COMMENTS ON THE CALIFORNIA RAPID ASSESSMENT METHOD FOR WETLANDS

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INTRODUCTION

The California Rapid Assessment Method for Wetlands (CRAM) is a methodology designed to support assessment and monitoring of all major wetland systems across all regions of the state. This review is intended to examine CRAM from the perspective of Corps of Engineers' regulatory responsibilities, specifically with regard to its potential applications in determining project impacts, conducting alternatives analyses, establishing compensatory mitigation requirements, and in monitoring mitigation projects to determine whether they are performing satisfactorily. These considerations are equally important in many planning applications, therefore this review may be of interest to persons involved in ecosystem restoration and similar initiatives that concern evaluation of wetland systems before and after changes to ecosystem processes or structure.

APPROACH

The perspective of this review is to evaluate whether CRAM includes the necessary elements of a rapid assessment technique, and whether it will likely perform as intended. In addition, the apparent strengths and limitations of CRAM are considered with particular reference to the performance of other wetland assessment approaches, particularly the Hydrogeomorphic Approach (HGM). This was accomplished primarily through review of a variety of documents and the CRAM website, and conversations with various experts in the development and application of wetland assessment approaches. No direct field testing was conducted for this review. However, my experience with California wetland and riparian ecosystems includes extensive sampling and assessment of riparian areas and, to a lesser extent, vernal pools in central and southern California. That experience was used to consider how CRAM might be applied in those systems, and the types of results that likely would be produced. My experience with California coastal systems and wetlands and riparian areas in northern California is much more limited and not sufficient to evaluate technical details (i.e., field sampling methods, appropriateness of condition indices, etc.) of CRAM with respect to those areas. However, my general comments concerning the structural and procedural elements of CRAM and its use in particular regulatory and planning scenarios is equally applicable across all systems and regions.

The principal documents consulted in the course of this review included the current version of the CRAM User's Manual (Collins et al. 2007), the CRAM Quality Assurance Plan (Fetscher et al. 2005), and an overview publication by Sutula et al. (2006). Other materials available through the CRAM website (www.cramwetlands.org) also were consulted. It should be noted that CRAM is constantly being updated and revised– several updates to the User's Manual have been issued during the course of this review– and it is possible that some of the questions or comments presented here have already been addressed somewhere in the extensive CRAM documentation.

ELEMENTS AND CHARACTERISTICS OF CRAM

1. Purpose

According to Fetscher et al. (2005):

> " The overall goal of CRAM is to provide a rapid, scientifically defensible, and repeatable assessment methodology that can be used routinely in wetland monitoring and assessment programs. Cram should be applicable to wetlands and streams through out the state of California. The general framework of CRAM should be consistent across wetland types and statewide, yet allow for customization to address special characteristics of different regions and wetland classes.
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> CRAM is designed for routine use in local, regional., and statewide wetland programs to monitor wetlands. It provides a consistent approach, without neglecting characteristic differences in wetland form or function between regions or between types of wetlands. CRAM is mainly intended for cost-effective, ambient monitoring and assessment at different scales, ranging from individual wetlands to watersheds, regions within the state, and to the state as a whole. The use of CRAM for ambient monitoring will, over time, help wetland managers and scientists quantify the relative influence of anthropogenic stress, management actions, and natural disturbance on the spatial and temporal variability in reference conditions. This information can then be used in the design, management, and assessment of wetland projects.
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> Additional, specific applications of CRAM could include: (1) preliminary assessments of wetland conditions and stressors to determine the need for intensive monitoring; (2) evaluation of wetland project performance under…(state, federal, and local laws and regulations)…and (3) assessment of restoration or mitigation progress relative to ambient conditions, reference conditions, and expected ecological trajectories."

The goal statement above, like other characterizations of CRAM in other documents, emphasizes monitoring as the principal purpose of CRAM. The method is not designed specifically to address the requirements of the Corps' regulatory and planning programs. However, the goal statement notes that the usefulness of CRAM for many of the potential applications of most interest to the Corps ("design, management and assessment" of wetland restoration and mitigation projects) will improve over time as experience and data accumulate as a result of monitoring. This implies that CRAM should not necessarily be expected to be particularly useful for those purposes at this early stage in its development and application. Like other rapid assessment approaches, CRAM is not intended to be used in lieu of more intensive approaches, such as species inventories or population estimates, where such detailed data is needed to meet regulatory, planning, or management needs.

2. Development

The development of CRAM has followed a stepwise progression of tasks designed to produce an assessment framework that is consistent across regions and wetland settings. Literature review, critical examination of existing assessment approaches, the construction of draft conceptual models and dissemination of interim products for review and field testing have all been important steps in the development process. More than most such efforts, the CRAM process has formalized the verification, calibration, and validation steps, and CRAM is actively maintained and updated through an online central repository for data as well as a website to disseminate new or revised information and schedule training opportunities. One reason that CRAM remains open-ended is that the developers recognize that a system this ambitious in scope will necessarily include areas that need considerable research and field testing before models and methods can be finalized. Thus the focus has been on developing a carefully defined framework, while the elements that populate that framework–the individual metrics, the ways they are measured and calibrated, etc. –are subject to change and refinement as the method is tested and the database of results grows larger. Similarly, the developers have alluded to the potential to create “add-on modules” to the core framework to address specific agency requirements, such as performance criteria tailored to regulatory monitoring needs.

3. Assumptions and components

CRAM incorporates many of the basic characteristics common to most rapid assessment methods. For example:

- Nearly all methods follow the lead of the original Habitat Evaluation Procedures (HEP) approach in using indirect indicators (e.g., habitat characteristics rather than animal counts) of system integrity or “health” and most aim to summarize their results in terms of an overall condition score or index. Depending on the intended use, that index can be multiplied by some spatial measure (acres, stream length, etc.) to generate units (e.g., Habitat Units in HEP or Functional Capacity Units in HGM).
- Most methods specify a region of applicability for the method, or for which its models have been calibrated, and they adopt a standardized classification system to divide the natural communities of the region into reasonably consistent and recognizable subtypes. In the case of CRAM, a hydrogeomorphic classification is used, but it is not highly subdivided into regional subclasses as it is in HGM.
- CRAM is intended to be fast, with a typical site assessment involving about a day, including both field time and data summarization and interpretation. This is a restriction common to most assessment approaches designed for routine use by natural resource agencies. Time and budget limitations usually dictate that

routine assessments must be handled quickly. The challenge in designing a comprehensive assessment tool is to maintain an acceptable level of technical rigor and precision while meeting the time restrictions.

- Most assessment methods, including CRAM, are based on a set of conceptual models that seek to capture key elements of ecological integrity, or condition, in terms of indicators of ecosystem structure or process that can be readily observed in the field or calculated from spatial data. These have been referred to as "crude logic models" in the context of HGM. In the case of CRAM, the conceptual models are concerned primarily with hydrology, community structure (physical and biological) and landscape context. The key elements of each conceptual model are captured in a series of narrative statements that identify the principal indicators of interest.

CRAM also differs in a number of important ways from most other assessment approaches, or it has unique characteristics that should be kept in mind when using it to conduct wetland assessments:

- CRAM uses conceptual models and indicators to reflect overall ecosystem functionality by means of a single condition score. The components of the score, the metrics used, and the field procedures are all based on what has been termed "organized professional judgment." In practice, this means that CRAM is largely the product of the combined professional experience of its authors and their numerous collaborators and that a certain degree of professional experience is required to apply the methodology effectively (which is true of all assessment approaches). Although the authors indicate that users must have, "at minimum, the skills and knowledge required to perform a wetland delineation," in fact there are elements of CRAM that require more of the user. For example, out-of-season assessments require "abundant experience," and application of many of the metrics requires considerable familiarity with the characteristics and management of specific systems. In some cases, such as the field assessment of stream entrenchment, it seems likely that considerable field experience will be needed before most users can reliably evaluate geomorphic settings, identify the bankfull stage, and similar requirements. Although the authors of CRAM acknowledge these problems within the discussion of the individual metrics, the overall impression left by the introductory materials is that CRAM training is sufficient to equip a user to apply the method in the field. This may be an overstatement in some instances.

- As with most other assessment approaches, the metrics used to generate the overall condition index largely reflect system reaction to stressors. In other words, the focus is on recognizing signs of functional degradation due to human influences. However, the developers of CRAM have taken care to keep condition metrics separate from direct observations of stressors, which are addressed in a "stressor checklist." The stressor checklists are not incorporated into the overall condition index, but are intended to provide insight into the reasons for condition scores that are less than optimal. Clearly, this also has direct applicability to restoration, and can help prevent common errors, such as trying to re-establish historic wetland communities where hydrology has been drastically altered.

- The developers of CRAM explicitly considered issues that had vexed developers of other assessment approaches with regard to the validity of using and combining metrics of differing scales (i.e., ordinal versus interval) and with different degrees of confidence and precision in their measurement (or estimation). All methods that attempt to consider a variety of factors, some more easily and accurately measurable than others, and to derive a single overall score representing ecosystem health or integrity, will be obliged to deal with the problem of combining unlike metrics. This has been the cause of much hand-wringing among developers of HEP, HGM, and other approaches, and all have come to the same basic conclusion as the authors of CRAM, which is that the practice of aggregating such data "…violates strict mathematical principals…," but that it is "necessary to allow managers to distill the large amounts of information associated with individual metric scores into overall assessments of condition" (Sutula et al. 2006).
- CRAM differs from HGM in the type of information produced by an assessment. CRAM generates a single condition score that combines multiple ecosystem processes and components. This approach tends to cause a loss of information, such that it is not apparent which components of the overall score are changing as a result of some action. It also tends to generate scores that cluster around the midrange, and are relatively insensitive to small or gradual changes. However, HGM has met with resistance from some potential users precisely because the final product of an HGM assessment is a set of condition scores (Functional Capacity Indices), which was intended to minimize the kinds of conceptual problems alluded to above (i.e., combining apples and oranges) and to make it more clear which specific functions are most likely to be impacted or improved by any particular proposed action. In practice, this has worked as intended up to a point. In particular it has informed discussions of mitigation options, allowing regional resource managers to determine that projected wetland losses influenced certain functions and not others, thereby providing flexibility in how those losses could be offset. Unfortunately, CE planners and regulators have struggled to use the multiple-score outputs of HGM in the context of Corps procedures and regulations, which generally call for a single number (e.g. "habitat units" or "functional units") to fuel calculations of impacts and mitigation requirements, or to be used in the planning process for ecosystem restoration projects. As a result, HGM data often are aggregated into a single index, like CRAM, despite the fact that the method is designed to allow analysis of differential effects on various wetland functions. Both CRAM and aggregated HGM scores can deconstructed to determine the principal functional impacts or improvements associated with any particular proposed action, but it seems likely that users will continue to want a single score to make most comparisons among project alternatives and similar applications.
- One advantage of CRAM not usually found in other assessment methods is the use of "stressor" evaluations as an adjunct to the wetland assessment process. This is specifically of use in suggesting effective restoration actions. Most assessment systems employ field indicators that focus on ecosystem structure, which tends to promote a focus on those structural attributes in the design of

restoration projects. Underlying processes that maintain and sustain wetlands, and the fundamental changes or chronic stresses that may interfere with those processes, often are assessed indirectly, if at all. CRAM specifically encourages identification of those stresses in a separate evaluation from the condition assessment procedure. This approach can be very useful in targeting restoration on process rather than structure, and can help identify "unrestorable" wetlands, where fundamental processes have been so completely altered that it is folly to attempt to re-establish historic conditions in terms of wetland composition and structure.

- One major difference between HGM and CRAM is the selection of reference systems for calibration of the metrics used in assessment models. HGM uses a combination of "least disturbed" and "best attainable" reference standards. In order to calibrate the condition indicators used in the HGM assessment models, sample data are collected from a large group of reference sites spanning the full known range of conditions along a the principal disturbance gradients influencing the regional wetland subclass. Samples representing the least disturbed condition are designated as the "reference standard," where all metric values are set to 1.0 (fully functional) on a scale of 0.0-1.0. Where the least disturbed condition is so rare (e.g., found only in isolated old-growth remnants), and so unlikely to be achieved within a reasonable time span on the majority of sites, then samples from sites designated as illustrating the "best attainable" condition are used to set the reference standard levels. Usually, these are a group of sites that are less than pristine, but are mature, self-sustaining systems with all structural elements in place and no serious chronic stressors evident. For example, reference standard forested wetlands in the southeast are generally uneven-aged stands with gap regeneration processes in place, several well-developed vegetation strata, a range of size classes in the woody debris layer, native soils, no significant infestation with exotic plant species, and no obvious alterations to hydrology. They are not, however, likely to be original, undisturbed, old-growth forests, nearly all of which were destroyed by 19th-and 20th century logging. In fact, using old growth as the reference standard would seriously compress the useful portion of the calibration curve for many variables. All other samples and their metric values are arrayed relative to the reference standard using any of various approaches, ranging from professional judgment in the field to direct gradient analysis and indirect multivariate methods.

  In contrast, CRAM uses the "culturally unaltered" condition as the reference standard. The idea is to improve the applicability of the reference standard across broad geographic areas. While HGM, HEP, and some other methods use continuous or interval numeric measures for many, if not all, metrics (e.g., tree basal area, shrub density, etc.) CRAM mostly uses narrative statements that try to capture a range of conditions. Generally, a set of 5 or so narrative statements are developed that are designed to capture the full range of conditions that might be encountered, and the user is supposed to select the statement that best matches the situation. The statements are intended to be mutually exclusive, and they are purposely kept to a minimum, with just a few intermediate states described between the extremes of the condition scale. While this approach is intended to maintain repeatability and consistency (i.e., various users are most likely to choose the same statement if only a few choices are offered), it has obvious drawbacks for the sensitivity of the system. In particular, this approach is highly susceptible to generating intermediate values across a very wide range of actual conditions, and of being unresponsive to fairly substantial changes within the intermediate ranges. This was the principal drawback of the original Wetland Evaluation Technique (WET), which was designed to apply to all wetlands nationally, and in the process lost most of its ability to discriminate among the most common examples of most wetland types. The metric descriptors used in CRAM have been crafted to avoid this danger as much as possible by eliciting very specific evaluations of actual site conditions, but the wide range of variation encompassed in most of the intermediate statements is still problematic.

- From the CE perspective, some of the most important potential applications of assessment approaches involve projecting future conditions to calculate specific gains or losses for with- and without-project scenarios, mitigation site development, and management effects. This was an integral part of the original HEP protocols, and has been shown to work well with HGM data. Such analyses can be based on stipulated future conditions based on professional judgment, but in order to make projections that can reflect rates of change and intermediate states of development, recovery trajectories should be developed. These exist for a subset of the available HGM guidebooks and have been used to evaluate project alternatives and mitigation scenarios for major CE projects as well as permit applications. The data needed to develop such trajectories are best assembled as part of the reference data collection process (Klimas 2006), and are not currently a focus of CRAM development. However, given the stated intention of the CRAM developers to actively maintain, build, and use the database to improve the approach, it seems appropriate that one important target would be to develop recovery trajectories suitable for generating future scenarios under conditions of interest to planning and regulatory offices of the Corps, EPA, and State agencies. This could be accomplished by having users characterize their assessment sites in terms of the time since disturbance, and to make a special effort to assess restoration sites of various ages.

SUMMARY

The logic, science, and structure of CRAM are consistent in most respects with the elements of various other rapid assessment approaches. CRAM employs a hydrogeomorphic classification and uses a “culturally unaltered” reference standard to facilitate general applicability to wetlands statewide. The output of the method is a single “condition score” for the assessment area, comprising the combined separate assessment scores for Landscape, Hydrology, and Physical and Biotic Structure. CRAM also provides the user with a separate “stressor checklist” to help identify sources of ecological degradation. The methods for applying CRAM in the field are fairly clear, and though the User’s Manual is a large and complex document, a set of Field Books” recently appeared on the CRAM website that extract only the guidance and data forms required to assess specific wetland classes (i.e., Estuarine, Riverine, and Depression wetlands). The construction and maintenance of a database to record results from all CRAM applications is a unique aspect of the CRAM program, with the potential to improve and refine CRAM continually as the knowledge base increases. Ongoing efforts to test the method and provide training to users are integral to the overall CRAM program, and new developments are regularly posted to a website. Overall, CRAM development and support programs have been well thought out and the result is a scientifically defensible product that can be used for most of the applications for which it is intended. For example, it appears to be well suited to monitoring, as illustrated in the "Wetland Tracker" demo available through the CRAM website. In some areas, CRAM falls short of meeting the needs of current Corps planning and regulatory offices, as described below. However, CRAM is specifically intended to be continually refined and adapted to new purposes, and the comments below are offered primarily to suggest potential areas for further development.

The CRAM User's Manual and other documents describing the system make various generalizations about the broad applicability of CRAM and the relatively low level of skill and experience required to use it. However, there are numerous potential exceptions, some of which are noted, but perhaps not emphasized sufficiently. While CRAM is designed to apply across all "major wetland types," in fact it cannot be applied as written in many settings. The User's Manual notes that CRAM is designed to be adapted to special circumstances as needed, and points out some examples (e.g., playa lakes are naturally "simple systems" and the CRAM emphasis on spatial diversity is inappropriate in them), but it does not appear to do so consistently. Similarly, the need for specialized experience to correctly interpret many indicators is underemphasized. The stated minimum requirement that users should be capable of delineating wetlands is unlikely to insure that they can recognize areas with altered hydroperiods, or characterize the grazing programs used in vernal pool landscapes, or otherwise apply criteria that require experience more than training. Considerable frustration might be avoided if new users are advised to bring experienced help in certain situations.

One potential limitation of CRAM derives from the effort to encompass all wetlands statewide within a single framework. The authors indicate that the system is structured to avoid one of the chief drawbacks to the HGM approach, which requires extensive field efforts to construct reference systems that may have fairly limited geographic applicability. By using narrative statements (rather than calibrated response curves) and setting the reference standards based on the culturally unaltered condition, CRAM aims to avoid the need to develop highly localized assessment criteria applicable only to particular wetland types within particular regions. However, in the end, the generalized assessment criteria must be subdivided anyway, excluding some wetland types or special situations, and CRAM becomes more complex than originally intended. A potentially greater drawback is that the statewide generalization approach and the combination of all metrics into a single grand condition score may not produce sufficient discrimination among wetlands of moderately different condition classes to be useful in some situations. It is likely that CRAM assessments will discriminate clearly between high-quality wetlands versus low-quality wetlands, but it seems unlikely to discriminate well among intermediate-quality wetlands because of the wide variety of conditions encompassed by the two or three descriptors in the intermediate range of the narrative assessment ratings. Most permit applications and large-scale projects avoid impacts to pristine wetlands, therefore intermediate and low-quality wetlands are going to be the focus of most regulatory and planning assessments using CRAM. The careful wording and detailed illustrations in the User's Guide will minimize this problem as much as possible, guiding users to select the correct narrative statement in most instances, but whether the overall results are sufficient to make clear choices among alternative actions remains to be seen.

Like other assessment approaches, CRAM can be used to assist in planning and designing restoration projects. Most CRAM metrics are defined in terms of field indicators that reflect physical and spatial attributes of wetland and riparian ecosystems. In that regard, they also provide restoration criteria in terms of targets for plant community structure, site diversity and connectivity, etc., that can be incorporated directly into the restoration design. With other assessment systems, this has been a potential pitfall, in that it encourages "designing to the metric," which might not always produce the best overall restoration, especially where fundamental processes and dynamics have been altered. However, the "stressor checklist" incorporated into CRAM provides an excellent adjunct tool for restoration planning, particularly with respect to identifying critical limitations on ecosystem recovery.

The existing CRAM User's Manual does not provide many specifics with regard to potential applications. The latest version of the Manual includes some example graphics for presenting CRAM results (Figure 3.7), but most potential users would likely appreciate a set of specific examples of CRAM applications to monitoring and other uses, perhaps in the form of case studies compiled on the CRAM website. In particular, there is no guidance provided on the use of CRAM to evaluate the adequacy of compensatory mitigation proposals. A full evaluation of competing impact and mitigation scenarios requires the projection of future conditions with- and without-project and with various restoration/mitigation alternatives. No tools, such as recovery trajectories, or specific recommendations or examples are provided for adapting CRAM for use in such situations. Without them, certain Corps responsibilities cannot be met using CRAM alone, at least in its existing format and under existing CE regulations. In particular, where the Corps planning process calls for calculation of annualized gains and losses of "environmental benefits," the current CRAM output is likely to be inadequate. To be fair, most other existing assessment systems are equally unsuited to the task – currently only HEP and a limited group of HGM guidebooks are structured to support calculation of annualized units that reflect variable rates of wetland condition recovery or loss. To a certain extent, this weakness in CRAM may be addressed over time as the database grows and new information is applied to the refinement of CRAM. However, some specific effort should be directed toward incorporating projections of future conditions into the CRAM methodology, and the user's guide or web site should include examples of how to apply CRAM across a variety of potential planning and regulatory scenarios.

Overall, this review indicates that CRAM is a reasonable and well-supported approach to wetland assessment, it should be applicable to most situations encountered in the field, and it likely can be applied rapidly and consistently. The structure of CRAM may prevent it from being sensitive to moderate or gradual changes in wetlands, particularly in the most common, moderately disturbed or impaired conditions. Future development should include clear guidance on how the method can be used in typical monitoring, planning, and regulatory scenarios. One important focus of future work should be the development of tools to predict the rate and extent of change over time in response to restoration actions, at least for some of the more common wetland communities, since the calculation of compensatory mitigation requirements and establishment of performance criteria would be major potential applications of CRAM for a variety of agencies.

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