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Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Watershed

CALIFORNIA Water Boards

State Water Resources Control Board

Appendix A. Bay-Delta Monitoring and Evaluation Program (BDMEP)

A.1 Introduction

The Bay-Delta Monitoring and Evaluation Program (BDMEP) identifies the monitoring, reporting, evaluation, and special studies (collectively referred to as monitoring activities) needed to implement the Bay-Delta Plan, assess compliance with the Bay-Delta Plan, evaluate the effectiveness of the Bay-Delta Plan, and inform potential updates to the plan. As a starting point, this initial BDMEP is defined by existing monitoring and reporting activities pursuant to water right conditions of the Department of Water Resources' (DWR) State Water Project (SWP) and the U.S. Bureau of Reclamation's (Reclamation) Central Valley Project (CVP).

This initial BDMEP will then be expanded as part of the periodic review and implementation process for the Bay-Delta Plan to develop a comprehensive BDMEP to cover monitoring activities needed for the entire Bay-Delta Plan. The structure, governance, and content of the comprehensive BDMEP will be informed by available monitoring and assessment models, frameworks, reviews, guidance, and regional monitoring programs (for example USEPA 2003[1]; Reynolds et al. 2016[2]; WRAMP[3]). The comprehensive BDMEP will incorporate existing monitoring activities in the Bay-Delta watershed, to the extent possible and as relevant, to avoid undue duplication.

A.2 Required Monitoring Activities

A.2.1 Required Monitoring Activities

The monitoring activities described in Table A-1 and Table A-2 are required to be conducted pursuant to water right requirements of the SWP and CVP included in State Water Board Decisions 1641, 1485, and 1422 (D-1641, D-1485, D-1422). The SWP and CVP share responsibilities for the required monitoring activities equally, except for activities that are indicated in Table A-2 as required by D-1422, which are the full responsibility of the CVP. Water right holders that are assigned responsibility to meet requirements for monitoring activities described in section 4.5 and Appendix A must ensure that the monitoring is conducted by qualified staff using quality assurance and control procedures.

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[1] U.S. Environmental Protection Agency (USEPA). 2003. *Elements of a State Water Monitoring and Assessment Program*. EPA 841-B-03-003. Prepared by USEPA, Washington, DC.

[2] Reynolds, J. H., M. G. Knutson, K. B. Newman, E. D. Silverman, and W. L. Thompson. 2016. A road map for designing and implementing a biological monitoring program. *Environmental Monitoring and Assessment* 188(7):399. https://doi.org/10.1007/s10661-016-5397-x

[3] https://mywaterquality.ca.gov/wetland-monitoring/wramp.html

The monitoring activities described in Table A-1 and Table A-2 are subject to review and update pursuant to the annual and periodic review processes in order to ensure that monitoring activities continue to meet applicable water right requirements. All monitoring activities are required to be conducted consistent with the processes described in section A.3. and are required to be conducted consistent with monitoring designs as of the date the current plan amendments are adopted, unless revisions are approved. Revisions to monitoring activities may be proposed to the State Water Board for approval following the process described in section A.3.1.

Surveys identified with footnote 1 in Table A-2 have been discontinued. In coordination with DWR and Reclamation, the State Water Board will initiate a process with the Delta Stewardship Council's Delta Science Program to identify any monitoring gaps generated by discontinuation of the three surveys needed to fulfill the monitoring purposes identified in D-1641, D-1485, and the Bay-Delta Plan. The process will then evaluate what monitoring or special studies, if any, would be needed to fill any identified monitoring gaps. As appropriate, the Board may also seek advice from the Delta Independent Science Board. During the first periodic review of the Bay-Delta Plan following approval of the current plan amendments by OAL, the Board will consider any advice from the Delta Science Program and Delta Independent Science Board and determine whether to require monitoring or special studies to fill any monitoring gaps.

A.2.2 Monitoring Purposes

The biological and water quality monitoring efforts identified in Table A-2 serve multiple purposes. General purposes for monitoring and reporting efforts include, but are not limited to, the following: (1) assessing compliance with and effectiveness of narrative and numeric requirements in the Bay-Delta Plan and water right conditions; (2) providing baseline information about flow, water quality, and ecosystem conditions to support trend assessments and understand the impacts of water diversions and freshwater flow needs; (3) evaluating the response of aquatic habitat and organisms to Bay-Delta Plan requirements; and (4) increasing understanding of watershed-scale characteristics and ecosystem functions to inform management actions.

Purposes for monitoring, assessment, and special studies are described in D-1641, D-1485, D-1422, and the Bay-Delta Plan and are summarized below for reference.

1. Establish baseline information for the purpose of assessing changes and trends in abundance and distribution of lower food web and fish populations and water quality parameters and support assessment of impacts from CVP and SWP project operations, other diversions, and discharges in the Bay-Delta watershed.
2. Identify Delta outflow needs for ecological benefits in the Bay-Delta watershed.

3. Identify and evaluate changes and trends in the abundance and distribution of lower food web and fish populations and water quality parameters potentially related to CVP and SWP project operations, Delta outflow, and salinity gradients.
4. Develop a better understanding of ecological interactions so that more accurate predictions of environmental impacts related to CVP and SWP project operations can be made.
5. Contribute to development and improvement of water quality and biological predictive tools regarding flow, salinity, and lower food web relationships.
6. Assess the achievement and effectiveness of narrative and numeric water quality and flow requirements in the Bay-Delta Plan and water right conditions.

The monitoring programs identified in Table A-2 fulfill, in part, monitoring obligations in water right conditions of the SWP and CVP. The specific purposes for each of the monitoring activities are described in more detail in Table A-2.

Table A-1. Specific Water Quality and Food Web Monitoring Requirements.

[Note to reader: The bolding and underlining that were used in the October 2024 draft to indicate changes from Table 5 of the 2018 Bay-Delta plan have been removed.]

STATION NUMBER	ALT STATION ID	STATION DESCRIPTION	LATITUDE[1]	LONGITUDE[1]	CONTINUOUS RECORDING[2]	CONTINUOUS MULTI-PARAMETER[3]	DISCRETE PHYSICAL CHEMICAL[4]	DISCRETE PHYTOPLANKTON[5]	DISCRETE ZOOPLANKTON[6]	DISCRETE BENTHOS[7]	HABS[8]
C2	CLL	Sacramento River at Collinsville	38.07395	-121.85010	*						
C3A	SRH	Sacramento River at Hood	38.36772	-121.52051		*	*	*			
C4	SAL	San Joaquin River at San Andreas Landing	38.10319	-121.59128	*						
C5	CNT	Contra Costa Canal at Pumping #1	37.99520	-121.70244	*						
C6	BDT	San Joaquin River at Brandt Bridge site	37.86454	-121.32270	*						
C7	MSD	San Joaquin River at Mossdale Bridge	37.78604	-121.30666		*					
C8	UNI	Old River near Middle River	37.82208	-121.37517	*						
C9		West Canal at mouth of Clifton Court Forebay Intake	37.8218	-121.55275						*	
	WCI		37.83075	-121.55703	*	*	*	*			*

STATION NUMBER	ALT STATION ID	STATION DESCRIPTION	LATITUDE[1]	LONGITUDE[1]	CONTINUOUS RECORDING[2]	CONTINUOUS MULTI-PARAMETER[3]	DISCRETE PHYSICAL CHEMICAL[4]	DISCRETE PHYTOPLANKTON[5]	DISCRETE ZOOPLANKTON[6]	DISCRETE BENTHOS[7]	HABS[8]
C10	SJR	San Joaquin River near Vernalis	37.69734	-121.26472	*	*	*	*			*
C13	MOK	Mokelumne River at Terminous	38.11691	-121.49888	*		*				*
C14	PCT	Sacramento River at Port Chicago	38.05881	-122.02607	*						
C19[9]	CCS	Cache Slough at City of Vallejo Intake	38.29687	-121.74784	*						
D4		Sacramento River above Point Sacramento	38.06214	-121.81792			*	*	*	*	*
D6		Suisun Bay at Bulls Head Point near Martinez	38.04427	-122.11764			*	*	*	*	*
D6A	MRZ	Suisun Bay at Martinez	38.02762	-122.14052		*					
D7	GZL	Grizzly Bay at Dolphin near Suisun Slough	38.11708	-122.03972	*		*	*	*	*	*
D8	RYZ	Suisun Bay off Middle Point near Nichols	38.05992	-121.98996			*	*	*		*

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D9	HON	Honker Bay near Wheeler Point	38.07245	-121.93923	*						
D10	MAL	Sacramento River at Chipps Island	38.04836	-121.91859		*	*		*		*
D11		Sherman Island near Antioch	38.04228	-121.79951	*						
D12	ANH	San Joaquin River at Antioch Ship Canal	38.01770	-121.80273		*	*		*		*
D15	SJJ	San Joaquin River at Jersey Point	38.05190	-121.68927	*						
D16	TWI	San Joaquin River at Twitchell Island	38.09690	-121.66912			*		*	*	*
D19		Frank's Tract near Russo's Landing	38.04376	-121.61477	*		*	*			*
D22	EMM	Sacramento River at Emmaton	38.08406	-121.73912	*						
			38.08453	-121.73914			*		*		*
D24	RVB	Sacramento River below Rio Vista Bridge	38.15891	-121.68721		*	*		*		
			38.15550	-121.68113						*	
D26		San Joaquin River at Potato Point	38.07667	-121.56696			*	*	*		*

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D28A		Old River near Rancho Del Rio	37.97038	-121.57271			*	*	*	*	*
	OBI		37.96980	-121.57210	*						
D29	PPT	San Joaquin River at Prisoners Point	38.05793	-121.55736	*						
D41		San Pablo Bay near Pinole Point	38.03016	-122.37287			*	*	*	*	
D41A		San Pablo Bay near mouth of Petaluma River	38.08472	-122.39067			*	*	*	*	
DMC1	DMC	Delta-Mendota Canal at Jones Pumping Plant	37.78165	-121.59050		*					
P8		San Joaquin River at Buckley Cove	37.97815	-121.38242			*	*	*	*	*
P8A	RRI	San Joaquin River at Rough and Ready Island	37.96277	-121.36587		*					
P12	OLD	Old River at Tracy Road Bridge	37.80493	-121.44929	*						
MD10		Disappointment Slough near Bishop Cut	38.04229	-121.41935			*	*	*		*

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S21	SNC	Chadbourne Slough at Sunrise Duck Club	38.18476	-122.08315	*						
S35	GYS	Goodyear Slough at Morrow Island Clubhouse	38.11918	-122.09581	*						
S42	VOL	Suisun Slough 300' south of Volanti Slough	38.18080	-122.04901	*		*	*	*		*
S49	BDL	Montezuma Slough near Beldon Landing	38.18686	-121.97080	*						
S64	NSL	Montezuma Slough at National Steel	38.12223	-121.88800	*						
C33	CYG	Cordelia Slough at Cygnus	38.152668	-122.09029	*						
NZ032		Montezuma Slough, 2nd bend from mouth	38.16990	-122.02112					*		
SLBAR3	BKS	Barker Slough at North Bay Aqueduct	38.27474	-121.79499	*						

STATION NUMBER	ALT STATION ID	STATION DESCRIPTION	LATITUDE[1]	LONGITUDE[1]	CONTINUOUS RECORDING[2]	CONTINUOUS MULTI-PARAMETER[3]	DISCRETE PHYSICAL CHEMICAL[4]	DISCRETE PHYTOPLANKTON[5]	DISCRETE ZOOPLANKTON[6]	DISCRETE BENTHOS[7]	HABS[8]
RSAC155	FPT	Sacramento River (I St. Bridge to Freeport)	38.45611	−121.50030	*						
RSAN050 - RSAN061	TRN	San Joaquin River (Turner Cut to Stockton)	37.99746 to 37.95242	-121.44435 to -121.31750	*		*				*
S71	MSL	Montezuma Slough at Roaring River	38.09340	-121.88720	*						
S72	ROR	Roaring River	38.093100	-121.887500	*						
HAB1		Frank's Tract eastern/southern side	38.057587 to 38.032837	-121.584754 to -121.588393		*	*				*
HAB2		McLeod Lake at Stockton Waterfront	37.95372	-121.2967		*	*				*
HAB3		Victoria Canal near Byron	37.8717	-121.5283		*	*				*

STATION NUMBER	ALT STATION ID	STATION DESCRIPTION	LATITUDE[1]	LONGITUDE[1]	CONTINUOUS RECORDING[2]	CONTINUOUS MULTI-PARAMETER[3]	DISCRETE PHYSICAL CHEMICAL[4]	DISCRETE PHYTOPLANKTON[5]	DISCRETE ZOOPLANKTON[6]	DISCRETE BENTHOS[7]	HABS[8]
HAB4		Big Break Regional Shoreline at San Joaquin River	38.0146	-121.728952		*	*				*
HAB5		Middle River at Middle River	37.9427017	-121.5341175		*	*				*
HAB6		Mildred Island	37.9828	-121.519797		*	*				*
LSZ2		Location(s) where the bottom EC = 2 mS/cm	Variable. One sampling location is required when the location of bottom EC=2 mS/cm is downstream (West) of the Confluence, and two locations (one on the Sacramento River and one on the San Joaquin River) are required when the location of bottom EC=2 mS/cm is upstream (East) of the Confluence				*	*	*		

STATION NUMBER	ALT STATION ID	STATION DESCRIPTION	LATITUDE[1]	LONGITUDE[1]	CONTINUOUS RECORDING[2]	CONTINUOUS MULTI-PARAMETER[3]	DISCRETE PHYSICAL CHEMICAL[4]	DISCRETE PHYTOPLANKTON[5]	DISCRETE ZOOPLANKTON[6]	DISCRETE BENTHOS[7]	HABS[8]
LSZ6		Location(s) where the bottom EC = 6 mS/cm	Variable. One sampling location is required when the location of bottom EC=6 mS/cm is downstream (West) of the Confluence, and two locations (one on the Sacramento River and one on the San Joaquin River) are required when the location of bottom EC=2 mS/cm is upstream (East) of the Confluence				*	*	*		

[1] Coordinates are geographic North American Datum 1983, accurate for 1:24,000 scale mapping.

[2] Continuous recording (every 15 minutes) of water temperature, electrical conductivity (EC), and/or dissolved oxygen. For municipal and industrial intake chloride objectives, EC can be monitored and converted to chloride concentration.

[3] Continuous, multi-parameter monitoring (recording every 1 to 15 minutes with telemetry capabilities) includes the following variables: water temperature, EC, pH, dissolved oxygen, turbidity, chlorophyll a fluorescence, tidal elevation, and meteorological data (air temperature, wind speed and direction, solar radiation).

[4] Discrete physical/chemical monitoring is conducted on a year-round, near-monthly basis at high slack tide and includes the following variables: macronutrients (inorganic forms of nitrogen, phosphorus and silicon), total suspended solids, total dissolved solids, total particulate and dissolved organic nitrogen and carbon, chlorophyll a, HAB visual indices and CI_{cyano} index, pH, dissolved DO, EC (specific conductance), turbidity, secchi depth, and water temperature. In addition, on-board continuous recording is conducted intermittently for the following variables: water temperature, dissolved oxygen, electrical conductivity, turbidity, and chlorophyll a fluorescence.

[5] Discrete sampling for phytoplankton enumeration and algal pigment analysis is conducted on a year-round, near-monthly basis at high slack tide.

[6] Tow or pump sampling for zooplankton, mysids, and amphipods is conducted on a year-round, near-monthly basis at high slack tide.

[7] Collection of discrete benthos and sediment grab samples and enumeration of the collected organisms is conducted on a year-round, near-monthly basis at high slack tide.

[8]Sampling for HABs will occur between May and October. Specific monitoring requirements and sampling frequency are described in Table A-3. HAB monitoring requirements do not supersede monitoring requirements listed in other columns of this table. Requirements listed in other columns may be used to satisfy HAB monitoring requirements.

[9] Monitoring at station C19 is only required at the later date of either 30 days prior to when water is being diverted at this location, or 30 days after notification by the City of Vallejo or State Water Board of an intent to divert water at this location.

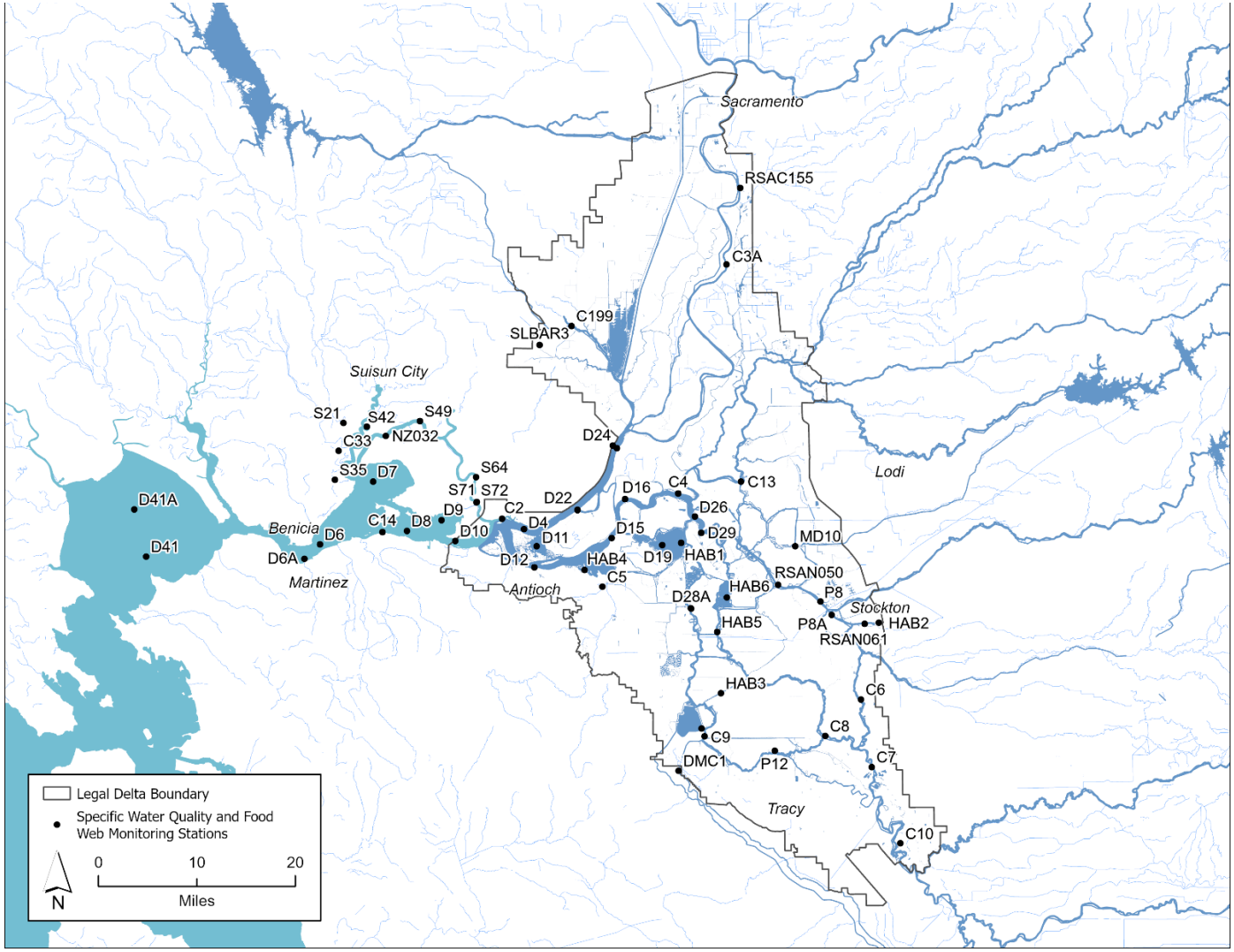

Figure A-1. Map of the Specific Water Quality and Food Web Monitoring Stations Described in Table A-1.

Stations LSZ2 and LSZ6 are not represented on the map since their locations vary depending on the position of the salinity field. Stations C9, D22, D24, and D28A each have two adjacent or overlapping locations, with different parameters measured in different locations. Table A-1 includes the coordinates and specific monitoring requirements for each station.

Table A-2. Required Monitoring Activities

MONITORING ACTIVITY	WATER RIGHT CONDITIONS THAT ARE FULFILLED, IN PART, BY THE MONITORING ACTIVITY	SHORT DESCRIPTION	MONITORING PURPOSE(S)
Environmental Monitoring Program	D-1641 terms 3, 11(a), Table 5, and Figure 4.	This study was initiated in 1971 and currently includes January – December monthly sampling from San Pablo Bay through the Delta for phytoplankton, zooplankton, benthos, and water quality. Sampled organisms include mysids, copepods, cladocerans, rotifers, other zooplankton, phytoplankton, and benthic invertebrates. Phytoplankton are sampled with a pump. Zooplankton are sampled with a mysid net (505 µm mesh), a Clarke-Bumpus net (160 µm mesh), and a pump (43 µm mesh). Benthic samples are collected with Ponar grabs. Water quality measurements include water temperature, dissolved oxygen, specific conductance, pH, turbidity, chlorophyll, and nutrient measurements.	• Compliance with specific monitoring requirements established in D-1641. • Measure and estimate the abundance of food available for important fishes in the estuary and track water quality in sampled habitats, including nutrients and harmful algal blooms. • Assess the effects Delta outflow and SWP and CVP operations on food resources and habitat quality for fish species. • Analyze status and trends of water quality and the food web. • Identify and monitor the introduction of non-native species into the estuary and observe how lower food web communities respond to these invasions.
Bay-Delta Continuous Monitoring	D-1641 Terms 3, 11 (a) and (b), Table 5, and Figure 4	This study was initiated in 1983 and currently includes a network of continuous flow, water quality, and multi-parameter monitoring stations throughout the Bay-Delta as specified in Table A-1 and including all other monitoring necessary to calculate or determine compliance with the water quality objectives.	• Compliance with specific monitoring requirements established in D-1641. • Evaluate compliance with water quality objectives and long-term trends in water quality and flow.

MONITORING ACTIVITY	WATER RIGHT CONDITIONS THAT ARE FULFILLED, IN PART, BY THE MONITORING ACTIVITY	SHORT DESCRIPTION	MONITORING PURPOSE(S)
San Francisco Bay Study	D-1485 terms 10(a) and (c) D-1641 term 11(b)	This study was initiated in 1980 and currently includes January – December, monthly sampling of more than 30 species of fishes, crabs, and shrimp at over 50 stations in open water and shoal habitats from the southern San Francisco Bay to western Delta, Sacramento River to confluence with Cache Slough, and San Joaquin River to Old River Flats in the central Delta. Fishes and invertebrates are sampled with an otter trawl to measure demersal fishes and other organisms and a midwater trawl to sample pelagic fishes and other organisms.	• Measure and estimate water quality and abundance and distribution of the most common pelagic and demersal fishes, crabs, and shrimp in the Bay-Delta primarily downstream of the Delta. • Establish baseline data and analyze the status and trends of pelagic and demersal fishes and other species. • Assess the effects Delta outflow and SWP and CVP operations on food resources, habitat quality for fish species, and abundance and distribution of fish species. • Support development and application of life history models. • Identify other factors that may contribute to abundance and distribution and trends. • Detect newly introduced or invasive species.
Fall Midwater Trawl	D-1485 terms 10(a), (b), and (c) D-1641 term 11(b)	This study was initiated in 1967 and currently includes September – December, monthly sampling of more than 30 species of pelagic fish, including sub-adult Delta smelt, water quality, zooplankton, and other invertebrates. Sampling occurs at more than 100 stations in open water and shoal habitats from San Pablo Bay through the Delta. Zooplankton are sampled with a mysid net (505 µm mesh) and a Clarke-Bumpus net (160 µm	• Measure and estimate the relative abundance and distribution of pelagic fishes and the availability of fall planktonic food sources. • Establish baseline data and analyze the status and trends of pelagic fish populations, other species, and community composition.

MONITORING ACTIVITY	WATER RIGHT CONDITIONS THAT ARE FULFILLED, IN PART, BY THE MONITORING ACTIVITY	SHORT DESCRIPTION	MONITORING PURPOSE(S)
		mesh). Fishes and invertebrates are sampled with a midwater trawl net.	• Measure water quality to evaluate habitat conditions for food web and fish species. • Assess the effects Delta outflow and SWP and CVP operations on food resources, habitat quality for fish species, and abundance and distribution of fish species • Support development and application of life-history models.
Spring Kodiak Trawl[1]	D-1485 terms 10(a), (b), and (c) D-1641 term 11(b)	This study was conducted from 2002 to 2023 from December – May, monthly sampling of maturing and adult Delta smelt and other pelagic fishes. The trawl net mesh ranges in dimension from 0.5 – 5 cm dimension and is deployed to the top 1.8 meters of the water column. Sampling occurs at 40 sites distributed from the Napa River, San Pablo Bay, Suisun Marsh, western, central, and eastern Delta, Sacramento River, and San Joaquin River to Rough and Ready Island.	• Measure and estimate the relative abundance and distribution of maturing Delta smelt and other pelagic fishes and associated risks from entrainment in the south Delta. • Support near real-time operational decisions. • Establish baseline data and evaluate status and trends in fish abundance, distribution, and fish community composition. • Assess the effects of Delta outflow and SWP and CVP operations on water quality and the abundance and distribution of fish and zooplankton. • Measure water quality to evaluate habitat conditions for food web and fish species.

MONITORING ACTIVITY	WATER RIGHT CONDITIONS THAT ARE FULFILLED, IN PART, BY THE MONITORING ACTIVITY	SHORT DESCRIPTION	MONITORING PURPOSE(S)
			• Support development and application of life-history models.
Smelt Larva Survey[2]	D-1485 terms 10(a), (b), and (c) D-1641 term 11(b)	This study was initiated in 2009 and currently includes January – March, sampling every two weeks for water quality and early life stage (larval) fishes. Fishes are sampled with an egg and larval net (500 µm mesh). Sampling occurs at 35 sites from Carquinez Strait, through Suisun Marsh, Sacramento River, Cache Slough complex, western and central Delta, export facilities, and San Joaquin River to Rough and Ready Island.	• Measure and estimate the relative abundance and distribution of larval fish in the Delta during the spring and summer. • Establish baseline data and evaluate status and trends of abundance and distribution of larval fish species. • Quantify potential for entrainment of native fish species at early life stages into adverse habitats and into the CVP and SWP export facilities. • Evaluate entrainment effects and trends on abundance and distribution of native fishes. • Measure water quality to evaluate habitat conditions for food web and fish species. • Support development and application of life history models.
20mm Survey[2]	D-1485 terms 10(a), (b), and (c) D-1641 term 11(b)	This study was initiated in 1995 and currently includes March – July, sampling every two weeks for zooplankton, water quality, and early life-stage pelagic fishes. Fishes are sampled with a rigid-mouthed net constructed of 1,600 µm mesh and zooplankton are sampled with a 160 µm mesh Clarke-Bumpus net attached directly above the fish net. Sampling occurs at a minimum of 47 stations from San Pablo Bay, Sacramento River,	• Quantify potential for entrainment of zooplankton and native fish species at early life stages into adverse habitats and into the CVP and SWP export facilities. • Evaluate entrainment effects and trends in abundance and distribution of native fishes.

MONITORING ACTIVITY	WATER RIGHT CONDITIONS THAT ARE FULFILLED, IN PART, BY THE MONITORING ACTIVITY	SHORT DESCRIPTION	MONITORING PURPOSE(S)
		Cache Slough complex, through western and central Delta, export facilities, and San Joaquin River to Rough and Ready Island.	• Measure water quality to evaluate habitat conditions for food web and fish species. • Assess whether diversion and outflow management decisions maintain early life stage habitat at a distance from SWP and CVP export facilities. • Support development and application of life history models.
Summer Townet Survey (1959)	D-1485 terms 10(a), (b), and (c) D-1641 term 11(b)	This study was initiated in 1959 and currently includes June – August, sampling every two weeks for juvenile and young pelagic fishes (including juvenile smelt and age-0 striped bass), zooplankton, and water quality. Fishes are sampled with a conical fixed-frame net. Zooplankton are sampled with a Clarke-Bumpus net (160 µm mesh) fixed to the top of the fish net. Sampling occurs at 40 stations from San Pablo Bay to Rio Vista on the Sacramento River, Cache Slough, Stockton Deepwater Ship Channel, western and central Delta, near export facilities, and San Joaquin River to Rough and Ready Island. Environmental data are collected during sampling to document habitat conditions and understand relationships between fish catch and water temperature, turbidity, salinity, and other measures of habitat conditions (e.g., harmful algal blooms).	• Measure and estimate the relative abundance and distribution of zooplankton, pelagic fish species, water quality, and habitat conditions in the summer months. • Establish baseline data and evaluate status and term trends in the abundance and distribution of zooplankton, pelagic fish species, water quality, and habitat conditions in the summer months. • Evaluate entrainment effects and water quality to improve summer and fall habitat conditions for native pelagic fish. • Evaluate the effects of the Suisun Marsh Salinity Control Gate operations on the zooplankton density and community composition in Montezuma Slough and in Suisun Bay. • Support development and application of life history models.

MONITORING ACTIVITY	WATER RIGHT CONDITIONS THAT ARE FULFILLED, IN PART, BY THE MONITORING ACTIVITY	SHORT DESCRIPTION	MONITORING PURPOSE(S)
Adult Sturgeon Study[1]	D-1485 terms 10(a), (b), and (c), D-1641 term 11(b)	This study was conducted from 1954-2022 and included August – October sampling for adult and subadult sturgeon is conducted to calculate abundance estimates. Samples are collected from commercial passenger fishing vessels, creel surveys, drifted trammel nets, and a mark recapture program.	• Estimate relative abundance and distribution, harvest, and survival of adult white sturgeon. • Assess effects of entrainment into small and large water diversions, sport fishing, and other variables on abundance and survival. • Identify the age structure of the white sturgeon population.
Adult Striped Bass Study[1]	D-1485 terms 10(a), (b), and (c) D-1641 term 11(b)	This study was conducted from 1969-2022 and included April – May sampling for adult striped bass is conducted to calculate abundance estimates. Samples are collected from commercial passenger fishing vessels, creel surveys, fyke traps, drifted gillnets, and a mark-recapture program.	• Measure and estimate relative abundance, harvest, mortality, growth, and movement patterns of striped bass. • Understand population dynamics of striped bass to inform management decisions, including predation effects on native fish populations and ecosystem changes affecting native species. • Understand effect of CVP and SWP operations on abundance and distribution of striped bass and ecological interactions of striped bass as part of the predator community.
Central Valley Juvenile Salmon and Steelhead Monitoring[2]	D-1485 terms 10(a), (b), and (c) D-1641 term 11(b)	This study was initiated in 1986 and currently includes September – June sampling for water quality and fishes. Fishes are sampled with a rotary screw trap. The primary sampling site is Knights Landing (river mile 89). Other sites include Tisdale Weir (river mile 120), Lower Sacramento River (rive mile 75), and the Feather River high flow channel.	• Quantify the abundance of juvenile Chinook salmon and steelhead out migrating through the Sacramento River near the town of Knights Landing. • Estimate the number of out migrating winter-run Chinook salmon prior to entering the Delta

MONITORING ACTIVITY	WATER RIGHT CONDITIONS THAT ARE FULFILLED, IN PART, BY THE MONITORING ACTIVITY	SHORT DESCRIPTION	MONITORING PURPOSE(S)
		Water quality data collected during sampling include water temperature, flow rate, turbidity, clarity, and depth.	relative to the long-term data record. • Quantify potential for entrainment of juvenile salmonids into adverse habitats and into the CVP and SWP diversion facilities. • Assess the effectiveness of water quality and flow requirements, such as Delta Cross Channel gate operations, in the Bay-Delta Plan and water right conditions, on the survival of juvenile salmon and steelhead migrating through the Sacramento-San Joaquin Delta watershed. • Develop age-structure, brood tables, and stock-recruitment relationships.
Delta Juvenile Fish Monitoring Program[2]	D-1485 terms 10(a), (b), and (c) D-1641 term 11(b)	This study was initiated in the 1970s and currently includes January – December, sampling up to three times weekly for water quality and fishes is conducted. This program includes several monitoring efforts with different sampling designs. Fishes are sampled with midwater trawls, Kodiak trawls, and beach seines. The Delta Juvenile Fish Monitoring Program was initially established in the 1970s to monitor juvenile fall-run Chinook salmon abundance, and to investigate how reduced river flows might affect the survival of young	• Measure and estimate water quality and the abundance and distribution of fish including migrating salmonids in the Bay-Delta estuary at shallow-water and pelagic habitats. • Establish baseline data and evaluate trends in abundance and distribution of migrating salmonids. • Develop flow-abundance relationships and inform understanding of survival and mortality using the long-term data record.

MONITORING ACTIVITY	WATER RIGHT CONDITIONS THAT ARE FULFILLED, IN PART, BY THE MONITORING ACTIVITY	SHORT DESCRIPTION	MONITORING PURPOSE(S)
		salmon. Today, year-round monitoring continues with an emphasis on populations of all races of Chinook salmon, Delta smelt, and other Delta resident fish. Delta Juvenile Fish Monitoring Program is inclusive of the Mossdale Trawl. Sampling occurs from the Sacramento River near Colusa and the San Joaquin River upstream of the confluence with the Tuolumne River, through the Delta, to north and central San Francisco Bay.	• Evaluate the effects of SWP and CVP operations and other stressors on survival and population dynamics. • Develop age-structure information, brood tables, and stock-recruitment relationships.
Enhanced Delta Smelt Monitoring[2]	D-1485 terms 10(a), (b), and (c) D-1641 term 11(b)	This study was initiated in 2016 and currently includes July – March weekly sampling for Delta smelt, other fishes, and water quality. Fishes are sampled with a Kodiak trawl and a 1600 µm mesh net. Sampling occurs at randomized sites from San Francico Bay, the Delta, the Sacramento River, and the San Joaquin River.	• Measure and estimate total abundance of Delta smelt on a weekly basis. • Measure and estimate spatial distribution of Delta smelt. • Evaluate entrainment effects and trends in abundance and distribution of native fishes with water quality, water diversion and outflow conditions.
Suisun Marsh Fish Study	D-1485 terms 10(a), (b), and (c) D-1641 term 11(b)	This study was initiated in 1980 and currently includes January – December, monthly sampling for water quality, fishes, and invertebrates. Fishes and invertebrates are sampled with beach seines and otter trawls. Sampling occurs within and near Suisun Marsh.	• Evaluate water quality conditions and abundance and distribution of juvenile and adult fish and invertebrates in Suisun Marsh year-round. • Evaluate long-term changes in the Suisun Marsh ecosystem.

MONITORING ACTIVITY	WATER RIGHT CONDITIONS THAT ARE FULFILLED, IN PART, BY THE MONITORING ACTIVITY	SHORT DESCRIPTION	MONITORING PURPOSE(S)
			• Evaluate the effects of the Suisun Marsh Salinity Control Gate operations on the ecosystem. • Assess the effects of diversions and Delta outflow on water quality and the abundance and distribution of fish and zooplankton. • Evaluate the effectiveness of restoration efforts.
Fish Salvage Monitoring[2]	D-1485 terms 10(a), (b), and (c) D-1641 term 11(b)	This study was initiated in 1957 and currently includes January – December, daily sampling for fishes is conducted continuously at SWP and CVP facilities in the southern Delta. Fishes that are entrained into diversions during SWP and CVP water exports are salvaged and counted.	• Quantify the number of fish entrained into SWP and CVP diversions. • Evaluate long-term trends of fish salvage, mortality due to salvage and entrainment, and abundance and distribution of native and sport fish species. • Inform real-time management decisions regarding mortality of endangered and threatened fish species. • Inform development of objectives and conditions to minimize impacts on native and sport fish species.
Fish Diet and Condition Study	D-1485 terms 10(a), (b), and (c) D-1641 term 11(b)	This study was initiated in 2005 and currently includes processing of fishes captured by other monitoring activities to identify digested zooplankton and aquatic invertebrates from the digestive tracts.	• Identify fish diets and food web relationships in the Bay-Delta estuary and their potential effects on abundance and distribution of fish species. • Inform management decisions relative to food production for native fish species.

MONITORING ACTIVITY	WATER RIGHT CONDITIONS THAT ARE FULFILLED, IN PART, BY THE MONITORING ACTIVITY	SHORT DESCRIPTION	MONITORING PURPOSE(S)
Fish Restoration Program Monitoring[2]	D-1485 terms 10(a) and (b) D-1641 term 11(b)	This study was initiated in 2015 and currently includes sampling for water quality, phytoplankton, zooplankton, invertebrates, benthos, fishes, and submersed aquatic vegetation at select restored and reference wetland sites. Zooplankton are sampled with a microzooplankton net (150 µm mesh) and a macrozooplankton net (500 µm mesh). Invertebrates are sampled with a sweep net (500 µm mesh) and a neuston net (500 µm mesh). Benthic samples are collected with a Ponar grab or sediment core. Fishes are sampled with a beach seine, otter trawl, and sand lampara net.	• Track and evaluate wetlands water quality and habitat conditions. • Assess the effectiveness of habitat restoration on fish abundance and distribution and food resources. • Assess wetland environments for abundance and distribution of phytoplankton, zooplankton, invertebrates, benthos, fishes, and submersed aquatic vegetation in the Bay-Delta estuary.
Stanislaus River Dissolved Oxygen	D-1422, Condition 8 (p. 32)	This study was initiated in 1999 and currently includes daily measurement of minimum dissolved oxygen levels at Ripon or at an alternate location approved by the Board.	• Evaluate compliance with water quality objectives and long-term trends in dissolved oxygen at Ripon for salmonid habitat.
New Melones Storage	D-1422, Condition 8 (p. 32)	Monitoring was initiated in 1985 and currently includes daily storage level in New Melones Reservoir.	• Inform compliance matters for water quality objectives and water right requirements.
Harmful Algal Blooms Monitoring (HABs)	D-1485, Conditions 10(a) and (b) D-1641, Condition 11	Monitoring for discrete physical/chemical water quality parameters, discrete phytoplankton and algal pigment analysis, HAB visual indices, and cyanobacterial toxins during May through October of each year following the tiered monitoring approach described in Table A-3.	• Monitor environmental drivers and status and trends during the bloom season (May to October). • Collect data needed to develop HAB predictive models. • Provide information about cyanobacterial toxin concentrations for public health notification. • Fill information gaps identified in the Delta Stewardship Council's

MONITORING ACTIVITY	WATER RIGHT CONDITIONS THAT ARE FULFILLED, IN PART, BY THE MONITORING ACTIVITY	SHORT DESCRIPTION	MONITORING PURPOSE(S)
			Delta Cyanobacterial HAB Monitoring Strategy. • Provide information about HABs in "hotspot" locations where toxic HABs regularly occur, through monitoring at six new locations listed in Table A-1. These hotspot locations were identified using the Water Quality Monitoring Council's HAB Reports Map.

[1] These surveys have been discontinued. In coordination with DWR and Reclamation, the State Water Board will initiate a process with the Delta Stewardship Council's Delta Science Program to identify any monitoring gaps generated by discontinuation of the three surveys needed to fulfill the monitoring purposes identified in D-1641, D-1485, and the Bay-Delta Plan. The process will then evaluate what monitoring or special studies, if any, would be needed to fill any identified monitoring gaps. As appropriate, the Board may also seek advice from the Delta Independent Science Board. During the first periodic review of the Bay-Delta Plan following approval of the current plan amendments by OAL, the Board will consider any advice from the Delta Science Program and Delta Independent Science Board and determine whether to require monitoring or special studies to fill any monitoring gaps.

[2] As required by DFW, USFWS or NMFS to comply with CESA or ESA requirements, revisions to this study may be implemented after a 30-day notice to the Executive Director of the State Water Board. The Executive Director may approve other minor modifications to these studies to accommodate logistical or operational needs. DWR and Reclamation may also propose substantive revisions, including termination, to this study as part of the processes described in section 4.5.1.1.

Table A-3. Harmful Algal Blooms, May to October Tiered Monitoring Approach

MONITORING TIER[1]	TRIGGER FOR MOVING INTO TIER	DATA COLLECTED AT SITE	LABORATORY ANALYSIS	COLLECTION FREQUENCY
Tier 1: Routine Monitoring	HAB visual index[2] ≤ 2 and CI_{cyano}[3] < 0.00228	HAB visual index, monitor CI_{cyano} index, sample for discrete phytoplankton[4] and algal pigment analysis, discrete physical/chemical monitoring	Quantitative microscopy for phytoplankton community identification and enumeration; discrete physical/chemical analysis	Once per month
Tier 2: Enhanced Monitoring	HAB visual index > 2 or CI_{cyano} ≥ 0.00228	Continue Tier 1 monitoring, discrete water samples to quantify toxigenic and total *Microcystis* cells and cyanotoxins	Continue Tier 1 laboratory analysis; molecular methods (e.g., qPCR) to quantify toxigenic and total *Microcystis* cells[5]	Twice per month
Tier 3: Enhanced Laboratory Analysis	*Microcystis* toxin biosynthesis genes detected above a threshold concentration in sample collected at Tier 2 site[6]	Continue Tier 2 monitoring, begin laboratory analysis for cyanotoxins	Continue Tier 2 laboratory analysis; analyze the cyanotoxins collected at Tier 2 site	

[1]The tiered monitoring approach described in this table is intended to reduce resources needed for monitoring by requiring enhanced monitoring only during active HAB events and is consistent with recommendations of the State Water Board Freshwater Harmful Algal Bloom Strategy for utilizing tiered approaches.

[2]*Microcystis* visual index will be used until other HAB indices are developed. *Microcystis* visual index values exceeding 2 are correlated with HAB toxicity in the Delta.

[3] CI_{cyano} was developed by the multi-agency Cyanobacterial Assessment Network (EPA, NASA, NOAA, USGS). A cyanobacteria index (CI) algorithm is used to estimate cyanobacteria concentrations using satellite remote sensing data. A CI_{cyano} value of 0.00228 corresponds to the World Health Organization Alert Level 1 chlorophyll a value of 12 µg/L, indicating a bloom is occurring. This index is to be monitored weekly during the bloom season.

[4] In addition to discrete phytoplankton monitoring, monitoring for benthic algal mats will be conducted in the tributaries.

[5]*Microcystis* is the most common toxin-producing cyanobacteria that forms HABs in the Delta. Molecular methods such as quantitative polymerase chain reaction (qPCR) may be used to quantify toxin biosynthesis genes. The presence of toxin biosynthesis genes suggests that cyanotoxins may be present in a sample.

[6]A concentration of 60,000 mcyE gene copies per mL will be used as a threshold unless a different threshold is approved in the monitoring workplan submitted for approval to the Executive Director.

A.3 Processes for Complying with Monitoring, Reporting and Special Studies Requirements

A.3.1 Review and Revision of Monitoring and Special Studies

Possible changes to the BDMEP monitoring and special studies requirements and activities, including monitoring designs, will be evaluated during the annual and periodic review processes for the Bay-Delta Plan and its implementation to ensure the monitoring and special studies are providing necessary information to support implementation of the Bay-Delta Plan and to consider possible needed updates to the plan for the reasonable protection of beneficial uses. Through the periodic review process, the State Water Board will establish and conduct a regular cycle of reviews that rotate through each monitoring activity in Table A-2, with the goal of reviewing each activity at least every 10 years. The State Water Board will conduct the reviews in coordination with the Delta Stewardship Council's Delta Science Program. Proposed changes to monitoring requirements or activities will be subject to public review and comment and must be supported by the best available scientific evidence, including consideration of the need to preserve the integrity of the long-term data record. Proposed changes to monitoring requirements or activities may proceed if approved by the Executive Director. Footnote 2 of Table A-2 identifies studies that may be modified due to ESA/CESA requirements. If studies are modified pursuant to ESA/CESA requirements, the Executive Director will consider what, if any, supplemental monitoring or special studies may be needed to meet the informational needs for the Bay-Delta Plan.

Each monitoring review will assess a set of thematically grouped monitoring activities and proceed through the following steps at a minimum, each of which will be documented in a report for public review and comment:

1) Identify the Bay-Delta Plan management and monitoring questions for the activities being reviewed;

2) Assess how well monitoring activities address the management and monitoring questions;

3) Assess any gaps, redundancies, or necessary improvements in the monitoring activities;

4) Develop recommendations for any changes to the monitoring activities; and

5) Assess the potential effects of recommended changes on the long-term data record and identify any recommended monitoring or special studies to maintain the long-term data record.

Refinements to monitoring protocols may be made to the extent they do not unreasonably interfere with the long-term data record. Where proposed changes would interfere with or disrupt long-term data records, special studies are required to calibrate the past methods with proposed future methods to maintain validity in analyzing long-term data collected with different methods.

A.3.2 Data Management and Quality

All data collected and calculated for the BDMEP is required to meet applicable data quality standards conforming to established standards for each field of study and to be conducted by qualified staff with appropriate training, expertise, and experience. All monitoring stations and measurement equipment are required to be regularly maintained and calibrated according to established standards. State Water Board staff will work with DWR, Reclamation, and other applicable entities as appropriate to establish for approval by the Executive Director standardized methods, quality assurance, instrument maintenance, and associated documentation for completing monitoring and related calculations pursuant to the requirements of this plan within one year of approval of the current plan amendments by OAL. These methods will be regularly reviewed and updated as appropriate as approved by the Executive Director. All records associated with maintenance, calibration, malfunction, or other topics associated with data collection, including records generated by organizations hired by responsible water right holders, are required to be made available to the State Water Board in a timely manner (not to exceed 30 days) upon request. The Executive Director may require changes to instrument maintenance, data quality management protocols, and data availability protocols to address any data quality issues as appropriate.

A.3.3 Reporting

All data collected or calculated for the BDMEP must be posted to a public website in a timely manner. This includes publication of provisional data, any corrected data after application of data quality control measures, and archiving of provisional data. For continuously collected data, provisional data are required to be posted in real time, and corrected data are required to be posted within 3 months of data collection. For discrete data, corrected data are required to be posted within 6 months of data collection. Methods (equations and data sources) used for producing calculated metrics are required to be published with the reported data.

Annual reports evaluating and summarizing results of all monitoring and special study activities from the prior water year are required to be submitted to the Executive Director by May 30 of each year, or an alternative date acceptable to the Executive Director. Annual Reports are required to include, at minimum, the following components:

i. Data quality review including, but not limited to, assessments of data quality, documentation of instrument operation and malfunction, maintenance records, and other relevant data quality information;

ii. Web addresses (URLs) to the public locations of the provisional and quality-controlled data and calculated metrics;

iii. Assessments of trends in measured and calculated parameters for the water year compared to the available historical record;

iv. Assessment of compliance with flow and water quality objectives and associated water right requirements; and

v. Any other relevant information as requested by the Executive Director.

A.3.4 Best Available Science

The State Water Board will require the use of best available science in implementing the Bay-Delta Plan. Nothing in these guidelines is intended to modify or otherwise change the State Water Board's existing peer review obligations and procedures pursuant to Health and Safety Code section 57004. The following definition of best available science is based largely on Appendix 1A of the Delta Stewardship Council's Delta Plan.

Best available science is specific to the decision being made and the time frame available for making that decision. Best available science is developed and presented in a transparent manner consistent with the scientific process, including clear statements of assumptions, the use of conceptual models, description of methods used, and presentation of summary conclusions.

Sources of data used are cited and analytical tools used in analyses and syntheses are identified. Best available science changes over time, and decisions may need to be revisited as new scientific information becomes available. Ultimately, best available science requires scientists to use the best information and data to assist management and policy decisions. The processes and information used should be clearly and transparently documented and effectively communicated to foster improved understanding and decision making.

A.3.4.1 Steps for Achieving the Best Science

Best available science follows the scientific process and includes the following elements:

i. Well-stated objectives

ii. A clear conceptual or mathematical model

iii. A well designed experimental or observational study with standardized methods for data collection

iv. Statistical rigor and sound logic for analysis and interpretation

v. Clear documentation of methods, results, and conclusions

The best science is understandable; it clearly outlines assumptions and limitations. The best available science is also reputable; it has undergone peer review conducted by active impartial experts in the applicable field(s) of study.

Scientific peer review addresses the validity of the methods used, the adequacy of the methods and study design in addressing study objectives, the adequacy of the interpretation of results, whether the conclusions are supported by the results, and whether the findings advance scientific knowledge.

There are several sources of scientific information and tradeoffs associated with each. The primary sources of scientific information, in a generalized ranking of most to least scientific credibility for informing management decisions, include the following:

i. Independently peer-reviewed publications including scientific journal publications and books (most desirable)
ii. Other scientific reports and publications
iii. Science expert opinion

In addition, when Traditional Ecological Knowledge is shared, it should be considered alongside Western science in informing decisions if permission for use is granted by the tribe. Each of these sources of scientific information may be the best available at a given time and contain varying levels of understanding and uncertainty. These limitations should be clearly documented when scientific information is used as the basis for decisions.

A.3.4.2 Guidelines and Criteria

There have been several efforts to develop criteria for defining and assessing best available science. In 2004, the National Research Council Committee on Defining the Best Scientific Information Available for Fisheries Management concluded that guidelines and criteria must be defined in order to apply best available science in natural resource management. The guidelines were based on six broad criteria: relevance, inclusiveness, objectivity, transparency and openness, timeliness, and peer review. The Delta Stewardship Council applied these criteria to the Delta Plan in Appendix 1A of the Delta Plan. Those criteria are further refined here to inform Bay-Delta Plan implementation and update processes.

Best available science for any actions to implement or update the Bay-Delta Plan should be consistent with the guidelines and criteria in Table A-4. These criteria were refined from criteria developed by the National Research Council and adapted by the Delta Stewardship Council. The Executive Director may request that reports or other documentation submitted pursuant to requirements of the Bay-Delta Plan document their scientific rationale for applying the criteria in Table A-4.

Table A-4 Criteria for Best Available Science

Criteria	Description
Relevance	Scientific information used should be germane to the Bay-Delta watershed and/or biological and physical components (and/or process) affected by the proposed decisions. Analogous information from a different region but applicable to the Bay-Delta watershed and/or biological and physical components may be the most relevant when scientific information specific to the Bay-Delta watershed is nonexistent or insufficient. The quality and relevance of the data and information used shall be clearly addressed.
Inclusiveness	Scientific information used should incorporate a thorough review of relevant information and analyses across relevant disciplines. Many analysis tools are available to the scientific community (e.g., search engines and citation indices).
Objectivity	Data collection and analyses considered should meet the standards of the scientific method and be void of nonscientific influences and considerations.
Transparency and openness	The sources and methods used for analyzing the science (including scientific and engineering models) used should be clearly identified. The opportunity for public comment is recommended. Limitations of research used should be clearly identified and explained. If a range of uncertainty is associated with the data and information used, a mechanism for communicating uncertainty should be employed.
Timeliness	Timeliness has two main elements: (1) data collection should occur in a manner sufficient for adequate analyses before a management decision is needed, and (2) scientific information used should be applicable to current situations. Timeliness also means that results from scientific studies and monitoring may be brought forward before the study is complete to address management needs. In these instances, it is necessary that the uncertainties, limitations, and risks associated with preliminary results are clearly documented.
Peer review	The quality of the science used will be measured by the extent and quality of the review process. Independent external scientific review of the science is most important because it ensures scientific objectivity and validity. The following criteria represent a desirable peer review process. Coordination of Peer Review. Independent peer review should be coordinated by entities and/or individuals that (1) are not a member of the independent external review team/panel and (2) have had no direct involvement in the particular actions under review. Coordination includes the vetting and selection of peer reviewers and all communication with peer reviewers until the review is complete. Independent External Reviewers. A qualified independent external reviewer embodies the following qualities: (1) has no conflict of interest with the outcome of the decision being made, (2) can perform the review free of persuasion by others, (3) has demonstrable competence in the subject as evidenced by formal training or experience, (4) is willing to utilize his or her scientific expertise to reach objective conclusions that may be incongruent with his or her personal biases, (5) is willing to identify the costs and benefits of ecological and social alternative decisions, and (6) is anonymous to and isolated from entities and individuals with direct involvement in the particular actions under review. When to Conduct Peer Review. Independent scientific peer review may be applied formally to proposed projects and initial draft plans, in writing after official draft plans or policies are released to the public, and/or to final released plans. Formal peer review may also be applied to outcomes and products of projects as appropriate.

When applying the criteria for best available science in Table A-4, the level of peer review for supporting materials and technical information (such as scientific studies, model results, and documents) is variable and relative to the scale, scope, and nature of the action. Peer reviews should be sufficiently detailed to answer the questions posed to the reviewers and/or provide specific technical recommendations.