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?”
Water Plan Update 2013
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
Water Plan Update 2013
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.
Water Plan Update 2013
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
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.
Water Plan Update 2013
CA Water Sustainability Indicators
Proposed Approach
Water Plan Update 2013
CA Water Sustainability Indicators

- Measurements (data)
- Indicators/Indexes (information)
- Status/Trend (knowledge)
- Stories (wisdom)

Intuitive/Obvious

Technical/Analytical
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.
<table>
<thead>
<tr>
<th><strong>Proposed Sustainability Objectives</strong></th>
<th><strong>Relationship to Water Plan 2009</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>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.</strong></td>
<td>CWP Objective 2, 9; RMS Reduce demand</td>
</tr>
<tr>
<td><strong>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.</strong></td>
<td>CWP Objective 1, 2, 7, 11, RMS Operational efficiency</td>
</tr>
<tr>
<td><strong>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.</strong></td>
<td>CWP Objective 3, 12, 13; RMS Increase water supply</td>
</tr>
<tr>
<td><strong>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.</strong></td>
<td>CWP Objective 4; RMS on water quality; chapter 4 discussion of water quality sustainability indicators</td>
</tr>
<tr>
<td><strong>5. Practice, promote, improve, and expand environmental stewardship to protect and enhance environmental conditions by improving watershed, floodplain, and aquatic condition and processes.</strong></td>
<td>CWP Objective 5, 12, 13; RMS Natural Resources</td>
</tr>
<tr>
<td><strong>6. Integrate flood risk management with other water and land management and restoration activities.</strong></td>
<td>CWP Objective 1, 6, 12, 13; RMS Improve flood</td>
</tr>
<tr>
<td><strong>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.</strong></td>
<td>CWP Objective 10; various RMSs; CWP Vol. 1 Chapter 6 Integrated Data and Analysis</td>
</tr>
</tbody>
</table>
Organizing indicators
<table>
<thead>
<tr>
<th>Sustainability Objective</th>
<th>Related CWP Objective and RMS</th>
<th>Example Indicators</th>
<th>Relevance to Sustainability Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
<td>CWP Objective 4; RMS on water quality; chapter 4 discussion of water quality sustainability indicators</td>
<td>Ratio of observed to expected native aquatic species</td>
<td>Protect and restore water quality for environmental health</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Surface-water Water Quality Index</strong></td>
<td>Surface water quality to safeguard human and environmental health</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Groundwater Water Quality Index</td>
<td>Ground water quality to safeguard human health</td>
</tr>
</tbody>
</table>
How do we measure condition?

Salmon egg – juvenile well-being and water temperature (San Joaquin River)
Vision

Goals

Themes

Objectives

Attributes & Processes

Indicators & Indices

Data & Data Analysis

Selection criteria

Agency mission

Stakeholder process

Target selection

Conceptual models

Spatial & temporal aggregation

Data management & provenance

Status & trends
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”.

Possible Normalization Approaches
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
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)”
<table>
<thead>
<tr>
<th>Goals</th>
<th>Measurable Objective</th>
<th>Condition</th>
<th>Trend</th>
<th>Confidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water quality and supply for natural and human communities</td>
<td>Water quality for aquatic health</td>
<td>50</td>
<td></td>
<td>Medium-high</td>
</tr>
<tr>
<td></td>
<td>Maintain natural stream flows</td>
<td>55</td>
<td></td>
<td>Medium</td>
</tr>
<tr>
<td>Protect and restore native animals and plants</td>
<td>Native birds</td>
<td>100</td>
<td></td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Native invertebrates</td>
<td>46</td>
<td></td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Native fish</td>
<td>49</td>
<td></td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Agricultural/urban development</td>
<td>90</td>
<td></td>
<td>Medium</td>
</tr>
<tr>
<td>Protect and enhance habitats, ecosystems, and watersheds</td>
<td>Protect aquatic connections</td>
<td>77</td>
<td></td>
<td>Medium-high</td>
</tr>
<tr>
<td></td>
<td>Protect landscape connections</td>
<td>33</td>
<td></td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Maintain natural production and nutrient cycles</td>
<td>82</td>
<td></td>
<td>Medium</td>
</tr>
<tr>
<td>Maintain and restore natural disturbance</td>
<td>Restore natural fire regimes</td>
<td>9</td>
<td></td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Encourage natural flooding, while protecting people</td>
<td>50</td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Improve social and economic conditions &amp; benefits from healthy watersheds</td>
<td>Enhance wildlife-friendly agriculture</td>
<td>83</td>
<td></td>
<td>Medium-high</td>
</tr>
<tr>
<td></td>
<td>Improve community economic status</td>
<td>51</td>
<td></td>
<td>High</td>
</tr>
</tbody>
</table>
Show connections between condition and changes needed to be sustainable

<table>
<thead>
<tr>
<th>Sustainability Objective</th>
<th>Example Indicators</th>
<th>Value</th>
<th>Influences</th>
<th>Management Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
<td>Ratio of observed to expected native aquatic species</td>
<td>47</td>
<td>Invasive weeds, water temperature, migration barriers, inadequate flows</td>
<td>Weed abatement, increased summer flows, fish ladders or barrier removal</td>
</tr>
<tr>
<td></td>
<td>Surface-water Water Quality Index</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>63</td>
<td>Discharge to waterways, inadequate summer flows, invasive weeds, water withdrawals/transfers, climate change</td>
<td>Improved discharge treatment, weed abatement, incentives for regional water supply and against inter-basin</td>
</tr>
<tr>
<td></td>
<td>Groundwater Water Quality Index</td>
<td>82</td>
<td>Agricultural chemicals, irrigation and drinking water withdrawals, inadequate septic, impermeable surface development</td>
<td>Best management practices for agriculture, conjunctive water management, wastewater treatment, improve regional development and redevelopment standards</td>
</tr>
</tbody>
</table>
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 m³/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
Water Plan Update 2013
CA Water Sustainability Indicators

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
Water Plan Update 2013
CA Water Sustainability Indicators

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
Water Plan Update 2013
CA Water Sustainability Indicators

Thank You!
Questions?

Fraser Shilling, UC Davis
(fmshilling@ucdavis.edu)
Summary

- Vision
- Definitions
- Framework
- Water Sustainability Objectives
- Water Footprint
- IRWM regions use of the developed Framework
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)
Water Plan Update 2013
CA Water Sustainability Indicators

Where are we going next?
Water Plan Update 2013
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
Water Plan Update 2013
CA Water Sustainability Indicators

Contact Information

Rich Juricich: juricich@water.ca.gov
Abdul Khan: akhan@water.ca.gov
Fraser Shilling: fmshilling@ucdavis.edu
Reporting can be automated or manual across wide range of time intervals (15 minute to annual)
Scientific workflow

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

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