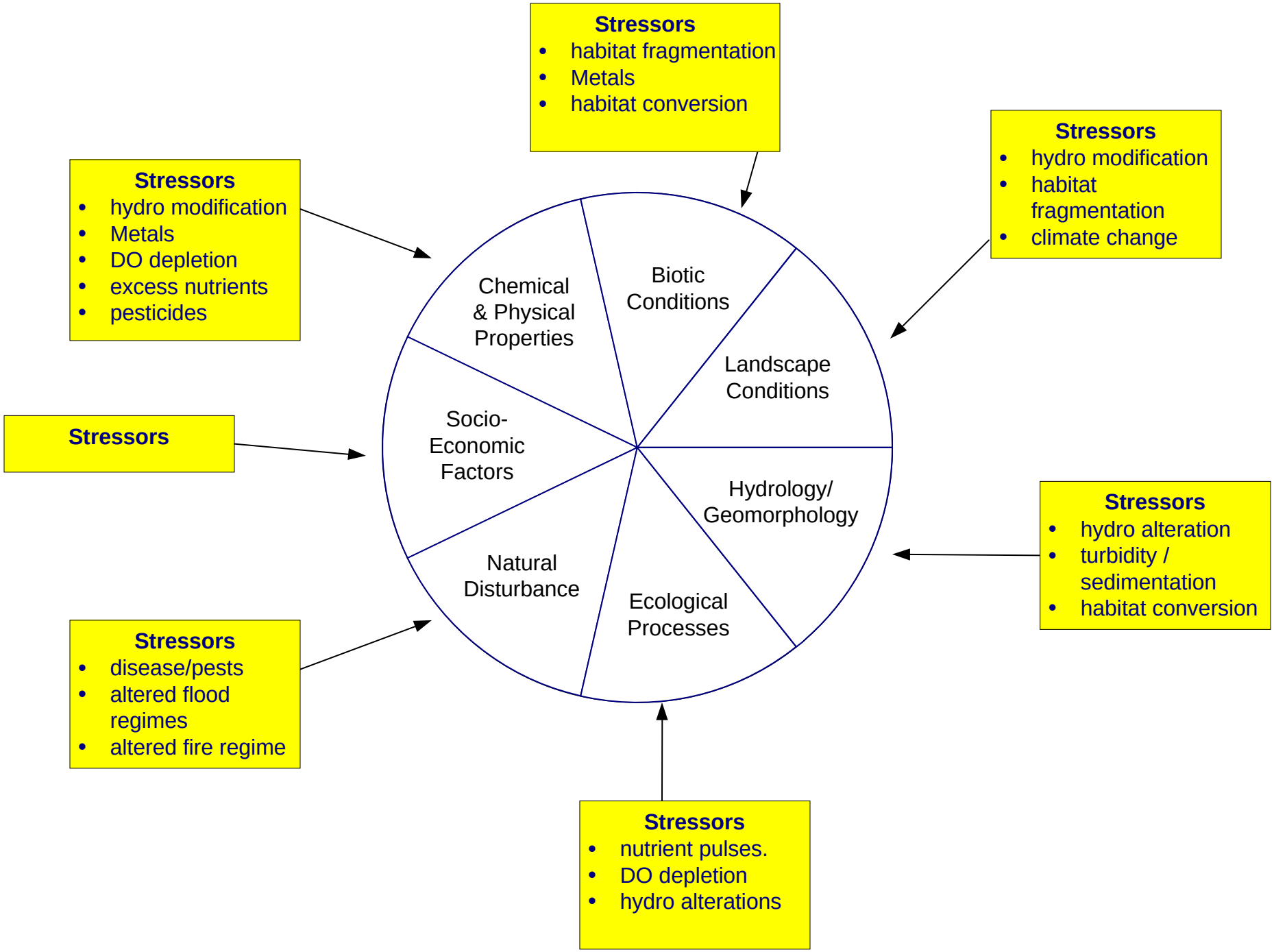


Basis for WAF (Governor's Strategy for Watersheds)

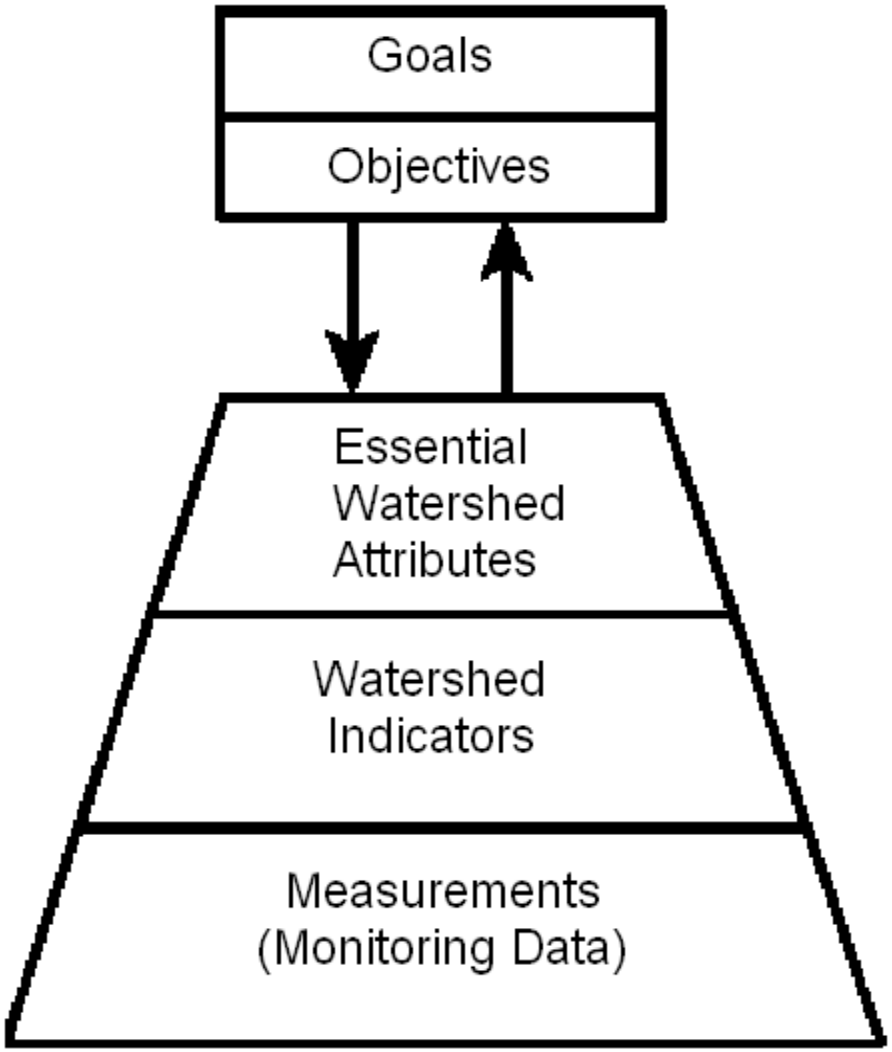
Essential Watershed Attributes



Watershed Assessment Framework


Stressors
habitat fragmentation
Metals
habitat conversion
Stressors
hydro modification
habitat fragmentation
climate change
Stressors
hydro modification
Metals
DO depletion
excess nutrients
pesticides
Chemical & Physical Properties
Biotic Conditions
Landscape Conditions
Stressors
Socio-Economic Factors
Hydrology/ Geomorphology
Stressors
hydro alteration
turbidity / sedimentation
habitat conversion
Natural Disturbance
Ecological Processes
Stressors
disease/pests
altered flood regimes
altered fire regime
Stressors
nutrient pulses.
DO depletion
hydro alterations

Modified SAB Framework

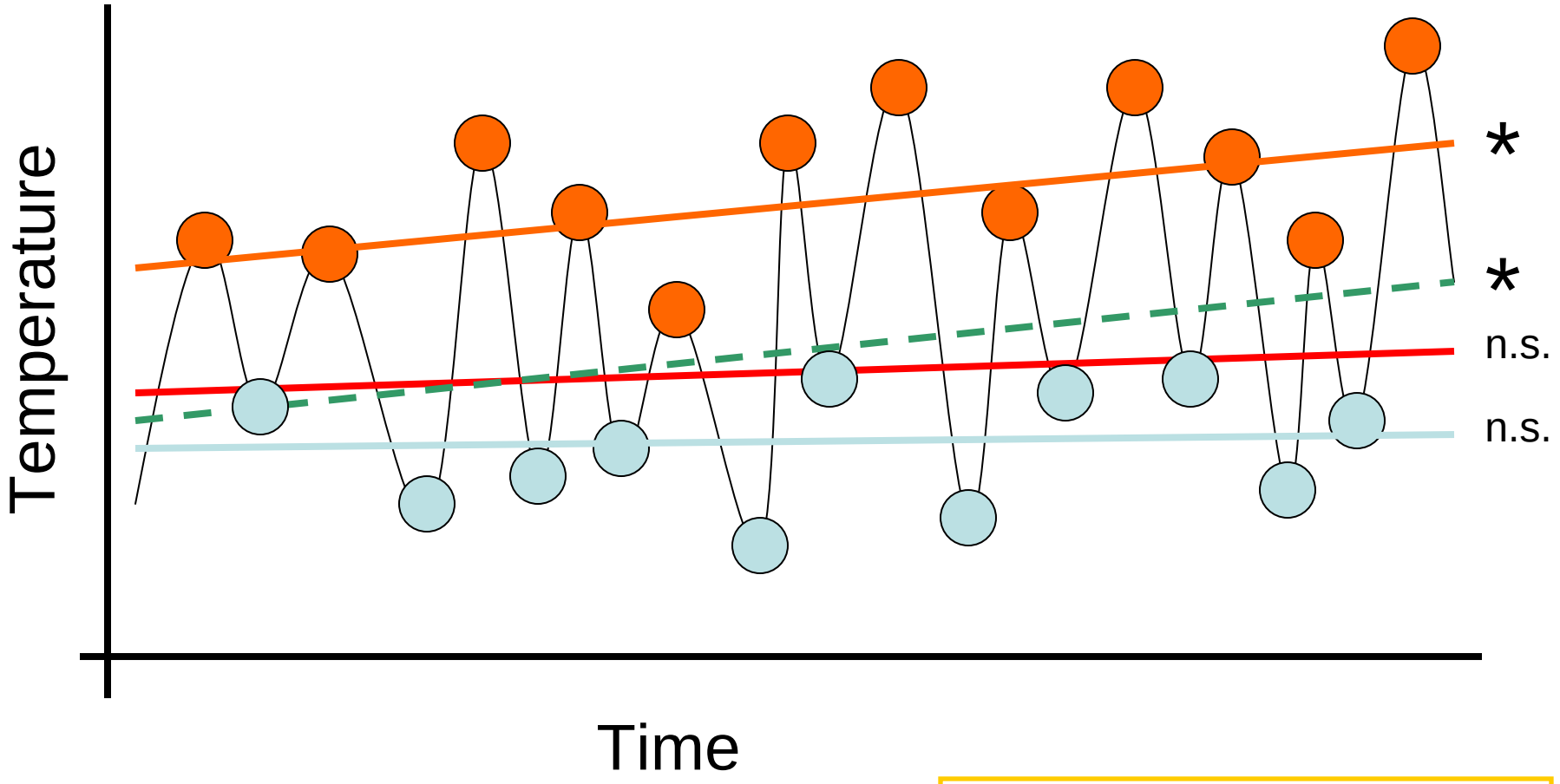


Potential Expression of WAF – Report Card

Category	Indicator	Metric	Score
Landscape Condition	Development	Impervious surface Fragmentation	?
Biotic Condition	Native fish	Out-migrants Habitat	?
Social/Economic Condition	Social welfare	Fishability School lunch programs	?
Hydrology/Geomorphology	Erosion	TSS Bed-load movement	?
Ecological Processes	Exotic invasion	Extent Rate of spread	?
Natural Disturbance	Fire	Spread risk Succession/regeneration	?
Chemical/Physical Properties	Toxics	Metals Pesticides	?

Some Issues & Examples

Statistical Analysis Over Time

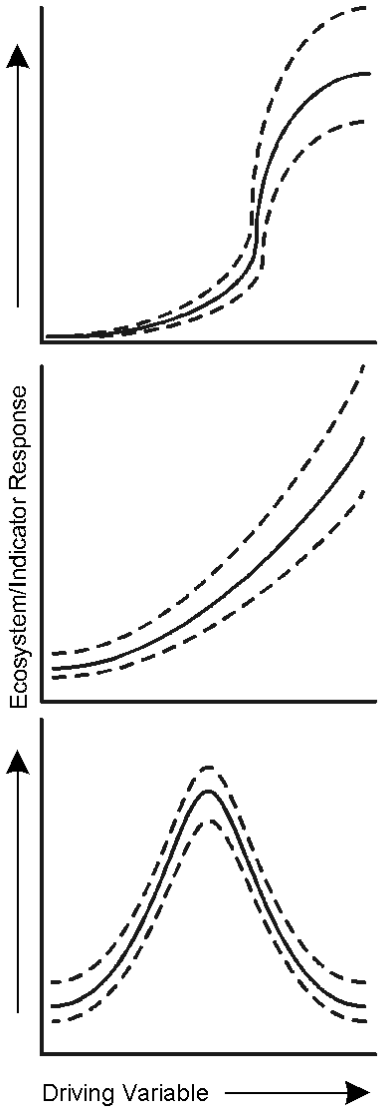


Trends Analysis

Some Issues & Examples

Comparison Analysis and Aggregation

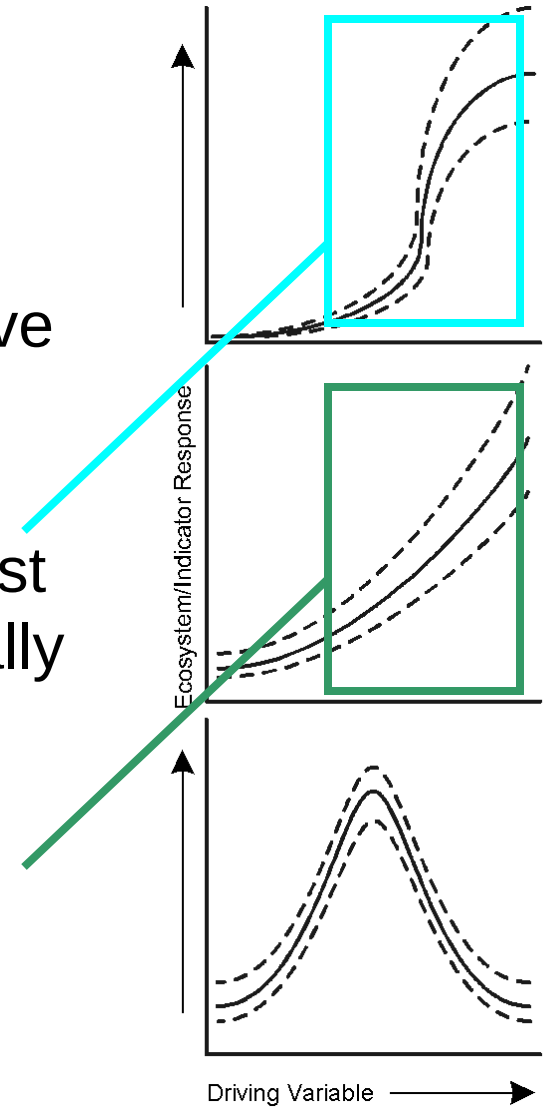
- Different indicators have different response patterns
- Makes aggregation and comparison among them challenging (but still possible)



Some Issues & Examples

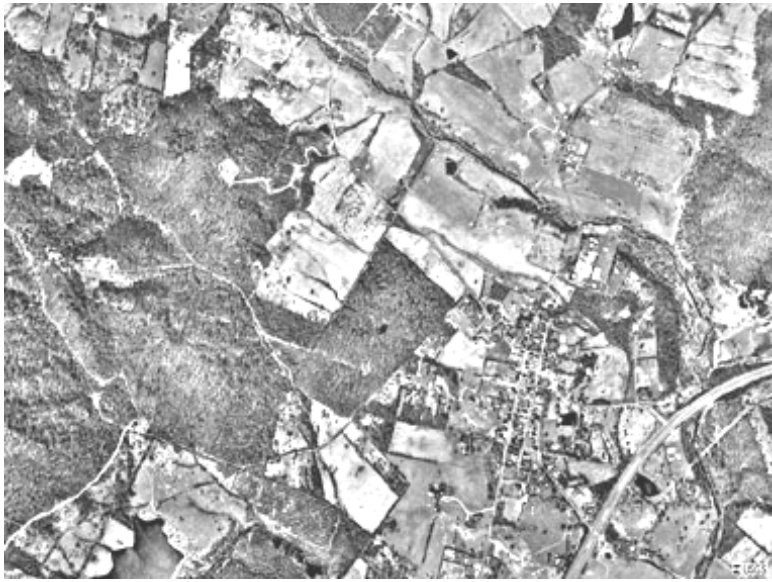
Suitability of Indicator/Index

- Different indicators have different response patterns & sensitivity
- Should we use the most sensitive (and potentially noisiest)?
- An index may be less noisy, but also less sensitive to change



Some Issues & Examples

Feature vs. Process



- Features are measurable attributes at a particular moment
- Processes are fluxes or changes over time
- Features and patterns can influence processes and vice-versa

Primary productivity

Erosion

Nutrient cycling

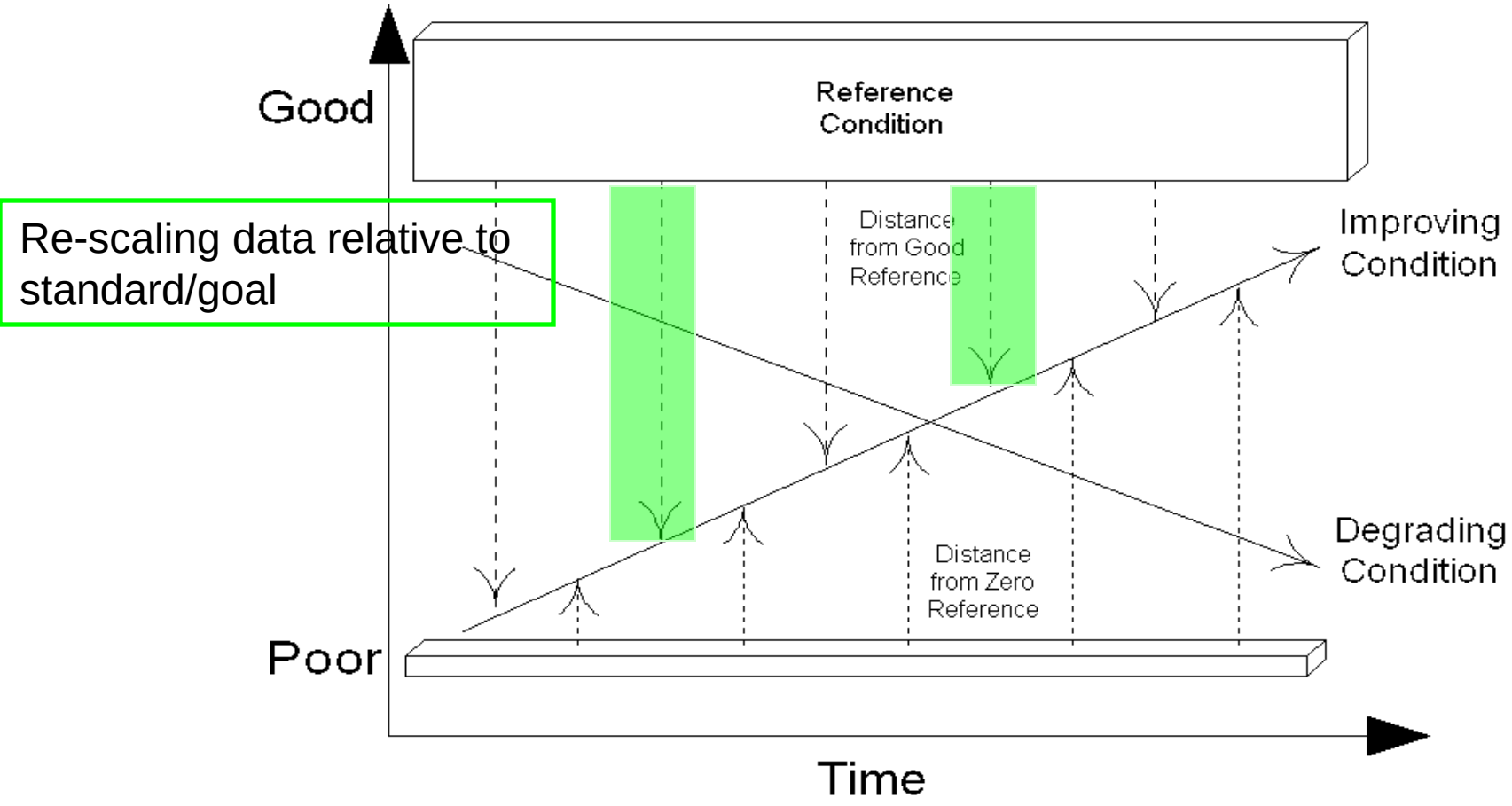
Land conversion

Diversity

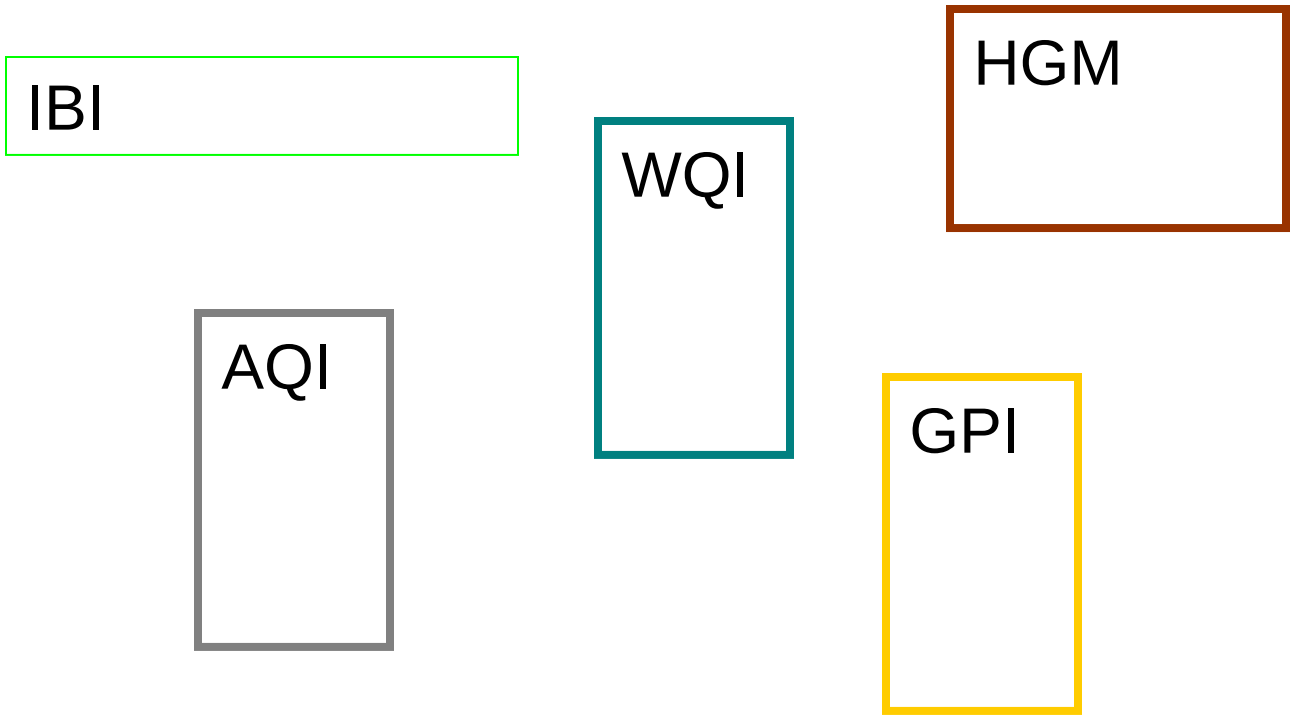
Some Issues & Examples

References and Standards

Re-scaling data relative to standard/goal



How do we integrate the parts to say something about watershed or waterway “condition”?



Aggregation into Index

Aggregation of dis-similar indicators into an index of condition depends on definition of a goal for doing so, defined scales of analysis, references, and good application of statistics and logic.

Aggregation into Index

- Basic Common Steps in Global Literature and Practice
  - Goals
  - Categories
  - Conceptual Model-Based
  - Re-Scaled Data
  - Condition, Performance, Health Score
  - Test and Confirm

Potential Expression of WAF – Report Card

Category	Indicator	Metric	Score
Landscape Condition	Development	Impervious surface Fragmentation	65±13
Biotic Condition	Native fish, BMIs, frogs, algae	Out-migrants Habitat	43±22
Social/Economic Condition	Social welfare	Fishability School lunch programs	84±3
Hydrology/ Geomorphology	Erosion	TSS Bed-load movement	71±15
Ecological Processes	Exotic invasion	Extent Rate of spread	34±8
Natural Disturbance	Fire	Spread risk Succession/regeneration	57±31
Chemical/Physical Properties	Toxics	Metals Pesticides	35±16

Potential Expression of WAF – Report Card

Category	Indicator	Metric	Score
Biotic Condition			43±22
I	Native fish	Out-migrants Habitat	28±13
II	Amphibians	Native/non-native species	19±11
III	BMI community structure	Community composition Tolerant/intolerant EPT/Coleoptera richness	46±28
IV	Periphyton	Community composition	37±2
V	Habitat structure	Sediment characteristics, woody structure	51±19
VI	Trophic conditions		57±31

Watershed Biotic-Condition Indicators

BMI

- Weigel, 2003 (organic pollution tolerance, sediment tolerance, species richness, number or percent EPT, Amphipoda, Isopoda, Diptera, and Chironomidae taxa, and percent shredder, scraper, and gatherer)
- Ode et al., 2005 (percent collector-gatherer + collector-filterer individuals, percent noninsect taxa, percent tolerant taxa, Coleoptera richness, predator richness, percent intolerant individuals, and EPT richness)

Periphyton

- Hill et al., 2000 (1) algal genera richness; 2) the relative abundances of diatoms, Cyanobacteria, dominant diatom genus, acidophilic diatoms, eutraphentic diatoms, and motile diatoms; 3) chlorophyll and biomass (ash-free dry mass) standing crops; and 4) alkaline phosphatase activity)

IBIs

These indices may have a place as stand-along indicators of "biotic condition", or they may contain the parts needed to inform the "biotic condition" part of the WAF and similar constructs.

Future

- Development and incorporation of aquatic biota and habitat indicators (demonstrated relevance and sensitivity)
- Development and use of statistical methods to measure change while taking into account seasonality
- Use of contemporary methods in re-scaling of data and multi-objective decision-support
- Incorporation of aquatic indicators into watershed and other environmental score-cards

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