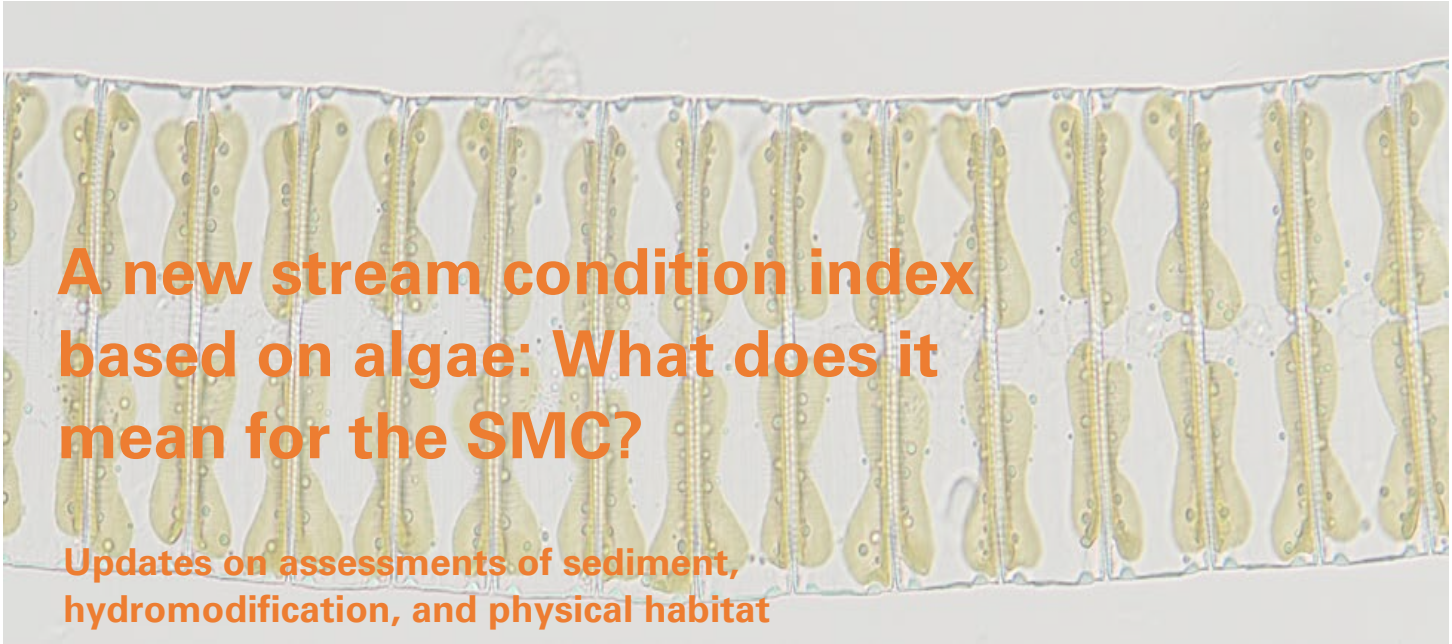
2017 Report on the SMC Regional Stream Survey



A new stream condition index based on algae: What does it mean for the SMC?

Updates on assessments of sediment, hydromodification, and physical habitat

Applications of SMC data to integrated reporting

Identifying constrained streams with landscape models

Southern California Stormwater Monitoring Coalition
Regional Watershed Monitoring Program

Contents

Cover photos: Green algae *Tetrasporidium javanicum* (top), the diatom *Eunotia pectinalis* (middle), and red algae *Sheathia* (bottom). Courtesy of Rosalina Hristova

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What is the Stormwater Monitoring Coalition (SMC)?

The SMC is a coalition of multiple state, federal, and local agencies that works collaboratively to improve the management of stormwater in southern California. SMC members include regulatory agencies, flood control districts, and research agencies: County of Los Angeles Department of Public Works, County of Orange Public Works, County of San Diego Department of Public Works, Riverside County Flood Control and Water Conservation District, San Bernardino County Flood Control District, Ventura County Watershed Protection District, City of Long Beach Public Works Department, City of Los Angeles Department of Public Works, California Regional Water Quality Control Board—Santa Ana Region, Los Angeles Region, and San Diego Region, State Water Resources Control Boards, California Department of Transportation, and the Southern California Coastal Water Research Project (SCCWRP). In addition, the SMC collaborates with the U.S. Environmental Protection Agency Office of Research and Development. For more information, visit the SMC webpage at http://socalsmc.org/.

The SMC has conducted a probabilistic survey of streams in the South Coast region since 2009. The goals of this survey are to provide the technical foundation for scientifically sound management of stormwater by answering three questions that provide context for evaluating site conditions:

1. What is the biological condition of streams in the South Coast region?
2. What stressors are associated with streams in poor condition?
3. Are the conditions of streams changing over time?

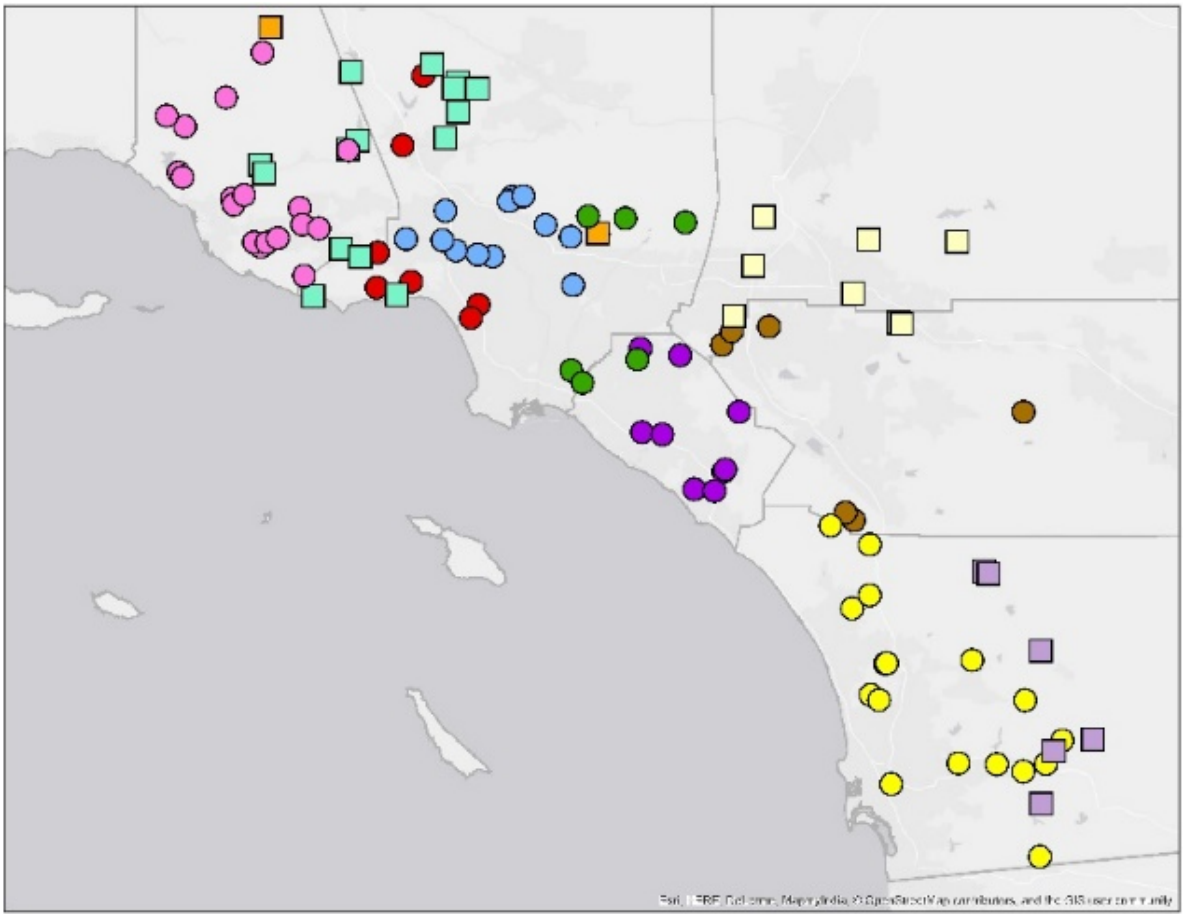
The first five-year cycle of survey took place between 2009 and 2013. The results of the first cycle are summarized in a report available on the SMC website. The survey continues with a new cycle that spans from 2015 to 2019, evolving to address new questions. This report summarizes the status of the survey and describes major developments and accomplishments that occurred in 2016. A comprehensive report will be released after completion of the fifth year of the current cycle.

Highlights from 2016

- A pilot study in Ventura and Orange Counties evaluated sediment chemistry and toxicity at bioassessment sites. A few hotspots of toxicity were found, although no contamination by pyrethroids was detected. This pilot study helped identify key challenges in assessing sediment in a probabilistic study, and will guide changes to the survey in future years. Results of this study are presented on Page 14.
- Similar to 2015, the 2016 survey served as a vehicle to explore a number of indicators and analytes beyond the standard assessment toolkit, such as hydromodification screening (highlighted in an article on Page 15), and DNA-based species detection methods.
- Southern California experienced its fifth consecutive year of drought, receiving 65 to 80% of mean annual rainfall. This drought led to streams drying earlier in the season, complicating sampling efforts.
- Trend sites showed that conditions in 2016 were similar to 2015, and that most changes in CSCI scores were relatively small (<0.1). However, large declines (≥ 0.1) were twice as common (25% of trend sites) as large increase (13% of trend sites). The mean CSCI score at trend sites was only slightly lower in 2016 (0.73) than 2015 (0.74), highlighting the relative stability of the region over this time period.

Sampling in 2016

In 2016, the SMC continued with the second year of the redesigned stream bioassessment survey, sampling 108 sites. About half of these sites were sampled in previous years, and they will be used to estimate trends in the region. The other half were randomly selected condition sites that have never been sampled before, and will be used to estimate overall conditions in the region. Consistent with the SMC's goals to provide comprehensive assessments of watershed health, these "condition" sites include a number of intermittent sites (i.e., streams where flow duration lasts less than a full year; to be determined following analysis of hydrologic data).



Stormwater agencies	Condition (# sites)	Trend (# sites)	Total (# sites)
Ventura County	10	8	18
Los Angeles County	5	2	7
Los Angeles WMP	5	8	13
San Gabriel RMP	1	5	6
Orange County	6	4	10
Riverside County	3	3	6
San Diego WMAs	13	4	17
Water boards			
RB4	8	7	15
RB8	4	4	8
RB9	0	6	6
SWB	0	2	2
Total	55	53	108

Sampling effort in 2016 by agency. WMP: Watershed Monitoring Program. RMP: Regional Monitoring Program. WMA: Watershed Management Area. RB: Regional Water Quality Control Board. SWB: State Water Resources Control Board.

A new stream condition index based on algae: What does it mean for the SMC?

As the state increasingly depends on biological endpoints to assess stream condition, there is growing recognition that these assessments are most effective when they are based on multiple components of stream ecosystems, like different types of aquatic organisms. Diverse organisms respond differently to changes in the environment, and assessment tools that leverage different assemblages can provide more robust assessments in environments subject to multiple stressors.

With that in mind, the State Water Resources Control Board launched the development of the ASCI to complement the invertebrate-based CSCI. This new index will improve the way streams in California are evaluated and managed. Understanding how the indices complement each other will better inform decisions about assessing, restoring, or protecting streams.

Although the ASCI won't be finalized until the summer of 2018, a provisional version is available (specifically, a multimetric index based on diatom and soft-bodied algal assemblages), creating an opportunity to evaluate index performance and what it means for stormwater and regulatory agencies in southern California.

Why are algae useful for assessing stream condition?

As primary producers, algae form a major part of the base of food webs in aquatic ecosystems and can be the first indicators of a stream's declining health. These diverse and ubiquitous organisms respond rapidly to changes in their local environment and are excellent sentinels of biological condition. Algae are particularly sensitive to nutrient concentrations and water quality conditions, making them useful bellwethers for problems associated with eutrophication. Algal indices have great utility in agricultural settings and undeveloped watersheds, thanks to their acute sensitivity to subtle changes in water quality. Additionally, algae-based assessments can reflect biological responses to management efforts in environments where insects have a limited capacity to respond, such as engineered channels.

ARTICLE HIGHLIGHTS

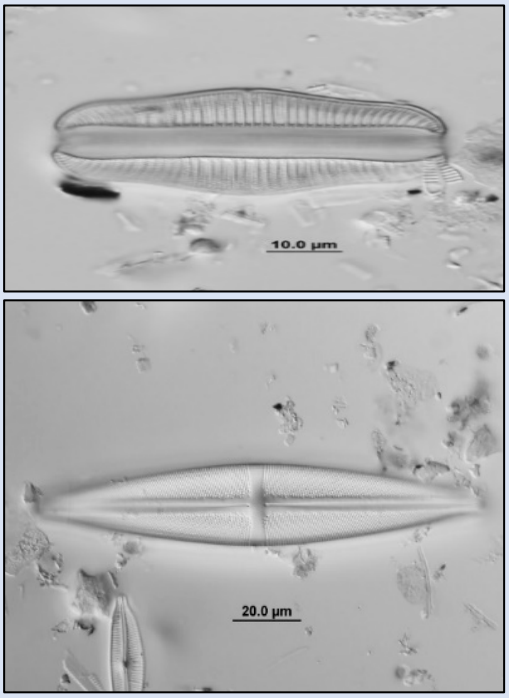
- The State Water Resources Control Board is developing an Algal Stream Condition Index (ASCI) to support state and regional policies. This index is being developed in large part with data collected by the SMC, which should improve index applicability in the South Coast region.
- A provisional version of the index paints a picture of the region that is consistent with assessments from other biological indices, like the California Stream Condition Index (CSCI): good conditions in undeveloped areas, and worse conditions in agricultural or urban streams.
- Algae tend to be highly responsive to nutrients and other water quality parameters, but less so to habitat quality. These life history traits contribute to the responsiveness of the index in streams with degraded habitats, such as engineered channels.
- The ASCI is best used as an additional line of evidence about aquatic life uses, as it is complementary to the CSCI for benthic macroinvertebrates. When used in tandem, these indices create a robust assessment toolkit that provides valuable information for stream monitoring and management decisions.

Freshwater algae of Southern California

Despite their small size, algae are some of the most important organisms in aquatic environments. Streams and rivers in California are home to some of the most diverse algal assemblages (including both soft-bodied algae and diatoms) and more endemic algae species are found here than any other state. Which species are the main players in southern California? How are they used for biological assessment?

Red algae (Rhodophyta) occur primarily in marine systems, but some species serve as indicators of good water quality in freshwater environments. Green algae (Chlorophyta and Charophyta) are common in freshwater and are particularly responsive to nutrients, making them useful indicators of nutrient over-enrichment in stream environments. In the South Coast region, the green alga Cladophora glomerata can form dense, unsightly mats under eutrophic conditions. Cyanobacteria, or “blue-green algae”, are also useful indicators of nutrient concentrations. Some blue-green algae are nuisance toxin-producing species that, under certain circumstances, form blooms that threaten both aquatic life and human health.

Mats of Cladophora glomerata in the Santa Margarita River gorge. Photo by Martha Sutula

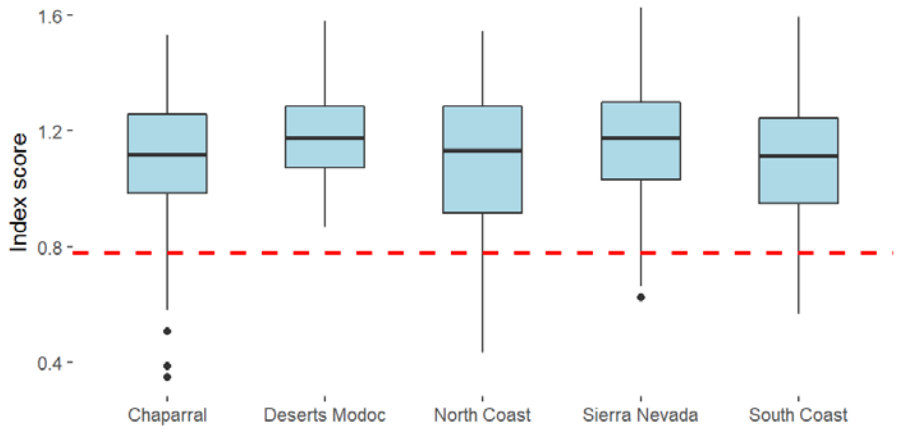


Stauroneis (top) is a motile diatom that can tolerate fine-sediment deposition. Rhopalodia (bottom) contains nitrogen-fixing endosymbionts, allowing it to survive in nutrient-limited streams. Photos courtesy of Diatoms of the Southern California Bight webpage

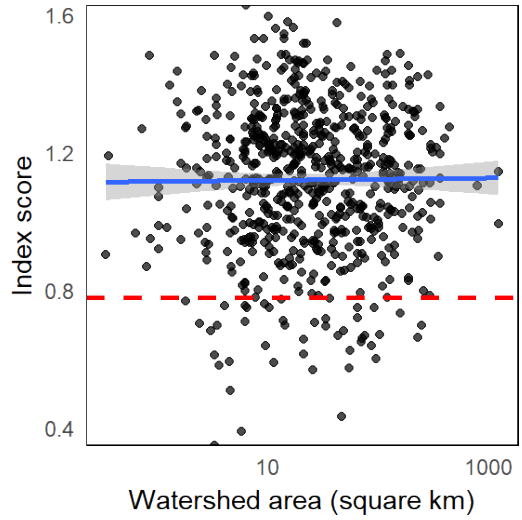
Diatoms, another major algal group that are abundant in California streams, possess unique cell walls composed of silica, giving them a “hard” exterior that sets them apart from other algae. Most species form a slimy film on cobbles and other stable substrates, rather than large filamentous clumps typical of many soft-bodied algae. Some species, such as Stauroneis, are motile, unburying themselves from fine-grained sediment; high abundance of these species may indicate sedimentation stress. Other species can convert elemental nitrogen to a biologically available form, allowing them to thrive in low-nutrient environments; the absence of these species may indicate a problem with nutrient enrichment. Many diatoms are tolerant to desiccation, which is important for survival in non-perennial streams.

How was the ASCI developed, and how well does it work?

The ASCI was developed using data from several statewide and regional sources, including the SMC's survey of streams in the South Coast region. The ASCI development dataset covers major ecoregions and land-use types in California, totaling more than 2000 sampling stations over several years of surveys. A rigorous screening process was used to identify metrics for the final index that were both sensitive to disturbance gradients and unbiased across the regions. This approach allows comparison of ASCI index scores across the state independent of natural geographic and climatic variation.



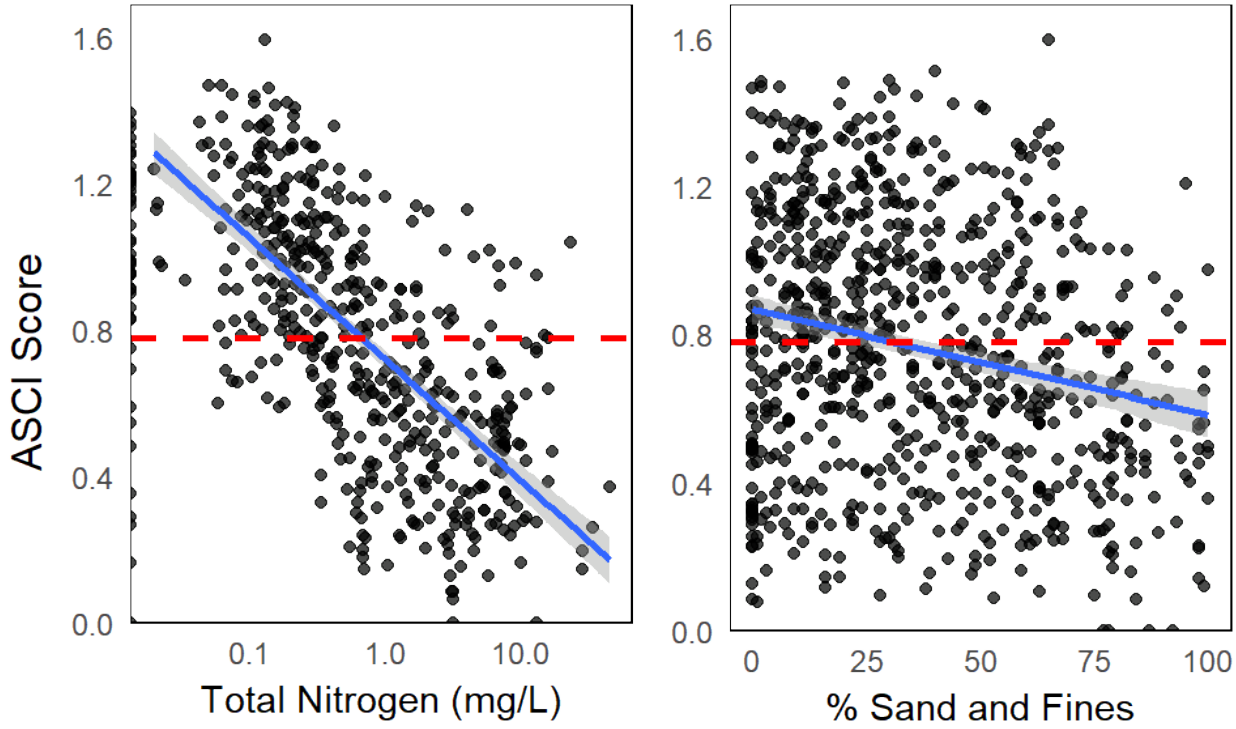
ASCI scores at reference sites are similar across the major ecoregions of California, indicating low bias. The dashed red line indicates the 10th percentile—a potential threshold for identifying reference conditions.



ASCI scores at reference sites are not strongly related to major natural gradients, such as watershed area. This low bias is a desirable characteristic of an index that will be used across the diverse environments of California.

How does water quality affect ASCI scores?

The ASCI was developed to respond to a wide variety of stressors and it is particularly responsive to changes in water quality. For example, index scores decline quickly as total nitrogen increases. Scores that indicate good condition were increasingly rare when nitrogen exceeded 1 mg/L. In contrast, the provisional ASCI is less responsive to certain measure of habitat condition, such as sands and fines in the streambed (a measure of sedimentation stress).



In general, ASCI scores are strongly related to measures of water quality (e.g., total nitrogen), but weakly related to measures of habitat quality (e.g., % sands and fines).

What does the ASCI tell us about the South Coast region?

In the South Coast region, the provisional ASCI paints a picture of water quality that complements other indices. The index demonstrates that algal communities in developed areas are more degraded than those in natural environments. Most high-scoring sites that are likely intact (i.e., those above the 30th percentile of scores at reference sites) are in high-elevation areas in the upper watershed or away from urban or agricultural areas. These high-scoring streams are most extensive in the Upper Santa Ana, San Jacinto, and Southern San Diego watersheds. Streams that are likely altered (i.e., scores below the 10th percentile of scores at reference sites) were more common in the Calleguas Creek, Lower Santa Ana, and Central San Diego watersheds. These patterns are similar to those seen with the CSCI in previous SMC reports.

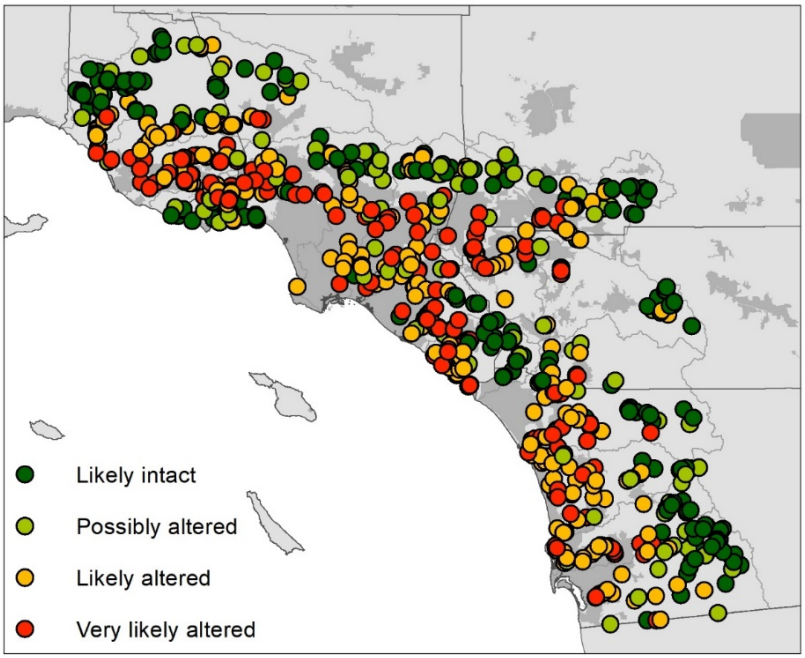
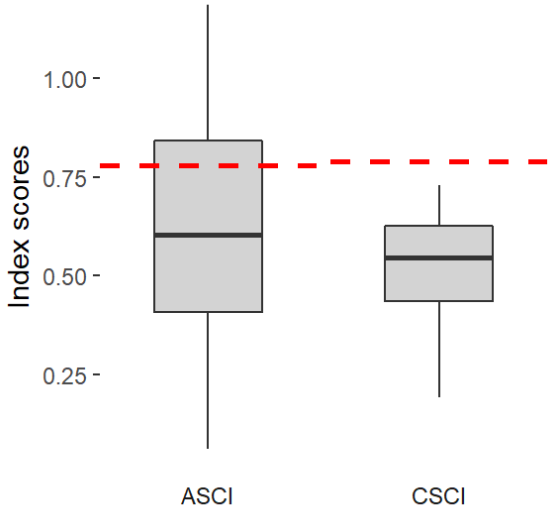


Fig 4. ASCI scores are highest in the mountains regions of the South Coast, while lower scores predominate in urban or agricultural areas.

Engineered channels are a common feature in urban areas of the South Coast region, and the ASCI shows that most of them are in poor condition. But while hardened channels never attained high scores for the CSCI, about a quarter of them did so for the ASCI. The fact that high ASCI scores were observed in hardened channels suggests that this index may respond to stressors (like poor water quality), even at sites where poor habitat constrains CSCI scores. Therefore, the ASCI may be an effective way to measure the impact of water quality improvements in engineered channels.

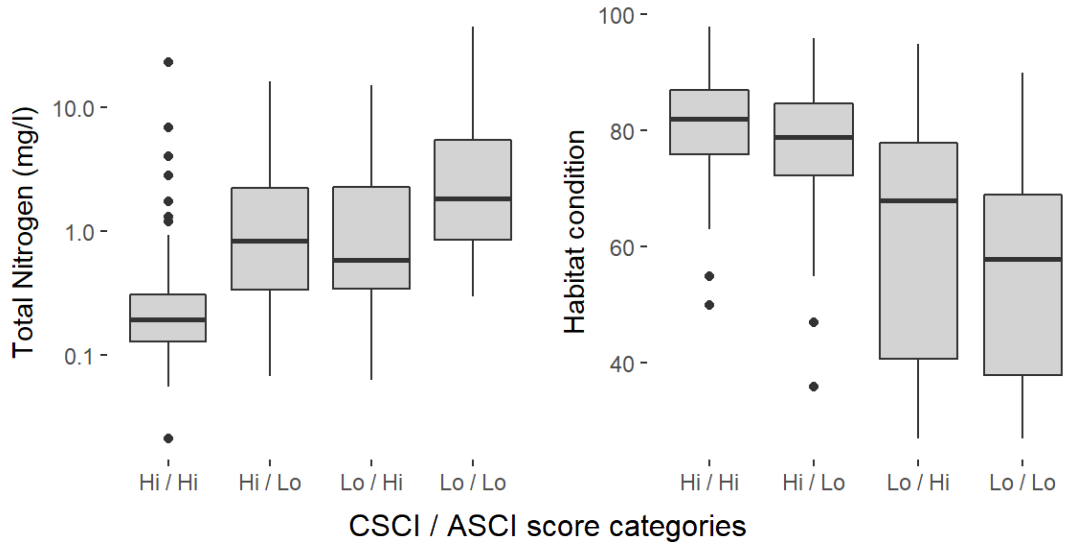


ASCI (algae) and CSCI (macroinvertebrate) indices in hardened channels. Unlike the CSCI, ASCI scores in hardened channels were frequently above the 10th percentile of reference sites (red dashed lines), meaning that engineered channels may support reference-like algal assemblages.

How does the ASCI complement other indices?

The ASCI and the CSCI both provide a measure of biological condition by looking at different members of stream biological communities. Thus, each index provides unique insights that, when taken together, provide a more complete picture of stream health than either index alone. Because algae and benthic macroinvertebrates respond to different stressors, the ASCI and CSCI can be used together to help identify causes of poor conditions.

The SMC dataset shows how the ASCI and CSCI complement each other. Where scores were high for both indices (28% of sites), stressors are typically absent. And where both scores are low (48% of sites), habitat and water quality tend to be poor. When the two indices disagree (33% of sites), water quality conditions tend to be intermediate. The ASCI was less sensitive than the CSCI to poor habitat conditions. Thus, assessments based on both indices can help managers evaluate the relative influences of habitat and water quality stressors.



Relationship of CSCI (macroinvertebrates) and ASCI (algae) to nitrogen and habitat condition. Index scores are grouped into high/low CSCI/ASCI combinations to demonstrate relationships with each driver. Habitat condition was measured with the California Rapid Assessment Method (CRAM), with higher scores indicating better conditions. Taken together, the CSCI and ASCI provide a more complete picture of the impacts of habitat and water quality on stream health.

Implementation and future developments

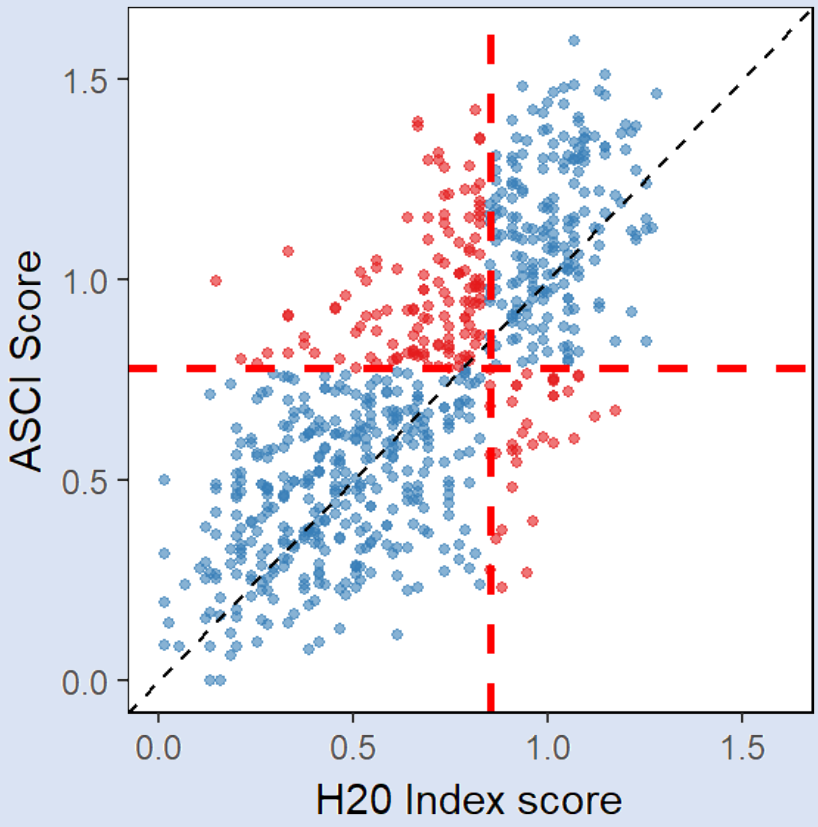
The addition of a second biological index to the bioassessment toolkit creates an opportunity to change the way streams are evaluated and managed in California by providing a more complete understanding of stream health. The ASCI and CSCI provide an opportunity to implement biological objectives and biostimulatory policies by linking nutrient enrichment to aquatic life impacts. Because the SMC has included algal bioassessments since the inception of its stream survey and has accumulated a robust dataset, the impacts of these policies can be evaluated and anticipated by member agencies. The addition of the ASCI to bioassessment programs will help both the regulators and regulated communities obtain a more comprehensive assessment of biological condition.

Initial implementation of the ASCI will occur over 2018. The provisional index presented in this article will be revised to reflect feedback from technical and stakeholder advisory groups, as well as the SMC bioassessment workgroup. SCCWRP is developing computational tools to aid in the calculation of ASCI scores, similar to the tools currently used to calculate the CSCI. Interactive applications are also being developed that will improve how users engage with and interpret ASCI results. Because the need for algal taxonomic data may soon outstrip the capacity of local labs to conduct analyses, the ASCI will be updated in three to five years to be compatible with DNA-based algae data. These developments will help ensure that the ASCI will provide a robust and complementary bioassessment tool for years to come.

Comparing the Statewide ASCI with regional indices

Since 2009, the SMC has used algal indices of biotic integrity (IBIs) developed specifically for Southern California to interpret data collected for its stream surveys. Because the ASCI is developed from a larger reference data set and is suitable for statewide application, it will likely replace the Southern California algal IBI for most regulatory and management applications. What will a transition to this new index mean for Southern California? How will it affect assessments of stream condition?

The new ASCI index provides similar assessments as the hybrid diatom and soft-bodied algae version of the Southern California IBI (H20), meaning that transitioning to a new index will change very few outcomes. Scores for the two indices are highly correlated (r2 = 0.54). Most sites (77%) had the same outcome for both indices, with respect to thresholds based on the 10th percentile of reference sites. Disagreements were most common among sites in intermediate conditions when scores were close to the index thresholds. When disagreements occurred, the ASCI found good conditions more frequently than H20 did (78% vs 22%).

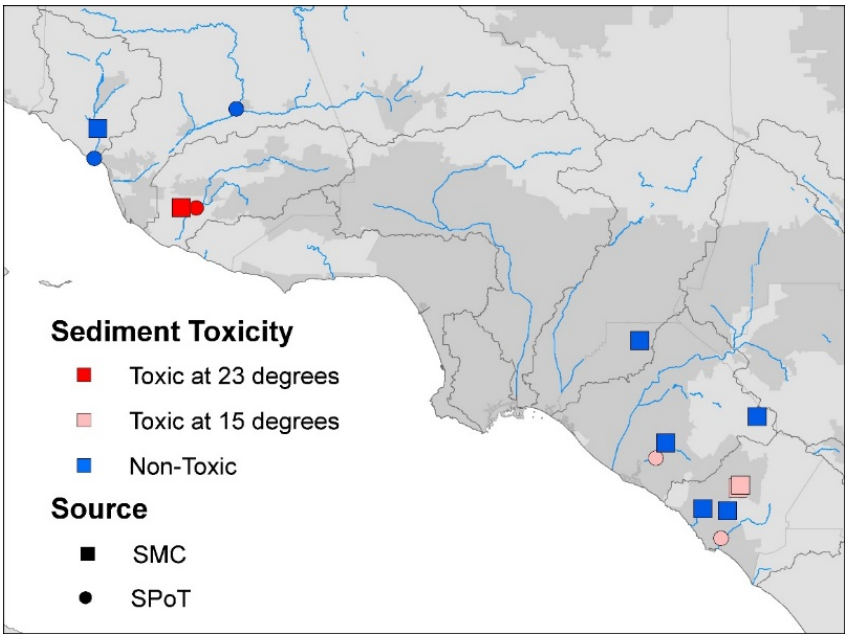


The ASCI provides similar results as H20, the hybrid diatom and soft-bodied algae index developed for Southern California. Points in blue represent sites in agreement relative to the thresholds for each index.

New indicators

Sediment toxicity: A problem in certain areas, but causes aren't clear

In 2016, the SMC began a pilot study to explore the extent of sediment contamination in streams in the South Coast region (specifically, Orange and Ventura Counties) and the relationship of sediment contamination to stream condition (based on bioassessment data). These results represent one of the first applications of sediment sampling in a probabilistic stream survey.



Sediment toxicity in Orange and Ventura counties, as measured by the SMC's stream survey and SWAMP's Stream Pollution Trends Monitoring Program (SPoT).

Sediments accumulate hydrophobic and particle-bound contaminants, and integrate historical pollutant discharges even when those contaminants are no longer being released into the environment. As such, they can be a continued source of contaminants to wildlife, beginning with exposure to sediment-associated invertebrates and progressing to higher levels of the food web by the fish and amphibians that feed on them.

ARTICLE HIGHLIGHTS

- Sediment quality remains a major gap in our knowledge of environmental factors that may affect stream condition.
- Assessing sediment quality in wadeable streams is hindered by the scarcity of fine-grained sediment at most sites, and by the fact that contaminants may be harmful at concentrations too low to detect by commonly used methods.
- Of the 28 sites evaluated, only 9 were amenable to sampling fine-grained sediment. Of these, 3 sites showed evidence of sediment toxicity but no site had detectable levels of microcystin, and pyrethroids were not detected at either of the 2 sites tested.
- Based on this study, the SMC will continue to sample sediment, prioritizing analyses based on the amount of sample that can be collected. Future intercalibration activities will aim to improve reporting limits for pyrethroids and other contaminants.

This study revealed two key challenges with sampling and assessing sediment in wadeable streams. First, fine-grained sediments are scarce or absent from many sites, meaning that sufficient material for analysis could only be collected at a handful of locations. Second, pyrethroids and other contaminants of interest are active at levels below the detection limits achieved by the labs in the pilot study. The first challenge may be reduced through prioritizing lab analyses based on the amount of material collected at each site. The second challenge could be addressed through method changes, trainings, and laboratory intercalibration activities, which the SMC may sponsor in the near future.

Methods of the pilot study followed SWAMP's Stream Pollution Trends (SPoT) monitoring program, allowing integration of their data with the SMC's results. Chemistry analysis focused on constituents often found in urban and agricultural runoff (synthetic pyrethroids and fipronil), as well as toxins produced by freshwater cyanobacteria (microcystin), and total organic carbon. Toxicity testing included the 10-day survival test with the freshwater crustacean *Hyalella*, and the 10-day survival and growth test with the midge *Chironomus*. *Hyalella* was tested under standard conditions 23°C, as well as cooler temperatures (15°C), which increases the sensitivity of the test organism to pyrethroid contamination.

Fine-grained sediments required for analysis are absent or limited in many streams in the region, which complicates integration of this indicator into a probabilistic survey. Of the 28 SMC bioassessment sites sampled within the pilot study boundaries, sediment was only able to be collected at 9 sites. Toxicity and microcystins were assessed at all 9 sites, and chemistry was measured at 2 of the 9 sites.

Although analyses were limited to 9 sites, this number was sufficient to detect toxicity at 3 locations. One site—an agricultural drainage ditch in the Calleguas Creek watershed —was identified as having toxicity to both *Hyalella* and *Chironomus,* but none of the pesticides or microcystins were detected. (A nearby site sampled by SPoT similarly showed toxicity.) The pesticides and microcystins were not detected in the other pilot study sediment sample analyzed for chemistry; however, the lab in the pilot study did not achieve reporting limits for pyrethroids that were comparable to SPoT, and low levels of contamination by these analytes cannot be ruled out. Two sites in Orange County (Tijeras Creek) showed low levels of toxicity, evident only at the colder temperatures. Microcystins were not detected in these samples and the Orange County samples were not analyzed for the pesticides. There were some initial challenges acclimatizing test organisms to the colder temperatures, so it is not clear if the toxicity can be attributed to undetected contaminants or to the test conditions; however, labs have improved acclimatization procedures, so future testing should provide more clarity.

The challenges of sampling and assessing sediment in wadeable streams are tractable through flexible study design and improved quality assurance. The SMC will start assessing sediment toxicity and chemistry throughout the South Coast region, focusing on a limited set of indicators (specifically, pyrethroids, grain size, and toxicity to *Hyalella* at two temperatures; *Chironomus* and microcystin will be dropped). The SMC will conduct a laboratory intercalibration exercise to explore lowering detection limits and ensure consistency among different labs.

Measuring stream alteration from hydromodification

Land use alteration and changes in flow management practices can dramatically affect stream hydrology, resulting in physical changes to the stream channel. These changes, referred to as "hydromodification", pose threats to property, as well as the instream and riparian environment. Typically, more impervious surfaces (e.g., roads, parking lots, roofs) in the watershed lead to increased peak flow volumes and "flashier" hydrographs (i.e., rapid rise in flow after rain, followed by steep decline to depressed baseflows). Hydromodification may also result from changes in flow management practices in response to climate variation or water usage needs.

Hydromodification affects stream morphology by incising the stream bed or eroding the stream banks. These changes can affect the ecological characteristics of the stream, causing divergence from the natural condition to a more perturbed state. Although many streams in urban portions of southern California are engineered to resist changes in flow hydrology, natural streams are sensitive environments that are highly susceptible to flow alteration. Sandy sediments are common in natural streams, and the lability of sand increases susceptibility to channel incision. Similarly, stream bank erosion is related to the material, angle, and height of the stream banks, where taller, steeper, and sandier banks are more susceptible to erosion. Together, channel incision and bank erosion describe the vertical and lateral susceptibility of a stream to hydromodification.

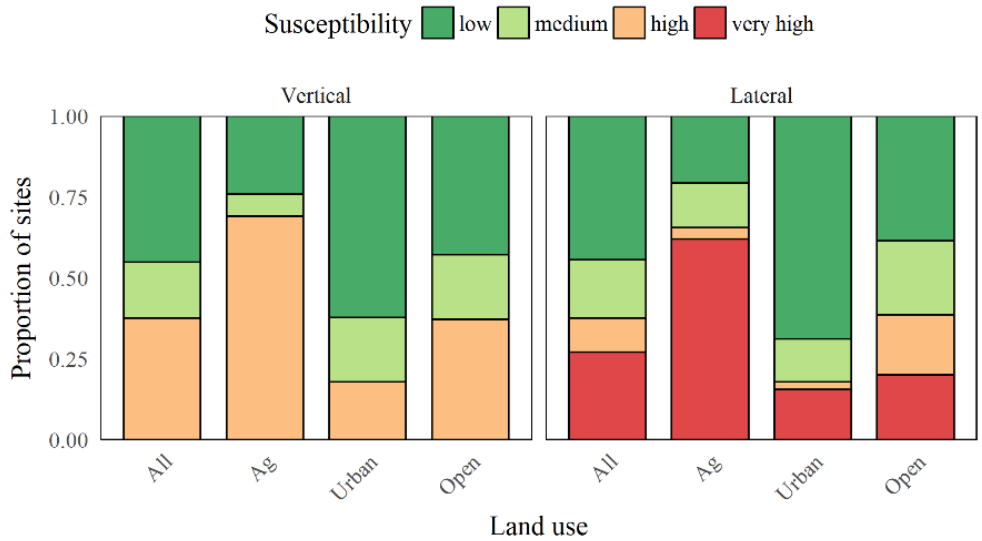
Understanding stream susceptibility in response to changes in flow can help prioritize the identification of streams that are likely affected by hydromodification. Starting in 2015, the SMC included hydromodification assessment as part of its annual stream survey, and 144 sites have now been assessed. This project is the first regional evaluation of stream susceptibility to hydromodification.

Key findings

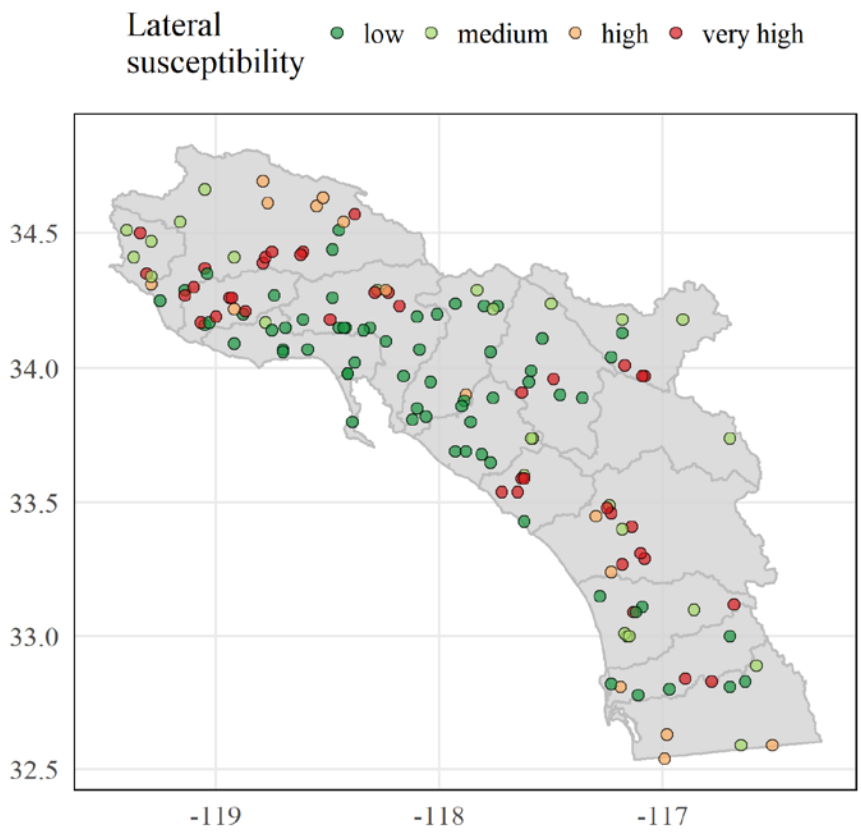
- Changes to a stream's hydrology (caused by diversions, dam operations, or nuisance flows from runoff or effluent) can result in rapid changes to channel shape, which may threaten nearby property if stabilization measures aren't taken. This process is known as hydromodification.
- The survey found that about one-third of streams in Southern California have high susceptibility to vertical or lateral hydromodification. However, most sites had low or medium susceptibility to vertical or lateral incision. About a quarter of the sites (26%) were fully armored with bedrock, concrete, or well consolidated material that resists vertical and lateral degradation.
- Agricultural streams were more susceptible to hydromodification than urban streams. Agricultural sites had high vertical susceptibility and high/very high lateral susceptibility (70% and 77% of agriculture sites, respectively), whereas urban streams had the highest proportion of low vertical and lateral susceptibility streams (66% and 71% of urban sites, respectively).

RECOMMENDATIONS

The data generated in these first two years will provide a baseline for measuring changes in regional stream stability over time. Repeated field surveys at existing sites will help evaluate rates of change in stream morphology, whereas additional surveys at new sites will help better characterize the spatial extent of potential impacts. More comprehensive surveys of streams in agricultural areas are critical to better characterize hydromodification in these highly susceptible environments. Combined, these assessments will guide stream management or restoration activities by prioritizing locations at high risk of hydromodification.



Bank erosion (i.e., lateral susceptibility) and streambed incision (i.e., vertical susceptibility) were a common concern in agricultural and open-space streams. In contrast, most urban streams were stable, thanks to armoring and other flood control measures.



Streams that are highly susceptible to hydromodification were most common in agricultural areas in Ventura, Riverside and San Diego counties, as well as portions of Orange and Los Angeles counties.

Assessing physical habitat integrity with a new index

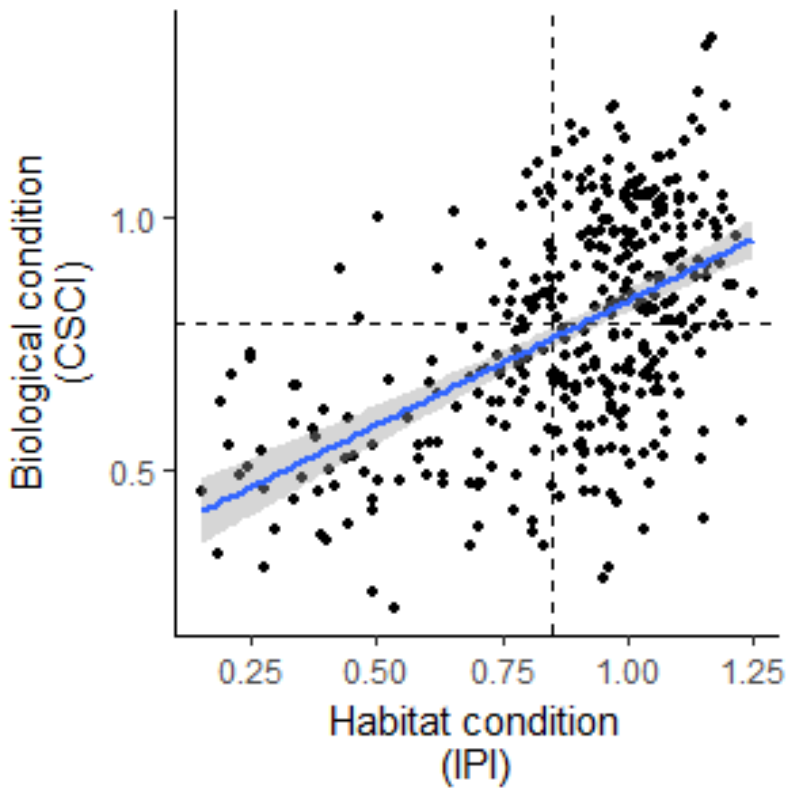
Physical habitat is a key driver of biological condition, as previous studies by the SMC have shown. However, characterizing the condition of physical habitat has long been a challenge, in part because of the complexity of the data. Consequently, physical habitat data has been underutilized, despite large efforts spent to collect the data during bioassessment. Fortunately, the IPI will soon enable managers to interpret physical habitat data as a potential cause of poor biological condition. This index may be used in several watershed management applications, such as causal assessments and evaluating restoration projects.

Following the predictive approach used in the CSCI for benthic macroinvertebrates, the IPI is based on statistical models that account for the natural variability in stream types found throughout the state. That is, sites are compared to unique benchmarks that are appropriate for local environmental conditions. For example, high levels of sands and fines may indicate poor conditions in mountainous regions, but are considered natural in low-elevation streams. Because the statistical models were developed in large part with data collected by the SMC, they are designed to work in the South Coast region. Additionally, the SMC technical workgroup has provided extensive review of a preliminary version of the index, leading to design changes that will improve its usefulness in urban areas with highly modified channels.

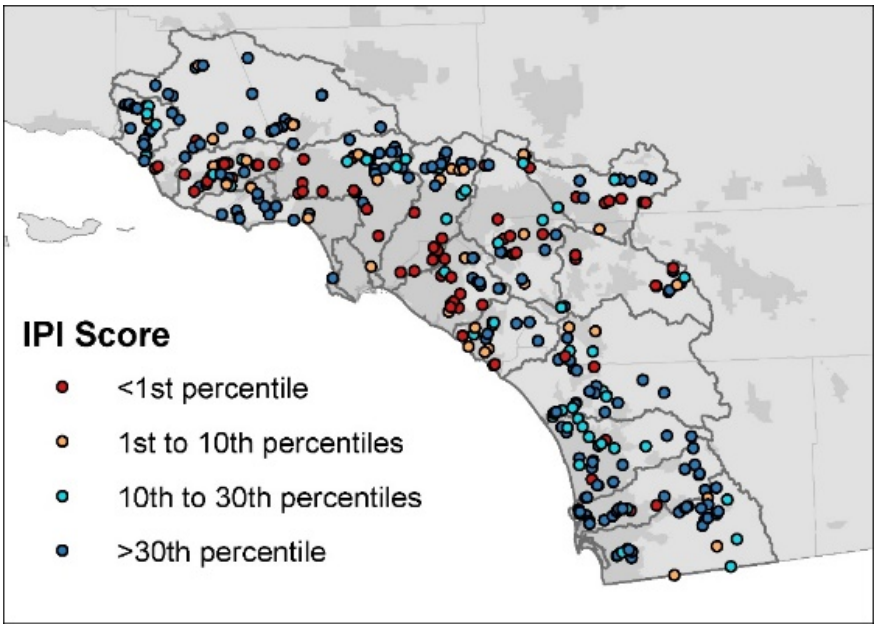
As with the CSCI, scores close to or greater than 1 indicate reference-like conditions, while lower scores indicate that the habitat may be degraded; scores below 0.85 (i.e., the 10th percentile of scores at reference sites) indicate that a site is unlikely to be in reference condition.

ARTICLE HIGHLIGHTS

- The State Water Resources Control Board has developed a new index to assess habitat quality (tentatively called the Index of Physical-habitat Integrity, or IPI), a key determinant of biological integrity. This index takes advantage of the wealth of data collected during routine bioassessment in a way that can directly inform causal assessments and evaluate management actions, like restoration.
- The SMC played a key role in providing data for IPI development, as well as reviewing and validating it for our region.
- Within the South Coast region, urban streams tend to have lower IPI scores (indicating worse habitat quality) than other streams, but certain areas contradict this pattern.
- The IPI will likely play an important role in managing streams in the South Coast region, where poor scores for bioassessment indices are often associated with habitat degradation.



The IPI has a strong relationship with the CSCI and other measures of biological condition. This will make the index particularly useful in causal assessments and in other efforts to improve biological integrity. Dashed lines indicate thresholds based on the 10th percentile of reference sites.



High-scoring sites were most common in the undeveloped interior of the South Coast region, but also in urban portions of San Diego county.

Based on SMC survey data, about two-thirds of streams in the South Coast region have reference-like habitat quality. Conditions in urban and agricultural streams tend to be poor, while streams with undeveloped catchments tend to have good habitat. However, there are notable exceptions to this trend: IPI scores at urban streams along the coast of San Diego and southern Orange Counties were often high, in contrast to urban streams in other areas. This pattern is consistent with local patterns of development. For example, urban development in coastal San Diego County often occurs atop mesas, leaving intact stream corridors within confined canyons.

A final report summarizing IPI design and applications is expected in the summer of 2018, and a tool to calculate IPI scores with R is currently under development.

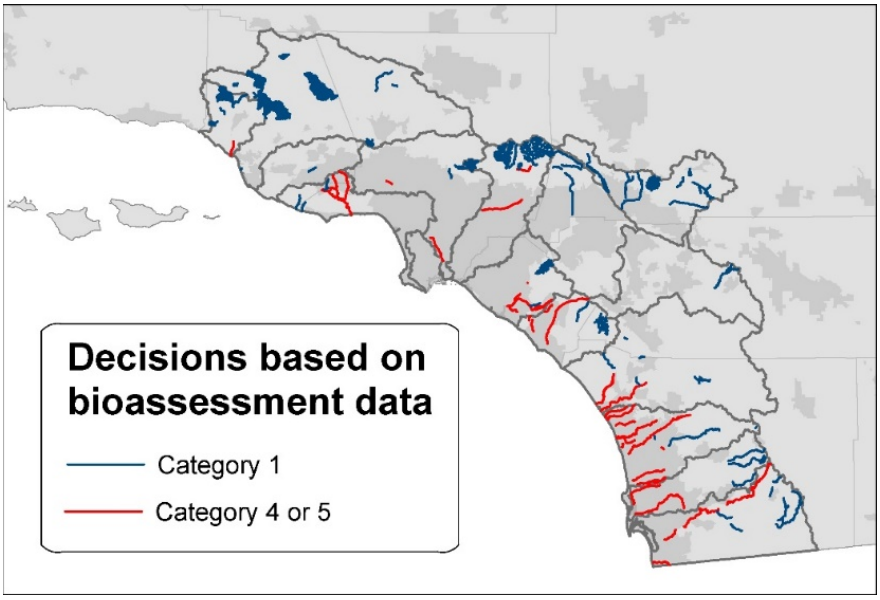
The IPI is based on five metrics that characterize different aspects of stream habitat condition:

Metric	Description
Ev_FlowHab	Evenness of flow habitats, such as riffles, pools, and glides. In degraded streams, one type (typically glides) tend to dominate.
H_AqHab	Diversity of aquatic habitats, such as woody debris, undercut banks, or filamentous algae. These habitats provide cover for fish and other aquatic life.
H_SubNat	Diversity of natural substrate types, such as cobbles, fine gravels, and boulders. Sedimentation and erosion tend to reduce substrate diversity, and consequently biological diversity.
PCT_SAFN+RC	Percent fines, sands, and concrete (substrate types that eliminate habitat for benthic macroinvertebrates and fish).
XCMG	Extent of riparian vegetation in the upper canopy, mid-canopy, and ground layer.

Applications of SMC data

Bioassessment data in the Integrated Report (305b/303d list)

2017 saw the first statewide application of bioassessment data to the State Board's Integrated Report on California's waters. Although previous reports included a few listings of streams impaired for benthic community effects, the 2014-2016 report identified 61 impaired streams (44 in the South Coast) based on low scores of bioassessment indices (i.e., scores below 0.79 for the California Stream Condition Index, or CSCI). These "category 4 and 5" listings were all associated with pollutants that exceeded water quality standards and now require actions for improvement to meet water quality standards.



Map of streams included in the 2014/20016 Integrated Report. In category 1 streams, all available data show that all assessed beneficial uses are supported, while data from streams in category 4 or 5 show that aquatic life uses are impaired.

ARTICLE HIGHLIGHTS

- Last year represented the first statewide application of bioassessment data to assess the aquatic life beneficial uses of steams in California's Integrated Report (i.e., Clean Water Act [CWA] 303(d) List/305(b) Report) to Congress.
- Beyond listing impaired waterbodies (61 sites statewide), the Integrated Report includes Category 1 listings (450 streams where all evidence show that all assessed beneficial uses are supported) for the first time, primarily based on CSCI scores.
- Data collected under the SMC survey helped make decisions about how to list these streams, and will be crucial for causal assessment and future listing/delisting decisions.

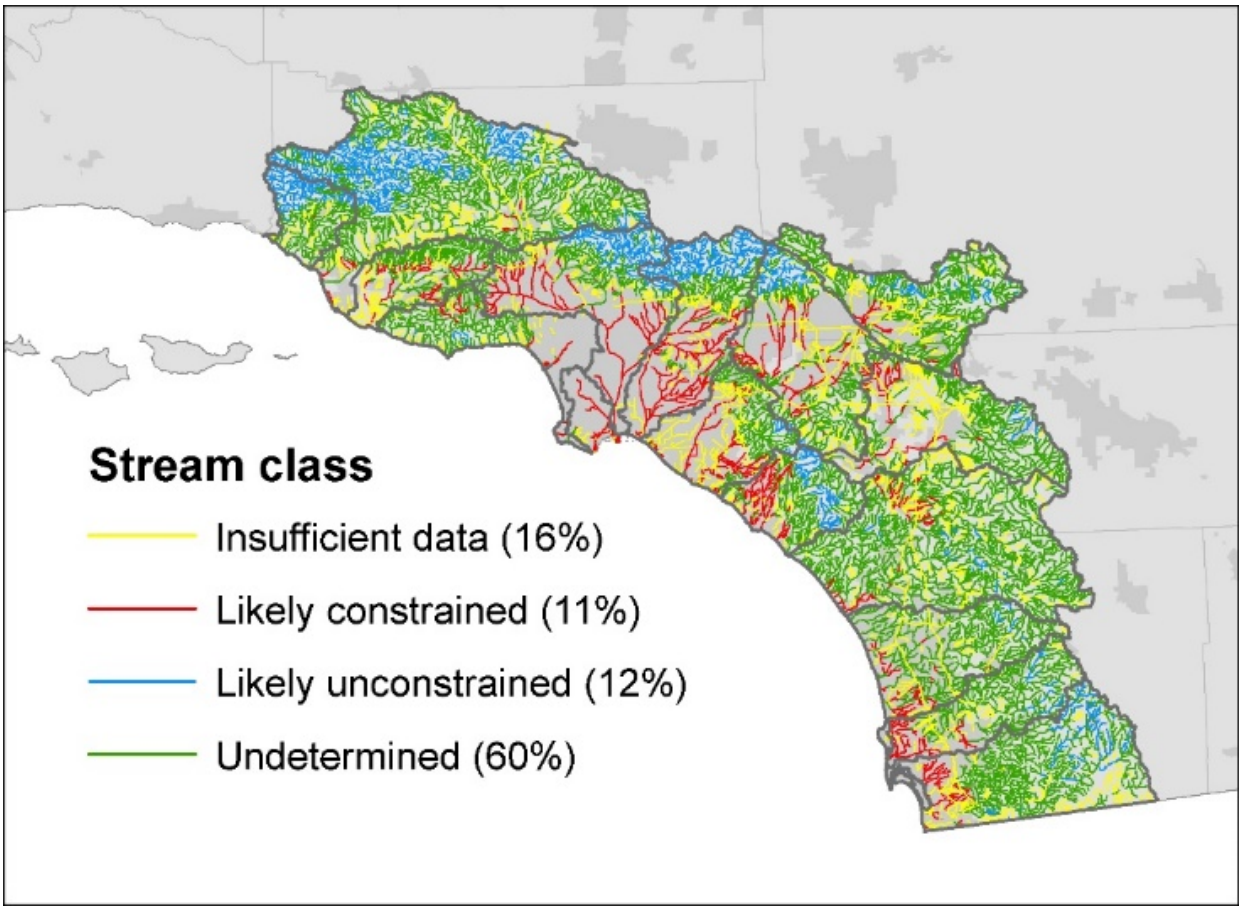
The recent report represents the first time that streams were listed in "category 1"— streams where all assessed beneficial uses are supported. Bioassessment data was the main driver for these designations: sites with CSCI scores above 0.92, along with evidence of minimal watershed disturbance, supported designation of category 1 streams. Over 450 streams statewide, including 76 in the South Coast region were designated as category 1 streams. In Southern California, category 1 streams are mostly located in the interior portions of the region, such as the San Gabriel mountains, portions of San Mateo Creek, and the headwaters of the Santa Ana River.

Data collected by the SMC stream survey was used to make these designations. Crucially, the survey will continue to provide data that will guide future decisions, such as causal assessment and identifying appropriate management options for impaired streams.

Landscape models for managing biointegrity

Developed landscapes are associated with an increase in many stressors that can degrade stream condition, such as elevated contaminant or nutrient concentrations, altered flow regimes, sedimentation, or habitat degradation. Consequently, biological conditions in urban streams may be limited or constrained. Identifying which streams are constrained, and what ranges of biological conditions are likely to occur in these systems presents a challenge for both science and policy. To assist these efforts, the SWRCB has developed a statistical model to predict likely ranges of scores of the CSCI based on landscape characteristics. This model—developed in part with bioassessment data from the SMC stream survey—can be used to identify constrained streams, where scores above key thresholds are unlikely to be attained. Likely constrained streams are identified based on relationships between landscape development and CSCI scores.

This model takes advantage of the StreamCat database—a database of landscape metrics calculated for nearly every stream reach in the United States. The models produce a range of likely CSCI scores, given measures of landscape alteration (such as % agricultural land use, or road density). These predictions can be made for any stream represented in StreamCat, even where no sampling has occurred. This means that locations of likely constrained and unconstrained streams can be mapped for the entire South Coast region.



Streams in urban areas, such as the Los Angeles basin or coastal San Diego County, are likely to be constrained, while streams in the undeveloped interior portions of the region are likely unconstrained.

Based on this map, about 11% of stream-miles in the South Coast region are likely constrained, meaning that they are unlikely (<10% chance) to score above 0.79 (a threshold for the CSCI used to identify poor conditions). These constrained streams are mostly located in urban and agricultural areas, such as the Los Angeles Basin, the Inland Empire, and coastal San Diego County. Another 12% are likely unconstrained, meaning that they are unlikely to score below 0.79. These streams are located in undeveloped areas, such as the San Gabriel mountains and the interior of Ventura County. For the remaining streams, data were either missing from StreamCat, or the range of likely scores straddles 0.79, meaning that the sites could not be designated as likely constrained or unconstrained.

The model can provide context that supports a number of management decisions. For example, low-scoring unconstrained streams may be a higher priority for restoration than low-scoring constrained streams. Streams that score substantially better or worse than the model predicts may be prioritized for follow-up monitoring to determine the factors that lead to these conditions. Potential applications will be explored in two case studies (in the San Gabriel and Santa Margarita watersheds) in 2018.

Key findings

- Models can predict expected biointegrity measures (like CSCI scores) from land-use characteristics (like road density or % urban landcover). These models can show where landscape development may constrain biological integrity.
- In the South Coast region, models predict that ~11% of our stream-miles are likely constrained, while another 12% are likely unconstrained.
- These models can support several management decisions and prioritization, like monitoring, protection, and causal assessment.