SAN DIEGO REGIONAL WATER QUALITY CONTROL BOARD

Response to Peer Review Comments

Biological Water Quality Objectives for the San Diego Region

September 2020

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

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1) Introduction

The California Water Quality Control Board, San Diego Region (San Diego Water Board) is proposing an amendment to the Water Quality Control Plan for the San Diego Basin (Basin Plan) to include Biological Water Quality Objectives for perennial and seasonal streams in the San Diego Region (proposed project). The proposed project establishes a numeric objective for perennial and seasonal streams based on the California Stream Condition Index (CSCI, Mazor et al. 2016) to ensure reasonable protection of a stream's aquatic life beneficial uses. This document presents the comments received from external peer reviewers on the proposed project and the San Diego Water Board responses.

The proposed Basin Plan amendment requires external scientific peer review pursuant to California Health and Safety Code Section 57004. This statute states that the reviewer's responsibility is to determine whether the scientific portion of the proposed rule is based upon sound scientific knowledge, methods, and practices. The San Diego Water Board provided the peer reviewers with the draft Basin Plan amendments, a Draft Staff Report including Appendices and the Substitute Environmental Document, as well as all references cited. The peer reviewers were provided with a list of conclusions (see Section 1.1 and 1.2 below) to address regarding the proposed project.

1.1 Conclusions

The San Diego Water Board identified three primary conclusions for the focus of the peer review. They are:

1. The underlying method for deriving the numeric biological objective for streams is scientifically sound and protective of Beneficial Uses.

The Basin Plan amendment proposes to incorporate a numeric water quality objective for streams using a reference-based predictive benthic macroinvertebrate scoring index (Mazor et al. 2016). The proposed Basin Plan amendment uses this index to set the water quality objective using a percentile of reference approach (Ode et al. 2016):

a. Use of benthic macroinvertebrates and the California Stream Condition Index – The underlying method for using benthic macroinvertebrates and the California Stream Condition Index is scientifically sound and will protect and restore the biological integrity associated with perennial and seasonal stream systems.

b. Use of a reference approach – The assumptions and methods used to identify and define "reference" as a biological integrity benchmark are scientifically sound and will protect and restore the biological integrity associated with perennial and seasonal stream systems.

c. Setting of index score threshold – The assumptions and methods to set the water quality objective as a percentile of reference using the California Stream Condition Index is scientifically sound, incorporates a margin of safety, and will identify sites that have a degraded biological condition. The allowance of site-specific scientific information on the physical, chemical, and biological condition of specific sites to prevent false positive identifications of impairment is scientifically sound.

2. The underlying methods and assumptions for implementation of the numeric biological objective for perennial and seasonal streams is scientifically sound and protective of Beneficial Uses.

The Basin Plan amendment proposes to incorporate a new implementation section within Chapter 4 of the San Diego Water Board Basin Plan. The implementation section, which is specific to biological objectives, identifies a framework for implementation of numeric biological objectives within various San Diego Water Board programs under the Clean Water Act and Porter-Cologne Water Quality Control Act.

3. The underlying method for deriving narrative guidance to use for the development of future numeric waterbody-specific or waterbody-type biological objectives is scientifically sound and protective of aquatic wildlife Beneficial Uses.

The Basin Plan amendment proposes narrative guidance for the development of future biological objectives for other surface waters within the San Diego Region (e.g. vernal pools, seagrass beds) or for using differing, additional, and/or higher trophic level organisms. The narrative guidance incorporates assumptions and conclusions regarding what constitutes attainment of biological integrity for the protection of aquatic ecosystem Beneficial Uses. The narrative guidance forms the basis for inclusion of proposed and future numeric biological objective translators.

1.2 Additional Peer Review

Reviewers were not limited to addressing only the specific issues presented above and were asked to contemplate the following “big picture” questions:

1. Taken as a whole, is the scientific portion of the proposed amendment based on sound scientific knowledge, methods, and practices?

2. Additional Comments or Suggestions

Reviewers were asked to note that some proposed actions may rely significantly on professional judgment where available scientific data are not as extensive as desired to support the statute requirement for absolute scientific rigor. In these situations, the proposed course of action is favored over no action.

2) Peer Review Comments and Responses

Four external peer reviewers provided the San Diego Water Board with comments on the proposed project. The comments and responses are organized by peer reviewer. The conclusion commented on is shown first, then the reviewer's comments are provided. The San Diego Water Board responses are labeled and follow the reviewer's comment.

2.1 Peer Reviewer – Dr. Yong Cao

Comment:
Conclusion 3
I have carefully read the staff report and all other review documents, particularly Section 3 regarding narrative biological objective guidance. Scientific community and water-quality resource managers have recognized the inadequacy of chemistry-based water quality objectives and physical assessments in protecting and restoring key beneficial uses of aquatic ecosystems for decades. In the past decades, great progress has been made to develop and test indicators of biological integrity based on scientifically sound methods, but surprisingly water-quality biological objectives have been put into regulation by only a few states. I am pleased to see that CA-EPA is leading this over-due change.

The narrative biological objective guidance proposed in this report is concise and informative, and the method used to derive it for the development of future numerical waterbody-specific or waterbody-type biological objective is scientifically sound and sufficient to protect the beneficial uses of streams and other aquatic ecosystems. The biological objective as defined in this report is consistent with the definition of "biological integrity" proposed by Dr. Karr in the 1990s, a concept that has been widely accepted by the scientific community for fulfilling the requirements of the Clean Water Act. The guidance uses the reference approach or unaltered analogous waters to define expected biological conditions, consistent with Karr's definition of biological integrity. Considering that many streams in California are still little disturbed by human activities, it is appropriate to define reference conditions based on minimally-disturbed streams, rather than based on other approaches, such as historical records or reconstruction of natural communities. I am also glad to see this report take the most advanced method to establish site-specific reference conditions, i.e., modelling and predicting the value of a biological metric expected under natural or unaltered conditions at a given site. This method is often far more effective to remove the effects of multiple natural environmental gradients (e.g., climate, altitude, and geology) on biotic metrics than traditional stream classification based on ecoregion, stream size, or other stratum.

The report proceeded to discuss the importance of ecological balance, resiliency, and native species composition for the beneficial use of ecosystems. Unaltered waters or reference sites appeared to be assumed to hold these properties in this report. This assumption holds well in general because biological communities typically have reached relative balance with their natural environments and among their constituent species through adaptation and interactions over thousands of years, and become resilient to natural disturbances, such as drought, flood, and fire, and certain human disturbances such as alien species invasion to some extent. I would make the assumption explicit.

San Diego Water Board Response: The San Diego Water Board agrees with the comment regarding making the assumption about reference sites explicit as this was the intention of the draft documents. Clarifying language has been added to the Draft Staff Report in Section 3.3 to address this comment.

Comments on other sections of the Staff Report

Comment:

1. Section 4.1, Page 30, Paragraph 2. Citations are needed regarding use of biological criteria in Ohio and North Carolina.

San Diego Water Board Response: Citations have been added to the referenced section regarding the use of biological criteria in other states.

Comment:

2. S4.4.1, P37, Par. 2, "Unlike…stress." No model could explain all natural variation among biological communities. However, the approach taken here is the best one available and normally more effective to reduce the compounding effects of natural factors in assessing biological conditions at a site than ecoregion or other stream classifications. Most other states should adopt the approach to re-calibrate their biological indicators.

San Diego Water Board Response: Comment noted.

Comment:

3. S4.4.3, P41, Par 1, "however, due to . . . Figure 5)." Some other factors may also contribute to the uncertainty in CSCI, including sampling variability, modelling errors, and unknown random processes. However, 10th percentile appears appropriate as the threshold.

San Diego Water Board Response: Comment noted

Comment:

4. S4.4.4, P43, Par 2, "stream segment". This term needs to be defined. Is it stream reach in USGS-HDPlus?

San Diego Water Board Response: The term stream segment is meant to be used as a general term throughout the document to refer to a portion of a particular stream. The use at the referenced point in the staff report has been clarified by removal of the term "segment," as it is referring to a stream in general. The determination of applicability of the term "stream segment" carries different meanings and is thus defined differently in various regulatory guidance documents. Examples include determining stream segments as described in Section 5.4, in the objective's own applicability, as well as for defining the reach used as a sampling site segment.

Comment:
5. S4.4.4, P43, Par 2, "the cause of a low . . . origin." Do natural causes need to be identified or remain general?

San Diego Water Board Response: In response to this and other peer review comments, the text regarding "natural in origin" has been moved from the Basin Plan objective chapter into the implementation chapter. This move does not have a significant change on the objective or its implementation. The revision clarifies that permit compliance at sites with naturally low CSCI scores will be addressed through the implementation activities, by which the natural causes are to be identified and evaluated on a site-specific basis in detail by the San Diego Water Board. Some examples of potential natural occurrences are listed on pages 44 and 45 of the Draft Staff Report (e.g. Hawkins and Sedall 1990 reference in the Draft Staff Report).

Comment:
6. S4.4.4, P44, regarding natural occurrence factors. As I mentioned earlier, a CSCI score slightly lower than the 10th percentile may be due to sampling variability. If so, re-sampling may be needed to confirm the result.

San Diego Water Board Response: The San Diego Water Board agrees, as variability in sampling is expected to be present for all water quality objectives in the Basin Plan. Existing implementation guidance from the State of California (Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List) for the number of samples needed for regulatory determination purposes under the Clean Water Act (CWA) is referenced in the implementation section of the Draft Staff Report (5.4).

Comment:
7. S4.4.4, P15, Par 1, "some groundwater . . . interactions." Interesting example. In fact, groundwater discharges often increase flow and decrease water temperature, and then benefits benthic macroinvertebrates and increase the CSCI score. However, it is difficult to detect and quantify groundwater discharges at the regional scale.

San Diego Water Board Response: The reference to natural sources is intended to refer to natural sources of stress that are not well represented in the CSCI development site. The San Diego Water Board expects that potential natural sources of stressors, such as those potentially found in ground water, will be addressed on a case-by-case basis.

Comment:

8. S5.1, P71, Par 2, I have three questions here.
i) "When included . . . . receiving waters". I understand that the receiving water is referred to as the stream segment receiving discharge. Does it include downstream segments, too? How far downstream? A clear definition of receiving waters will be helpful.
ii) "In many cases, ... percentile objective." I also see the potential space lag in the effect of a discharge. For example, discharge of fine sediments and nutrients into a fast-running creek segment, the direct receiving water, may not cause many biological changes, but could cause eutrophication, siltation, and in turn biological impairment downstream where the stream gets larger and slows down. Is the downstream reach still part of the receiving water? Clarify.
iii). Strong dispersal from upstream sources might also reduce or overwrite the biological signal of a discharge (or other disturbances) into receiving stream segment. Is that a concern?

San Diego Water Board Response: The San Diego Water Board, per the Basin Plan, considers receiving waters to include those surface waters that are or may be subject to a discharge. A specific length or downstream extent of receiving waters from a discharge is not defined as this may vary according to the discharge and receiving water properties. Thus, receiving waters include those waters downstream from the immediate point of discharge, including the scenario identified in ii) above. The intent of the use of biological objectives is to assist in determining if strong dispersal or space lag related to a discharge is impacting receiving waters at the discharge site and downstream. In regards to iii), the over-riding intent and purpose is to use biological objectives to identify the attainment of the beneficial use, and subsequently use additional physical and chemical information to determine the sources that need to be addressed. This is paired with monitoring associated with discharges. Thus, for specific discharges, permit-determined monitoring approaches that include receiving water and discharge monitoring can address this concern (e.g. upstream/downstream discharges paired with discharge pollutant monitoring).

Comment:

9. S5.3.3, P77, Par 2, "The Receiving . . . and sources." When applicants need to collect biological and habitat data themselves, do they have the necessary expertise or training? Or, do they simply turn to consulting services for help? Just wondering.

San Diego Water Board Response: In the San Diego Region most applicants utilize consulting services to collect biological or habitat data. However, training from the State of California has been offered annually to government agencies and the public for over 10 years on the methods used to collect biological data.

Comment:
10.S.5.3.3, P79, Par 1, "The Receiving Water . . . wadeable streams." Any specific requirement on how far upstream and downstream from a discharge point the assessment should be done?

San Diego Water Board Response: The San Diego Water Board expects this determination to be done as part of the permitting process on a case by case basis, as is done with physical and chemical monitoring, because many factors may vary for both the stream and discharge, which in turn will impact site selection for sampling. The permitting process is also a public process that allows for public input and consideration in this regard. The San Diego Water Board has also clarified the term "wadeable" in the objective for clarity in permitting.

Comment:
Comments on Basin Plan Chapter 4 Implementation
1. P1, Par 2, "the ecology of a stream". Is "ecological properties / characteristics" a better term than "ecology"?

San Diego Water Board Response: The San Diego Water Board agrees with the comment and has modified the referenced text for clarity.

Comment:
2. P13, Par 2, "Monitoring may be . . . bioassessment." Do most permittees have the expertise needed to perform bioassessment? Will San Diego Water Board provide training and technical help?

San Diego Water Board Response: Please see prior response on this subject.

Comment:
3. P18, Par 3, "when a CSCI score . . . . reference sites." Two questions: i) how is interannual variability calculated? Over how many years? ii) how to define "similar reference sites"? In the case of O/E Index, stream groups are defined. One may take the sites in a group to which a test site is predicted to belong with the highest probability as "similar reference sites". However, in the case of CSCI, no stream groups are defined. Clarify.

San Diego Water Board Response: Interannual variability of reference sites was first calculated and evaluated as part of the CSCI development process and is included in Mazor et al. 2016. The State of California maintains an existing network of long-term reference sites, which includes many of the sites used in CSCI development. These data can be used over an extended time period, which the San Diego Water Board does not believe is warranted to pre-define, to evaluate inter-annual variability (e.g. see Figure 12 of the Draft Staff Report). Of these sites, reference sites with similar natural conditions can be determined using the CSCI model, which, as a predictive model, identifies the pool of similar reference sites based on natural gradients. This is an optional output of the CSCI calculation.

Comment:
4. P18, Par 4, " . . . Stream Biological Objectives though . . . " Should it be "through"?

San Diego Water Board Response: Yes, the typo has been corrected.

Comment:
5. P20, Figure TBD, Step 3. "Peer-reviewed and Published". Many new online journals come out each year and some do not appear to have a rigorous review process. I would like to add some phrase like "in a reputable journal", but who will define "reputable"?

San Diego Water Board Response: The San Diego Water Board does not believe this phrase needs to be added, as the incorporation of future biological objectives into the Basin Plan would be subject to a regulatory review process that mirrors this process, including additional scientific peer review.

Comment:
The Big Picture
The Staff Report and other documents are well written. The scientific portion of the proposed rules as a whole is based on sound scientific knowledges, methods, and practices. In the past decades, substantial progress has been made in terms of understanding biological beneficial use of waters, defining reference conditions for specific stream sites, and diagnosing the cause of biological impairment. This report well incorporated the progress and developed a set of rules that will greatly complement chemical-physical water quality criteria in protecting and restoring freshwater resources.

The methods used in this report to define reference conditions, protect, and restore

biological conditions of aquatic ecosystems are based on a fundamental premise that the biological conditions in a stream segment are largely controlled by natural chemical and physical environments and human disturbances at both local and watershed scales. This premise are well supported by scientific data from streams. However, some biological processes, particularly species dispersal may mediate the responses of biological communities to human disturbances and natural environment. In the case of restoration, the responses of biological communities to improved water quality and habitat improvements could be constrained by lack of species sources. Similarly, the biological impact of a given disturbance may be underestimated because of strong species dispersal from upstream. Certain human activities, such as transportation, boating, and fishing, may not significantly affect water quality or habitat quality, but they could introduce invasive species and then reduce biological conditions through competition or predation. I understand that a biological process is often location-specific and not easy to model, but it may play a significant role under certain circumstances. A short discussion may be needed to address the implications of biological processes for bioassessment.

San Diego Water Board Response: The San Diego Water Board has added some additional clarifying language and citations in Section 5.4 of the Draft Staff Report regarding external biological processes and impacts, specifically in the invasive species portion of the Draft Staff Report. In regard to species dispersal and disturbance, the San Diego Region does have a large percentage of stream miles estimated to be in good biological condition using the CSCI, and all hydrologic units in the region, with the exception of the smaller Pueblo hydrologic unit (n = 1 sampled location), contained sampled streams where CSCI scores met conditions expected at similar reference sites. In addition, recent literature has found that overland dispersal benthic macroinvertebrate can be an important conduit, especially in arid regions (e.g. Razeng et al. 2016). Thus, the San Diego Water Board expects that 1) for restoration, dispersal will be sufficient to improve biological condition, and 2) other indicators, such as those for physical habitat, can be used to determine if dispersal may be “mediating” anthropogenic disturbance impacts, and to evaluate restoration need and potential within the appropriate regulatory or non-regulatory context.

2.2 Peer Reviewer – Dr. Patrick Edwards

Comment:
OVERVIEW
The purpose of this review is to evaluate Conclusion 1 of the Biological Objective for Perennial and Seasonal Streams for the San Diego Region. Conclusion 1 States: "The Basin Plan amendment proposes to incorporate a numeric water quality objective for streams using a reference-based predictive benthic macroinvertebrate scoring index. The proposed Basin Plan amendment uses this index to set the water quality objective using a percentile of reference approach." "The reviewer's charge is to evaluate the scientific assumptions, findings, and conclusions for the San Diego Water Board Biological Objectives Basin Plan Amendment." With this in mind, I evaluated the three parts of Conclusion 1 and present my findings below**.**

In conducting this review, I have carefully read the Stream Biological Objective Language, chapters 1-4 of the Staff Report (Loflen and Fetscher 2019), Mazor et al 2015 and Mazor et al 2016. I have experience developing biologic criteria and I have high confidence in my review of conclusion 1 and the related documentation. **It is my opinion that the underlying method for deriving the numeric biological objective for streams is scientifically sound and protective of Beneficial Uses** (emphasis from peer viewer)**.**

San Diego Water Board Response: Comment noted.

Comment:
REVIEW
a. Use of benthic macroinvertebrates and the California Stream Condition Index (CSCI)
The use of biocriteria as a management tool for monitoring stream health is well established in the scientific literature and there is ample evidence regarding the use and value of stream macroinvertebrates as indicators of stream ecosystem condition (Rosenberg and Resh 1993, Barbour et al 1999, Karr 1995). The proposed biological objective utilizes a "reference stream approach." This approach identifies a least-disturbed stream to represent the undisturbed or the "to be obtained" biological community. The biologic community of the study stream is then compared to the reference stream to determine if the study stream is impaired or unimpaired (Hughes 1986, Whittier et al 2007, Mazor et al 2015).

While the advantages of using a reference stream approach are well documented in the literature (Hughes 1986), there are several important issues to consider when implementing this strategy, including reference stream selection (Whittier et al 2007), biologic metric validation (Mazor et al 2016, Bowman and Somers 2006) and the natural variability of stream macroinvertebrates (Li et al 2001). In the San Diego region, one of the major concerns for applying a reference approach is related to variability in CSCI scores due to flow regimes in nonperennial streams. Mazor et al 2015 investigated the effect of flow duration on CSCI scores and found that the CSCI is applicable in most nonperennial streams as long a certain sampling conditions are met. The proposed CSCI biological objective adequately addresses the limitations and sampling considerations described in Mazor et al 2015. The field data collection methods and laboratory protocols utilized in the proposed biological objective are standard practices commonly used by federal, state and local agencies. **The underlying method for using benthic macroinvertebrates and the California Stream Condition Index is scientifically sound and will protect and restore the biological integrity associated with perennial and seasonal stream systems** (emphasis from peer viewer).

San Diego Water Board Response: Comment noted

Comment:
b. Use of a reference approach
The proposed amendment will utilize existing California SWAMP data to identify and select reference "comparator" sites from a state-wide pool of more than 750 sites that have been repeatedly sampled over time. Selection of reference site is based on landuse criteria, water chemistry and the biota present in the stream. The potential for selecting reference streams not indicative of reference condition is minimized by on-the-ground verification and other information about the streams. **The assumptions and methods used to identify and define "reference" as a biological integrity benchmark are scientifically sound and will protect and restore the biological integrity associated with perennial and seasonal stream systems** (emphasis from peer viewer).

San Diego Water Board Response: Comment noted

Comment:
One aspect of the Staff Report and proposed reference approach that needs clarification is the planned sampling regime and details about how study stream data will be compared to reference streams. It is not clear in the Staff Report how frequently streams will be evaluated and if they will be compared to reference sites each sample year or assessed using a mean value derived from multiple samples. Table 2 lists the years of collection; however, there are clearly sites that don't get sampled every year (e.g. Figure 10). What happens if a stream is not sampled or a sample cannot be obtained? I suggest adding more details about the sampling regime and methods for comparing study and reference streams in sections 4.1 or 4.2 of the Staff Report.

San Diego Water Board Response: As discussed in a prior response, the sampling regime is dependent upon which of the various purposes for monitoring stream biological integrity may be occurring. Sampling may occur to evaluate long term trends; responses to specific discharges or natural events, or on a probabilistic basis for overall ambient assessment. Thus, the frequency of sampling specific sites, and the manner they are used for comparison (trend, mean score, targets) is dependent upon the regulatory or non-regulatory purposes of the sampling, which is discussed throughout Section 5 of the Draft Staff Report, and more specifically in Section 5.10.

As an example, the periodic sampling of targeted sites through federal and State of California ambient monitoring programs (e.g. Environmental Monitoring and Assessment Program (EMAP), Surface Ambient Monitoring Program (SWAMP)) will allow for periodic assessment of scores over time, allowing for trend analysis to detect changes. This trend analysis may be used as part of the regulatory integrated reporting process under Clean Water Act Sections 305 and 303. However, this process also uses alternative approaches for assessment of bioassessment results pursuant to the State of California's Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List.

Language has been added in Section 4.2 regarding the Reference Condition Management Program (RCMP), and as a footnote in Table 2. Additional language has been added to parts of Section 5 to further clarify that existing implementation programs specify or allow for project-specific determination of sampling and comparison requirements.

Comment:

c. Setting of index score threshold

The CSCI score will be used as the biological objective to determine compliance. The CSCI utilizes both a multimetric index and a ratio of observed-to-expected taxa (Mazor et al 2016). The CSCI threshold criteria will be established at 0.79, which is the lower 10th percentile of all reference streams. The CSCI method has been validated and published in the peer reviewed literature (Mazor et al 2016). The lower 10th percentile is a reasonably conservative threshold for identifying unimpaired streams and reflects the reality of balancing the potential for generating false positives and false negatives. Streams with scores below the criteria will can be confirmed through an additional process to ensure that the stream is truly different than the reference site. **The assumptions and methods to set the water quality objective as a percentile of reference using the California Stream Condition Index is scientifically sound, incorporates a margin of safety, and will identify sites that have a degraded biological condition. The allowance of site-specific scientific information on the physical, chemical, and biological condition of specific sites to prevent false positive identifications of impairment is scientifically sound** (emphasis from peer viewer)**."(**sic).

San Diego Water Board Response: Comment noted. Note that in response to other peer review comments, the San Diego Water Board has moved the confirmation process for naturally occurring low CSCI scores from the Chapter establishing the objective into the implementation chapter of the Basin Plan. This move does not have a significant change on the objective and provides clarity that the identification of sites with naturally low CSCI scores will, for permit compliance purposes, be addressed through the current regulatory implementation process.

Comment:
BIG PICTURE REVIEW
A) Overall, the proposed amendment is scientifically sound. The challenges of using a reference streams as baseline for listing criteria has been adequality addressed by the and the CSCI has been published in the peer reviewed literature (Mazor et al 2016). The application of the CSCI in non-perennial streams is an important consideration for this amendment and has been investigated by Mazor et al 2015. I agree with the findings of the Mazor et al 2015 report; which states that the CSSI methods are not likely to be affected will not be affected by seasonal drying of stream if certain sampling conditions are met including adequate flow at the time of the sample and a at least 4 weeks since the last drying event. Furthermore, I also agree that efforts should be made to sample more unimpacted non-perennial streams to incorporate as reference streams. And Finally, the proposed 0.79 CSCI criteria is a reasonable threshold that reflects the limitations of the reference stream approach and the potential for stream misclassification. **As a whole, the scientific proportion of the proposed criteria is based upon sound scientific and knowledge, methods and practices** (emphasis from peer viewer)**.**

San Diego Water Board Response: Comment noted.

Comment:
b) Anything Missed? One aspect of this amendment that may warrant further consideration is the scientific error associated with the CSCI reference stream approach. False positives occur when a stream is below the CSCI threshold but in reality, the stream is not degraded. The false negative occurs when a stream is classified as unimpaired, but in reality, it is impaired. This situation presents a unique challenge to using bioassessment for meeting water quality objectives because false negatives, which can be result of a poorly classified reference sites, are more difficult to identify and result in unidentified degraded streams that may never be addressed.

I recognize that substantial efforts are made to minimize the misclassification of sites; however, the screening mechanisms described in the Staff Report are primarily focused on misclassifications that results in a false positive. As far as I can tell, only sections 4.4.2 and 4.4.3 address the issue of a false negative and they do so in a vague manner. For example, “Due to this uncertainty, the 10th percentile is used as a threshold for the CSCI” (page 41). Given that a false negative error has serious consequences; i.e. a degraded stream is classified as unimpaired, it’s my opinion that the report should more explicitly address this issue.

San Diego Water Board Response: The San Diego Water Board agrees with the comment regarding concerns about the possibility of a false negative error. There is concern that a site could have a CSCI score above the threshold but in reality could not be fully supporting the WARM and/or COLD beneficial use. Additional discussion of false negatives has been added to Section 4.4.3 of the Draft Staff Report. The San Diego Water Board has chosen the 10th percentile threshold to balance the inherent risk between both false positives and false negatives, and therefore we recognize that there will be some chance of both false positives and false negatives as occurring. As with all water quality objectives we cannot completely eliminate both false positive and negatives at the same time, but the percentile chosen seeks to balance the two as best as possible, given the limits of modeling and of data availability, the reality of sampling error, and limits to understanding and controlling sources of variability. The language added to address false positives is critical from a regulatory implementation perspective, as there are likely more potential regulatory consequences to be addressed from false positives than from false negatives. However, the simple achievement of the 10th percentile threshold does not preclude the San Diego Water Board from using non-regulatory tools to further improve stream conditions. There are existing tools and metrics the San Diego Water Board may utilize to determine if specific streams may be further improved beyond the proposed Biological Objective using non-regulatory methods (e.g. grants) independent of the CSCI score. Much like the false positive approach, other stream assessment metrics and tools (e.g. CRAM, Algal Condition Indices, ESA species, eDNA monitoring) and modeling efforts (e.g. Beck et al. 2019) can be used to determine if a stream may be "under-performing" biologically compared to similar sites, even when meeting the stream biological objective. This allows for the identification of sites that might be considered "false negatives."

2.3 Peer Reviewer – Dr. Dave Lytle

Comment:
Summary of my review:
Overall I found that the document meets all of the criteria listed above. The underlying method of benthic macroinvertebrate bioassessment is sound and incorporates modern ecological principles relevant to aquatic ecosystems, especially as they relate to intermittent waters. The reference approach is well-formulated and likely to be robust to variability across site conditions and changes due to land use and climate change. The index score threshold is justified based on considerations specific to southern California as well as biomonitoring efforts in other states. The implementation of these objectives follows a reasonable schedule, the methods are clearly articulated, and they are compatible with Beneficial Uses as articulated in the document. I commend the authors for developing a thoughtful approach grounded in current science. This could become a model for other regions and states to adopt practices for biomonitoring intermittent waters. One challenge for the methodology -- a challenge that is common to most biomonitoring studies -- will be how to account for natural seasonal and interannual variability in benthic invertebrate community structure. I elaborate on this point in the review below.

San Diego Water Board Response: Comment Noted. The development of the CSCI relied on a statewide network of long-term reference sites that has enabled California scientists to evaluate the potential of both seasonal and inter-annual variability in benthic macroinvertebrate communities over extended time periods. These considerations were included in the development of the CSCI.

Evaluations of long-term variability and seasonal variability in historic indices and metrics (e.g. older unmodeled Indices of Biotic Integrity metrics) were conducted by the authors of the CSCI (see Mazor et al. 2009), including seasonal variability for intermittent streams in the San Diego Region prior to CSCI development (Mazor et al. 2014, Note this report was also scientifically published as: Mazor, R.D., Stein, E.D., Ode, P.R. and K. Schiff. 2014. Integrating intermittent streams into watershed assessments: applicability of an index of biotic integrity. Freshwater Science 33(2): 459-474). Initial studies were conducted in the 1990s (e.g. Harrington et al. 1999) to evaluate seasonality in benthic macroinvertebrate communities and were used to set the current recommended index period by ecoregion (see Figure 2 in Ode et al. 2016b). Additional work in intermittent streams (Mazor et al. 2014 and 2015) validated the recommended sampling index period to earlier in the spring for intermittent streams. For example, Mazor et al. 2014 (e.g. Figure 7) found low variability in indices for low-stress sites sampled from April to August, further demonstrating that indices for these systems perform well over the range of the index period.

This research was subsequently used in the development of the modeled CSCI, and the CSCI itself examined inter-annual variability at reference sites when determining precision (see Mazor et al. 2016). Note that this is discussed in the methods selection for development of the O/E and pMMI portions of the index, and the San Diego Water Board contends that this approach sufficiently incorporates expected variability for use in a water quality objective.

Comment:
Integration of intermittent and ephemeral waterways into our assessment of water quality has been achieving much deserved attention in recent years. This is logical given that intermittent and ephemeral stream reaches form the dominant ecosystem type in most aridland regions including southern California. Basic research into our understanding of these ecosystems has surged in recent years, with much attention from the National Science Foundation and the Environmental Protection Agency. Our counterparts in Europe are actively developing and implementing biomonitoring programs that incorporate intermittent and ephemeral streams. Even the US Department of Defense has actively embraced this effort by funding research projects throughout the western US, including Camp Pendleton, Naval Air Weapons Station China Lake, and Fort Hunter-Liggett in California. Thus our understanding of the basic ecology underlying intermittent and ephemeral waterways is sufficiently mature to allow the development of sophisticated and accurate biomonitoring programs for these ecosystems.

San Diego Water Board Response*:* Comment noted. The San Diego Water Board has also been funding research for conducting bioassessment of ephemeral streams when they are dry. A reference to this work has been added to the Draft Staff Report at Section 4.5. In response to other peer review comments, the prior definition of perennial and seasonal streams in Chapter 3 has been moved and incorporated into a definition of ephemeral stream segments for exclusion from the Stream Biological Objective applicability. Clarification regarding the use of the term ephemeral is included in Chapter 3, consistent with the ability to sample and United States Environmental Protection Agency definitions (USEPA 2008). Additional information has been added to the Draft Staff Report in Section 4.5 to further prevent confusion of terms.

Comment:
Some of the contributing authors to this report have been active in publishing their methods and concepts in peer-reviewed scientific journals such as *Freshwater Biology*, *Freshwater Science*, and *Ecological Indicators*, thus ensuring a solid scientific basis for applications.

San Diego Water Board Response: Comment Noted.

Comment:
3.1 The use of bioassessment methods rather than specific chemical monitoring is well justified.

San Diego Water Board Response: Comment Noted.

Comment:
3.3 Use of a reference site approach is also well supported by other studies which have come to the same conclusion. The large number of reference sites available (currently 750 statewide) makes this objective viable.

San Diego Water Board Response: Comment Noted.

Comment:
3.3.4 Resiliency. Since rivers and streams in aridland systems are particularly dynamic and prone to natural disturbances such as flood and drought, this is a key point that strengthens the approach. The discussion of resilience concepts based largely on Oliver et al. (2015) is relevant here and adds to the approach justification.

San Diego Water Board Response: Comment Noted.

Comment:
4.4.2 The point about unmapped anthropogenic activities (illegal grazing, cultivation) impacting the pool of reference sites is a good one, but not easily remedied.

San Diego Water Board Response: Comment Noted.

Comment:
4.4.3 Use of a 10% threshold for impairment seems to be well justified - at least this is a commonly used cutoff in other biomonitoring applications.

San Diego Water Board Response: Comment Noted.

Comment:

4.4.4 Naturally occurring factors. This is one of the main challenges of any biomonitoring program -- how to deal with naturally occurring variability within and among sites. In general I feel that the authors have done an excellent job identifying possible factors, and the reference site approach with all of its refinements (identifying natural gradients via GIS, iterative resampling to identify nonconforming sites, etc.) represents the state of the art. Some clarification on how the methodology could account for known seasonal and inter-annual variances in community composition could be discussed. For example, it is well known that there is a degree of among year turnover or detectability in invertebrate communities (McElravy et al. 1989 J. North American Benthological Society, Resh et al. 2005 Freshwater Science), which will lead to some differences in community structure and possibly condition. Similarly, California and other Mediterranean climate streams exhibit a seasonal oscillation in community composition with EPT (Ephemeroptera, Plecoptera, Trichoptera) more dominant during winter and wet years and OCH (Odonata, Coleoptera, Hemiptera) increasing in summer or dry periods (Bonada & Resh 2013 Hydrobiologia, Tonkin et al. 2017 Ecology). The latter point may be addressed somewhat by standardization of sampling timing (as is discussed in section 4.5 and in Ode 2016b), but the occurrence of wet or dry year types may affect the results as well.

San Diego Water Board Response: The San Diego Water Board agrees that the current approach represents the state of the art. Extensive continuous monitoring of reference sites in California and the San Diego Region has documented some interannual variability in reference stream benthic invertebrate community, though there is no evidence that such interannual variability has an impact on CSCI scores at reference sites (e.g. see Figures 11, 13 in the Draft Staff Report), and the CSCI itself used repeat sampling of reference sites for precision purposes as discussed in the Mazor et al. 2016 publication. Reference sites in the RCMP consistently score within the expected reference distribution during both drought and non-drought years, and the CSCI development dataset encompassed a period of ten years, which included wet and dry years. The San Diego Water Board contends that the latter point regarding community shifts is well addressed by the standardization of monitoring methods, which includes requirements for the SOP to be met to allow for sampling during the representative time period. Please also see response to the first comment regarding index timing.

For naturally occurring factors that may cause a low CSCI score, the relevant text from the objective regarding naturally low CSCI scores has been moved into the implementation chapter. This move does not have a significant change on the objective, and provides clarity that the identification of sites with naturally low CSCI scores for compliance purposes is addressed through the regulatory implementation process.

Comment:

Hydromodification. As the authors state this is a factor that surely has impacts on stream community composition and thus quality scores, but is in need of further research and development. One place where this surely has an effect is with flow augmentation due to treated wastewater returns, which can at times result in increases in biological scores.

San Diego Water Board Response: Comment noted. The San Diego Water Board currently has one facility that discharges treated wastewater (sewage) to streams, though extensive bioassessment monitoring upstream and downstream of the discharge point has not documented changes in benthic macroinvertebrate communities attributable to the discharge. In addition, the discharge only occurs during the rainy season, which prevents a scenario of augmented flow during critical low-flow periods.

Comment:4.5 (and also language in Chapter 3 of the amendment): Seasonal streams are defined here as "freshwater streams that are expected to be inundated with flowing water for at least four weeks between the months of February and October, except during periods of atypical or extreme drought. Seasonal streams have sufficient flows to conduct bioassessment sampling for stream aquatic benthic macroinvertebrates in most years. Seasonal streams do not include those streams that only exhibit ephemeral flow, which is flow that occurs only during or immediately following (e.g. 24-48 hours) rainfall events." The 4 week delay in sampling from onset of surface flows would likely allow sufficient time for development and growth (and thus detectability) of intermittent stream specialist taxa such as stoneflies and blackflies (see Bogan & Carlson 2018 *Illiesia*). The sampling timeline guidances in Table 4 seem like a reasonable framework to achieve the correct timing. One related factor is the role that hydroperiod, the duration of surface water occurrence, might play in determining community composition. I don't see any mention of instrumentation, but deployment of wet/dry sensors could be a useful way to determine the duration of surface water occurrence.

San Diego Water Board Response: Comment noted regarding the sampling timeframe and a clarification has been made in the definition regarding the continuance of flow for the 4 week period. The objective has also been slightly modified to specifically separate out ephemeral streams to prevent confusion between seasonally intermittent and ephemeral. The San Diego Water Board agrees that deployment of instrumentation, which is now common at many stream bioassessment sites in California, including many RCMP sites, can assist in the determination of the duration of surface water occurrence, especially since anthropogenic activities can impact the hydroperiod. It is important to note that other methods besides sensors are available, and that the specific monitoring of the hydroperiod may vary depending on the specific implementation concerns regarding biological objectives.

Comment:
4.7.1 The RWB approach is a definite advantage when sampling intermittent streams due to their variability in flow conditions and microhabitats.

San Diego Water Board Response: Comment noted.

Comment:
5 Program implementation. Much of this section pertains to the specifics of permitting and adherence to state and federal policies. As an ecologist I have less to comment on for this section, however I do note areas where ecological considerations come into play.

San Diego Water Board Response: Comment noted.

Comment:
5.3 As noted above, flow augmentation due to discharge (to get rid of pollutants or otherwise) can fundamentally change stream character by shifting the hydrograph from ephemeral to intermittent, or from intermittent to perennial. I suspect this can be accommodated by careful selection of reference sites, and I see that the topic is discussed on p.78 as well.

San Diego Water Board Response: Comment noted. In addition, water level loggers and conductivity loggers have, beginning in 2013, been deployed at a subset of reference sites in the statewide reference pool to document flow duration (e.g. Figures 11 and 13) as an additional way to document reference condition. For example, undocumented illegal cannabis grows that divert water could unknowingly impact reference-pool sites, thus depressing the accurate representation of reference-quality condition scores.

Comment:
5.3.3 An important point is made here - that deviation from the natural flow regime can have negative effects including facilitating nonnative species and changes to benthic invertebrate communities.

San Diego Water Board Response: Comment noted.

Comment:
5.6 I am not an expert on policy related to CWA permitting, but I did find this section somewhat vague on specifics relating to what actions would be taken given specific biological findings. Perhaps the details of implementation will be articulated secondarily, and this material is just intended for general guidance, and determining who is responsible for what aspects of permitting?

San Diego Water Board Response: The comment is correct regarding the articulation of site-specific implementation details. The adoption of a water quality objective requires a description of the program of implementation, which is provided as Chapter 4. This material is intended to provide general guidance for implementation of the objective but also to describe how the objective is expected to be implemented and complied with considering site-specific circumstances under different permitting or regulatory frameworks with applicable public review and participation process requirements.

Comment:
Appendix 1 and 2. I consider these as background material and so do not review them here. The Mazor et al. paper is a good one and forms a solid foundation for the methods outlined in the other documents.

San Diego Water Board Response: Comment noted.

Comment:
Chapter 3 amendments. These are reasonable and discussed in the context of intermittent stream definitions, above.

San Diego Water Board Response: Comment noted.

Comment:
Chapter 4 amendments. Implementation. I found the specifics of this section, both legal and logistical, to be outside my area of knowledge in places. That said, I saw no indication that the proposed methods, timelines, and policies are at odds with the fundamental biomonitoring principles set forth in the other documents.

San Diego Water Board Response: Comment noted.

2.4 Peer Reviewer – Dr. Wendy Monk

Comment:
This review focuses on Conclusion 1 for the Draft Biological Objectives report based on the San Diego Regional Water Quality Control Board Biological Objectives for the San Diego Region (referred to as Draft Report in the remainder of the review). Broader comments on the overall document are provided.

The proposed amendments to develop and incorporate biological objectives into the broader Basin Plan reflects the wider scientific consensus that comprehensive watercourse assessments should involve more than individual ecosystem components. This is particularly important within multiple stressor environments because of highly variable spatial and temporal responses of different measured ecosystem components (e.g., water quality vs. benthic algae vs. benthic macroinvertebrates) to potential natural and anthropogenic stressors. The authors of the Draft Report clearly acknowledge that watercourse assessment objectives should move away from a solely bottom-up view (e.g., using water quality alone) and directly incorporate biological objectives in a structured design that involves multiple attributes for a more complete ecosystem assessment. The approach, methods and proposed amendments for implementation presented within the Draft Report are scientifically sound and use the best-available scientific and data methods, where the use of potentially-subjective scientific judgement is relatively limited, with the exception of individual re-assessments of reference sites outside the 10th percentile although these are also supported by data-based methods and consensus approaches. However, further clarification and additional details are needed to support some of the statements and analyses within the Draft Report and these are outlined in the review below.

San Diego Water Board Response: Comment noted. Specific responses regarding clarification and details are included in responses below.

Comment:
The State of California has developed an extensive monitoring program for both benthic macroinvertebrate and soft algae and diatoms. The authors of the Draft Report highlight the importance of applying a complete ecosystem approach for site assessment moving beyond water chemistry and incorporating biological objectives. The adoption of a top-down approach, which is well supported within the wider scientific literature, underlies the methods and assessment development within the Draft Report. The use of benthic macroinvertebrate sampling paired with other sampling of other ecosystem components (e.g. benthic algae, water chemistry, habitat surveys, etc.) is a scientifically-sound approach for a bioassessment program.

San Diego Water Board Response: Comment noted.

Comment:
The Draft Report provides a summary of the sampling and laboratory methods for both benthic macroinvertebrates and soft algae and diatoms. However, further detail could be provided to support the understanding of both the benthic macroinvertebrate and benthic algae data including additional laboratory information (e.g., taxonomic resolution for benthic algae and diatoms, clarification that SAFIT II and IIa taxonomy are at the genus-/species-level with Chironomid reported at the subfamily level (IIa), laboratory subsampling procedures for both methods, high-level summary of QA/QC procedures). Also, additional information could be provided to describe how the duplicate paired benthic macroinvertebrate and benthic algae samples from the 10% of sites are used in assessment of the sampling program. The description of the physical habitat surveys could also be expanded, for example how often are physical habitat surveys conducted outside of a benthic sampling event? Depending on the stream type, hydrological variability (including flashiness), sediment mobility and the length of the delay then this could affect the site-level habitat assessment.

San Diego Water Board Response: The San Diego Water Board has provided some additional clarifying language further describing the existing State of California Standard Operating Procedures. Language regarding the use of duplicative samples in QA/QC procedures has been added to Section 4.7 of the Draft Staff Report, though specific QA/QC measurement quality objectives may vary by project. Additional clarifying language has been added to the referenced section reflect that physical habitat should be sampled during baseflow conditions (e.g. when benthic macroinvertebrates should be sampled).

Comment:

Other bioassessment metrics are discussed within the Draft Report (e.g., benthic algae) that can be linked to the Stream Biological Objective. Benthic algae is further discussed as a bioassessment indicator because it is routinely collected and is also part of the duplicate sampling at 10% of study sites. However, it must be remembered that benthic macroinvertebrates and benthic algae have differing temporal responses given their turnover. This should be considered when quantifying site status (both in terms of impact and also in terms of reference state).

San Diego Water Board Response: The San Diego Water Board agrees that algae can provide important additional information regarding the biological condition, as benthic algae can exhibit a faster temporal response to certain anthropogenic impacts, can be more sensitive to specific pollutants (e.g. nutrients), and can be less sensitive to physical habitat impacts. As such, the San Diego Water Board agrees that the inclusion of algae as an additional line of evidence for consideration in the implementation of the proposed biological objectives will both assist in determining reference-quality for select sites as well as be used in determining potential causative stressors. The State of California is currently developing a statewide Algal Stream Condition Index, akin to the California Stream Condition Index, which when published is expected to assist in this regard. Lastly, to provide clarity regarding the use of additional lines of evidence, the objective language has been modified and references to additional lines of evidence for sites with naturally low CSCI scores has been moved to the implementation chapter.

Comment:
Further, the use of water chemistry data to support a site assessment is a routine measure but can be problematic depending on frequency of samples, parameters assessed and field procedures to maintain high quality samples. Importantly, the authors highlight these potential sources of error and emphasise (sic) that multiple water chemistry samples are needed before a site is assigned, and combined with additional evidence as necessary.

San Diego Water Board Response: Comment noted.

Comment:
The discussion for the inclusion of both perennial and regularly seasonal intermittent streams within the assessment is well supported by direct evidence from several peer-reviewed scientific publications. However, the authors only briefly discuss assessments outside of these two stream types – do these findings also hold true in ephemeral streams or is that part of the ongoing research (reference to Loflen, unpublished data)? Or are ephemeral streams more formally included in the definition of seasonal intermittent streams as suggested in Section 4.5 but with caveats because of sampling limitations? Are the distribution of these stream types changing given changing climatic conditions (short- and long-term) and the ongoing statewide drought?

San Diego Water Board Response: To clarify, the definition of perennial and seasonal streams in Chapter 3 of the objective specifically does not include ephemeral stream segments. In response, Chapter 3 has been modified to specifically exclude ephemeral streams more directly by editing the language and providing a specific exclusion for ephemeral streams. The prior definition of perennial and seasonal streams has been incorporated into the definition of ephemeral stream segments for exclusion and is consistent with USEPA terms (USEPA 2008). The referenced section of the Draft Staff Report regarding ephemeral streams has been modified for clarity through removal of analogous ephemeral stream terms that include "intermittent," and now specifically refers to ephemeral streams consistent with the definition in the objective and with USEPA terms (USEPA 2008). A reference to ongoing research into conducting bioassessment in such streams has been added. These streams cannot feasibly be sampled using traditional bioassessment methods as they typically do not develop sampleable benthic macroinvertebrate communities representative of those used in CSCI development.

In regards to the comment regarding climate change, one of the purposes of the statewide network of reference sites, many of which utilize water level logger deployments, is to document potential changes in the distribution of stream types resulting from changing climactic conditions. For example, the impacts of California's multi-year drought (and 2017 year of record rainfall) on reference site hydrology in the San Diego Region can be seen in Figures 11 and 13.

Comment:

The authors of the Draft Report highlight the recommendations of Mazor et al. 2015 with typical sampling periods depending on stream types and whereby a minimum of a four-week sampling delay from the start of stream flow/last storm resetting event is used prior to sampling to allow for recolonization and stabilized community composition. However, later in Section 4.5, the authors refer to a "two, and preferably, three week" delay following a storm event so clarification is needed here. Further paragraph 2 on page 62 mostly duplicates information from earlier paragraphs within Section 4.5 and could be incorporated with that earlier text.

San Diego Water Board Response: The referenced section has been modified for clarity. The referenced 2-3 week delay is a required minimum period from the State of California SOP based on recommended references in the literature regarding the time period needed for sufficient benthic macroinvertebrate recolonization of habitat following scouring events. The State of California SOP states that "Ultimately, the time of delay from a scouring event to the acceptable window for sampling will depend on environmental setting and time of year." The work from Mazor et al. 2015 that found a 4 week delay to be appropriate provides more specific recommendations that build upon the minimum SOP requirements.

Comment:

The CRAM method is presented in a high-level summary but additional detail could be provided to explain how metric scores are aggregated across the four categories. Are these categories equally weighted? How are they combined? How are the different potential stressors tallied?

San Diego Water Board Response: The San Diego Water Board does not agree that that level of detail is warranted within the Draft Staff Report. The referenced documents contain all of the details regarding the CRAM method. Some additional language has been added to clarify that the metric scores, attributes, and final score are calculated in accordance with the CRAM manual, and that stressor information is not tallied but documented for potential future consideration.

Comment:
The adoption of a reference approach for assessment is a widely-accepted method within the scientific literature to assess freshwater systems through both models and index calculations. The approach to identify site types and representative reference samples allows for the identification of tailored reference communities for use in an observed vs. expected assessment.

San Diego Water Board Response: Comment Noted.

Comment:
The objective of the Clean Water Act is to "… restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (page 23) but there is no accepted definition of the term integrity in the CWA, although the authors of the Draft Report note that it was discussed extensively in committee. However, it is unclear if the authors of the Draft Report accept the presented definition by Karr (1999), which is widely cited and generally accepted within the broader scientific community in the field, and if this is the basis for the development of the reference approach and subsequent assessment.

San Diego Water Board Response: The San Diego Water Board references the Karr (1999) publication in the discussion of biological integrity. The term "biological integrity" does not include a definition within the Basin Plan amendment, as biological integrity can encompass multiple Beneficial Use categories for waterbodies beyond those covered under the proposed biological objectives document, which focuses specifically on the direct WARM and COLD Beneficial Uses. In this regard, the narrative guidance and use of a reference approach are viewed as being representative of the biological integrity of these Beneficial Uses.

Comment:
The definition of reference is difficult and often subjectively defined depending on the focus of the assessment. Here a reference site is defined as "one that is exposed to very low or no anthropogenic stress" (page 24 of the Draft Report) allowing minimal disturbance sites to serve as reference. However, the authors should provide spatial and temporal bounds on this definition. How often are reference sites re-evaluated? What is the spatial frame of the reference site? How far upstream? Lateral connection?

San Diego Water Board Response:
The selection of reference sites used in the development of the CSCI, consistent with the proposed narrative guidance, is discussed in the Ode et al. 2016 publication. This was based on the State of California's *Recommendations for the Development and Maintenance of a Reference Condition Management Program* (Ode and Schiff 2009), which built upon fifteen years of prior experience conducting biological assessments in California.

Comment:
The reference stream approach was developed through the Reference Condition Management Program (RCMP). The program has data from 750 reference sites around the State. These reference sites are reported to represent natural gradients across different environmental variables. These sites are filtered by geospatial variables to assess their level of disturbance and can be assess by "on-the-ground post-hoc validation". How confident are the authors of the Draft Report that the pool of reference sites within the RCMP are fully representative of the range of variability in the State of California? How many reference sites are within each site type? Are they spatially and temporally replicated? The authors indicate that these reference pool sites will be re-evaluated over time but with caveats of feasibility and necessity. This is important, particularly given the potential temporal delays to updates for geospatial assessment layers (i.e. outdated layers), the sometimes rapidly changing land use and land cover (including potential illegal activities) and evolving assessment methods. However, it would be advisable to identify a core set of reference sites or a small percentage of rotating sites that should be reassessed on a regular rotation beyond the general temporal updates. These focused assessments would provide a structured approach to assess temporal change across the range of reference sites and highlight areas of change. If a shift is observed within a site or if assessments highlight a general change in conditions of a group of sites, how will the RCMP respond to these changes? How will new and more representative reference sites be added to the program?

San Diego Water Board Response:
Please see above response regarding the publication on selection of reference sites used in CSCI development. The State of California RCMP specifically chose targeted reference sites to capture the expected ranges of natural variability throughout the State of California. This dataset has been further supplemented with regional SWAMP efforts (including the San Diego Region) as well as by other entities (e.g. the Stormwater Monitoring Coalition, SMC). The RCMP sites, regional San Diego sites, and SMC sites are sampled as suggested by the comment, with a subset of sites sampled on an annual basis. The RCMP is managed jointly by the State of California Water Resources Control Board and Department of Fish and Wildlife. Lead scientists from the California Department of Fish and Wildlife can add additional representative reference sites to the source pool if requested and verified. These scientists also work with the State Water Boards to assess reference sites for changes associated with temporal change (e.g. due to climate change). As identified in the CSCI publication (Mazor et al. 2016), the "reference data set was spatially representative and encompassed >10 y of sampling. Long-term temporal coverage improves the representation of climatic variability, including El Niño-related storms and droughts." Longer-term evaluation of responses to climate change will be possible with the RCMP program.

Comment:
Resistance and resilience to disturbances varies across different habitats and ecosystems. The authors explore the concept of resilience in the setup of reference sites focusing on the importance of interplay across different levels (e.g., population, community, species/individual). It might also help to discuss the concept of resistance to disturbance given its significance in understanding the integrity of an ecosystem and its key links with resilience. Note that there is a very strong reliance in the Oliver et al. 2015 citation and it would be beneficial to include other references that explore the concept including links to recovery from disturbance (e.g., Hodgson et al. 2015 https://doi.org/10.1016/j.tree.2015.06.010)

San Diego Water Board Response: The Draft Staff Report (Section 3.3) states that Ecological resilience is the degree to which an ecosystem can absorb, or withstand, environmental stress or disturbance, and still maintain self-organization (i.e., characteristic structure and function (Holling 1973; Gunderson and Holling 2001)). This discussion has been expanded and references to the suggested Hodgson publication, which provides a good concise summary, included.

Comment:
The SWAMP data led to the development of the California Stream Condition Index (CSCI) in 2015 using available benthic macroinvertebrate data. The use of the single 10th percentile threshold for the CSCI is typical within bioassessment frameworks (see RIVPACS program developed by the Environment Agency of England and Wales and the Australian AUSRIVAS program documentation and scientifically peer-reviewed publications as examples for their identification of reference condition). Indeed as described by the authors of the Draft Report, sites below the 10th percentile threshold are likely to be altered by single or multiple disturbances. The 10th percentile also balances the risk of Type I and Type II errors, thereby minimizing risk. However, the authors should also consider the potential for higher CSCI scores at reference sites. Within other national (e.g., RIVPACS and AUSRIVAS programs) and regional bioassessment programs, reference sites are identified in the band between the 10th and 90th percentiles of reference samples to provide the most conservative group of reference sites. Sites with reference samples >90th percentile represent sites with potential organic enrichment or a possible biological hotspot that warrants further investigation. Further, there should be an assessment of the potential uncertainty around a calculated CSCI value, for example adding confidence intervals around the proposed reference values?

San Diego Water Board Response: The San Diego Water Board concurs that the 10th percentile is appropriate to identify a degraded benthic macroinvertebrate and balances risk. As prescribed in prior responses, the proposed project would utilize existing tools to identify sites that might warrant further investigation, including those situations described in the comment. In regards to the potential uncertainty around a calculated CSCI value, there are multiple approaches that could be used to evaluate the level of confidence. The comment does not provide enough information regarding the context of need for the uncertainty, which is addressed on a project specific basis. It is presumed that the comment is in regards to the precision of the scoring (e.g. how much variability is there in a single sample (and thus score), therefore how representative is that score of the true population). This differs from setting the objective based on scores from the reference population, and that variability in site scores (which was incorporated into CSCI development). For example, the State of California's Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List requires that in order to determine if a stream's biological community is impaired, at least two samples from different stream stations or years must be assessed to provide replication and reduce uncertainty associated with potential variability in a single sample. The San Diego Water Board agrees that sites with very high CSCI scores should be investigated as biological hotspots. There is no evidence that such sites in the region exhibit organic over-enrichment (such as referenced for AUSRIVAS).

Comment:
The approach adopted for the CSCI that allows for reference sites within similar site types based on physical (non-anthropogenic) factors forms the base for calculation of variables from other scientifically-defensible reference condition approaches at both regional and national scales (e.g., AUSRIVAS, RIVPACS, etc.) Importantly the authors of the Draft Report discuss potential limitations relating to the calculation of CSCI scores. However, while the calculation of the CSCI allows for the prediction of the expected community in terms of compositional structure, it is unclear how this approach can assess the "functional organization of the community" as proposed by the authors of the Draft Report and this could be expanded within the Draft Report.

San Diego Water Board Response: The San Diego Water Board has added some additional language in the Draft Staff Report. The comment is a common one that often arises in the development of biological integrity indices that use observed/expected and community composition metrics. The linking of "biological integrity" and "functional organization of the community" has been addressed in the literature for over thirty years (e.g. see Karr and Dudley 1981). The utilization of the reference approach relies on the basic scientific principle, which is rooted in the Clean Water Act's discussions in committee, that the use of scientifically defined reference sites can be used as the baseline for determining the physical, chemical, and biological integrity of waters. Systems possessing this integrity are able to recover from or withstand natural (and some anthropogenic) perturbations because the functional organization of the community has not been changed due to anthropogenic activities. Essentially, the index score is a measurement of the attributes of the community that give that community its overall functional organization as an ecological system.

Comment:
The additional assessment of sites outside the 10th percentile of the reference distribution is important and the approach to consider additional measures for site status makes sense. However, further detail could be provided to formalise(sic) this assessment, for example how do the other methods of assessment align with the biological assessment? At what point is a site considered satisfactory by the San Diego Water Board? What if conflicts are observed across the different components? Are these sites reassessed over time?

San Diego Water Board Response:

The additional assessment of sites outside the 10th percentile would be conducted at the discretion of the San Diego Water Board, consistent with the implementation of narrative determination statements in other water quality objectives. To provide clarity and detail regarding the process, the additional assessment portion of the draft objective has been moved into the Basin Plan's implementation chapter. This move does not have a significant change on the objective itself or its implementation. The move provides clarity that the identification of sites with naturally low CSCI scores for compliance purposes is addressed through a current regulatory implementation process. This allows for site-specific details to be evaluated and determined by the San Diego Water Board though a set process, rather than attempting to include specific details for all sites within a water quality objective. There are potentially a wide range of implementation scenarios that could arise where the additional assessment could be appropriate, and such assessment is appropriate on a site-by-site basis in consideration of what natural factors may be impacting or precluding the use of the CSCI due to site specific conditions. For example, it may not be appropriate to utilize toxicity testing due to naturally occurring levels of a specific chemical, while physical habitat data may still be appropriately considered. In addition, the level of confirmation regarding naturally-occurring factors may vary from site-to-site.

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