Chapter 6
Water Quality

High water quality is vital to natural processes and human activities. Water quality is considered an essential issue to CABY stakeholders who share a common concern for its protection within the region. The CABY region generally experiences high water quality that typically meets and exceeds State and federal regulatory standards, with a few critical exceptions. Sediment, mercury, water temperature, and aquatic invasive species are issues that must be addressed now and into the future to ensure continued high-quality water in the CABY region. Best management practices and activities to maintain high water quality, and restore areas with less than ideal water quality, varies by issue and by site.

This chapter describes problem areas and includes cases resulting from historic activities that caused degradation, especially in the foothill elevations. Specific strategies for addressing water quality issues are discussed in Chapter 9, Issues and Objectives, and Chapter 10, Resource Management Strategies.

6.1 Regulatory Overview for Water Quality

The IRWMP is guided by the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins, as well as various watershed management initiatives and water quality goals and objectives set forth by CABY stakeholders and adopted by at least one agency (local, federal, or State) with statutory authority in the CABY region. The relevant plans address water quality protection and enhancement as well as wetland, ecosystem, environmental and habitat restoration and improvement, recreation, and public access. Summaries of each plan and how they relate to this document are included below.

6.1.1 Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins

The State and Regional Water Boards (Water Boards) are responsible for protecting California's water resources. The Water Boards are located within nine regions of California based on major watersheds. The Sacramento and San Joaquin River Basin Plan addresses water quality within the four CABY watersheds. The preparation and adoption of regional Basin Plans is required by the California Water Code (Section 13240) and the Federal Clean Water Act. Basin Plans are adopted and amended by Regional Water Quality Control Boards (RWQCB) under a structured process involving public participation and State review. Basin Plans are designed in accordance with the State Control Plan

adopted by the State Water Board and include water quality criteria to protect designated beneficial uses of water ways.

6.1.1.1 Basin Plan Goals and Objectives Related to CABY IRWMP

The Basin Plan sets forth an implementation and monitoring plan to achieve water quality objectives and preserve the designated beneficial uses assigned to each water body and associated tributaries. Beneficial uses are critical to water quality management in California. State law defines beneficial uses of California's waters to protect against degradation of: "...domestic; municipal; agricultural and industrial supply; power generation; recreation; aesthetic enjoyment; navigation; and preservation and enhancement of fish, wildlife, and other aquatic resources or preserves" (Water Code Section 13050(f)). Water quality conditions are stated in terms of whether there is water of sufficient quality and quantity to protect or enhance those stated beneficial uses.

The identified beneficial uses as stated in the Basin Plan are described below.

***Beneficial Uses**:* Municipal and Domestic Supply, Agricultural Supply, Industrial Service Supply, Industrial Process Supply, Groundwater Recharge, Freshwater Replenishment, Navigation, Hydropower Generation, Water Contact Recreation, Non-contact Water Recreation, Commercial and Sport Fishing, Aquaculture, Warm Freshwater Habitat, Cold Freshwater Habitat, Estuarine Habitat, Wildlife Habitat, Preservation of Biological Habitats of Special Significance, and Rare, Threatened, or Endangered Species.

Water quality objectives included in the Plan set criteria for meeting the Plan's goals for several water quality parameters. Parameters identified in the Plan for both surface waters and groundwaters are listed below.

***Inland Surface Waters**:* Bacteria, Biostimulatory Substances, Chemical Constituents, Color, Dissolved Oxygen, Floating Material, Oil and Grease, pH, Pesticides, Radioactivity, Salinity, Sediment, Settleable Material, Suspended Material, Tastes and Odors, Temperature, Toxicity, and Turbidity.

***Groundwater**:* Bacteria, Chemical Constituents, Radioactivity, Tastes and Odors, and Toxicity.

6.1.2 Watershed Management Initiative (WMI) for the Sacramento Hydrologic Region (2003)

In 1996, the Water Boards adopted the Watershed Management Initiative (WMI) to better address water quality issues on a watershed scale. The premise of WMI is that water quality and ecosystem problems are best prioritized, addressed, and solved at the local watershed level rather than at the individual discharger, water body, or State agency level. The WMI facilitates input and involvement of local stakeholders and provides an avenue to achieve water quality improvements and to develop unique and effective solutions based on the individual characteristics of each watershed. The WMI makes more efficient use of limited State resources and serves as a tool to establish partnerships with watershed stakeholders to achieve common water quality goals in a collaborative, integrated fashion (SWRCB website 2013).

The WMI for the Sacramento Hydrologic Region includes the American, Bear, and Yuba watersheds; the Cosumnes is included in the San Joaquin Hydrologic Region. Many of the issues addressed in the Central Valley Regional Water Quality Control Board's (CVRWQCB) 2003 Watershed Management Initiative –

Central Valley Reports are identical to CABY's water quality issues (see Chapter 9, Issues and Objectives). These common issues include metals, sedimentation, and temperature.

Many of the Regionwide Activities listed in Section II of the WMI are 'currently unfunded,' including:

- Expand the level of support in watersheds where staff is currently active and expand activities into additional subwatersheds
- Expand work with watershed groups to develop grant ideas and proposals
- Work with local planning agencies to bridge the gap between land use and water quality planning
- Work closely with agencies involved in associated activities such as salmon restoration and wetland enhancement
- Coordinate monitoring efforts within a watershed and integrate regional board programs with those of other agencies and organizations
- Provide continuity between project development, implementation, and post-project monitoring of State or federally funded projects

The CABY Planning Committee (PC) provides a forum consisting of diverse stakeholders to potentially address the unfunded WMI activities.

6.1.2.1 Watershed Management Initiative (WMI) for the San Joaquin Hydrologic Region

The Watershed Management Initiative for the San Joaquin Hydrologic Region includes the Cosumnes River, but only to a minor degree. The State of the Watershed Report for the San Joaquin River Watershed only mentions the Cosumnes once in the chapter. However, many of the issues described above for the Sacramento River Region are relevant in the Cosumnes watershed.

6.1.3 Water Projects that Match Water Quality with Water Use

Many of CABY's water systems are designed to match water quality to the appropriate type of use. The California Water Plan Update 2009 describes the effort to match water quality to use:

> *"Matching water quality to use is a management strategy that recognizes that not all water uses require the same quality water. One common measure of water quality is its suitability for an intended use; a water quality constituent often is only considered a contaminant when that constituent adversely affects the intended use of the water. High quality water sources can be used for drinking and industrial purposes that benefit from higher quality water, and lesser quality water can be adequate for some uses."*

For example, in general it is inefficient to use expensive and highly valued 'treated' water for irrigation purposes. Recycled water and untreated (raw) water are better options for irrigation and landscaping. Presented below is an overview of various CABY projects that are considered a good match for water quality with water use. Additional CABY projects are described in Chapter 12, Project Review Process.

Matching Water Quality to Agricultural/Landscape Uses

Recycled Water Programs: A number of water purveyors in the CABY region are developing recycled water supplies, which can be treated to Title 22 standards. The use of recycled water serves as a source of water that offsets the demand for potable water. For example, El Dorado Irrigation District uses

recycled municipal water in the El Dorado Hills and Cameron Park areas for landscape purposes. This is considered a better match of water quality to the type of water usage.

Matching Water Quality to In-stream and Ecosystem Use

Promoting In-stream Uses: Ambient, in-stream water must be suitable to support a wide range of aquatic habitats and conditions. Water quality for in-stream uses must meet physical, chemical, and biological objectives specific to the habitat and in-stream needs. The seven integrated projects that make up the CABY Mercury Initiative provide a good example of CABY's efforts to improve water quality for in-stream and ecosystem use. The projects are designed to address the region's oldest and longest neglected water quality impacts: mercury and sediment drainage from abandoned mines. Mercury is a powerful neurotoxin that can cause decreased reproductive success. This has been documented in fish-eating birds, but the neurotoxic effects hold true for any vertebrate species, including humans.[1] Of particular concern are animals that have a diet made up primarily of fish, such as river otters and osprey. The CABY region was the scene of the most intensive mining and related mercury pollution in California (California Department of Conservation (CDOC) 2003).

The seven projects in the CABY Mercury Iniatitive are designed to improve overall watershed function by:

1) improving habitats with less contamination from suspended sediment and mercury;
2) improving infiltration to eth vadoze zone[2] as opposed to surface runoff from surfaces devoid of soil from hydraulic mining practices; and
3) reducing sediment sources that drain into and fill CABY region reservoirs and result in shallow, warm-water habitat where formerly a deeper, cooler habitat provided cold-water refuge.

Matching Water Quality to Drinking Water Use

Protect Public Health: To avoid the additional cost of treatment, and to provide multiple barriers of protection for public health, it is best that drinking water supplies start with the highest quality source water available. The CABY project entitled *Canal Water Quality Monitoring and Evaluation Program* is designed to keep people from throwing yard waste, household garbage, and carcasses into drainage canals that may be used for domestic consumption downstream.

6.2 Current and Future Water Quality Conditions

Surface water quality for human consumption is considered very high in the CABY region. Water quality concerns for ecosystems, however, include methyl mercury, temperature, and sediment, as well as other legacy mining contaminants at designated Clean Water Act Section 303(d) locations displayed below in Figure 6-1. These contaminants are not considered significant in the context of drinking water supplies or treatment.

The mid-elevation watersheds were compromised in certain areas by historic land use practices beginning with mining more than 150 years ago.[3] Historic gold mining such as hydraulic and/or placer

[1] C. Monohan, 2013
[2] The soil or "eth" vadoze zone is the unsaturated region of soil extending from the ground surface to an underlying aquifer or geologic formation
[3] West Placer County Conservation Strategy 2004

mining caused heavy metal contamination and in some areas completely altered stream geomorphology. Significant deposits of mining debris still persist in many stream reaches of the CABY region especially within watersheds around the 2,000-5,000-foot elevation range: these sites contribute to degraded water quality.

Water quality within these middle- and lower-elevation watersheds also has been impacted by historic and ongoing practices, such as historical timber harvest in riparian areas that resulted in increased sediment delivery to streams, and stormwater runoff causing degraded aquatic habitat and chemical and bacterial contamination of water bodies.[4] More recently, these same foothill regions are under pressure from development and land use conversion. Poor livestock grazing practices, recreation activities, and runoff from roads impact riparian areas in this region as well.

Poorly constructed roads in the CABY region sometimes contribute to stream sediment due to erosion. In some areas, Off Highway Vehicle (OHV) use contributes sediment to streams that affect in-stream flows for aquatic species and impacts to riparian areas. Finally, natural events such as powerful storms can cause floods, slope failures, and excessive erosion especially in areas with highly erosive soils on steep terrain that have lost vegetative cover — the risk of these large slumping events is increased by unrestored hydraulic mine sites, logging activities, and areas destroyed by catastrophic wildfires.

Recent watershed assessment studies using national protocols (the Watershed Condition Framework) conducted by the Tahoe and Eldorado National Forests indicated water in the upper watersheds is of good quality overall. However, as described below, the region does experience challenges in specific problem locations, and for designated beneficial uses for natural ecosystems.

6.2.1 CABY Region Drinking Water Quality

One of the primary uses of the CABY region watersheds is as a source of drinking water supply. The California Department of Public Health (DPH) requires all surface water suppliers to conduct a watershed sanitary survey and then update that study every five years. The watershed sanitation surveys conducted in the CABY region have found the watersheds to have excellent drinking water quality, as demonstrated by the most recent 2008 Update to the American River Watershed Sanitary Survey[5] (also known as Source Water Assessment). The study was jointly conducted by 11 participating water utilities and identifies key findings and presents recommendations for source and treated water protection. The study focused on constituents of interest for drinking water purposes, including; turbidity, fecal coliform, *Escherichia coli* (*E. coli*), *Giardia*, *Cryptosporidium*, total organic carbon (TOC), disinfection by-products (DBPs), and other detected constituents that have a primary or secondary drinking water standard.

The study identified seven potential contaminating activities: forest management, recreation, river corridor use, urban runoff, wastewater, industrial facilities, and source water spills. The 2008 study concluded the American River provides source water that is “an excellent supply for drinking water. There are no persistently detected contaminants and the source water can be treated effectively with direct, conventional and membrane filtration.”

[4] Yuba River Monitoring Program 2000
[5] Starr Consulting and Palencia Consulting Engineers 2008

The sixteen study recommendations focus on assisting the participating water utilities with meeting all drinking water treatment and regulatory compliance goals, identifying opportunities for coordination with outside agencies to address potential source water quality impacts, and encouraging the implementation of effective stakeholder activities to protect source water quality.

More recently Nevada Irrigation District (NID) teamed up with Placer County Water Agency (PCWA) in 2012 to update its Watershed Sanitary Survey for the Yuba and Bear watersheds. This survey describes the susceptibility and types of constituents that may come into contact with the drinking water source and confirmed that the Yuba and Bear watersheds have very low levels of contaminants. Those contaminants found are usually associated with wildlife and human recreational activities.[6] NID's continuous monitoring of seven water treatment plants includes source water entering the treatment system, water in the treatment processes, as well as the treated water. The survey indicates that NID can expect no loss of water used for urban purposes due to water quality impacts.[7]

6.2.2 Clean Water Act Section 303(d) List

While drinking water supplies in the CABY region remain of high quality, Table 6.1 lists the Clean Water Act Section 303(d) listed (2010 list) water bodies in the planning area classified as impaired because they are unable to support certain designated beneficial ecosystem functions. The heavy metal pollution legacy (primarily mercury) is the most high-profile water quality contaminant in the region which poses significant risks to aquatic organisms and ecosystem health. Mercury is introduced here in the context of Section 303 (d) listings, while bioaccumulation of mercury is discussed below in the "Mercury" section.

The Upper Yuba has six water bodies (Deer Creek [Yuba County], Humbug Creek, Kanaka Creek, Englebright Lake, Little Deer Creek, and Scotts Flat Reservoir) listed as impaired due to mercury, arsenic, copper, zinc, sediment/siltation, and/or pH. The Upper Bear watershed has six impaired water bodies (Wolf Creek, Lake Combie, French Ravine, Upper Bear River, Rollins Reservoir, and Camp Far West Reservoir), mostly due to mercury contamination, but with secondary contamination from fecal coliform and bacteria. The South Fork American River is listed for mercury contamination from below Slab Creek Reservoir to Folsom Reservoir, and the Cosumnes River is listed in its entirety for aquatic exotic species.[8]

The State of California identified the Bear River and South Fork Yuba River as Priority 1 Impaired Watersheds (RWQCB Basin Plan) requiring restoration to improve water quality as a result of the large amounts of mercury.

[6] Source: NID Water Quality Report for 2011 (reported in 2012)
[7] Source: NID Agricultural Water Management Plan December 2012, Pg. 3-9
[8] California Resources Agency 2004, EPA 2006

Table 6-1
2010 Clean Water Act Section 303 (d) List of Water Quality Limited Segments Within the CABY Region (Listed from North to South)

Watershed	Water Body	Pollutant/ Stressor	Potential Sources	Estimated Size Affected	Expected TMDL Completion Date
Yuba	Deer Creek (Yuba County)	pH	Resource Extraction	4.3 miles	2021
	Humbug Creek	Mercury, Copper, Sediment/ Siltation, Zinc	Resource Extraction	2.2 miles	
	Kanaka Creek	Arsenic	Resource Extraction	9.7 miles	
	Little Deer Creek	Mercury	Resource Extraction	4.1 miles	
	Englebright Reservoir	Mercury	Resource Extraction	754 acres	
	Scotts Flat Reservoir	Mercury	Resource Extraction	660 acres	
Bear	French Ravine	Bacteria	Land Disposal	1.7 miles	2015
	Wolf Creek	Fecal Coliform	Agriculture, Urban Runoff/ Storm Sewers, Recreational Activities (non-boating)	23 miles	
	Lake Combie	Mercury	Resource Extraction	362 acres	
	Bear River, Upper	Mercury	Resource Extraction	10 miles	
	Camp Far West Reservoir	Mercury	Resource Extraction	1,945 acres	
	Rollins Reservoir	Mercury	Resource Extraction	774 acres	
American	South Fork American River	Mercury	Source Unknown	37 miles	2021
Cosumnes	Cosumnes River	Exotic Species	Source Unknown	53 miles	2019

In many places mercury concentrations violate federal water quality limits as well.

The State Water Resources Control Board and nine Regional Water Quality Control Boards are currently in the process of developing a Statewide Policy to control mercury in California's waters. Key elements of the Policy will include:

1. a Control Program for mercury in the State's reservoirs, and
2. new standards (objectives) for mercury in the tissues of certain species of fish.

According to the most recent public information release (July 2012), the Water Board will consider adopting the Policy in late 2013. Once adopted, reservoir operators, land managers, and others will be expected to design and implement sediment and mercury control programs to comply with the Policy's requirements and reduce mercury contributions to the State water system. This policy will have serious cost implications for CABY region water managers, as well as to ratepayers from potential pass-through charges.

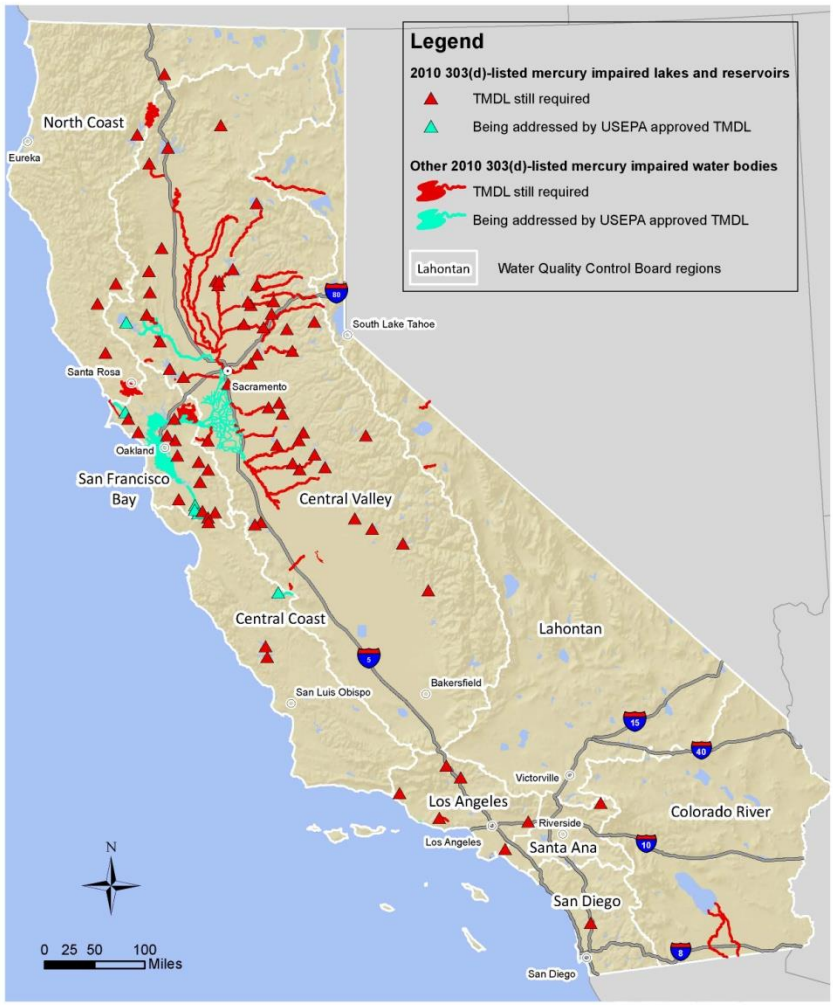

***Figure 6-1**: State Water Resources Control Board map of 303(d) listed water bodies in California that may be addressed through the proposed Statewide Mercury Policy (SWRCB 2012)*

As displayed in Figure 6-1 above, the CABY region includes a high concentration of listed water bodies compared to other regions in the state.

The CABY project known as *Sediment and Mercury Abatement Initiative* is designed to identify implementation measures for mecury and sediment in the upper watersheds for the Methylmercury Total Maximum Daily Load (TMDL) in the Delta and upcoming Statewide Mercury Policy and other mercury TMDLs in the upper watershed tributaries. Chapter 12, Project Review Process, includes a detailed discussion of this proposed project.

There is a fish advisory for the Cosumnes for mercury, but it is listed in 303(d) for toxic sediments related to agriculture. More than 12 regional water bodies are 303(d) listed as impaired for mercury in

the CABY region (CVRWQCB 2010). All studies that have been completed to determine mercury levels in fish tissue from CABY water bodies have shown levels over the EPA threshold for safe consumption (0.3ppm mercury in fish tissue). Table 6.2, Impaired Water Bodies and Fish Advisories Inside and Downstream of the CABY Region, lists the results of these studies.

Table 6-2
Impaired Water Bodies and Fish Advisories Inside and Downstream of the CABY Region

STREAMS LISTED AS IMPAIRED	COUNTY	POLLUTANT	FISH ADVISORY	SPECIES
Yuba River Watershed				
North Fork of the Yuba	Sierra, Yuba	Mercury		
New Bullards Bar Reservoir		Mercury		
Middle Fork of the Yuba River	Nevada, Yuba	Mercury		
Humbug Creek	Nevada	Mercury, Copper, Zinc, Sedimentation, Siltation		
South Fork of the Yuba River (Spaulding Reservoir to Englebright Reservoir)	Nevada	Mercury, Temperature, and Water		
Englebright Lake	Yuba, Nevada	Mercury	Mercury, 3/18/09	Rainbow Trout; Bluegill or other sunfish; and Largemouth, Smallmouth, or Spotted Bass
Lower Yuba River		Mercury		
Bear River Watershed				
Rollins Reservoir	Nevada, Placer	Mercury	Mercury, 3/18/09	Catfish
Combie Lake	Nevada, Placer	Mercury	Mercury, 3/18/09	Bass, Sucker
Lower Bear River (below Camp Far West Reservoir)		Mercury, Diazinon, Copper, Chlorpyrifos		
Bear River (Lower Bear River Reservoir to Mokelumne River, North Fork, Amador County)	Amador	Copper		
Bear River (from Allen to Upper Bear River Reservoir, Amador County)	Amador	pH (low)		
Camp Far West Reservoir	Yuba, Nevada, Placer	Mercury	Mercury, 3/18/09	Bluegill or other sunfish; Largemouth, Smallmouth, or Spotted Bass, Catfish

Table 6-2
Impaired Water Bodies and Fish Advisories Inside and Downstream of the CABY Region

STREAMS LISTED AS IMPAIRED	COUNTY	POLLUTANT	FISH ADVISORY	SPECIES
Upper Bear River (from Combie Lake to Camp Far West Reservoir, Nevada and Placer Counties)	Nevada, Placer	Mercury		
Scotts Flat Reservoir		Mercury		
Deer Creek (from Deer Creek Reservoir to Lake Wildwood, Nevada County)	Nevada	Mercury		
Deer Creek (Yuba County)	Yuba	pH		
Little Deer Creek		Mercury		
Gold Run (Nevada County)	Nevada	Mercury		
Lake Wildwood		Mercury		
Wolf Creek (Nevada County)	Nevada	Fecal Coliform		
American River Watershed				
Hell Hole Reservoir		Mercury		
Oxbow Reservoir (Ralston Afterbay)		Mercury		
American River, South Fork (below Slab Creek Reservoir to Folsom Lake)		Mercury		
Slab Creek Reservoir		Mercury		
North Fork of the American River		Mercury		
Folsom Lake	Sacramento, El Dorado, Placer	Mercury	Mercury, 10/15/08	Bluegill, Green sunfish or other sunfish, Trout <=16 inches; Catfish, Chinook king salmon, largemouth, smallmouth, or spotted bass, Trout >16 inches

Table 6-2
Impaired Water Bodies and Fish Advisories Inside and Downstream of the CABY Region

STREAMS LISTED AS IMPAIRED	COUNTY	POLLUTANT	FISH ADVISORY	SPECIES
Lake Natoma	Sacramento	Mercury	Mercury, 10/15/08	Bluegill, Green sunfish or other sunfish, Trout <=16 inches; Catfish, Chinook king salmon, Largemouth, smallmouth, or spotted bass, Trout >16 inches
Cosumnes River Watershed				
Lower Cosumnes River	El Dorado	Sediment Toxicity	Mercury, 02/15/2012	American Shad, Chinook (king) salmon, Clams, Steelhead trout**; Carp, Crayfish, Redear or other sunfish, Sucker, Bass, Catfish, Crappie, Striped Bass, and White sturgeon
Upper Cosumnes River	El Dorado	Invasive Species		

Sources:
CA. Gov. Impaired Water Bodies. 2013. 2010 Integrated Report (Clean Water Act Section 303(d) List / 305(b) Report) – Statewide; 303(d) list - Excel file (includes potential sources). State Water Resources Control Board Available at: http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2010.shtml
CA. Gov. Office of Environmental Health Hazard Assessment. 2012. Advisory Map. Available at: http://www.oehha.ca.gov/fish.html

Fish tested in Combie Reservoir (largemouth bass and Sacramento sucker) and in tributaries of the Yuba River were among the highest in mercury in a statewide survey completed by the State Water Resources Control Board's Surface Water Ambient Monitoring Program (Davis et al., 2010). The findings from the most comprehensive survey of fish in the Yuba and Bear watersheds (May et al., 1999) found that fish tissue levels meet and exceed Cal/EPA Office of Environmental Health Hazard Assessment (OEHHA) and Food and Drug Administration levels (0.3ppm mercury in fish tissue.):

- Englebright Reservoir: All smallmouth and spotted bass that were >1 foot and >250 grams (1/2 lb) had levels >0.3 ppm
- Scotts Flat Reservoir: Most largemouth bass >1 foot and 500 grams (1 lb) had levels >0.3 ppm
- Rollins Reservoir: Most channel catfish and most largemouth bass >1 foot and >400 grams had levels >0.3 ppm
- Combie Reservoir: All largemouth bass >1 foot and >400 grams had levels >0.7 ppm
- Camp Far West: All spotted and largemouth bass and channel catfish >1 foot and >300 grams had levels >0.5 ppm, half of the spotted bass exceeded FDA level of 1.0 ppm
- Bear River at Dog Bar Road and Little Deer Creek at Pioneer Park: Half of brown trout sampled >10 inches and >200 grams had levels >0.3 ppm

PCWA conducted methylmercury studies between 2007 and 2010 looking at concentrations in sport fish. About 55 percent of fish exceeded the OEHHA's guidelines for methylmercury, and over 16 percent of crayfish exceeded the standard (PCWA 2010d). Data concerning mercury and methylmercury in water, sediment, and biota from sites in the Bear River watershed are available online (http://ca.water.usgs.gov/mercury/bear-yuba/) (Wiener et al., 2003). An updated list of fish consumption advisories for water bodies without site-specific fish consumption advisories may be found at: http://www.sierrafund.org/news/606-statewide-advisory.

In the summer of 2013, the State of California released comprehensive safe-eating guidelines for fish from all California's lakes and reservoirs that do not have location-specific guidelines issued. This means that there is now information available for any lake fished in the Sierra.

6.2.3 Water Quality Data and FERC Relicensing

Seven hydroelectric projects in the CABY region recently conducted, or are currently conducting water quality studies and analyses as part of FERC relicensing efforts. The data collected as part of relicensing provides substantive detail on baseline water quality conditions and the associated ongoing water quality monitoring further increases the accuracy and specificity of the baseline data. As described below, the extraordinary research, data, and analyses have contributed significantly to our understanding of the water quality conditions within the CABY region and led to the development of a CABY program to utilize these data as a platform for water quality data collection throughout the region.

The four hydroelectric projects with associated water quality studies fall within the American watershed and include the Upper American River Hydroelectric Project (SMUD 2005), the El Dorado Hydroelectric Project (EID 2006), the Chili Bar Hydroelectric Project (PG&E 2005), and the Middle Fork American River Hydroelectric Project (PCWA 2010). Two additional hydroelectric projects in the northern CABY region recently completed relicensing studies and analyses. These two projects include Drum-Spaulding Hydroelectric Project (PG&E 2013), Yuba-Bear Hydroelectric Project (NID 2013). Another hydroelectric project in the northern CABY region, the Yuba River Hydroelectric Project (YCWA 2016), is currently conducting studies, scheduled to be completed within the next three years.

CABY's 2010 IRWMP planning grant application identified the studies conducted for relicensing PCWA's Middle Fork American River Project as particularly relevant due to its focus on three of CABY's primary issues: water quality, fish, and mercury. These three issues were first identified in early 2006 as priorities in the region at CABY's initial meetings as a Regional Water Management Group. Because PCWA's relicensing studies are directly related to CABY's priorities, these studies were identified as a cost-share in this IRWMP update. Each relicensing study includes clear descriptions of the study objectives, study area, approach, data analysis, and results.

PCWA's relicensing study issues of water quality, fisheries, and mercury contamination were taken into account with CABY's issue prioritization. The draft relicensing documents were distributed to various stakeholders including resource agencies, Native American Tribes, non-governmental organizations, and members of the public to solicit further feedback. Each study was subjected to a 60- or 90-day public comment period, depending on the topic. A final study plan addressing comments on relicensing studies was prepared and distributed. PCWA shared the final studies with the CABY organization as well as individual stakeholders, and CABY will incorporate this information into its IRWM data management process through the 2013 planning grant.

6.2.3.1 Relicensing Cost-Share Tasks

The following paragraphs present brief descriptions of the relevant relicensing documents identified as cost-share tasks for this update and how these studies contribute the CABY's top priority issues. Studies from three hydroelectric projects informed the regional description by adding detail about potential issues and by identifying particular locations of concern. These hydroelectric projects are listed below.

Table 6-3
FERC Relicensing Documents Relevant to the CABY IRWMP

FERC Project	FERC Project License ID	Expiration	Licensee Involved
El Dorado	184	October 2046	El Dorado Irrigation District
Middle Fork American River	2079	28 February 2013	Placer County Water Agency
Yuba-Bear	2266	30 April 2013	Nevada Irrigation District

Western Placer Creeks (WPC) Work Group: The WPC located in the American watershed is one of the longest-lasting work groups in the CABY region and its efforts have benefited significantly from relicensing studies conducted in the region. For example, baseline fisheries data collected as part of PCWA's relicensing studies, in combination with the forthcoming YCWA relicensing data, provide a framework and scope for fish population baseline analyses that can be conducted in the WPC region. This example serves as a standard to integrate relicensing studies and data into future studies in the watershed.

Resource Management Strategies: The PCWA data informed the selection of State-approved CABY region RMS and led to the identification of two additional CABY region strategies.

Issues, Objectives, and Conflicts: The data from PCWA relicensing studies were used by CABY to help confirm and inform priority issues such as water quality, mercury, and fisheries. The data provide a baseline condition in specific areas that allows for comparison in certain locations. The CABY PC requested other relicensing data be added to the suite of background documentation.

6.2.3.2 Development of a CABY Region Searchable Database

As the PCWA relicensing data was incorporated into the CABY revision process, it became clear that the data had direct relevance to water quality issues, as well as future project implementation and monitoring efforts. The data's level of detail makes its utility even more significant for CABY stakeholders when it is applied to individual projects or when used to address specific issues and concerns. These results and findings led CABY's technical assistance team to request help to organize all regionally significant relicensing data into a searchable Sacramento River Watershed Information Module (SWIM) database that can be accessed by CABY stakeholders (see Chapter 15, Technical Analysis).

CABY has access to extensive data from PCWA, EID, Sacramento Municipal Utility District (SMUD), NID, and PG&E, as well as future information from Yuba County Water Agency that could be used as part of the database. This database is comprised of thousands of detailed study plans, technical evaluations, and follow-up monitoring activities. Simple access to this data can be achieved through updating the SWIM system web-based tools.

6.2.4 Future Water Quality Conditions

Future water demands in the CABY region are projected to increase substantially over the next three decades (see Chapter 7, Water Supply). Development pressures in the CABY region can impact both natural and constructed water supply systems and create a greater level of disturbance through roads, canals and pipes, and general traffic. These disturbances may take place in previously remote areas such as forest ecosystems. The CABY region stakeholders are interested in programs that consider the link between natural resource management and California's water supply.

For example, it has been increasingly noted that forest ecosystems play a critical role in delivering clean water for the public. The Forest Service recently launched a program that identifies areas of interest for protecting surface water quality called Forests to Faucets.[9] On a macro scale, the Forests to Faucets data identifies areas that supply surface water, have consumer demand for this water, and are facing significant development threats. The mapping done in this program shows the link between forests and the provision of surface water – a key watershed-based ecosystem service.

6.2.5 Quality of Groundwater, Imported Water, and Water from Storage Facilities

6.2.5.1 Groundwater

As discussed further in Chapter 7, about five percent of the water supply in the Mountain Counties Area is from groundwater, which is generally used in single family homes, though it is included as part of a few public water systems.[10] The groundwater resources of the region are poorly understood. Most of the water management agencies within the region (i.e., irrigation and water districts) do not use groundwater resources as a primary water supply. The only organizations that manage the use of groundwater resources and water quality are the cities and counties that issue well drilling permits and mandate water quality testing.

6.2.5.2 Imported Water

No water is imported to the CABY region from outside basins, although California relies on water exported from the CABY watersheds. There are some inter-basin transfers within the CABY region, discussed in Chapter 7, Water Supply.

6.2.5.3 Water from Storage Facilities

Water storage facilities in the CABY region include upper-elevation reservoirs that capture predominantly snowmelt and precipitation and mid-elevation reservoirs which are predominantly rain fed. These reservoirs are used for consumptive, irrigation, hydroelectric generation, environmental/ beneficial uses and recreation. In specific locations, some mid-elevation storage facilities experience

[9] http://www.fs.fed.us/ecosystemservices/FS_Efforts/forests2faucets.shtml
[10] DWR 2009

water quality issues resulting from sedimentation and legacy mining; however, the high-elevation reservoirs have very good water quality with no major issues.

Water supply and distribution infrastructure in the CABY region between reservoirs is one of the most complex systems in the state, with water moving between elevations and between watersheds as part of the overall water system distribution network. This network is developed and maintained by PG&E, NID, and PCWA to the north and EID, Georgetown Divide Public utilities District (GDPUD), and SMUD to the south. As mentioned above, in general, water quality of the distribution system is not considered an issue except in specific locations. For example, mercury-laden sediment occurs within the upper reaches of Rollins and Combie Reservoirs, and water temperatures in the upper reaches of those reservoirs become warmer due to the shallow waters.

6.3 Water Quality Protection and Improvement Needs in the CABY Region

Water emanating from the CABY region watersheds is generally of high quality; nonetheless, sediment, mercury, bacterial contamination, water temperature, and prevention of aquatic invasive species are all areas of focus to ensure continued high quality water in the CABY region now and into the future.

6.3.1 Sedimentation and Erosion

Although sediment is a natural component of mountain river systems, it can present challenges to watershed management in the CABY region. Sedimentation can cause reduction in reservoir capacities, increased water treatment costs, and adversely impact aquatic biota and habitat. Sedimentation is a natural process, but human activity has accelerated that process in some areas within the CABY region. In general, sedimentation is increased when soil cover is reduced or eliminated. Historic mining activities, especially hydraulic mining, created conditions where mercury-laden sediment continues to move within CABY watersheds: for example, at Malakoff Diggins, at Rollins Reservoir, and in the Bear River above Combie. Some ongoing ground-disturbing activities produce sediment that can be transported by runoff into waterways. High intensity forest wildfires and lack of management post-fire can result in landslides and accelerated erosion and sedimentation.

Some levels of erosion and sediment deposition are important for riverine processes, including providing substrate for spawning, and sediment for streambank and floodplain development. Active watershed stewardship is necessary to prevent excessive sedimentation in the CABY region from becoming problematic. Excessive sediment deposition moving through the riverine system into storage reservoirs can create high levels of turbidity and stress aquatic organisms as well as reduce reservoir capacity. For example, NID estimates that about 12,000 acre-feet of reservoir storage capacity, or 18 percent, has been lost at Rollins Reservoir due to sedimentation since its construction in 1965.

Massive amounts of sediment draining from eroding hydraulic mining sites also impacts water quality and water storage in the CABY region. Today, historic hydraulic mining sites exhibit extreme badlands topography, and continue to erode massive amounts of sediment contaminated with mercury during storm events. For example, a study at Malakoff Diggins Hydraulic Mine found that as much as 3,000 lbs/min of sediment were being discharged during storm events (DWR 1987). The CABY Sediment and Mercury Abatement program will address sediment using erosion control and water filtration technologies at the source at Malakoff Diggings and Relief Hill Mine, which both drain into the Yuba watershed (see Chapter 12, Project Review Process, for project details).

6.3.1.1 Studies and Findings by Drainage

Yuba Watershed

The Yuba River watershed also contains a significant amount of sediment as a result of historic mining. Historic hydraulic mining involved directing high-pressure water cannons at exposures of Eocene gravel and washing the excavated sediment slurry through mercury-laden sluice boxes. Hydraulic mine tailings were conveyed into adjacent watercourses, leading to dramatic increases in sediment loads and severe aggradation. Gilbert (1917) estimated that hydraulic mining contributed approximately 682 million cubic yards of sediment to Yuba River channels. Extensive remobilization of stored hydraulic-mining sediment began as early as 1861 when severe winter storms delivered substantial volumes of sediment to the Central Valley. In 1941, the California Debris Commission built Englebright Dam to trap hydraulic-mining sediment mobilized in the Upper Yuba River watershed. The majority of the Middle Yuba River and South Yuba River channels have since recovered their pre-mining bed elevations; however, significant volumes of hydraulic mining sediment remain stored in wide mainstem reaches and in smaller upland tributaries of these two rivers. Studies of the Yuba River and adjacent watersheds suggest that these smaller tributaries are asymptotically incising toward pre-mining channel-bed elevations; therefore, remobilization of hydraulic mining sediment continues to affect sediment yields from impacted basins and contribute to lost water storage space in reservoirs.[11]

Sediment loads in the Yuba watershed can be attributed to other human activities such as past timber harvest practices, road construction associated with rural housing development, and recreation. A tributary of the South Yuba River, Humbug Creek, is listed as a 303(d) water body under the Clean Water Act for sediment. The Upper Yuba is considered a "priority watershed" for action by the State under the California Unified Watershed Assessment. The high concentrations of suspended sediment in the Humbug Creek watershed can be attributed to abandoned mines in the Malakoff Diggings Historical State Park, and clear-cuts on private lands.[12]

West Placer Creeks

The West Placer Creeks are in a condition and location to facilitate local repopulation of anadromous fish. Because of a present population for fish and the accessibility of the fish to the creek network, there is a possibility for augmenting the fish population in this area.[13] There are, however, some restoration efforts and improvements in water quality needed. In many portions of Antelope Creek and Clover Valley Creek the stream channel has high sediment loads and a lack of pools. Creating pool habitats, reducing sediment input to the channel, cleaning stream gravels to promote increased aquatic insect production, and ensuring that riparian vegetation is allowed to reproduce would improve conditions here and in many other areas. Improving sediment transport through the system would be an overall benefit to aquatic organisms in general. The physical habitat conditions in the channel, specifically the amount of sediment, are a limiting factor for juvenile fish production. A major reduction in the quantity of sediment entering the channel is critical to improving hatching and emergence success and long-term juvenile rearing capability.[14]

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[11] Curtis, J.A., Flint, L.E., Alpers, C.N., Wright, S.A., and Snyder N.P. (2006). Sediment transport in the Upper Yuba River Watershed, California, 2001–03. In U.S. Geological Survey Scientific Investigations Report 2005-5246, 74 pp. Retrieved October 23, 2006, from http://pubs.usgs.gov/sir/2005/5246/

[12] Schilling, F. (n.d.). State of the Yuba: an assessment of the Yuba River watershed. Nevada City, CA: University of California

[13] Donald Bren School of Environmental Science and Management, Master of Environmental Science and Management Class of 2003 Group Project Brief (2003). Available on the web at www.bren.ucsb.edu

[14] Bailey Environmental (2003). Streams of western Placer County aquatic habitat and biological resources resource assessment. Prepared for Placer County Planning Department. Lincoln, CA: Bailey Environmental

Bear Watershed

The Bear River contains a large volume of mining sediment largely from two tributaries: Greenhorn and Steephollow Creeks. Sediment is stored in its main channel where three storage reservoirs are present. Due to its low-elevation headwaters (5,000-foot elevation), relatively low average annual discharge (around 273,000 acre-feet), and protracted sediment releases from water storage reservoirs, this sediment has not been flushed, but continues to be a potential problem for fish habitat in the river.[15] The storage reservoirs have an infill of sediment which continues to increase in depth and reduce the storage capacity. In addition to sediment, the Bear River is listed on the EPA 303(d) list for mercury due to legacy mining practices. This high volume of mining sediment, in combination with restricting levees, has caused the Lower Bear channel to become deeply incised.[16] Additionally, the Bear River channel has not returned to pre-mining levels due to two main factors: 1) as mentioned, the Bear River headwaters are at relatively low elevations, resulting in discharges of low-to-moderate magnitude, and 2) hydraulic mining sediment was of much larger magnitude than in other local watersheds.[17]

American Watershed

High intensity forest fires, such as the Star Fire of 2000, pose a significant threat in this and other CABY watersheds. Heat at ground level can bake organic matter, reducing permeability and increasing runoff, thus leading to accelerated erosion and sedimentation.

Past management activities in the watershed have resulted in soil compaction and erosion (e.g., roads, landings, and skid trails) in some areas. These areas have altered hydrologic function and are at increased risk of surface runoff and gully erosion. Gully erosion is typically initiated by channelized water runoff from areas where water cannot infiltrate the soil, such as roads.[18]

Tributaries to the Middle Fork have been negatively impacted by inadequate management during the past, including activities such as mining, over-grazing, road construction, and timber harvesting. Today, these land use practices are heavily regulated and land managers have advanced their management practices, increasing watershed health. PCWA has completed sediment transport studies in the Middle Fork as an accompaniment to their FERC relicensing process. Duncan Canyon, which flows into the Middle Fork downstream of French Meadows Reservoir, periodically transports large amounts of bedload (cobble and gravel deposition), even though the channel is relatively stable. This sediment is principally derived from natural channel downcutting in the numerous unstable seasonal tributaries, as well as from some bank undercutting along the main channel, exacerbated by periodic natural peak flow events.[19]

Cosumnes Watershed

A recent (2003) inventory of the Cosumnes watershed focused on channel and watershed processes as sources of sediment within the watershed. These include processes that contribute sediment through

[15] James, L. A. (1988). Historical transport and storage of hydraulic mining sediment in the Bear River, California: A study of the timing, volume and character of hydraulic mining sediment production and channel responses to the sediment as well as present conditions

[16] Eberhart, Allan (2006). White Paper: Bear River Watershed Assessment. Retrieved June 6, 2006, from http://motherlode.sierraclub.org/4-BearRiver.htm

[17] Ibid, James, L. A.

[18] MacDonald, L. and Coe, D. (2005). Sediment production and delivery from the unpaved forest roads in the Sierra Nevada. Geophysical Research Abstracts, Vol. 7, 08831

[19] USDA Forest Service, Tahoe National Forest (n.d.) Middle Fork American River watershed assessment. Nevada City, CA: USDA Forest Service

either lateral movement of the stream channel (bank erosion and bar formation), or vertical movement of the streambed (degradation and aggradation). The inventory included channel classification, a bank stability survey, a ground disturbance survey, and an analysis of historical geomorphology. It found that, in the Mountain Section (in the upper watershed), 81 percent of the streambanks surveyed had negligible amounts of bank instability, 17 percent had moderate amounts, and 2 percent had significant amounts of instability. In the Foothill and Valley Sections, 8 percent of stream banks surveyed had negligible amounts of bank instability, 33 percent had moderate amounts, and 59 percent had significant amounts of instability. Findings from the ground disturbance survey of 244 disturbed sites (representing 5,381 acres), indicated that almost half the sites (120) were located in the upper watershed.[20] Erosion from land use activities, roads, and OHV use contribute sediment throughout the Cosumnes River watershed.

Recent surveys of spawning gravel indicate that they are cemented by silt. This silt may have been introduced into the river primarily by past mining, grazing, road construction, and forestry practices.[21]

In the Middle Fork Cosumnes River, sediment is being deposited and bank stability is being affected near Dogtown Creek due to suction dredging. Most of the disturbance consists of channel excavations, cobble piles, and bank cuts in the active channel, lower banks, and floodplain areas. All areas of the watershed have relatively high road densities and near-stream road densities compared to other watersheds in the Sierra Nevada.[22]

In the North Fork Cosumnes River, as on other CABY rivers, many land use activities, past and present, have the potential to cause excessive erosion. Potential consequences of accelerated erosion include a reduction in the productive capacity of the soil, adverse effects on water quality, and heightened potential for landslides.[23]

6.3.2 Mercury Methylation

Mercury contamination and attendant mercury methylation is a pervasive issue in the Bear, American, and Yuba River watersheds (Alpers et al., 2005). Moreover, management and restoration of the Bay-Delta ecosystem is complicated by mercury contamination from historic mining sites in the Sacramento and San Joaquin River watersheds, the principal sources of fresh water for the Bay-Delta system. Mercury-laden sediment now contaminates downstream reaches of streams and rivers. A challenge to scientists and managers involved with restoration of this ecosystem is to avoid increasing exposure of biota to methylmercury, a toxic form of mercury. The methylation of mercury makes the pollutant 'bio-available' and if consumed is a neurotoxin. Methylmercury readily accumulates in organisms and biomagnifies (concentrates) in fish and wildlife at the top of aquatic food webs. Documented

[20] Jones & Stokes and Northwest Hydraulic Consultants (NHC) (2003). Cosumnes River Watershed inventory and assessment: phase two. Sacramento, CA: Jones & Stokes

[21] Philip Williams and Associates (PWA) and The Nature Conservancy of California (TNCC) (1997). Analysis of opportunities for restoring a natural flood regime on the Cosumnes River floodplain. San Francisco, CA: TNCC; The Nature Conservancy of California (TNCC) (1992). Cosumnes River Watershed strategic plan. San Francisco, CA: TNCC; Hart and Engilis (1995). Middle Cosumnes River Watershed: River corridor and vernal pool/grassland study areas. San Francisco, CA: The Nature Conservancy of California; Quidachay, K.B., Britting, S., Ehrgott, A. (2000). Upper Cosumnes River watershed conservation project: environmental assessment. Coloma, CA: American River Conservancy

[22] USDA Forest Service, Eldorado National Forest (2002). Middle Fork Cosumnes River Watershed landscape and road analysis. Placerville, CA: USDA Forest Service

[23] USDA Forest Service, Eldorado National Forest (2002). North Fork Cosumnes River Watershed landscape and road analysis. Placerville, CA: USDA Forest Service

consequences of methylmercury pollution and consequent dietary exposure include: 1) direct adverse effects on the health of fish, wildlife, and humans; 2) contamination of fishery resources that diminishes their nutritional, cultural, socioeconomic, and recreational benefits; and 3) socio-cultural damage to indigenous peoples who fish for subsistence.

From 1900 to 1960 several billion cubic meters of alluvial material was dredged for gold, and millions of pounds of mercury was discharged. These alluvial 'dredge fields' are generally downstream from dams on the major tributaries – including the Yuba, American, and Bear Rivers – and are situated in floodplains that provide critical habitat to anadromous fish. Many of the dredge fields contain mercury-contaminated tailings from hydraulic-mining activities that took place further upstream before dams were constructed. Additional mercury was released in association with dredging processes at these alluvial sites. The release of mercury from gold mines in the Sierra, and the form of mercury in those mines, has not been extensively studied; however, initial observations indicate that it may be more readily methylated. Elemental mercury and gold-mercury amalgam are often visible in streams draining hydraulically mined areas of the Sierra Nevada and in the dredged goldfields downstream, such as those on the Yuba and American Rivers. Data concerning mercury and methylmercury in water, sediment, and biota from sites in the Bear River watershed are available online.[24, 25]

The USGS estimates that up to 8,000,000 of the 26,000,000 pounds of mercury used in the Sierra Nevada may have been 'lost' during gold recovery, including during hydraulic mining. The mercury is present in the bottom of rivers and reservoirs, as well as in pits, sluices, and tunnels remaining in abandoned mine lands where it can be mobilized. It is transported by erosion and runoff as elemental mercury, in ionic form (i.e., Hg^{2+}), in dissolved form, adsorbed to particles, and as droplets of the metal.

6.3.2.1 Studies and Findings of Non-listed Sites

The following discussion is focused on watershed-level studies outside the Clean Water Act Section 303(d) listed sites.

The Nevada County RCD commissioned mercury studies through the United States Geological Survey (USGS) in 2001-2003 to track levels of mercury in fish on the Bear River. One of the findings is that "fish from reservoirs and streams in the Bear-Yuba watersheds (see Figure 7) have bioaccumulated sufficient mercury to pose a risk to human health."[26] For example, Camp Far West has a 'do not eat fish advisory' for bass and catfish (see http://oehha.ca.gov/fish/so_cal/campfarwest.html).

PCWA conducted methylmercury studies between 2007 and 2010 looking at concentrations in sport fish. The PCWA studies consisted of the collection of over 140 fish samples at FERC project reservoirs (Hell Hole, French Meadows, Ralston Afterbay, and Middle Fork Interbay), and at one river site, and the collection of crayfish from French Meadows and Hell Hole Reservoir. A State-certified laboratory completed the fish-tissue analyses and the results were compared to the State Office of Environmental

[24] http://ca.water.usgs.gov/mercury/bear-yuba/

[25] Wiener, J.G., Gilmore, C.C., and Krabbenhoft, D.P. (2003). Mercury strategy for the Bay-Delta Ecosystem: a unifying framework for science, adaptive management, and ecological restoration. La Crosse, Wisconsin: University of Wisconsin

[26] Alpers, CN, MP Hunerlach, JT May, and RL Hothem. Mercury Contamination from Historical Gold Mining in California. Fact Sheet #: 2005-3014 Version 1.1. U.S. Geological Society. Sacramento, CA. 2005. Available from: http://pubs.usgs.gov/fs/2005/3014/fs2005_3014_v1.1.pdf.

Health Hazard Assessment guidelines. About 55 percent of fish exceeded the OEHHA's guidelines for methylmercury, and over 16 percent of crayfish exceeded the standard.[27]

The USGS and others are conducting measurements of mercury and methylmercury in the biota, sediments, and waters in reservoirs and near/within abandoned mine lands of the Yuba/Bear systems. There are not currently direct measurements being done for the atmospheric deposition of mercury; however, mercury can originate from the atmosphere, and this form of mercury can become bioavailable. There are only a few measurements for the waters and sediments of the Upper Bear and Yuba Rivers and their tributaries. Though research is limited, it is known that mercury is leaking gradually from abandoned mine tunnels, sluice boxes, and pits. Dredge tailings are thought to be a potential hotspot, as is sediment disturbance during secondary mining near abandoned mine features, or in contaminated sediments. Mercury is assumed to be slowly migrating downstream in the creeks and rivers, temporarily lodging in the benthic sediments and pockets in the channel bedrock.[28]

6.3.3 Other Contamination

Non-sediment, non-mercury contaminants in the CABY region potentially include microbes and biological contamination. Possible sources of these pollutants can include recreation, agricultural discharges and practices, stream and bank alterations, illegal dumping, timber harvest, and wildlife.[29]

Public lands within the CABY region have experienced significant increases in recreation activity in the last 20 years. More than 50,000 recreationists raft and kayak the American River annually, rendering it one of the most intensely utilized recreational river systems in the nation. Similarly, from 1997 to 2001, the number of OHVs in use on national forests increased by almost 40 percent. These advances expand opportunities for Americans to enjoy public lands; however, they point to a need for sound management practices to ensure the protection of soils, water quality, and wildlife habitat.

Although a relatively small percentage of the CABY region is urbanized, increasing development and the conversion of lands to impervious surfaces can result in pollutant spikes during storm events.[30] Extreme runoff from urban areas results in unnatural flow surges and carries hydrocarbons, bacteria, lawn chemicals, and a host of other pollutants to the river systems.

6.3.3.1 Studies and Findings on Other Contaminants

Water quality monitoring conducted by PCWA during its relicensing process for the Middle Fork Hydroelectric Project (FERC #2079) showed high water quality throughout the Middle Fork watershed. Coliform sampling of natural waters was a component of the voluntary monitoring done by PCWA during the same study, and all study sites and times were found to be less than 200 colonies/100mL except for one location during the fall sampling (300 colonies/100mL; at river mile 2.9 on Long Canyon Creek).[31]

[27] PCWA 2010d
[28] Schilling, F. (n.d.). Mercury contamination in the Yuba and Bear Watersheds. Nevada City, CA: University of California
[29] Black & Veatch Corporation and Standish-Lee Consultants (2002). Watershed sanitary survey update and source water assessment. Sacramento, CA: Black & Veatch Corporation
[30] Schmitt, J., and A. Michael (2004). Rainfall infiltration under urban soil surface conditions – experiment and model results. In 13th Annual Soil Conservation Organization Conference: Conserving Soil and Water for Society: Sharing Solutions. Brisbane, July 2004
[31] PCWA 2008

Identifying sources and management strategies regarding biological contamination requires more research, especially as recreational use increases. Recently the Tahoe and Eldorado National Forests conducted environmental analyses to determine the effects of motorized vehicle use on National Forest System lands, and they developed guidelines for that use.[32, 33] Creating public awareness and providing education for land use best management practices can help prevent biological contamination.

Studies have shown the conversion from rangeland and forest to housing subdivisions and commercial developments can increase the amount of impervious surfaces and can introduce urban pollutants to stream systems.[34] Wolf Creek, a tributary to the Bear River, is listed as a 303(d) water body for *E. coli* (see Table 6.1, 2010 Clean Water Act Section 303(d) List of Water Quality Limited Segments within the CABY Region). However, this is likely an isolated issue as the most recent Watershed Sanitation Survey Update conducted in 2008 on the American River watershed resulted in findings of excellent water quality in all categories sampled throughout the watershed (see section 6.1.1 Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins).

6.3.4 Water Temperature

Water temperature is an important water quality parameter in the CABY region. Water temperatures can affect aquatic ecosystems by altering the water's ability to hold essential and beneficial dissolved gases (such as oxygen) in solution, as well as affecting mercury methylation, as mentioned above, and the hospitability of the water body to exotic species such as invasive mussels. Water temperatures may be influenced by dams, releases of surface water from reservoirs, water diversions and in-stream flows, riparian canopy, and could be affected by climate change through an altered hydrology.

6.3.4.1 Studies and Findings on Temperature

In California, the timing and amounts of water released from reservoirs and diverted from streams are legally regulated with consideration of their effects on various native aquatic species, especially those listed as threatened or endangered under the Federal and State Endangered Species Acts, and additional designated species of regulatory concern. These include winter-run and spring-run Chinook salmon, Coho salmon, coastal and Central Valley forms of steelhead and rainbow trout. Conversely, some amphibians require a different water temperature than those identified as ideal for salmon and steelhead. California constitutes the warm, southern end of the geographic range of most of these species. By 2100, climate change is expected to cause a considerable rise in average air temperature, raise water temperatures, greatly reduce snowpack volume, and shift the seasonal pattern of surface water runoff to more in winter and less in spring and summer. These physical changes are likely to influence water temperatures and thus the ecology of aquatic life in the region. In many low- and middle-elevation California streams today, summer temperatures often come close to the upper tolerance limits for cold-water species, such as salmon and trout. Thus, anticipated climate change effects may be enough to raise water temperatures above the tolerance limits for salmon and trout in many streams, favoring instead non-native fishes such as carp and sunfish.[35] Chinook salmon and

[32] Eldorado National Forest 2008
[33] Tahoe National Forest 2010
[34] Ibid. Booth, D.B.
[35] California Department of Water Resources (DWR) (2006). Progress on Incorporating Climate Change into Planning and Management of California's Water Resources; Technical Memorandum Report. Sacramento, CA: DWR

steelhead, for example, prefer temperatures of less than 20°C in mountain streams, although they may tolerate higher temperatures for short periods.[36]

A water temperature monitoring program is in place at 20 different locations within the Middle Fork American River system. This program includes 12 monitoring locations on the Rubicon River, 7 sites on Long Canyon Creek, and 3 locations on the North Fork American River. During spring and summer storm events, when water spills from the top of reservoirs in the American River watershed, water temperatures have been shown to increase immediately downstream. Water temperatures below powerhouses tend to be cooler while operating. Because of reservoir spilling, water temperatures were coldest in early June and warmest during mid-July at several sites.[37] Maps regarding temperature modeling along the Middle Fork of the American River, completed by PCWA for their FERC relicensing process, are available in a final, and updated, report (PCWA 2010b). The maps completed as part of this data collection and reporting display the changes this hydropower system has had on the Middle Fork in lowering average summer temperatures due to reservoir releases. Reservoir operations can change the habitat suitability for endemic species in the area and are therefore considered in project management and licensing.

On the South and Middle Yuba Rivers, low flows, high water temperatures, and sediment have contributed to problems for the cold-water adapted aquatic communities.[38, 39] The CABY region harbors numerous meadows in the upper reaches of the watersheds important because they can cool and filter water as well as reduce peak flood flows, much as manmade reservoirs do. The CABY project known as Meadow Enhancement and Restoration in the Yuba, Bear, and American River Watersheds (see Chapter 12, Project Review Process) is designed to enhance and restore meadow habitats thereby improving water temperature for the benefit of downstream users with the added benefit of enhancing crucial wildlife habitat.

6.3.5 Aquatic Invasive Species

Prevention of aquatic invasive species[40] (AIS) such as quagga mussels and Asian clams infestation is a potential water quality concern in the CABY region, although no infestations have been documented to date. AIS are already a serious problem for California[41] as they threaten the diversity and abundance of native species and natural communities, the ecological stability and water quality of infested waters, and the commercial, agricultural, aquacultural, and recreational activities dependent on these waters. The economic consequences of AIS impacts can be substantial, from decreased productivity of commercial fisheries to expenditure of billions of dollars to alleviate AIS impacts in water bodies after they become infected (Pimentel et al. 2000).

6.3.5.1 Studies and Findings on Invasive Species

AIS in the CABY Region: A number of programs are in place in anticipation of AIS infestations. These programs involve thorough inspections and examinations by trained personnel. For example, water

[36] Moyle (2002). Inland fishes of California. Merced, CA: University of California Press
[37] Placer County Water Agency (PCWA) (2006). Draft 2005 water temperature study report (Middle Fork American River). Auburn, CA: PCWA
[38] Schilling, F. (n.d.). State of the Yuba: an assessment of the Yuba River watershed. Nevada City, CA: University of California
[39] Upper Yuba River Studies Program Study Team, for DWR. (June 2006) Upper Yuba River Watershed Chinook Salmon and Steelhead Habitat Assessment
[40] Aquatic invasive species include algae, insects, crabs, clams, fish, plants, and other invaders
[41] California Aquatic Invasive Species Management Plan 2008

purveyors adopted invasive mussel protection plans and Nevada County Supervisors adopted a resolution petitioning the State for stricter measures to protect against invasive mussels in California waterways. The resolution asks the State to implement and fund an inspection program for quagga and zebra mussels and other AIS detected in regional waterways.[42] Nevada County is the second county to adopt the measure, following Lake County. Officials from Nevada and Lake Counties plan to reach out to other county leaders statewide to lobby for support for this measure.

Prevention measures are designed to address prevention and spread of AIS. Prevention measures include activities such as inspection, quarantine and decontamination of watercraft, enforcement of legal authority, and strengthening the code of conduct for businesses dealing with aquatic organisms. Inspection and decontamination of recreational equipment such as watercraft (including boats, rafts, kayaks, and float tubes), fishing gear, clothing, waders, rope, cooling tanks, and live wells prevents the spread of many AIS such as dreissenid mussels, aquatic plants, and other unwanted pests. Preventing the introduction of AIS is far more cost efficient compared to control efforts.

AIS in California and Adjacent Watersheds: The broad-scale introduction of species into California waters most clearly began with the shipment of tens of thousands of barrels of oysters from the East Coast after the establishment of the transcontinental railway.[43] The huge influx of settlers, the establishment of maritime commerce, and a multitude of other human activities through the 1900s contributed to continued invasions. Since then hundreds of AIS have found their way into California waters, via transoceanic ships, aquaculture, the aquarium trade, the bait industry, recreational activities, biological research, environmental restoration projects, and through freshwater deliveries up and down the state. Nationwide, non-native species have contributed to 68 percent of the fish extinctions in the past 100 years and the decline of 70 percent of the fish species listed under the Endangered Species Act.[44]

A local case study involves Lake Tahoe. Beginning in 2009, all boats entering Lake Tahoe were required to have an inspection for AIS. The number of watercraft requiring decontamination has increased annually. In August of 2011, 37 quagga mussels were found at the Spooner Lake Inspection Site. The boat had arrived from Lake Mead, a water body known to be infected with AIS. In 2010, a boat was found to be infested with New Zealand mud snails. In 2008, infestations of Asian clam (*Corbicula fuminea*) were discovered in Lake Tahoe. Based on the damage caused in the Great Lakes region by zebra and quagga mussels, these European freshwater invertebrates could threaten California's entire water delivery system, irrigation network, and freshwater ecosystems, and it is likely that global movements of goods and services will continue to introduce and spread AIS.

6.3.6 Water Quality Monitoring

Current water quality monitoring activities in the CABY region are conducted by local jurisdictions (e.g., water agencies, county environmental health), local watershed groups, conservation groups, and Resource Conservation Districts (RCDs). The purpose and scope of these monitoring activities varies within watersheds and across the region. Governmental agencies are required to collect water quality information associated with a host of operational activities (e.g., raw water, treated water, wastewater discharge, FERC license requirements). These activities are conducted using strict protocols and incorporate rigorous quality control and quality assurance standards.

[42] The Union 9/28/11
[43] Barrett 1963
[44] Wilcove et al. 1998

Extensive water quality monitoring is currently performed by water purveyors in the CABY region, as required by State and federal law and the FERC relicensing processes. As guided by regulations and permits, source waters, treated water, and areas near land use activities are periodically analyzed for pH, water and air temperature, dissolved oxygen, conductivity, turbidity as well as bacterial constituents, inorganic chemical constituents, general chemical parameters, and organic chemicals, metals, and pesticides. Additionally, water purveyors are required to produce water quality reports to regulatory agencies at regular intervals. This information is available to the public as well as shared with stakeholder groups such as CABY.

Agricultural stakeholders in the CABY region created watershed water quality coalitions as a response to the Central Valley Regional Water Quality Control Board's removal of an exemption for agricultural discharge in 2003. At that time, under the Irrigated Lands Regulatory Program, the Placer/Nevada/South Sutter/North Sacramento (PNSSNS) Water Quality Coalition and the El Dorado County Agriculture Water Management Corporation were formed. These two coalitions have spent over $1.5 million generated by landowner fees to perform monitoring activities and to report the analysis annually to the applicable water quality control board. The Irrigated Lands Regulatory Program requires these agricultural coalitions to monitor discharges for legacy contaminants, metals, pesticides, among many other parameters. The areas in the CABY region were found to be low-threat areas with zero exceedances found since 2003.[45, 46]

The State of California encourages and promotes citizen-based water quality monitoring as a means of creating watershed awareness and engaging citizens to enhance watershed health. In the past 10 years, numerous citizen monitoring programs have taken root throughout the CABY region. Most of these groups were aided through past State grants, and some are still active, using grant-funded equipment and approved methodologies. The water quality monitoring parameters and data being collected displays the range of indicators these volunteer groups are experienced in. Citizen monitoring data in the CABY region can be found on the CABY website with links to the various watershed groups and organizations.

Non-regulatory-driven monitoring, such as that performed by citizen-monitoring groups, may be performed for a variety of reasons including watershed education, stewardship, or baseline data collection activities. While providing useful data for certain purposes, these monitoring efforts may not always employ strict quality control standards. Several citizen water quality monitoring training sessions have become available throughout the region in the past few years. These sessions seek to improve quality control and quality assurance protocols for citizen monitoring groups, as well as creating a standard for regional data collection. CABY supports training for quality data collection to bolster the volume of data collected and diversity of sites sampled.

Consistency with regard to collection method, modernity of tools, uniformity of analysis methods, or any number of uncontrollable variables is imperative to establishing a useful scientific database. The CABY region has discussed assembling quality-controlled data sets to create a CABY-wide database that can connect with the pre-existing Sacramento River Watershed Information Module database that can be accessed by CABY stakeholders. Many of the participating organizations, such as EID, NID, PCWA, South

[45] Source: Sacramento Valley Water Quality Coalition Annual Report 2011
[46] Source: March 21, 2000, Letter from El Dorado County Agriculture Water Management Corporation to CVRWQCB

Yuba River Citizens League, Sierra Streams Institute, and American Rivers, have experience in data collection and management, as well as essential location-specific experience. For further discussion, see Chapter 2, Stakeholder Involvement.