

System Indicators

Water & Air Quality, Temperature,
Precipitation, and Snowpack



Water Quality in the Sierra Nevada (2010)

September 2012

Water Quality in the Sierra Nevada

The State Water Resources Control Board (SWRCB) 2010 303(d) List (List), developed under the Clean Water Act, was used for this System Indicator. The List indicates water bodies that exceed defined water quality standards, but does not provide data on the actual level of pollutants. [See description of List methodology at the end of this section.]

A new List is developed every few years, with the last previous years being 2006 and 2002. The 2010 List is the first one with data available in GIS (Geographic Information System) format, which allowed us to quantify water bodies (miles of stream/acres of lakes and reservoirs) specific to the Sierra Nevada Conservancy (SNC) boundary. Unfortunately, this precludes us from being able to compare the 2010 data to that of previous years in a comprehensive way.

Even more problematic in comparing to previous years is that the number of impairment listings has increased dramatically between reports. Statewide, the 2002 List included 1,883 listings. This grew to 2,238 in 2006, and 3,507 in 2010. As the 2010 SWRCB Staff Report states, rather than necessarily indicating a worsening in pollution, “The large number of new listings is most likely a result of the large volume of new water quality data that has become available since the 2006 List. In addition, more protective water quality standards are now applicable to some water bodies.” There were also some de-listings in 2010 (see pg. 16 at the end of this section).

Now that the List provides GIS compatibility, it will be possible to clearly track new listings and de-listings in the Sierra Nevada in future years.

The List certainly doesn’t provide a complete story of water quality in the Sierra Nevada. It only includes surface water bodies; it does not assess groundwater quality. The List also does not quantify the actual level of the pollution. It does, however, provide a continuous, legally authoritative review of pollutants in surface waters to the extent that the health and beneficial use of water resources is compromised.

Overview of water impairments

The List identifies Rivers & Streams (referenced in this report as Streams, and measured in miles) and four kinds of area water bodies: Lakes & Reservoirs, Saline Lakes, Wetlands, and Estuaries (all referenced in this report as Lakes, and measured in acres). Many streams and lakes have multiple pollutants or other impairment issues.

The List identifies impaired water bodies as to both a pollutant category and specific pollutants. For instance, Pesticides is a category which includes specific pesticides such as Diazinon, Diuron, Group A pesticides, etc. (see table on next page). In some cases, it makes more sense for this report to assess pollutant categories and in other cases, specific pollutants.

The List also includes the sources of the pollutants, when known. Unfortunately, a large proportion of the impairment sources are identified as ‘unknown’.

Overall, water quality in the Sierra Nevada is certainly better than many areas of the State, such as the Central Valley and Southern California. However, there are certain pollutants that are

extensive and specific to the history or current land use of the Sierra Nevada, which warrant focus. These top issues include mercury, temperature, nutrients, pathogens, and toxicity.

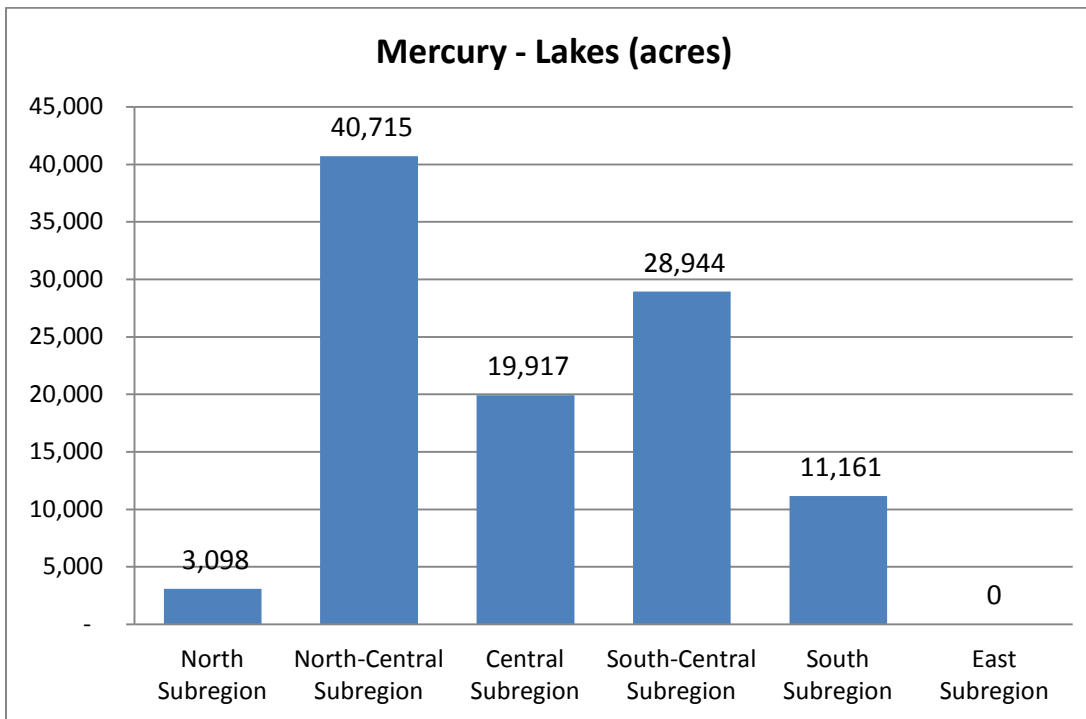
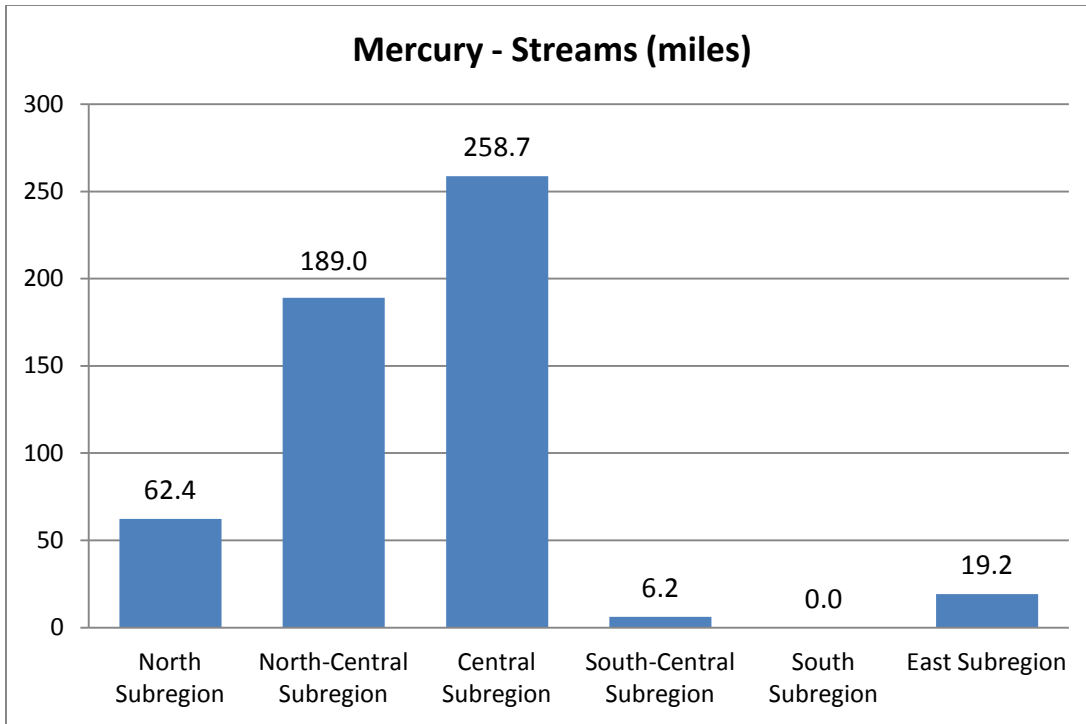
303(d) List Impairments within the SNC Region	
Pollutant Category	Pollutant
Metals and Metaloids	Mercury, Arsenic, Aluminum, Cadmium, Copper, Iron, Manganese, Silver, Zinc, unspecified metals
Miscellaneous	Invasive species, pH, Temperature
Nutrients	Nitrogen (including as Nitrates), Phosphorus, organic enrichment/low-dissolved oxygen, ammonia
Other inorganics	Sulfates
Other organics	PCB's
Pathogens	Bacteria, E. Coli, Fecal coliform, unspecified pathogens
Pesticides	Chlorpyrifos, Diazinon, Diuron, Group A, Pyrethroids
Salinity	Salinity, Total dissolved solids
Sediment	Sediment/Silt, Turbidity
Toxicity	Sediment toxicity, Unknown toxicity

Mercury

Within the SNC Region, 535.5 miles of rivers and creeks, and 103,835 acres of lakes and reservoirs are listed for mercury impairment. Mercury is in almost all cases a gold mining legacy. As expected, the majority of rivers and creeks listed for mercury are in the 'gold country' within the Central and North-Central Subregions, and are identified as a consequence of 'resource extraction'. Major listed river segments include the North and South forks of the American (a total of 121 miles), the Feather River (59 miles), the Bear River (27 miles in Placer, Nevada, and Yuba Counties), Butte Creek in Butte County (48 miles), and the Yuba River (133 miles). However, over 60 miles of the Susan River in Lassen County is also listed for mercury, with the source identified primarily as 'natural'. Additionally, the source of mercury in creeks in the East Subregion (Mono County) is listed as natural or unknown.

The geographic distribution of lakes and reservoirs listed for mercury is a bit different even though historic gold mining is still primarily the cause. While the North-Central and Central Subregions account for a large share of the mercury impairment in streams, the South-Central Subregion encompasses nearly 30,000 acres of impaired lakes. Major lakes and reservoirs in these three Subregions identified for mercury (approximately 90,000 acres total) include Lake Almanor, Lake Oroville, Folsom Reservoir, Don Pedro Lake, Hetch Hetchy, and McClure Reservoir. One small lake in the heart of the Central Subregion with known severe mercury contamination, Lake Combie, was the focus of a previous SNC grant to assess the potential for mercury extraction from lake sediment.

The South Subregion includes four lakes on the List for mercury, totaling over 11,000 acres (including Pine Flat Reservoir, and Millerton, Hensley, and Kaweah Lakes), while Lake Britton and a small portion of an arm of Lake Shasta extending into the Region account for 3,100 acres in the North Subregion. In total, 27 lakes and reservoirs are listed for mercury.



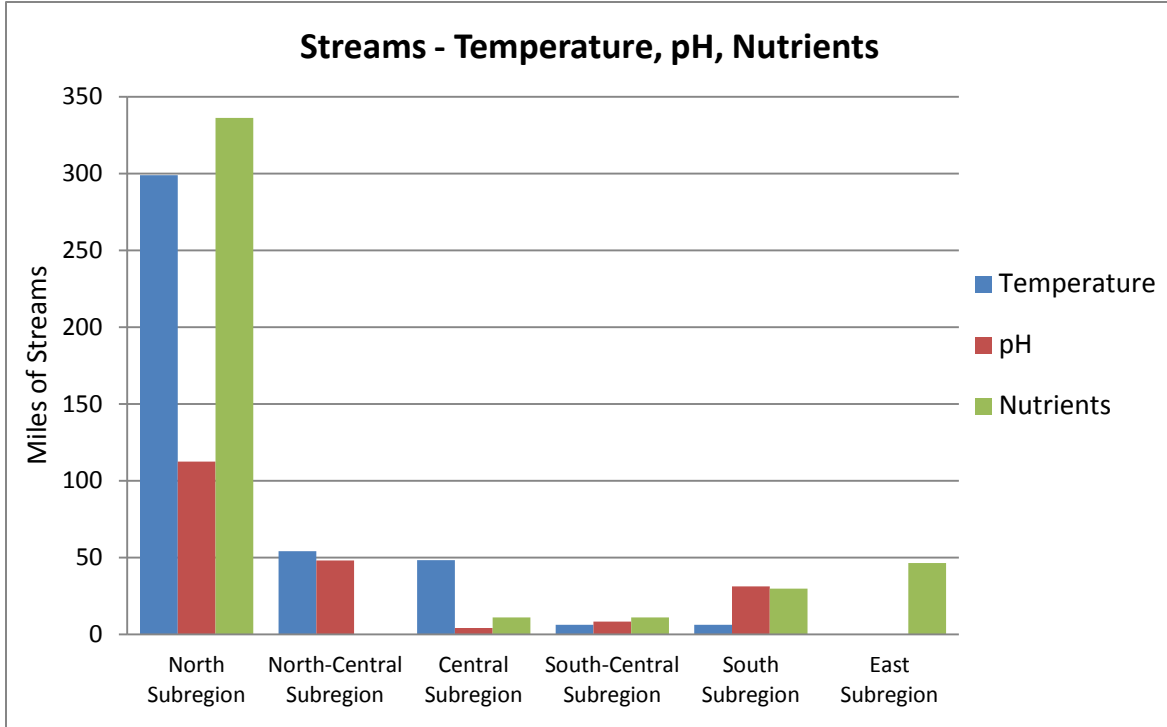
The map on the next page provides a visual depiction of mercury pollution in the Sierra Nevada.

Mercury Impairment in the Sierra Nevada



Three impairments – Temperature, pH, and Nutrients

As the following chart clearly shows, issues with stream temperature, pH, and nutrients are all dominated by the North Subregion.



Lakes are a different story. There are no lakes identified for temperature issues, but 37,910 acres of lakes are identified for nutrients and 9,785 acres of lakes are identified for pH. While more than half of the acres of lakes with nutrient impairment are in the North Subregion (all in Lassen County), there is also substantial lake nutrient impairment in the South and East Subregions. Almost all of the lake pH impairment is in the South Subregion.

Lakes – pH and Nutrients (acres)		
	pH	Nutrients
North Subregion	19	20,705
North-Central	0	0
Central Subregion	0	0
South-Central	299	0
South Subregion	9,467	9,466
East Subregion	0	7,739
Total	9,785	37,910

Temperature

There are 414 miles of rivers and creeks listed for temperature (water too warm) in the SNC Region. Of these, 299 miles (72 %) are accounted for by the Pit River running through Modoc, Lassen, and Shasta Counties. The source for the increased temperature is identified on the List as 'grazing'. Precisely how the cattle grazing is causing increased water temperature is not described on the List, but a presumed major cause is a reduction of cooling vegetation along the river and tributary creeks.

The majority of the rest is in the North-Central Subregion (North Fork Feather River) and Central Subregion (South Fork Yuba River). The cause for the Feather River, below Lake Almanor, is listed as 'hydromodification'¹; for the Yuba River, between Spaulding and Englebright Reservoirs is listed as 'unknown'.

Increased water temperature can impact aquatic wildlife by changing the habitat characteristics, both directly by moving ambient temperature out of the accustomed range for specific aquatic species, and also by facilitating nutrient loading and changes to pH to the detriment of aquatic life.

Nutrients

In general terms, 'nutrients' are chemicals or compounds that 'feed' organic life; in the context of water quality, to the detriment of the aquatic ecosystem. In terms of the List, 'nutrients' are identified not only as specific chemical 'foods' (often fertilizer runoff), but also as the impacts of nutrients – undesirable enrichment of organic materials in the water and resulting reduced oxygen in the water.

'Nutrients' is a pollutant category which comprises a number of 'pollutants' – nitrogen (or nitrates), phosphorus, organic enrichment, and low-dissolved oxygen. These specific pollutants are very much interrelated. These nutrients feed microorganisms which consume oxygen in the water. Higher water temperatures both aid this organic growth and reduce the ability of water to hold oxygen, reducing the water's ability to supply oxygen to aquatic wildlife.

As shown in the chart above, the North Subregion accounts for over 336 miles of the total 435 miles (77 %) listed for nutrient impaired rivers and creeks in the SNC Region. This includes the same 299 miles of the Pit River as well as 37 miles of the Susan River headwaters. Eagle Lake (20,705 acres) is the only lake in the North Subregion listed for nutrients (nitrogen and phosphorus).

In the East Subregion, the upper West Fork of the Carson River in Alpine County, along with a couple of creeks in Mono County, are listed for nutrients. Listed large lakes in the East Subregion include Bridgeport Reservoir and Crowley Lake. Thirty miles of the Fresno River above Hensley Reservoir is listed in the South Subregion, as are Hensley Lake and Lake Isabella.

The List identifies agriculture and grazing as either the primary or contributing source for 77 percent of the 435 miles of streams cited for nutrient pollution, including the 299 miles of the

¹ Hydromodification is defined as: alteration of the hydrologic characteristics of coastal and noncoastal waters, which in turn could cause degradation of water resources. In the case of a stream channel, this is the process whereby a stream bank is eroded by flowing water.

Pit River for which agriculture and grazing is the indicated source of excess nutrients that result in low-dissolved oxygen. The sources of excess nutrients in the East Subregion listed rivers include silviculture, waste disposal, hydromodification, and recreation along with agriculture and grazing. The source for other streams is listed as 'unknown'.

The List identifies many nutrient sources for 20,705 acre Eagle Lake, including agriculture, grazing, recreation, municipal runoff, atmospheric deposition, and natural sources. Sources of nutrients for most of the other lakes are listed as unknown.

pH

pH is a measure of the acidity of water. Most aquatic life is acclimated to a fairly small pH range. If the pH of the water gets out of that range in either direction, the health of the organism will suffer, or perhaps the fish, plant, or organism will no longer be able to survive there.

A total of 205 miles of streams and 9,785 acres of lakes in the SNC Region are listed for pH impairment. As shown in the chart above, 112.5 miles (55%) of impaired streams are in the North Subregion while the majority of impaired acres of lakes (97%) are in the South Subregion. Butte Creek is the only stream listed in the North-Central Subregion, while Deer Creek in Tulare County accounts for most of the pH stream impairment in the South Subregion. The source for the pH impairment for all streams is listed as 'unknown' except for 4.3 miles in Nevada County which is noted as 'natural'.

Deer Creek in Tulare County (29 miles) is listed for **high** pH. The Bear River in Amador County (8 miles) is listed for **low** pH. For the other 168 miles of pH- impaired streams, the List does not indicate if the pH is low or high.

There are two large reservoirs listed for pH – Lakes Isabella (7,710 acres) and Hensley (1,669 acres) – both in the South Subregion. Amador Lake (299 acres) is listed for high pH; the other four listed lakes are not specified as to high or low pH. The source of pH impairment for all lakes is listed as unknown.

Pathogens

'Pathogens' is a pollutant category which includes specific pathogenic descriptions: bacteria, E.Coli and fecal coliform, as well as unspecified pathogens. These are all really different ways of describing different aspects of the same thing – harmful bacteria from animal or human feces. Pathogens are a specific concern for human health.

302 miles of streams are listed for pathogens within the Region, with the bulk located in North, South-Central, and East Subregions (see map and table on next pages). As opposed to many of the other 303(d) impairments, the pathogens listings are nearly all limited to creeks rather than major rivers (the Carson and East Walker Rivers in the East Subregion are the two exceptions).

Pathogen Impairment in the Sierra Nevada



Many of the creeks are listed for multiple sources, which are a combination of agriculture and human sources including sewage/waste and recreation. A number of creeks are listed for 'unknown' sources, while a few are listed strictly as agriculture. Three creeks in Tuolumne County all around the Sonora/Jamestown area are listed for E.Coli. Wolf Creek in Nevada County (23 miles, listed for fecal coliform, source 'unknown') runs through highly populated wildland-urban interface, though it does support some grazing.

The East Walker River in Mono County is identified for a combination of agriculture, recreation, and urban sources; the Carson River in Alpine County is identified as primarily agriculture caused. The only lake listed for pathogens is 28 acre Ramona Lake in Fresno County, listed for E. Coli, and the source listed as unknown.

Miles of Impaired Rivers and Streams		
	Pathogens	Toxicity
North Subregion	108.2	62.4
North-Central	0	258.0
Central Subregion	24.4	1.7
South-Central	101.5	58.2
South Subregion	0	45.9
East Subregion	67.7	0
Total	301.8	426.2

Toxicity

Toxicity refers to substances in water that produce detrimental physiological responses in human, plant, animal, or aquatic life. It applies whether toxicity is due to a single substance or to the interactive effect of multiple substances. Toxicity is assessed through analysis of indicators such as species diversity and population density, growth anomalies, indicator organisms and biotoxicity tests.

Over 426 miles of streams are listed for toxicity in the SNC Region (see table above). The largest extent, 258 miles, is in the North-Central Subregion. Unfortunately, the List provides no direct indication of what is actually causing the toxicity in the various water bodies. Virtually all of the streams are simply classified as 'unknown toxicity'. For all the listings, the cause is listed as 'unknown'. Many of the streams listed for toxicity are also listed for other impairments that might produce toxicity (including mercury, pesticides, pathogens, salinity, and pH), but some are not listed on the List for anything but toxicity.

In the North-Central Subregion, 221 miles of the Feather River (all branches, plus Concow Creek, a tributary) are listed for toxicity. The Susan River accounts for all the toxicity listing in the North Subregion. Most of the listing in the South-Central Subregion is accounted for by Bear Creek in Mariposa County and Littlejohns Creek in Calaveras County, though lower portions of Stanislaus and Tuolumne are listed. Deer Creek in Tulare County and Lower Kings River in Fresno County account for most of the South Subregion listing. Only one lake in the

Sierra Nevada is listed for toxicity, the 28 acre Ramona Lake that is listed for several other impairments.

Arsenic

Arsenic is listed for only two streams in the Sierra Nevada: 9.7 miles of Kanaka Creek in Sierra County (North-Central Subregion) and 1.7 miles of an unnamed tributary to Mammoth Creek in Mono County. The source for Kanaka Creek is identified as resource extraction; the source for Mammoth Creek tributary is listed as unknown.

There is only one lake listed for arsenic – 57,757 acre Honey Lake in the North Subregion. The multiple sources indicated include natural sources, unspecified nonpoint sources, construction/land development, and hydromodification.

Arsenic is a naturally occurring element in the Sierra, but mining has caused exposure and concentration in tailings and stream courses. Arsenic is highly toxic.

Pesticides

‘Pesticides’ is a pollutant category that encompasses any number of specific pesticides, five of which are identified in the SNC Region (see table at beginning of Water Quality section). Most are insecticides. Class A pesticides are those that are known human carcinogens.

There are 41.5 miles of streams listed for pesticides in four of the six Subregions, not including the North and East Subregions. They include 11 miles of Bear Creek in Calaveras County.

Most of the listings for the Region include the lower reaches of rivers that flow out of the Sierra into the Central Valley:

- Bear River below Camp Far West Reservoir
- Feather River below Lake Oroville
- Kings River below Pine Flat Reservoir
- Lower Stanislaus River below Tulloch Reservoir
- Tuolumne River below San Pedro Reservoir

These river segments are listed for multiple agricultural insecticides. It should be noted that there may be little or no pesticides for the portions of these listed segments that are actually within the SNC boundary, but because the listing is for the entire segment and the segments fall both within and outside the SNC boundary, there is no way of knowing whether the pollutant is actually in the Region or not. For instance, the List includes a 20 mile stretch of the Tuolumne River from Don Pedro Reservoir to the San Joaquin River as impaired for three pesticides. Only 3.5 miles of this stretch (just below Don Pedro Reservoir) is inside the SNC Region and included in our figures. However, it is highly likely that these agricultural pesticides are found primarily or entirely downstream in the farmland of the Valley rather up in the foothills within the SNC Region immediately below the dams.

There are no lakes listed for pesticides.

Other Impairment issues

Metals other than Mercury

There are various metals, largely mining legacy (except for Honey Lake), identified in the streams and lakes of the Sierra Nevada – primarily copper, manganese, zinc, and iron. A total of 70.5 miles of streams are listed for one or more metals (other than mercury and arsenic). They include 9.4 miles of Little Grizzly Creek in the North-Central Subregion, 8 miles of Deer Creek (El Dorado County) in the Central Subregion, 11 miles of Bear Creek (Calaveras County) in the South-Central Subregion, and the East Walker River and Mammoth Creek in the East Subregion.

The Honey Lake Area Wetlands and Wildlife Management Ponds (a total of 63,257 acres) are listed for ‘metals’; individual metals are not identified. Multiple sources are described, including natural sources, agriculture, and geothermal development. Comanche Reservoir in the South-Central Subregion is listed for copper and zinc; Haiwee Reservoir Inyo County is listed for copper.

Metals other than Mercury		
	Streams (miles)	Lakes (acres)
North Subregion	1.1	63,257
North-Central	10.9	0
Central Subregion	14.8	0
South-Central	16.5	2,433
South Subregion	0	0
East Subregion	27.2	1,703
Total	70.5	67,393

Sediment

‘Sediment’ is a pollution category which contains sediment/siltation and turbidity as specific pollutants. Sediment/siltation of streams can damage fish spawning habitat and negatively affect downstream water quality. Turbidity is a measure of the cloudiness of water.

A total of 93 miles of streams are listed for sediment/siltation. The Central Subregion accounts for 46.2 miles (the Truckee River and various creeks). The East Subregion contains 32.5 miles of listed rivers and creeks, and the Fall River in the North Subregion accounts for 11.8 miles.

There are a wide variety of identified sources for the sediment/siltation. They include silviculture, resource extraction, and urban sources in the Central Subregion. For the 35-mile stretch of the Truckee River, the List includes those causes along with grazing, land development, hydromodification, and recreation. In the East Subregion, grazing and silviculture are major sources of sedimentation. On the Fall River in Shasta County, silviculture is the identified source.

Two rivers are also listed for turbidity. The Susan River below Susanville (16.5 miles) is due to agriculture. Eight miles of the East Walker River below Bridgeport is listed for both sediment and turbidity.

Salinity

There are just over 200 miles of rivers and creeks in the SNC Region listed for salinity, all in the North and East Subregions. In the North Subregion, 54 miles of the Susan River and 37 miles of the Pit River, as well as 12 miles of Bidwell Creek in the far north-east of Modoc County have excess salinity, with the source indicated as unknown. In the East Subregion, the East Fork Carson River accounts for 46 miles and Rock Creek (a tributary to the Owens River) for 35 miles. Salinity in Rock Creek, and 4 miles of Monitor Creek in Alpine County, is a result of mining.

There are two main saline water bodies, listed for salinity/total dissolved solids/chlorides. The history of Mono Lake (39,744 acres) is well understood. Causes of the salinity are natural sources and hydromodification. The other is Honey Lake and the associated waterfowl management ponds (total 58,422 acres). The salinity arises from the constant cycle of dry season evaporation of the lake. Identified sources on the List include natural and nonpoint sources, agricultural diversions and return flows, and geothermal development. Ramona Lake in Fresno County (28 acres) is the only other lake listed for salinity (source unknown).

PCB's

All the listed PCB impairments are in the North-Central Subregion associated with the Feather River (North and South Forks plus Lower Feather River totaling 93.7 miles) and Lake Oroville (15,400 acres). The sources are 303(d) listed as 'unknown', though PCB's are man-made industrial related chemicals. PCB's are carcinogenic and highly toxic.

Sulfates

Four miles of Monitor Creek in Alpine County is listed for Sulfates from mining legacy.

Conclusions related to water quality

Pollutants differ as to the duration of their impact, and whether current practices are adding to the flow or they are a legacy of past practices. Some will require extensive cleanup or mitigation while others can be reduced or eliminated as a natural outcome of changing land management practices.

Mercury contamination in and around stream courses is a particularly extensive and intractable problem. Its evidence and consequences will linger for decades and centuries without specific cleanup efforts to clean up historic mine tailings and stream bottoms, or in some way keeping them out of the active ecosystem. Other metals, arsenic, and PCBs are also of this nature, though not as extensive in scope.

Other pollution problems may be more solvable. Pathogens, excess nutrients, and pH could be reduced through implementation of various agricultural and grazing practices, and by addressing sewage issues where they occur. The SNC has funded and aided numerous projects, working with landowners to improve their ability to graze cattle with reduced adverse impacts on water quality.

The List provides a sign post of where much of the work to improve water quality needs to be targeted. Detailed information and strategies need to be coordinated with the Regional Water Quality Control Boards to bring resources to these efforts.

Regional Board 5 – Central Valley Region – contains all the west drainage of the Sierra Nevada and northeastern California within the SNC Region. Region Board 6 – Lahontan Region – contains all the east drainage of the Sierra Nevada.

De-Listings

There were only two de-listings to the 2010 List within the SNC portion of SWRCB Region 5. They were the Feather River, below lake Oroville, which was delisted for the pesticide Diazinon (but this stretch of river is still listed for other pesticides); and Lower Bear River Reservoir in Amador County, which was delisted for copper.

There were more de-listings in Region 6. These included: Upper Truckee River for pathogens; Mammoth Creek, headwaters to Twin Lakes (Inyo County) for mercury and metals; East Walker River, below Bridgeport, for nitrogen and phosphorus; and Twins Lakes (Mono County) for nitrogen and phosphorus.

These de-listings were generally a result of re-evaluation of the weight-of-evidence on which the original listing was based (such as additional sampling and data), rather than a known reduction or elimination of the pollution source.

The 2010 303(d) List - Methodology

The State Water Resource Control Board (SWRCB) develops the 303(d) List under the mandate of the federal Clean Water Act. This mandate requires the states to identify waters that do not meet applicable water quality standards, with technology-based controls alone, and to develop Total Maximum Daily Loads (TMDLs). The SWRCB collects data on water quality and potential failure to meet standards from both internal programs and outside agencies. For the 2010 List, the agency received over 22,000 fact sheets detailing potential surface water quality impairments in California. Each fact sheet includes one or more Lines of Evidence (LOEs), a description of data and information used as a basis for recommending a decision – why the impairment should be placed on the List, or taken off.

There is not a simple measure of acceptable pollution levels for water bodies in general, though there are detailed determination procedures for each pollutant. An acceptable threshold for a particular pollutant depends on the water body and takes into account the effects as well as the concentration of the pollutant. The SWRCB uses a ‘weight-of-evidence’ approach (detailed in the Water Quality Control Policy) to make a final determination on whether to include an impairment on the list (or delete one). It also establishes a date for which a TMDL criteria for each impaired lake or stream segment must be established. For most of the Region 5 or Region 6 water segments, the TMDL date is around 2019 to 2021.