GCDAMP 2019-20 ‘Knowledge Assessment’ Guidance

*Glen Canyon Dam Adaptive Management Program  
November 13, 2019*

# Introduction to the Knowledge Assessment

This document presents the rationale and methods for a Knowledge Assessment (KA) for the Glen Canyon Dam Adaptive Management Program (GCDAMP) Technical Work Group (TWG). The GCDAMP advises the Secretary of the Interior (Secretary) on:

* Meeting environmental and cultural commitments.
* Long-term monitoring and the status of resources.
* Studies undertaken to increase knowledge of the effects of routine and experimental dam operations, other management actions, and environmental factors on key resource values.
* Activities undertaken to comply with applicable laws.

The GCDAMP carries out a substantial program of monitoring and research, and manages large bodies of data and knowledge, in order to advise the Secretary on these topics. The ultimate purpose of this advice is to sustain a robust program of adaptive management.

The GCDAMP periodically undertakes a review of the knowledge on which it bases its advice to the Secretary. This knowledge and advice crucially help inform the decisions of the Secretary concerning adaptive management of dam operations and their impacts. The review – here termed a ‘knowledge assessment’ – assesses the knowledge, and the reliability or certainty of the knowledge, for three broad objectives, to: (1) summarize what is known; (2) assess ongoing needs for monitoring to sustain crucial knowledge; and (3) identify crucial gaps and weaknesses in this knowledge that require attention.

This KA is intended as a planning tool to help the TWG with developing a recommendation to the Adaptive Management Work Group for the FY21-23 Budget and Work Plan. It is a part of a broader process of information gathering and assessment used for the GCDAMP that also includes but is not limited to formal consultations (e.g., tribal government to federal government consultations), Annual Reporting meetings, TWG meetings, and TWG ad hoc group meetings. For example, the outcomes of this KA are intended to be used by the Budget Ad Hoc Group to help organize discussions of potential work activities to be considered for the FY21-23 Budget and Work Plan. Because this document describes only a western scientific knowledge assessment approach and not a traditional ecological knowledge (TEK) assessment approach, the product from this effort is only a part of a broader assessment of knowledge. A TEK assessment approach is expected to be piloted this year so it is important to again note that this western scientific knowledge assessment is only part of a broader assessment of knowledge.

Subject matter experts are expected to lead much of the KA process described in this guidance document and to generate most of its information. Others, though, are encouraged to participate in the process because participation is itself a pathway for gaining awareness and knowledge.

Dates and times for meetings and calls will be posted on the gcdamp.com WIKI to facilitate broad participation. This part of the KA is expected to be completed by the January Annual Reporting Meeting but to accomplish this work by then, resource team leads may not have the flexibility to schedule meetings and calls to accommodate every interested participant.

# Knowledge Assessment Structure

The present Knowledge Assessment seeks to present its findings in the form of a set of simple tables that facilitate both the compilation and communication of findings. A set of easily understood, graphical symbols will be used to summarize the findings to further simplify their communication. The approach presented below represents the second iteration of a trial approach, toward establishing a standard assessment process that can be repeated with minimal effort. Lessons learned from the 2017 Knowledge Assessment have been considered herein.

The Glen Canyon Dam Long-Term Experimental and Management Plan, Final Environmental Impact Statement (LTEMP FEIS) (2016) focuses on the following resource topics (shown in alphabetical order):

* Air quality
* Aquatic food base
* Archaeological and cultural resources
* Climate change
* Humpback chub
* Hydropower and energy
* Invasive fish species
* Other native fish species
* Rainbow trout fishery
* Recreational experience
* Riparian vegetation
* Sediment
* Tribal resources
* Water delivery
* Water quality
* Wildlife

The 2017 Knowledge Assessment focused on a subset of the topics in this master list, consisting of the following eleven priority resource topics (shown in alphabetical order):

|  |  |
| --- | --- |
| * Aquatic food base | * Rainbow trout fishery |
| * Archaeological and cultural resources | * Recreational experience |
| * Humpback chub | * Riparian vegetation |
| * Hydropower and energy | * Sediment |
| * Invasive fish species | * Water quality |
| * Other native fish species |  |

Given feedback from the TWG, the present Knowledge Assessment will focus on a subset of the topics in the 2017 list, consisting of the following nine priority resource topics (shown in alphabetical order):

|  |  |
| --- | --- |
| * Aquatic food base | * Rainbow trout fishery |
| * Humpback chub | * Recreational experience |
| * Hydropower and energy | * Sediment |
| * Invasive fish species | * Water quality |
| * Other native fish species |  |
|  |  |

The present Knowledge Assessment recognizes that the topic on the master list, “Tribal resources,” in fact refers not to a separate set of resources, but rather to the same resources of interest to the GCDAMP as a whole, considered from the standpoint of traditional values among the several Native American tribal constituents of the GCDAMP. A lesson learned from the 2017 Knowledge Assessment is that this western scientific Knowledge Assessment approach is unsuitable for considering traditional perspectives of the several Native American tribal constituents of the GCDAMP. A different approach needs to be developed to consider “Tribal resources” properly. During the October 2019 TWG meeting, the TWG discussed how traditional perspectives and knowledge could be documented as part of the broader KA process. There was agreement to have the tribal representatives of the TWG develop ‘one-pager’ type documents to describe their perspectives and knowledge. Note, tribal representatives are also key participants in the process described in this guidance document.

Specifically, the present Knowledge Assessment seeks to answer three sets of questions for each of the nine selected resource topics, from a scientific perspective:

1. **Status and Trend**
   1. What is our present understanding (hypotheses) concerning the status of the condition(s) addressed by the topic? (Note, quantifiable objectives have not been developed for most resource topics, therefore, a lesson learned from the 2017 Knowledge Assessment was that this question may not be appropriate for all resource topics).
   2. What is our present understanding (hypotheses) concerning the strength and direction of any trend(s) in these conditions?
   3. How certain or uncertain is this understanding (confidence)?
2. **Drivers and Constraints** *(see definition later in document)*
   1. What is our present understanding (hypotheses) concerning the factors (drivers and constraints – see definitions below) that significantly shape the status and trends in these conditions?
   2. What is our present understanding (hypotheses) concerning the strength and direction of these effects?
   3. How certain or uncertain is this understanding (confidence)?
3. **Effects of Management Actions**
   1. What is our present understanding (hypotheses) concerning the ways in which each type of GCDAMP management action affects or could affect the status and trends in these conditions?
   2. What is our present understanding (hypotheses) concerning the strength and direction of these effects?
   3. How certain or uncertain is this understanding (confidence)?

The last of these three sets of questions may focus on the following actions, identified in the LTEMP FEIS as components of the Selected Alternative[[1]](#footnote-1) and in other agency decision documents (Note, a lesson learned from the 2017 Knowledge Assessment was that not all management actions need to be evaluated every year.):

|  |  |
| --- | --- |
| * Spring HFEs[[2]](#footnote-2) ≤ 45,000 cfs in March or April | * Humpback chub translocation |
| * Proactive Spring HFEs ≤ 45,000 cfs in April, May, or June | * Mechanical removal of rainbow trout from LCR[[3]](#footnote-3) reach |
| * Fall HFEs ≤ 45,000 cfs in October or November | * Mechanical removal of invasive fish species |
| * Fall HFEs > 96‐hr duration | * Larval humpback chub head-start program |
| * Trout management flows | * Riparian vegetation restoration (not assessed for 2019-20) |
| * Macroinvertebrate production flows | * Incentivized harvest (new for 2019-20) |

Through its answers to the three core questions presented above, the present Knowledge Assessment seeks to:

* Summarize information on status, trends, and the state of knowledge for the nine priority resource topics, from a scientific perspective.
* Summarize expectations about the likely effects of proposed LTEMP management actions.
* Document the state of knowledge of how antecedent conditions, as well as external drivers and constraints, may affect the outcomes of different management actions.
* Identify potential needs for continuing, increasing, reducing, revising, or adding monitoring, research, and other information-gathering efforts to address potentially crucial gaps in knowledge.

The present Knowledge Assessment employs a set of standard tables and methods to ensure consistency in each of these four tasks among the teams of experts who will carry out the actual review and respond to feedback on their results from the remainder of the GCDAMP Technical Work Group. This standard methodology in turn will make it easier to maintain and update the resulting information. Future Knowledge Assessments likely will also update these methods.

The remainder of this document provides guidance for using a set of tables and definitions to carry out the Knowledge Assessment. These tables allow the preparers (expert teams) to summarize their answers to these three sets of questions for each resource topic, summarize the rationale for their answers, and present recommendations for monitoring and research to address crucial gaps in knowledge.

# Assessing Status and Trend

The GCDAMP knowledge assessment of status and trend for each resource topic uses a standard table, an image of which is shown below (*not shown actual size*). A separate spreadsheet provides the actual (blank) table template. The methodology for the review of status and trend is adapted from the methods established by the National Park Service for its Natural Resources Condition Assessments (<http://www.nature.nps.gov/water/nrca/>) (NPS 2014), with some additions adapted from the Sacramento-San Joaquin Delta Ecosystem Restoration Program ([https://www.dfg.ca.gov/ERP/ conceptual\_models.asp](https://www.dfg.ca.gov/ERP/%20conceptual_models.asp)) (DiGennaro et al. 2012).



The table recognizes that GCDAMP investigators typically focus on several specific characteristics, conditions, or variables for each resource topic. For example, the investigations of sediment focus on sandbar area, sediment storage in sandbars and within-channel deposits, both total storage and its spatial distribution, and sediment transport as both suspended sediment and bedload. Similarly, the investigations of the aquatic food base focus on overall biomass productivity, overall species diversity, the relative proportions of particular species of both algae and aquatic macroinvertebrates, and how these vary over time and space.

Additionally, GCDAMP investigators may track each characteristic, condition, or variable using one or more specific, *technical measures*. These technical measures often are defined in existing investigative protocols. For example, the assessment of sediment storage described in the current (FY18-20) Triennial Work Plan relies on a battery of technical measures, including yearly conventional topographic surveys of volume and area at 47 high-elevation sandbar sites, estimates of area based on daily imagery from remotely deployed digital cameras at 42 high-elevation sandbar sites, remote sensing of area at > 1000 high-elevation sandbar sites every four years, conventional topographic surveys of volume and area at high-elevation sandbars in 30 to 80-mile segments every 3 to 10 years, and combined bathymetric and topographic surveys of low-elevation fine-sediment storage volume in in 30 to 80-mile segments every 3 to 10 years.

However, previous investigations may not yet have defined technical measures for all specific characteristics, conditions, or variables of interest for each resource topic. In these latter circumstances, whenever possible, the person or team preparing the status/trend table for the resource topic should identify one or more technical measures that could provide information on the specific characteristics, conditions, or variables of interest. A subsequent rating of “Low” for confidence (see below) should then reflect the absence of established or well-defined technical measures for the characteristics, conditions, or variables of interest.

The person or team preparing the status/trend table for an individual resource topic must assess present understanding of *each technical measure* on three dimensions: the current status of the characteristic, condition, or variable; any trend(s) in this status; and confidence in the status and trend assessments. The person or team preparing the table for an individual resource topic also must provide a brief rationale for the resulting ratings for status/trend and confidence; and may also offer recommendations for monitoring and research to address crucial gaps in knowledge.

Note, the person or team preparing the status/trend table should include the most important but least number of resource characteristics and technical measures as is feasible. An outcome of this approach is that some characteristics that have importance will not be included which may be a cause for concern. A lesson learned from the 2017 Knowledge Assessment, however, was that having too many resource characteristics and techincal measures is a concern because the large amount of information is itself an obstacle for understanding. The present Knowledge Assessment aims to test a different approach to determine if the information can be made more useful. The definitions and rating levels for assessing status, trend, and confidence are as follows:

## Status (Rating Definitions)

Note, some but not all resource topics have formal condition targets, therefore, resource topics that have undefined condition targets should be identified as “Unknown” (see “Unknown” definition below).

* Resource is in Good Condition: The resource characteristic, or its specific technical measure, lies within an acceptable range of condition. This range may be a reference range, or a target specified in some management policy or guidance.
* Condition Warrants Moderate Concern: The resource characteristic, or its specific technical measure, lies outside its acceptable range of condition but could be improved through the application of existing management methods without significant changes in management policies or expenditures.
* Condition Warrants Significant Concern: The resource characteristic, or its specific technical measure, lies outside its acceptable range of condition and cannot be improved through the application of existing management methods without significant changes in management policies or expenditures.
* Unknown: (1) There is not sufficient information about the resource characteristic or its specific technical measure, to assess for evidence of status. This rating typically calls for ratings of “Unknown” for trend and “Low” for confidence. However, in some cases it may be possible to assess trend but not status. In such cases the user must explain why it is possible to assess trend but not status. Or (2) the acceptable range of condition has not yet been defined for the resource characteristic or its specific technical measure.

## Trend (Rating Definitions)

Note, resource topic trends are not to be evaluated as “Improving” or “Deteriorating” as was used in the 2017 Knowledge Assessment. Instead, trends should be evaluated as “Increasing” or “Decreasing” (see definitions below).

* Condition is Increasing: The resource characteristic, or its specific technical measure, shows an increasing trend since the 2017 Knowledge Assessment or, if a condition target exists, toward or further into its acceptable range of condition.
* Condition is Unchanging: The resource characteristic, or its specific technical measure, shows no trend since the 2017 Knowledge Assessment, or if a condition target exists, no trend of either improvement or deterioration in condition.
* Condition is Decreasing: The resource characteristic, or its specific technical measure, shows a decreasing trend since the 2017 Knowledge Assessment, or if a condition target exists, away or departing from its acceptable range of condition.
* Unknown: There is not sufficient information about the resource characteristic or its specific technical measure, to assess for evidence of any trend.

## Confidence (Rating Definitions)

Note, not all sources of evidence or knowledge bear equal weight. It is critical for the resource teams to strictly follow the definitions below.

* High: Current understanding of status and trend is subject to little or no disagreement or uncertainty among investigators and in peer-reviewed studies; is supported by substantial, high-quality, documented expert knowledge and/or evidence and, where appropriate, by well-accepted statistical analyses; and is consistent with well-accepted principles in the relevant fields of knowledge and/or with studies in highly analogous systems.
* Medium: Current understanding of status and trend is subject to moderate disagreement or uncertainty among investigators and among peer-reviewed studies; and is supported by some documented expert knowledge and/or evidence and analyses. The expert knowledge and/or evidence and analyses may be limited or subject to methodological weaknesses, but nevertheless may be consistent with well-accepted principles in the relevant fields of knowledge and/or with studies in highly analogous systems.
* Low: Current understanding of status and trend is subject to substantial disagreement or uncertainty among investigators and among peer-reviewed studies; is supported by only limited or undocumented expert knowledge and/or evidence and analyses that may also be subject to methodological weaknesses; and may be inconsistent with well-accepted principles in the relevant fields of knowledge and/or with studies in highly analogous systems. Ratings of “Unknown” for status and/or trend typically receive ratings of “Low” for confidence.

## Data Entry

The person or team preparing the status/trend table for an individual resource topic will proceed through the following steps:

1. Rename the file to identify the resource topic being addressed, by inserting the correct information in the two places provided in the Master Template file name [**GCDAMP KA Tables v2 (insert impact topic name) (insert version date).xlsx**]. Note, if a 2017 Knowledge Assessment table was prepared, that table should be used. The following steps, therefore, should mostly consist of verifying that the 2017 Knowledge Assessment information is still valid and updating information as appropriate.
2. Insert in Row 2 the name of the resource topic being addressed, by selecting the appropriate name from the provided drop-down list. The definitions for the Resource Topic entries are provided in the ‘Topic & Action Labels’ worksheet (tab).
3. Enter the information in Rows 3 and 4 for the names of the table preparer(s) and the preparation date.
4. Enter the requested information in Rows 7 onward for each technical measure, for each resource characteristic of interest. The values for Status, Trend, and Confidence are entered by selecting the appropriate value from the provided drop-down lists. The definitions for the values in these lists are provided in the ‘Scoring Values’ worksheet (tab).
5. See below for instructions on Reporting Rationales and Reporting Recommendations.

# Assessing Drivers and Constraints

Drivers and constraints consist of environmental conditions and dynamics – including human actions – that determine the quality, abundance, spatial or temporal distribution, or other characteristics of some condition. A causal relationship exists between a driver or constraint and some characteristics of a condition when a change in the driver or constraint results in a change in the characteristic. Note, assessing drivers and constraints in this way should help with the conceptual understanding of these resources.

GCDAMP management actions also constitute potential drivers of conditions in the Colorado River ecosystem. However, the present Knowledge Assessment addresses the effects of management actions separately, as discussed later in this guidance document.

The GCDAMP knowledge assessment of drivers and constraints for each resource topic again uses a standard table, an image of which is shown below (*not shown actual size*). A separate spreadsheet again provides the actual (blank) table template. The methodology for the review of potential drivers and constraints is adapted from the logic of the National Park Service for its Natural Resources Condition Assessments (<http://www.nature.nps.gov/water/nrca/>) (NPS 2014), with critical additions adapted from the Sacramento-San Joaquin Delta Ecosystem Restoration Program ([https://www.dfg.ca.gov/ERP/ conceptual\_models.asp](https://www.dfg.ca.gov/ERP/%20conceptual_models.asp)) (DiGennaro et al. 2012).



The drivers/constraints table recognizes that GCDAMP investigators typically recognize multiple drivers and constraints, which they estimate (hypothesize) may significantly affect status and trends for each resource topic. The person or team preparing the “drivers and constraints” table for an individual resource topic must first list all the drivers and constraints of potential interest. For example, the assessment of sediment storage described in the current (FY18-20 Triennial Work Plan recognizes needs to understand the effects of sediments inputs from the Paria and Little Colorado Rivers as well as minor tributaries, the effects of channel macro- and meso-scale geometry on sediment storage and transport, and the effects of submerged vegetation on the output from various methods for mapping river bed composition. Similarly, studies of the aquatic food base indicate that overall productivity can vary in response to variation in water temperature, chemical composition, and turbidity; the duration of sunlight hitting the channel; and variation in flow velocity and stage and their consequences for the timing and duration of exposure of channel substrates. Each of these drivers or constraints in turn may be shaped by additional drivers or constraints. For example, water temperature varies with conditions in the Glen Canyon Dam forebay, dam operations, and air temperature. Turbidity varies with mineral precipitation and transport along the Little Colorado River and suspended sediment transport along both the Little Colorado and mainstem Colorado Rivers, where it varies with sediment storage, sediment inputs, and river discharge. The duration of sunlight hitting the channel varies with cloud cover, season, and several aspects of canyon geometry. The person or team preparing the drivers/constraints table must decide which drivers or constraints to include in the table, based on those drivers or constraints identified by the literature and investigators as important for consideration by the GCDAMP.

The person or team preparing the drivers/constraints table must then assess each hypothesized driver or constraint on three dimensions: the hypothesized strength of the effect that the driver or constraint has on some characteristic, condition, or variable of interest; the hypothesized direction of this effect; and confidence in these assessments. The person or team preparing the drivers/constraints table for an individual resource topic also must provide brief rationale for the resulting ratings; and may also offer recommendations for monitoring and research to address crucial gaps in knowledge. The definitions and rating levels for assessing strength, direction, and confidence are as follows.

## Strength of Effect (Rating Definitions)

* Strong: Even a relatively small change in the driver or constraint of interest will result in a relatively large change in the affected condition (or, in the case of resource topics that condition is not assessed, the condition trend), and this cause-effect relationship is not significantly subject to random variation or affected by variability in other factors.
* Moderate: The driver or constraint of interest must undergo a relatively large change in order to cause a relatively large change in the affected condition (or, in the case of resource topics that condition is not assessed, the condition trend); and/or this cause-effect relationship is subject to moderate random variation or is moderately affected by variability in other factors.
* Weak: Even a relatively large change in the driver or constraint of interest will result in only a relatively small change in the affected condition (or, in the case of resource topics that condition is not assessed, the condition trend); and/or this cause-effect relationship is subject to significant random variation or is strongly affected by variability in other factors.
* Unknown: There is not sufficient information, with which to evaluate the strength of the cause-effect relationship, even though there is sufficient information to support a hypothesis that at least some type of cause-effect relationship may exist. This rating typically would call for ratings of “Unknown” for the direction of effect and “Low” for confidence. However, in some cases it may be possible to estimate the direction but not the strength of an effect. In such cases the user must explain why it is possible to assess the direction but not the strength of the effect.

## Direction of Effect (Rating Definitions)

Note, the 2017 Knowledge Assessment used the terms “Positive Effect” and “Negative Effect” but those terms are not used in the present Knowledge Assessment. A lesson learned from the 2017 Knowledge Assessment was that those terms were interpreted by some persons and teams to be value-based judgements instead of fact-based judgements. This Knowledge Assessment aims to avoid concerns with potentially co-mingling subjective and objective information by focusing on if the direction of effect is simply “Increasing” or “Decreasing” (see definitions below).

* Increasing Effect: An increase in the magnitude, duration, frequency, or spatial extent of the driver or constraint consistently results in an increase in quality, abundance, and/or spatial and temporal distributions of the affected condition.
* Decreasing Effect: An increase in the magnitude, duration, frequency, or spatial extent of the driver or constraint consistently results in a decrease in quality, abundance, and/or spatial and temporal distributions of the affected condition.
* No Effect: An increase or decrease in the magnitude, duration, frequency, or spatial extent of the driver or constraint does not consistently result in an increase or decrease in quality, abundance, and/or spatial and temporal distributions of the affected condition.
* Unknown: There is not sufficient information, with which to evaluate the direction of effect.

## Confidence (Rating Definitions)

Note, not all sources of evidence or knowledge bear equal weight. It is critical for the resource teams to strictly follow the definitions below.

* High: Current understanding of the proposed cause-effect relationship is subject to little or no disagreement or uncertainty among investigators and in peer-reviewed studies; is supported by substantial, high-quality, documented expert knowledge and/or evidence and, where appropriate, by well-accepted statistical analyses; and is consistent with well-accepted principles in the relevant fields of knowledge and/or with studies in highly analogous systems.
* Medium: Current understanding of the proposed cause-effect relationship is subject to moderate disagreement or uncertainty among investigators and among peer-reviewed studies; and is supported by some documented expert knowledge and/or evidence and analyses. The expert knowledge and/or evidence and analyses may be limited or subject to methodological weaknesses, but nevertheless may be consistent with well-accepted principles in the relevant fields of knowledge and/or with studies in highly analogous systems.
* Low: Current understanding of the proposed cause-effect relationship is subject to substantial disagreement or uncertainty among investigators and among peer-reviewed studies; is supported by only limited or undocumented expert knowledge and/or evidence and analyses that may also be subject to methodological weaknesses; and may be inconsistent with well-accepted principles in the relevant fields of knowledge and/or with studies in highly analogous systems. Ratings of “Unknown” for the strength and/or direction of an effect typically receive ratings of “Low” for confidence.

## Data Entry

The person or team preparing the drivers/constraints table for an individual resource topic will proceed through the following steps:

1. Check that the file name correctly identifies the resource topic being addressed (see instruction #1 for status/trend tables, above). Note, if a 2017 Knowledge Assessment table was prepared, that table should be used. The following steps, therefore, should mostly consist of verifying that the 2017 Knowledge Assessment information is still valid and updating information as appropriate.
2. Insert in Row 2 the name of the resource topic being addressed, by selecting the appropriate name from the provided drop-down list. The definitions for the Resource Topic entries are provided in the ‘Topic & Action Labels’ worksheet (tab).
3. Enter the information in Rows 3 and 4 for the names of the table preparer(s) and the preparation date.
4. Enter the requested information in Rows 7 onward for each resource characteristic of interest. The person or team preparing the table is responsible for entering the names of the drivers and constraints of interest. The values for Strength, Direction, and Confidence are entered by selecting the appropriate value from the provided drop-down lists. The definitions for the values in these lists are provided in the ‘Scoring Values’ worksheet (tab).
5. See below for instructions on Reporting Rationales and Reporting Recommendations.

# Assessing Effects of Management Actions

The GCDAMP seeks to manage the impacts of dam operations and related actions on the Colorado River ecosystem. GCDAMP management actions constitute a distinct subset of drivers that cause or potentially could cause changes in the quality, abundance, spatial and temporal distributions, or other characteristics of a resource or other condition. As noted above, the present Knowledge Assessment addresses the effects of management actions separately from the effects of other drivers and constraints, as discussed earlier in this guidance document. The GCDAMP relies on knowledge of these effects – known or hypothesized – to guide its actions.

The GCDAMP knowledge assessment of the potential effects of each type or management action on each resource topic again uses a standard table, an image of which is shown below (*not shown actual size*). A separate spreadsheet again provides the actual (blank) table template. The methodology for the review of the potential effects of the various types of management actions is adapted from the logic of the National Park Service for its Natural Resources Condition Assessments (<http://www.nature.nps.gov/water/nrca/>) (NPS 2014), with critical additions adapted from the Sacramento-San Joaquin Delta Ecosystem Restoration Program ([https://www.dfg.ca.gov/ERP/ conceptual\_models.asp](https://www.dfg.ca.gov/ERP/%20conceptual_models.asp)) (DiGennaro et al. 2012).



The table again (as with the assessment of status and trend) recognizes that GCDAMP investigators typically focus on specific characteristics, conditions, or variables for each resource topic; and may track each characteristic, condition, or variable using one or more specific, technical measures. The person or team preparing the table on the potential effects of various types of management actions on each resource topic must assess present understanding of *each technical measure* on three dimensions: the hypothesized strength of the effect that the management action type has on the measure of interest; the hypothesized direction of this effect; and confidence in these assessments. As noted above for the status/trend tables, previous investigations may not yet have defined consistent technical measures for all specific characteristics, conditions, or variables of interest for each resource topic. In these circumstances, the person or team preparing the management/effects table for the resource topic should use whatever technical measures were proposed in the accompanying status/trend table. A subsequent rating of “Low” for confidence (see below) should then reflect the absence of established or well-defined technical measures for the characteristics, conditions, or variables of interest and the ways in which management actions might affect them.

The person or team preparing the management/effects table for an individual resource topic also must provide brief rationale for the resulting ratings; and may also offer recommendations for monitoring and research to address crucial gaps in knowledge. The definitions and rating levels for assessing strength, direction, and confidence are as follows. The definitions for strength and direction of effect differ from those applied to drivers and constraints, above, in asking the person or team preparing the table to consider also how each action causes *or could cause* some effect.

## Strength of Effect (Rating Definitions)

* Strong: The management action causes or could cause a relatively large change in the affected measure or condition (or, in the case of resource topics that condition is not assessed, the condition trend), and this cause-effect relationship is not significantly subject to random variation or affected by variability in other factors.
* Moderate: The management action causes or could cause a relatively moderate change in the affected measure or condition (or, in the case of resource topics that condition is not assessed, the condition trend), and/or this cause-effect relationship is subject to moderate random variation or is moderately affected by variability in other factors.
* Weak: The management action causes or could cause only a relatively small change in the affected measure or condition (or, in the case of resource topics that condition is not assessed, the condition trend), and/or this cause-effect relationship is subject to significant random variation or is strongly affected by variability in other factors.
* Unknown: There is not sufficient information, with which to evaluate the strength of the cause-effect relationship, even though there is sufficient information to support a hypothesis that at least some type of cause-effect relationship may exist. This rating typically would call for ratings of “Unknown” for the direction of effect and “Low” for confidence. However, in some cases it may be possible to estimate the direction but not the strength of an effect. In such cases the user must explain why it is possible to assess the direction but not strength of the effect.

## Direction of Effect (Rating Definitions)

Note, the 2017 Knowledge Assessment used the terms “Positive Effect” and “Negative Effect” but those terms are not used in the present Knowledge Assessment. A lesson learned from the 2017 Knowledge Assessment was that those terms were interpreted by some persons and teams to be value-based judgements instead of fact-based judgements. This Knowledge Assessment aims to avoid concerns with potentially co-mingling subjective and objective information by focusing on if the direction of effect is simply “Increasing” or “Decreasing” (see definitions below).

* Increasing Effect: The management action causes or could cause an increase in the quality, abundance, and/or spatial and temporal distributions of the affected measure or condition.
* Decreasing Effect: The management action causes or could cause a decrease in the quality, abundance, and/or spatial and temporal distributions of the affected measure or condition.
* No Effect: The management action does not or could not cause either an increase or a decrease in the quality, abundance, and/or spatial and temporal distributions of the affected measure or condition.
* Unknown: There is not sufficient information, with which to evaluate the direction of effect.

## Confidence (Rating Definitions)

Note, not all sources of evidence or knowledge bear equal weight. It is critical for the resource teams to strictly follow the definitions below.

* High: Current understanding of the proposed cause-effect relationship is subject to little or no disagreement or uncertainty among investigators and in peer-reviewed studies; is supported by substantial, high-quality, documented expert knowledge and/or evidence and, where appropriate, by well-accepted statistical analyses; and is consistent with well-accepted principles in the relevant fields of knowledge and/or with studies in highly analogous systems.
* Medium: Current understanding of the proposed cause-effect relationship is subject to moderate disagreement or uncertainty among investigators and among peer-reviewed studies; and is supported by some documented expert knowledge and/or evidence and analyses. The expert knowledge and/or evidence and analyses may be limited or subject to methodological weaknesses, but nevertheless may be consistent with well-accepted principles in the relevant fields of knowledge and/or with studies in highly analogous systems.
* Low: Current understanding of the proposed cause-effect relationship is subject to substantial disagreement or uncertainty among investigators and among peer-reviewed studies; is supported by only limited or undocumented expert knowledge and/or evidence and analyses that may also be subject to methodological weaknesses; and may be inconsistent with well-accepted principles in the relevant fields of knowledge and/or with studies in highly analogous systems. Ratings of “Unknown” for the strength and/or direction of an effect typically receive ratings of “Low” for confidence.

## Data Entry

The person or team preparing the management/actions table for an individual resource topic will proceed through the following steps:

1. Check that the file name correctly identifies the resource topic being addressed (see instruction #1 for status/trend tables, above). Note, if a 2017 Knowledge Assessment table was prepared, that table should be used. The following steps, therefore, should mostly consist of verifying that the 2017 Knowledge Assessment information is still valid and updating information as appropriate.
2. Insert in Row 2 the name of the resource topic being addressed, by selecting the appropriate name from the provided drop-down list. The definitions for the Resource Topic entries are provided in the ‘Topic & Action Labels’ worksheet (tab).
3. Enter the information in Rows 3 and 4 for the names of the table preparer(s) and the preparation date.
4. Enter the requested information in Rows 7 onward for each technical measure, for each resource characteristic of interest. Select the name of each management action of interest from the provided drop-down list. The definitions for the values in the Management Action list are provided in the ‘Topic & Action Labels’ worksheet (tab). The values for Strength, Direction, and Confidence are entered by selecting the appropriate value from the provided drop-down lists. The definitions for the values in these lists are provided in the ‘Scoring Values’ worksheet (tab).
5. See below for instructions on Reporting Rationales and Reporting Recommendations.

# Reporting Rationales

The tables for assessing status and trend, drivers and constraints, and effects of management actions all require the user to state the rationale for each assessment (table row). The purpose of these entries is to *summarize* the information on which the assessment rests. At its simplest, each entry could consist of a brief statement of present understanding accompanied by a list of key studies or bodies of evidence. Where the assessment rests on more limited evidence and/or documented expert knowledge, or undocumented expert knowledge, the user may provide a longer statement explaining the assessment – but again with list of key studies or bodies of evidence as appropriate. In either case, the user should point the reader to any specific documents that may provide a more complete discussion of the topic and explanation of the present assessment.

# Reporting Recommendations

The tables for assessing status and trend, drivers and constraints, and effects of management actions all provide a place where the user can offer recommendations concerning monitoring and research needs. The user should identify technical measures or conditions that warrant continuing monitoring to address ongoing needs for knowledge, if adequate monitoring already takes place. The user also should identify technical measures or conditions that warrant improved monitoring, if monitoring already takes place but does not meet all needs; or new monitoring in cases where crucial monitoring does not yet take place.

Similarly, the user should identify ongoing research studies that warrant continuation, if that research adequately addresses crucial gaps or weaknesses in knowledge. The user also should identify ongoing research studies that need improvement to better address crucial gaps or weaknesses in knowledge; or new research studies to address crucial but as yet unattended gaps or weaknesses.

Finally, the user may also offer recommendations on ongoing monitoring or research studies that could be reduced in scope or set aside without harming GCDAMP needs.

# Literature Cited

DiGennaro, B., D. Reed, C. Swanson, L. Hastings, Z. Hymanson, M. Healey, S. Siegel, S. Cantrell, and B. Herbold. 2012. Using Conceptual Models and Decision-Support Tools to Guide Ecosystem Restoration Planning and Adaptive Management: An Example from the Sacramento–San Joaquin Delta, California. San Francisco Estuary and Watershed Science 10(3):1-15. <http://escholarship.org/uc/item/3j95x7vt>.

National Park Service (NPS). 2014. National Park Service-Natural Resource Condition Assessment (NPS-NRCA) Guidance Update, January 20, 2014. Online: [http://www.nature.nps.gov/water/nrca/](http://www.nature.nps.gov/water/nrca/index.cfm).

1. The Selected Alternative also includes summer low flow experiments. However, these will not be attempted until during the second 10 years of implementation of the LTEMP. The present Knowledge Assessment must focus on topics that may bear on the Triennial Work Plan for FY 2021-2023. The present Knowledge Assessment therefore will not address the potential effects of summer low-flow experiments. [↑](#footnote-ref-1)
2. HFE: High flow experiment [↑](#footnote-ref-2)
3. LCR: Little Colorado River [↑](#footnote-ref-3)