The Stream Condition Index: A Multi-Indicator Tool For Enhancing Environmental Management Communication

Marcus W. Beck ([marcusb@sccwrp.org](mailto:marcusb@sccwrp.org)), Raphael D. Mazor ([raphaelm@sccwrp.org](mailto:raphaelm@sccwrp.org)), Kenneth C. Schiff ([kens@sccwrp.org](mailto:kens@sccwrp.org)

# Introduction

* A cornerstone of the Clean Water Act is to restore and maintain the chemical, physical, and biological integrity of the Nation’s waters. (CWA)
  + All three lines of evidence are necessary to ensure aquatic life beneficial uses are fully supported (CWA §305b, 303d)
  + Monitoring physical habitat integrity is necessary to ensure all of the necessary environmental niches are present to support aquatic life (Poff or other Keystone PHab ref)
  + Monitoring chemical integrity is necessary because even with suitable physical habitat, unbalanced chemical composition can impair aquatic life (EPA Green Book)
  + Monitoring biological integrity, closest to the beneficial use, is necessary because unmeasured habitat or chemical water quality can impair balanced ecosystems (Stoddard, Ode).
* A tremendous amount of effort is spent monitoring all three lines of evidence
  + Cite some programs here that spend a lot of effort and money on the triad (EPA EMAP, PSA, SMC, Ohio, Maryland, etc)
* A common challenge when monitoring multiple indicators is how to communicate the complex physical, chemical, and biological results in a scientifically rigorous, repeatable, yet readily understandable way to non-scientists. (NRC)
  + Most environmental managers and decision makers are not scientists and don’t understand the intricate, nuanced details of ecological data
  + Rarely are ecological data black and white, so many of decisions asked of mangers are made in the “grey zone” (pick from thousands of refs)
  + This is particularly true when the different lines of evidence are not in complete agreement
* Currently, there are many examples of how to effectively communicate single lines of evidence
  + IBIs (Karr)
  + O/E (Hawkins)
  + Combined IBI and O/E (Mazor)
  + BRI (Smith) or AMBI (Borja) –if you want to include marine
* Ideally, scientists would combine multiple indicators into a single index, although this rarely occurs
  + Honestly, can’t think of a good one. Maybe you have an example. To me, the SQO is perhaps the best example
  + Most frequently, the three indicators are individually simplified and presented in groups, leaving managers to decide which is most important.
* The goal of this study was to develop the Stream Condition Index, a single index that combines physical, chemical, and biological indicators into a scientifically rigorous, yet easy to understand tool for management decision making.

# Methods

## General Approach

* The SQI uses a stressor-response conceptual approach
  + Stressors include chemistry and physical habitat
    - PHab can sometimes be considered a response, but we treat it as a stressor
  + Response includes benthic invertebrates and algae
    - Multiple taxa groups are critical for balanced outcomes
  + Focused on So Cal
    - Lots of data
    - A wide range of stress and response
    - Mandate for decision making
* Philosophical drivers
  + Simple single answer at the end to support management decision making (set up for categorical scores at the end)
  + Must be easily deconstructed so scientists can quickly glean what stressors or responses are driving the final score (Set up for the flowchart and for the web site)
  + The primary pursuit is stream biological condition (set up to the stressor modeling)

## Stressor Components

* Chemical Index
  + N, P, Cond
  + Describe modeling
  + Maybe include details as supplemental material?
* Physical Habitat Index
  + General description (Cite PIBI)
  + CRAM
  + PHab

## Response Components

* Invertebrate index, CSCI
  + General description (Cite Mazor)
* Algae index, ASCI
  + General description (Cite Theroux)

## Stream Condition Index

* Flow chart description
* Combining stressors
* Combining responses
* Combining stress and Response
* Linking final score to management actions (the categorical descriptions)

## Application

* SMC data set
* Evaluation parameters/Performance metrics
* Web app (or leave this for discussion

# Results

* SQI performance metrics
  + Precision
  + Any others?
* Percent So Cal stream miles or site frequency in each category
  + As a set up for the value of the categorical scoring
* Overall agreement among stressor indicators
  + As a set up for do we need multiple indicators?
* Overall agreement among response indicators
  + As a set up for do we need multiple indicators?
* SQI trends either overall or at example sites

# Discussion

* The SQI provides a management tool that is easily understandable
  + The categories are descriptive of the outcomes
  + Particularly important in a place like southern California where priority setting is critical
* The SQI is technically robust and is easily deconstructed for scientists to decipher details
  + Can quickly reach individual stressor or response values/data
* The SQI utilizes a relatively new approach for scoring stress
  + Examples where pPIBI or pChem exist in the literature
  + How the RF model varies relative to other chemical magniture&frequency stressor scores (i.e, Canadian tool, RB3)
  + No previous PHab tool
* Drawbacks to the SQI
  + Does not include all stressors (i.e., all chemicals, flow modification, etc)
  + Does not include all responses (i.e., vertebrates, etc)
  + The approach can/cannot incorporate these variables in other places/with more data?
* The utility of the SQI is enhanced with the web application
  + Drop and calculate
  + Spatial scaling
  + Instantaneous data dives
  + The restoration calculator tool
  + (optional) Linkage to the SCAPE for “restoration” and RSCA tools for “causal assessment” categories