# Appendix D - Santa Clara River Causal Assessment Case Study

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### **Executive Summary**

A causal assessment was conducted in the middle reaches of the Santa Clara River in Santa Clarita, California. This assessment was conducted to determine the causes behind observed biological impairments in the stream. Specifically, the impairment in the Santa Clara River was a low (35.8 out of 100) Southern California Index of Biotic Integrity (IBI) (Ode et al. 2005) score observed in 2006 at the long-term monitoring site (designated RD) immediately downstream of the Los Angeles County Sanitation District's (LACSD) Valencia Water Reclamation Plant outfall. Seven monitoring sites along the Santa Clara River and its tributaries (RB, RC, RE, RF, SAP8, SAP11, and SAP14) were selected as the comparator sites. All of the sites had similarly poor to fair IBI scores (27.2 - 45.8) to the test site. To better differentiate among the sites, four submetrics of the Southern California IBI: 1.) % abundance of collector-gatherer taxa (e.g., *Baetis* spp); 2.) % of non-insect taxa (e.g., oligochaetes); 3.) % of tolerant taxa (e.g., *Physa* spp.); and 4.) number of predator taxa were used as biological endpoints in a number of the analyses.

This causal assessment was performed following the USEPA's CADDIS causal assessment framework (USEPA 2000). In brief, this approach consists of: 1.) Identifying a site with biological impairment (test site); 2.) Selecting similar sites within the same stream network for comparison (comparator sites); 3.) Identifying the potential stressors to the stream (candidate causes); 4.) Analyzing differences in stressors, biology, and their interaction at the test and comparator sites (within the case); 5.) Comparing stressors, biology, and their interaction at the test site to similar data from elsewhere (outside the case); and 6.) Summarizing these results into a narrative classifying the potential stressors as likely, unlikely, or uncertain causes to the biological impairment.

This assessment was conducted as a partnership between the Southern California Coastal Water Research Project, the Sanitation Districts of Los Angeles County, and the Los Angeles Regional Water Quality Control Board. The assessment partners decided to focus on seven candidate cause stressors potentially responsible for the biological impairment observed at the RD site in Santa Clara River: 1.) Habitat simplification; 2.) Metals; 3.) Elevated conductivity; 4.) Increased nutrients; 5.) Pesticides; 6.) Temperature; and 7.) River discontinuity. These stressors were chosen by the project partners based upon input from the local stakeholders familiar with the stream, the watershed characteristics, and potential anthropogenic disturbances to the system. Each one of these candidate cause stressors was comprised of a number of proximate stressors (e.g., dissolved metals, sediment-bound metals, periphyton-bound metals), upon which the actual analyses were conducted to assess the impact of the candidate cause. Data were not available for every proximate stressor within each candidate cause at every site (e.g., pyrethroid pesticides or sediment-bound metals), but enough data were available for some degree of evaluation for all seven of the candidate causes.

The causal assessment was conducted with preexisting data provided by LACSD. The RD, RB, RC, and RE sites are part of LACSD's National Pollutant Discharge Elimination System (NPDES) monitoring network associated with their Valencia and Saugus outfalls. The remaining comparator sites were part of special study related to nitrogen loads in the Santa Clara River conducted concurrently with the routine monitoring in October 2006. The chemical, biological (benthic macroinvertebrates), and physical habitat data from the NPDES monitoring

program provided the bulk of the information needed for the within the case portion of the causal assessment. These data were also supplemented with algal community structure and temporally intensive water quality data from the test and all comparator sites as part of the special nitrogen study. Data used in the outside the case portion of the causal assessment were assembled from a variety of sources, including: the State of California's State of California's Reference Condition Monitoring Program (RCMP), the Surface Water Ambient Monitoring Program (SWAMP), various probabilistic stream biomonitoring programs (e.g., Perennial Stream Assessment [PSA] and Stormwater Monitoring Coalition [SMC]), and appropriate examples from the scientific literature.

Within the CADDIS causal assessment framework, there are a number of potential types of evidence (i.e., analyses) that can be brought to bear in the within the case and the outside of the case portions of the assessment. The spatial temporal co-occurrence and stressor-response types of evidence were used in the within the case step. The field stressor-response, laboratory stressor-response, and reference condition comparison evidence types were used in the outside the case step.

The overall results from the causal assessment are summarized in Table ES-1. Of the seven candidate causes, there was supporting evidence that elevated conductivity and temperature may be partially responsible for the impaired biological condition at the test site. Conversely, the evidence indicated that heavy metals (dissolved metals), pesticides (non-pyrethroid pesticides), and increased nutrients were likely not a cause for the impairment. There was inconsistent or contradicting evidence for both habitat simplification and river discontinuity in the within the causes in the outside the case analyses. Consequently, both habitat simplification and river discontinuity were ruled as indeterminate; not excluded, but not confirmed as causes for the observed biological impairment.

Outcome	Candidate Cause	Evidence & Comments
Probable	Conductivity	Elevated conductivity and TDS at RD compared to some of the comparator sites and outside the case sites. Consistent stressor response relationships with outside the case.
Stressors	Temperature	Elevated mean temperature and reduced range compared to inside the case comparator sites. Stressor response relationship w/ non-insect taxa inside the case. No outside the case data were available for evaluation.
Defended	Heavy Metals	Levels of some metals in the water column at RD similar to or below comparator sites, but there was supporting stressor response evidence inside the case. However, all concentrations were well below toxic effect levels. No data were available for sediment or periphyton-bound metals.
Refuted Stressors	Pesticides	All measured pesticides and herbicides in the water column were below detection limit. Pyrethroids were not measured in the water column and no sediment pesticide measurements of any kind were available.
Y	Nutrients	Consistent inverse stressor responses and lower nutrient responses at RD compared to inside the case sites. No data from outside the case were available for evaluation.
Unresolved	Habitat Simplification	Lower or indeterminate levels at RD compared to in- and outside the case. Inconsistent stressor response relationship in- and outside the case. There was relatively little outside the case data available for evaluation.
Stressors	River Discontinuity	Lower or indeterminate levels at RD compared to inside the case. Inconsistent stressor response relationship in- and outside the case. There was relatively little outside the case data available for evaluation.

Table ES-1. Overa	II results from	the causal	assessment.
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The most confident conclusions that could be made about candidate causes were those examples where both within the case and outside the case data were available. For the stressor-response and reference condition comparison outside of the case evidence types, data were selected from sites with similar geographic/environmental characteristics to the RD site. Sites were selected to reduce the variability in the observed biological communities due to non-anthropogenic forcing factors (e.g., elevation, slope, or underlying geology) known to have an influence on benthic macroinvertebrate community structure (e.g., Allan 2004, Mykrä et al. 2008). These outside of the case evidence types were extremely valuable in the causal assessment process, as there was degraded biology, not only at the test site, but at nearly all of the within case comparator sites. This pattern weakened our confidence in the diagnostic power of the within the case analyses used by themselves. Contextualizing the stressors and observed biotic response(s) with data from outside the case allowed us to come to more definitive conclusions about the role of conductivity, pesticides, and metals in the observed impairments. Conversely, the lack of these types of evidence was one of the contributing factors to our uncertainty about the roles of river discontinuity and habitat simplification.

The assessment provided enough evidence that, based upon the available data, allowed us to exclude three candidate causes (metals [dissolved metals], pesticides [non-pyrethroid], and increased nutrients) and indicate two others (conductivity and temperature). As noted previously, this success was due in large part to the ability to bring in data from environmentally similar streams from outside the watershed to compare against data from within the stream.

### **Case Definition**

This causal assessment was conducted as a response to low Southern California Index of Biotic Integrity (IBI) (Ode et al. 2005) scores observed in the upper Santa Clara River in October 2006. The assessment was conducted as a partnership between the Southern California Coastal Water Research Project, the Sanitation Districts of Los Angeles (LACSD), and the Los Angeles Regional Water Quality Control Board. The actual test site for the assessment was the long-term monitoring site RD located immediately downstream of the Los Angeles County Sanitation District (LACSD) Valencia Water Reclamation Plant outfall in Santa Clarita, CA. The Southern California IBI is a multi-metric index that uses community structure of benthic macroinvertebrates to evaluate the condition of a stream. During the 2006 Autumn sampling (Table 1), the RD site had a score of 35.8; below the existing threshold for impairment of two standard deviations of the mean score of reference sites (39).

Site	Taxon	Relative Abundance	Site	Taxon	Relative Abundance
	Chironomidae	65.3		Tricorythodes sp	25.2
	Oligochaeta	15.1		Chironomidae	17.6
RB	Argia sp	5.8		Fallceon quilleri	17.0
	Physa /Physella sp	5.6		Physa / Physella sp	7.3
	Physa Physena sp	5.0		Hydroptila sp	7.3 5.7
	Fallceon quilleri	44.1	RF	Dasyhelea sp	4.5
	Baetis sp	25.7	, M	Oligochaeta	4.5
	Chironomidae	5.7		Prostoma sp	3.2
RC	Tricorythodes sp	5.5		Planariidae	3.2
ne	Ostracoda	4.3		Callibaetis sp	2.4
	Oligochaeta	4.3		Simulium sp	2.4
	Hydroptila sp	2.7		Simulum sp	2.2
		<u> </u>		Chironomidae	43.2
	Chironomidae	28.0		Fallceon quilleri	43.2
	Physa /Physella sp	14.3		Hydroptila sp	9.0
	Fallceon quilleri	14.5		Oligochaeta	5.9
	Tricorythodes sp	9.9	SAP 8	Simulium sp	5.0
	Ostracoda	9.1		Ostracoda	4.5
RD	Planariidae	6.2		Tricorythodes sp	4.1
	Hydroptila sp	5.0		Hydrellia sp	4.1
	Caloparyphus / Euparyphus sp	3.0			
	Oligochaeta	3.0		Chironomidae	58.5
	Baetis sp	2.4		Fallceon quilleri	15.0
			SAP 11	Tricorythodes sp	13.0
	Fallceon quilleri	31.3		Physa /Physella sp	4.8
	Chironomidae	30.0			
	Oligochaeta	9.7		Chironomidae	87.3
RE	Tricorythodes sp	9.3	SAP 14	Oligochaeta	6.2
	Baetis sp	5.5	*******		
	Ostracoda	3.7			
	Hydrellia sp	2.6			

Table 1. Top 90+ % most abundant taxa at each of RD and the comparate	or sites in	n Autumn	2006.

Comparator sites were located in the Santa Clara River above (RB and RC) or below (RE, SAP8 and RF) the test site, as well as on nearby tributaries (SAP11 and SAP14; Figure 1). The test and comparator sites comprised the within the case portion of the assessment. The test and mainstem comparator sites were part of the LACSD Valencia and Saugus water reclamation plant outfall National Pollutant Discharge Elimination System (NPDES) Permit monitoring network. As part of the NPDES monitoring network, synoptic measures of biological, chemical, and physical habitat data from the 2006 period of interest were collected at the same time as the RD test site. Additionally, there was monthly chemistry/water quality data collected from most of the sites prior to the collection of the biological data. Data from the RF, SAP8, SAP11, and SAP14 comparator sites were part of a special study where macrobenthic community structure, physical habitat, algal community structure, nutrients, and temporally intensive water quality were collected. Tributaries sites were free from the influence of the LACSD wastewater outfalls. These data formed the core of the comparative analyses that made up the causal assessment and were used in the within the case spatial co-occurrence and stressor-response lines of evidence.

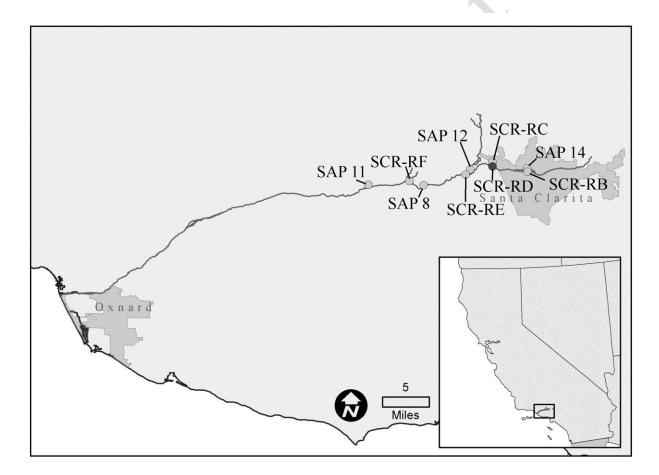


Figure 1. A map of the Santa Clara River showing the location of the RD test site and the comparator sites RB, RC, RE, RF, SAP8, SAP11, and SAP12. Inset with a map of the west coast of US for reference.

The upper of the Santa Clara River and its tributaries that comprise the test and comparator sites are part of a low gradient (<1% slope) system with a relatively mobile, sandy bottom. The

constrained flood plain is consolidated sand with some riparian vegetation (e.g., grasses and small woody growth). The surface water of the river is intermittently discontinuous during dry weather flows. The test site was wetted year round due to the LACSD discharge and surface water flow at RD was contiguous with RC and RE, but was disconnected from the RB site. There is shallow-groundwater /hyporheic connection between all of the NPDES sites (Markle pers. comm.). The upper reach of the Santa Clara River runs through urban and suburban development and this portion of the river (State Water Resources Control Board [SWRCB] Reach 5 and Reach 6) is on the US Environmental Protection Agency (USEPA) 303(d) list for chlorpyrifos, fecal coliform bacteria, diazinon, and toxicity impairments (CA EPA 2012).

The actual biological endpoints chosen as response variables in the assessment, in addition to the total IBI score, consisted of four submetrics of the Southern California IBI: 1.) % abundance of collector-gatherer taxa (e.g., *Baetis* spp); 2.) % of non-insect taxa (e.g., oligochaetes); 3.) % of tolerant taxa (e.g., *Physa* spp.); and 4.) number of predator taxa (e.g., *Dicranota* spp). The four submetrics were chosen because they were of specific interest to the stakeholders and they allowed for greater differentiation among the target and comparator sites (Figure 2). Additionally, as components of the IBI, insights into the poor scoring of these metrics should provide direct insights to the causes behind the low overall IBI scores.

All of the comparator sites had relatively similar macrobenthic community structure (Table 2) and IBI scores (Figure 2a) to RD. The macrobenthic communities of the RD and comparator sites were dominated by chironomids, *Fallceon quilleri*, *Tricorythodes* sp., and *Physa* sp. These taxa are indicative of degraded macrobenthic conditions and observed across the entirety of the upper portions of the Santa Clara River. Similar taxa were observed at the comparator sites, hindering the contrasts that lead to causal inference.

Macrobenthic community and stream physical habitat data were collected in October of 2006. Macrobenthic community sampling was conducted using a kick-net, and individual samples from multiple transects were composited along a 150-m reach, encompassing approximately 1.0 m<sup>2</sup> of streambed. Macrobenthic and physical habitat were collected, processed, and analyzed using California Bioassessment Procedures (Harrington 2002). Water chemistry and water quality data were collected as monthly grab or point samples. The NPDES data were supplemented with algal community data, monthly water grabs for nutrients, and quarterly diurnal water quality (pH, dissolved oxygen, temperature, and conductivity) measurements collected as part of the nitrogen TMDL special study (see Santa Clarita Valley Sanitation District of Los Angeles County [2007] for methodology details).

The statewide perennial wadeable stream assessment data (Ode et al. in prep) was used for casual assessment. These data from elsewhere were comprised of >600 reference sites and >1500 sites with varying level of stress. There is a great deal of heterogeneity among this population of streams and it was thought that only streams with a similar ecosystem setting should be used in the analysis. There are a number of different approaches to characterizing and selecting streams and a simple approach based upon elevation and slope was chosen for this assessment. Streams selected for comparison to the RD site were filtered for similar natural gradients: slope <1.5%; elevation <333m. There were 32 samples from 22 reference sites and there were 540 samples from 515 stressed sites.

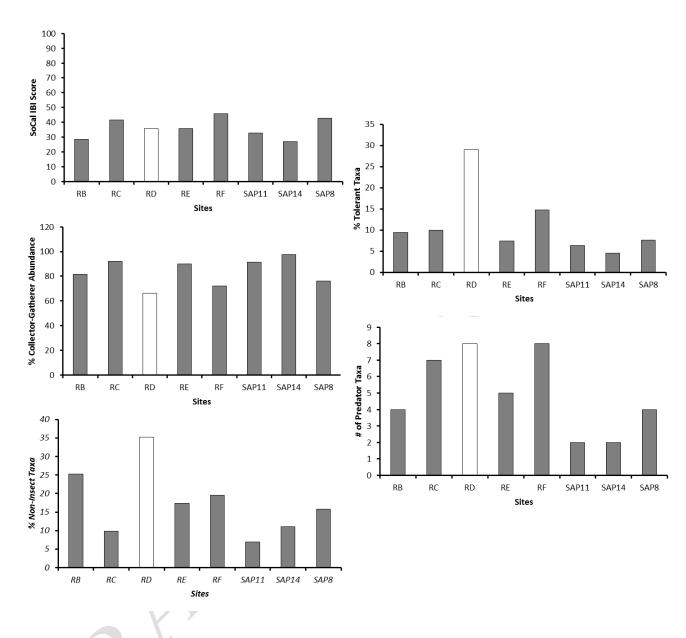


Figure 2. Southern California Index of Biotic Integrity (IBI) scores measured at the target and comparator sites in Fall 2006 (a), as well as the biological endpoints used in the stressor-response portions of the assessment (b - e).

# Table 2. Inventory of the type of data and its original source used in the analyses of each candidate cause and their component proximate stressors for each line of evidence used in the causal assessment.

				Data Within the	Case Lines of Evidence	Data From Out	side the Case Lines of Evi	idence
Candidate Cause /Conceptual Diagram	Proximate Stressor	Data Available	Data Source	Spatial Co- Occurrence	Stressor Response From the Field	Reference Condition	Stressor Response From the Field	S-R from lab
Elevated Conductivity	Increased Conductivity	Mean of monthly point measures made during quarter previous to biotic sampling (July-September).	NPDES Monitoring	Comparison of RD to individual comparator sites	Spearman's rank correlations with percent non-insect taxa, percent tolerant taxa, percent collector-gatherer abundance, and number of predator taxa among RD and the comparator sites.	Comparison of RD to environmentally similar reference sites	Relative risk calculation at stressor level observed at RD for percent non-insect taxa, percent tolerant taxa, percent collector-gatherer abundance, and number of predator taxa using stressor and biological data from environmental similar sites to establish the expectation.	No Data Available
	Increased TDS	Mean of monthly point measures of TDS, chloride, and hardness made during quarter previous to biotic sampling (July-September).	NPDES Monitoring	Comparison of RD to individual comparator sites	Spearman's rank correlations with percent non-insect taxa, percent tolerant taxa, percent collector-gatherer abundance, and number of predator taxa among RD and the comparator sites.	No Data Available	No Data Available	No Data Available
	Change in Algal Community	Bray-Curtis similarity to RD site based upon algal community structure.	Nitrogen Loading Special Study	Comparison of RD to comparator sites in multivariate space	Spearman's rank correlations with percent non-insect taxa, percent tolerant taxa, percent collector-gatherer abundance, and number of predator taxa among the comparator sites.	No Data Available	No Data Available	No Data Available
	Increase in Toxic Algal Compounds			No Data Available	No Data Available	No Data Available	No Data Available	No Data Available
Increased Nutrients	Increased Frequency of Hypoxia	Frequency of mild hypoxia (2-5 mg O <sub>2</sub> L <sup>-1</sup> ) observed in in monthly daytime point measurements during quarter prior to biological sampling. Frequency of hypoxia (<2 mg O <sub>2</sub> L <sup>-1</sup> ) observed in daytime point measures during quarter prior to biological sampling. Frequency of mild hypoxia (2-5 mg O2 L-1) observed in diel data collected over 24 hr period during month of biological sampling. Frequency of hypoxia (<2 mg O2 L-1) observed in diel data collected over 24 hr period during month of biological sampling.	Special Study	Comparison of RD to individual comparator sites	Spearman's rank correlations with percent non-insect taxa, percent tolerant taxa, percent collector-gatherer abundance, and number of predator taxa among RD and the comparator sites.	No Data Available	No Data Available	No Data Available

Candidate Cause	Proximate			Data Within th	e Case Lines of Evidence	Data From Outsid	e the Case Lines of Ev	idence
/Conceptual Diagram	Stressor	Data Available	Data Source	Spatial Co- Occurrence	Stressor Response From the Field	Reference Condition	Stressor Response From the Field	S-R from lab
Increased Nutrients (cont.)	Increased pH	Mean of monthly point measures made during quarter previous to biotic sampling (July - September). Mean of diel data collected over 24 hr period during the month of biotic sampling	NPDES Monitoring and Nitrogen Loading Special Study	Comparison of RD to individual comparator sites	Spearman's rank correlations with percent non-insect taxa, percent tolerant taxa, percent collector-gatherer abundance, and number of predator taxa among RD and the comparator sites.	No Data Available	No Data Available	No Data Available
	Increased Ammonia Concentration	Mean of monthly point measures made during quarter previous to biotic sampling (July-September).	NPDES Monitoring and Nitrogen Loading Special Study	Comparison of RD to individual comparator sites	Spearman's rank correlations with percent non-insect taxa, percent tolerant taxa, percent collector-gatherer abundance, and number of predator taxa among RD and the comparator sites.	No Data Available	No Data Available	No Data Available
	Increased Other					7		
	Sediment			No Data Available	No Data Available	No Data Available	No Data Available	No Data Available
Pesticides	Pesticides Increased Other Water Column Pesticides	Maximum observed values of 4,4'-DDD, 4,4'-DDE, Acrolein, Acrylonitrile, Aldrin, alpha-BHC, cis-1,3- Dichloropropene, delta- BHC, Diazinon, Dieldrin, Endosulfan I, Endosulfan II, Endosulfan sulfate, Endrin aldehyde, Endrin, Heptachlor Epoxide (Isomer B), Heptachlor, Methoxychlor, o,p'-DDD, o,p'-DDE, o,p'-DDT, p,p'- DDT, Technical Chlordane, and Toxaphene in 12 months prior to biological sampling Frequency of dectection of any compound above detection limit	NPDES Monitoring	Comparison of RD to individual comparator sites	Spearman's rank correlations with percent non-insect taxa, percent tolerant taxa, percent collector-gatherer abundance, and number of predator taxa among RD and the comparator sites.	No Data Available	No Data Available	Comparison of Diazinon concentrations observed at RD to species sensitivity distribution (SSD) curves developed by US EPA.
	Increased Water Column Pyrethroids			No Data Available	No Data Available	No Data Available	No Data Available	No Data Available
	Increased Sediment Pyrethroids			No Data Available	No Data Available	No Data Available	No Data Available	No Data Available
	Increased Water Column Herbicides	Maximum observed value of 2,3,7,8-TCDD, 2,4,5-TP (Silvex), and 2,4'-D in 12 months prior to biological sampling.	NPDES Monitoring	Comparison of RD to individual comparator sites	Spearman's rank correlations with percent non-insect taxa, percent tolerant taxa, percent collector-gatherer abundance, and number of predator taxa among RD and the comparator sites.	No Data Available	No Data Available	No Data Available

Candidate Cause	Drovimate			Data Within the	e Case Lines of Evidence	Data From Outside the Case Lines of Evidence		
/Conceptual Diagram	Proximate Stressor	Data Available	Data Source	Spatial Co- Occurrence	Stressor Response From the Field	Reference Condition	Stressor Response From the Field	S-R from lab
Heavy Metals	Increase in Dissolved Metals	Mean of point measures of Antimony, Arsenic, Barium, Beryllium, Cadmium, Chromium, Copper, Hexavalent Chromium, Iron, Lead, Mercury, Nickel, Selenium, Silver, Thallium, and Zinc collected in quarter previous to biotic sampling (July-September).	NPDES Monitoring	Comparison of RD to individual comparator sites	Spearman's rank correlations with percent non-insect taxa, percent tolerant taxa, percent collector-gatherer abundance, and number of predator taxa among RD and the comparator sites.	No Data Available	Relative risk calculation at stressor level observed at RD for percent non-insect taxa, percent tolerant taxa, percent collector-gatherer abundance, and number of predator taxa using stressor and biological data from environmental similar sites to establish the expectation.	Comparison of Arsenic, Cadmium, Chromium, Copper, Nickel, Selenium, and Zinc values observed at RD to species sensitivity distribution (SSD curves developed by US EPA.
	Increase in Particulate Bound			No Data Available	No Data Available	No Data Available	No Data Available	No Data
	Metals							Available
	Increased							
	Concentration of			No Data Available	No Data Available	No Data Available	No Data Available	No Data
	Metals in					no bata manabic		Available
	Periphyton							
Temperature	Increased Water Temperature	Mean of monthly point measures made during quarter previous to biotic sampling (July-September). Mean of diel data collected over 24 hr period during the month of biotic sampling	0 0	Comparison of RD to individual comparator sites	Spearman's rank correlations with percent non-insect taxa, percent tolerant taxa, percent collector-gatherer abundance, and number of predator taxa among RD and the comparator sites.	No Data Available	No Data Available	No Data Available
	Decreased Variability in Water Temperature	September). Max -	NPDES Monitoring and Nitrogen Loading Special Study	Comparison of RD to individual comparator sites	Spearman's rank correlations with percent non-insect taxa, percent tolerant taxa, percent collector-gatherer abundance, and number of predator taxa among RD and the comparator sites.	No Data Available	No Data Available	No Data Available
		SP'						

Candidate Cause	Drovimata			Data Within th	e Case Lines of Evidence	Data From Outs	side the Case Lines of Evi	idence
/Conceptual Diagram	Proximate Stressor	Data Available	Data Source	Spatial Co- Occurrence	Stressor Response From the Field	Reference Condition	Stressor Response From the Field	S-R from lab
	Decreased Recruitment of Fauna			No Data Available	No Data Available	No Data Available	No Data Available	No Data Available
	Decrease in Woody Debris	Length of reach (m) with woody debris during biological sampling.	NPDES Monitoring and Nitrogen Loading Special Study	Comparison of RD to individual comparator sites	Spearman's rank correlations with percent non-insect taxa, percent tolerant taxa, percent collector-gatherer abundance, and number of predator taxa among RD and the comparator sites.	No Data Available	Relative risk calculation at stressor level observed at RD for percent non-insect taxa, percent tolerant taxa, percent collector-gatherer abundance, and number of predator taxa using stressor and biological data from environmental similar sites to establish the expectation.	No Data Available
River Discontinuity	Increase in Sands and Fines	Percent of reach with sand or fine sediment substrate during biological sampling.	Nitrogen Loading	Comparison of RD to individual comparator sites	Spearman's rank correlations with percent non-insect taxa, percent tolerant taxa, percent collector-gatherer abundance, and number of predator taxa among RD and the comparator sites.	Comparison of RD to environmentally similar reference sites	Relative risk calculation at stressor level observed at RD for percent non-insect taxa, percent tolerant taxa, percent collector-gatherer abundance, and number of predator taxa using stressor and biological data from environmental similar sites to establish the expectation.	No Data Available
	Decrease in Cobbles	Percent of reach with cobble substrate during biological sampling.	NPDES Monitoring and Nitrogen Loading Special Study	Comparison of RD to individual comparator sites	Spearman's rank correlations with percent non-insect taxa, percent tolerant taxa, percent collector-gatherer abundance, and number of predator taxa among RD and the comparator sites.	No Data Available	No Data Available	No Data Available
	Burial of Cobbles	Mean percent embeddedness of cobbles observed during biological sampling.	NPDES Monitoring and Nitrogen Loading Special Study	Comparison of RD to individual comparator sites	Spearman's rank correlations with percent non-insect taxa, percent tolerant taxa, percent collector-gatherer abundance, and number of predator taxa among RD and the comparator sites.	No Data Available	Relative risk calculation at stressor level observed at RD for percent non-insect taxa, percent tolerant taxa, percent collector-gatherer abundance, and number of predator taxa using stressor and biological data from environmental similar sites to establish the expectation.	No Data Available
		) >						

Candidate Cause	Ducuinata			Data Within the	e Case Lines of Evidence	Data From Outs	side the Case Lines of Ev	idence
/Conceptual Diagram	Proximate Stressor	Data Available	Data Source	Spatial Co- Occurrence	Stressor Response From the Field	Reference Condition	Stressor Response From the Field	S-R from lab
River Discontinuity (Cont.)	Increased Simplification of Habitat	Euclidean distance from RD location in nMDS comparison of sites based upon the presence of different substrates (artificial, boulders, roots, woody debris, sands+fines, gravel, cobbles, or bedrock), filamentous algae, overhanging vegetation, undercut banks, large woody debris, and mean thalweg depth.	NPDES Monitoring and Nitrogen Loading Special Study	Comparison of RD to comparator sites in multivariate space	Spearman's rank correlations with percent non-insect taxa, percent tolerant taxa, percent collector-gatherer abundance, and number of predator taxa among the comparator sites.	No Data Available	No Data Available	No Data Available
	Change in Food Source	Euclidean distance from RD location in nMDS comparison of sites based upon the occurrence of course particulate organic matter, macrophyte, filamentous algae, woody debris, and fine sediments.	NPDES Monitoring and Nitrogen Loading Special Study	Comparison of RD to comparator sites in multivariate space	Spearman's rank correlations with percent non-insect taxa, percent tolerant taxa, percent collector-gatherer abundance, and number of predator taxa among the comparator sites.	No Data Available	No Data Available	
Habitat Simplification	Increase in Channel Depth	Mean of thalweg depth (cm) measured at the transects and inter- transects of the reach during biological sampling.	NPDES Monitoring and Nitrogen Loading Special Study	Comparison of RD to individual comparator sites	Spearman's rank correlations with percent non-insect taxa, percent tolerant taxa, percent collector-gatherer abundance, and number of predator taxa among RD and the comparator sites.	No Data Available	Relative risk calculation at stressor level observed at RD for percent non-insect taxa, percent tolerant taxa, percent collector-gatherer abundance, and number of predator taxa using stressor and biological data from environmental similar sites to establish the expectation.	
	Decrease in the extent of Riffle Habitat	7				No Data Available	No Data Available	
	Decrease in Woody Debris	Length of reach (m) with woody debris during biological sampling.	NPDES Monitoring and Nitrogen Loading Special Study	Comparison of RD to individual comparator sites	Spearman's rank correlations with percent non-insect taxa, percent tolerant taxa, percent collector-gatherer abundance, and number of predator taxa among RD and the comparator sites.	No Data Available	Relative risk calculation at stressor level observed at RD for percent non-insect taxa, percent tolerant taxa, percent collector-gatherer abundance, and number of predator taxa using stressor and biological data from environmental similar sites to establish the expectation.	

Candidate Cause	Ducuinanto			Data Within th	e Case Lines of Evidence	Data From Outs	side the Case Lines of Ev	idence
/Conceptual Diagram	Proximate Stressor	Data Available	Data Source	Spatial Co- Occurrence	Stressor Response From the Field	Reference Condition	Stressor Response From the Field	S-R from lab
	Increase in Sands and Fines	Percent of reach with sand or fine sediment substrate during biological sampling.	NPDES Monitoring and Nitrogen Loading Special Study	Comparison of RD to individual comparator sites	Spearman's rank correlations with percent non-insect taxa, percent tolerant taxa, percent collector-gatherer abundance, and number of predator taxa among RD and the comparator sites.	Comparison of RD to environmentally similar reference sites	Relative risk calculation at stressor level observed at RD for percent non-insect taxa, percent tolerant taxa, percent collector-gatherer abundance, and number of predator taxa using stressor and biological data from environmental similar sites to establish the expectation.	
Habitat Simplification	Increase in Simplified Habitat	Euclidean distance from RD location in nMDS comparison of sites based upon the presence of different substrates (artificial, boulders, roots, woody debris, sands+fines,	NPDES Monitoring and Nitrogen Loading Special Study	Comparison of RD to comparator sites in multivariate space	Spearman's rank correlations with percent non-insect taxa, percent tolerant taxa, percent collector-gatherer abundance, and number of predator taxa among the comparator sites.	No Data Available	No Data Available	
(cont.)	Decrease in Cobbles	Percent of reach with cobble substrate during biological sampling.	NPDES Monitoring and Nitrogen Loading Special Study	Comparison of RD to individual comparator sites	Spearman's rank correlations with percent non-insect taxa, percent tolerant taxa, percent collector-gatherer abundance, and number of predator taxa among RD and the comparator sites.	No Data Available	No Data Available	
	Decrease in Extent of Undercut Banks	Percent of reach with undercut banks during biological sampling.	NPDES Monitoring and Nitrogen Loading Special Study	Comparison of RD to individual comparator sites	Spearman's rank correlations with percent non-insect taxa, percent tolerant taxa, percent collector-gatherer abundance, and number of predator taxa among RD and the comparator sites.	No Data Available	Relative risk calculation at stressor level observed at RD for percent non-insect taxa, percent tolerant taxa, percent collector-gatherer abundance, and number of predator taxa using stressor and biological data from environmental similar sites to establish the expectation.	

### **Candidate Causes**

The following list of candidate causes was developed as the outcome of discussions held among the data analyst and the local stakeholders at a workshop held February 2012. Stressors were proposed and eventually included/excluded for consideration based upon the local stakeholders' knowledge of the Santa Clara River watershed, the human activities therein, as well as its environmental, geological, and hydrological characteristics. Each candidate cause consists of a series of proximate stressors, the stressors that directly touch the in-stream biota.

*Candidate Cause*: Elevated Conductivity – Most freshwater streams have some degree of natural conductivity imparted by the underlying geology of the stream's watershed (i.e. CaO, MgO content). Alterations to that "natural" conductivity level can have adverse effects on macrobenthic community structure reducing the numbers of stenohaline taxa through outright toxicity or increased physiological/osmotic stress that consumes energy normally dedicated to growth and reproduction (Kinne 1971, Hassell et al. 2006). As noted in the conceptual diagram (Figure 3), there were two proximate stressors within the elevated conductivity candidate cause: 1.) Increased total dissolved solids (TDS); and 2.) Increased conductivity

Candidate Cause: Habitat Alteration – Most wadeable streams have a high degree of physical habitat heterogeneity (e.g., riffles vs. pools, woody debris, undercut banks) at small spatial scales (10's of meters) that produce a multitude of different niches, which are in turn occupied by different macroinvertebrate species. This habitat heterogeneity increases the overall diversity of the macrobenthic community because individual taxa are often dependent on specific habitat characteristics (e.g. complex structure, fast moving water, or deep pools). Habitat alteration can have negative effects on the macrobenthic community. Habitat alteration ranges from direct modification of the stream bed and channel walls for flood or erosion control (concrete or rip rap walls), to modification of the riparian corridor, or development within the stream's upland watershed. Habitat alteration reduces habitat complexity and heterogeneity, acting as a barrier for certain taxa to recruit or survive in-stream. In the conceptual diagram (Figure 4), habitat alteration has 10 potential proximate stressors: 1.) Change in available food; 2.) Increase in channel deepening, 3.) A decrease in the amount of riffle habitat, 4.) A decrease in the amount of instream wood debris; 5.) An increase in sands and fines; 6.) An increase in the extent of undercut banks; 7.) A decrease in the number of cobbles; and 8.) A decrease in overall substrate complexity.

*Candidate Cause*: Metals – While there are some natural sources of metals to streams due to the erosion of metal bearing soils in the underlying geology of a watershed (e.g., Aluminum or Iron), most metals observed in streams are related to anthropogenic activities. Most metals impact stream macroinvertebrates by causing cell wall failure, interference with ion transfer, and interference with respiratory function. Metals can be transferred to stream biota either through direct ingestion or absorption from the water column. Consequently, the conceptual model for increased metals (Figure 5) has three proximate stressors: 1.) increase in dissolved water column metals; 2.) increase in metal concentration of periphyton; and 3.) increase in particulate bound metals.

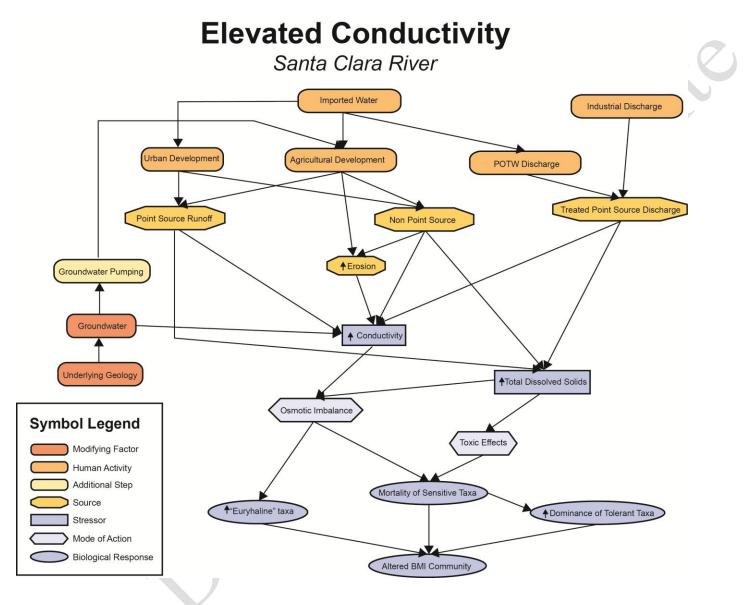


Figure 3. Elevated conductivity conceptual diagram detailing proximate stressors, potential sources, and potential modes of action to impacting the macrobenthic community.

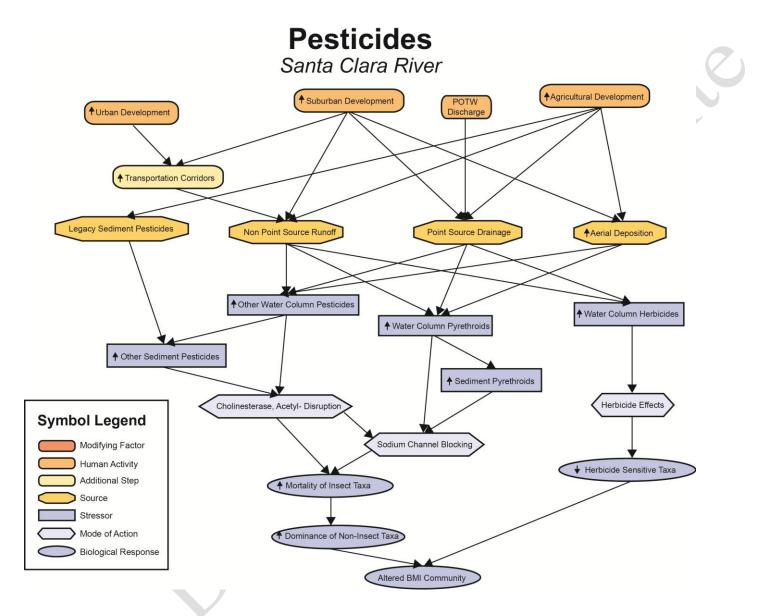


Figure 4. Pesticides conceptual diagram detailing proximate stressors, potential sources, and potential modes of action to impacting the macrobenthic community.

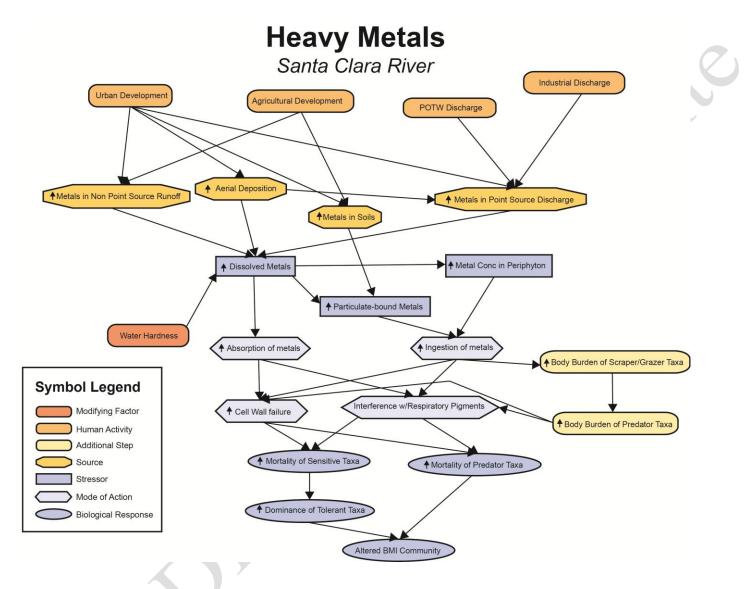


Figure 5. Heavy metals conceptual diagram detailing proximate stressors, potential sources, and potential modes of action to impacting the macrobenthic community.

*Candidate Cause*: Increased Nutrients – Stream macroinvertebrates typically experience problems from increasing concentrations of the different species of nitrogen and phosphorus as indirect effects, where the increased nutrients influence autotrophic community structure and primary production rates. These effects can include clogging of micro-habitats by algal mats, changes in algal taxa and their palatability to grazers, increased dominance of cyanobactieria and other toxic algae, or night time hypoxia. Ammonia toxicity is the primary direct effect that increased nutrients can have on stream macrobenthic community structure, with certain taxa being more sensitive than others (Arthur et al. 1987, Hickey and Vickers 1994). In the conceptual diagram (Figure 6), increased nutrients is comprised of five proximate stressors: 1.) A change in algal community structure; 2.) An increase in toxic compounds; 3.) An increase in water column pH; 4.) An increase in the frequency of hypoxia; and 5.) An increase in ammonia concentration.

*Candidate Cause*: Pesticides – Much like metals, there is a large amount of evidence about the negative effects of pesticides on stream macroinvertebrates (e.g. Hickey and Clements 1998, Pollard and Yuan 2006). Pesticides, especially insecticides, have acute and chronic toxic effects on stream macroinvertebrates. This candidate cause includes current-use pesticides (synthetic pyrethroids) and legacy pesticides (diazinon, DDT), which can be dissolved in the water column or adsorbed to sediments. There were five proximate stressors in the conceptual model (Figure 7): 1.) Increased water column synthetic pyrethroids; 2.) Increased sediment synthetic pyrethroids; 3.) Increased "other" water column pesticides; 4.) Increased "other" sediment pesticides; and 5.) Increased water column herbicides.

*Candidate Cause*: Temperature – Water temperature can be one of the key environmental variables setting community structure among stream macroinvertebrates, with certain taxa flourishing best in cold water conditions and others in warm water. In temperate climates like southern California, seasonal temperature fluctuations are an important reproductive or metamorphic cue for stream fauna (e.g., Harper and Peckarsky 2006). Point source discharges and non-point source runoff can increase mean stream temperatures and decrease the range in temperature flux over short and long timescales. To capture both of these aspects, the temperature conceptual diagram (Figure 8) had two proximate stressors: 1.) Elevated water temperature; and 2.) Decreased variability in water temperature.

*Candidate Cause*: River Discontinuity – Though likely connected by hyporheic flows, the surface waters of the Santa Clara River are disconnected by stretches of dry streambed between the RB and RC monitoring sites for most of the year due to the natural climate, permeability of the riverbed, groundwater pumping, and surface water diversions. This discontinuity could potentially impact community structure by, among other things, limiting downstream recruitment of juvenile invertebrates, a loss of large woody debris from the upper watershed, limiting the export of sand and other fine grain sediments. The conceptual diagram (Figure 9) contains six proximate stressors: 1.) Decreased recruitment; 2.) A decrease in woody debris; 3.) A decrease in cobbles; 4.) An increase in sands & fines; 5.) Burial of cobbles; and 6.) An increase in simplified habitat.

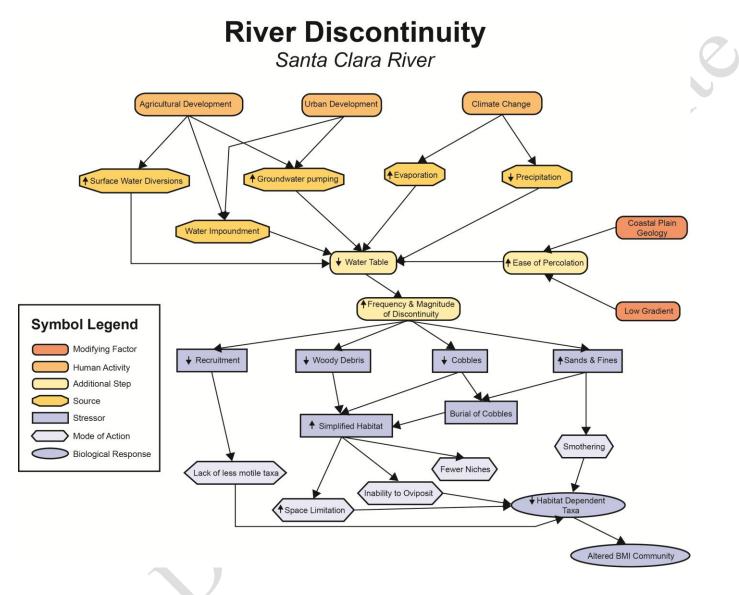


Figure 6. River discontinuity conceptual diagram detailing proximate stressors, potential sources, and potential modes of action to impacting the macrobenthic community.

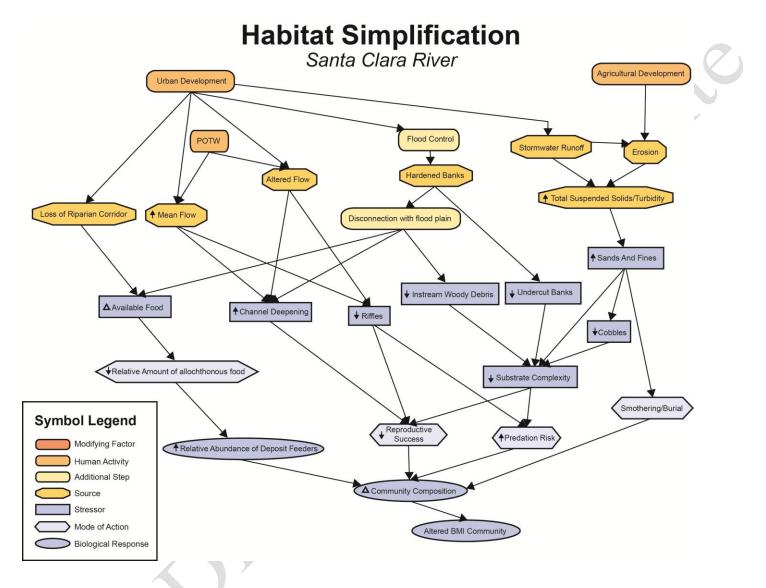


Figure 7. Habitat simplification conceptual diagram detailing proximate stressors, potential sources, and potential modes of action to impacting the macrobenthic community.

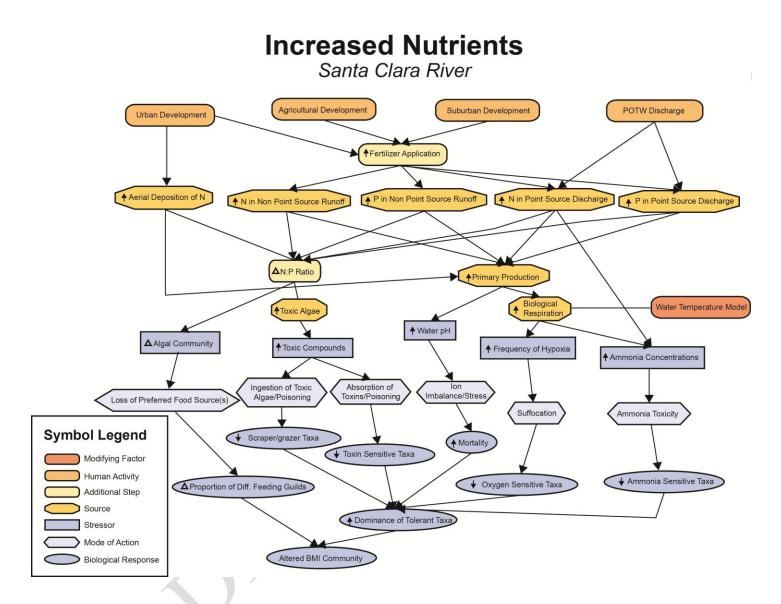


Figure 8. Increased nutrients conceptual diagram detailing proximate stressors, potential sources, and potential modes of action to impacting the macrobenthic community.

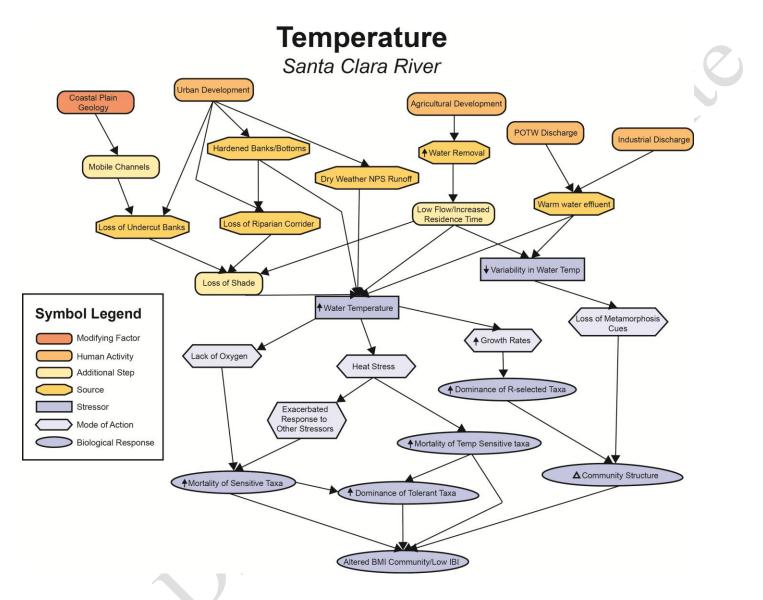


Figure 9. Temperature conceptual diagram detailing proximate stressors, potential sources, and potential modes of action to impacting the macrobenthic community.

### **Identifying the Cause**

In this causal assessment of degraded biological condition observed at the RD site in the Santa Clara River, seven candidate causes were evaluated including conductivity, habitat simplification, river discontinuity, metals, increased nutrients, temperature, and pesticides. Based upon our review of the available data across seven comparator sites elevated conductivity and temperature were the two most likely causes behind the low IBI scores observed at RD in 2006. Metals, pesticides, and nutrients were likely not causes. Habitat simplification and river discontinuity could not be diagnosed or refuted due to conflicting evidence and lack of data. The summary of all scores for all evidence types are presented in Table 3.

Elevated conductivity was indicated as a likely stressor based on three lines of evidence. First, the quarterly mean observation of conductivity at the test site far exceeded the range of conductivity values measured at ecologically similar sites in the statewide reference network. Relative risk patterns of conductivity and macrobenthic invertebrates used in outside of the case stressor response line of evidence indicated that the levels of conductivity observed at RD were high enough to potentially produce the degraded levels of % non-insect taxa, # of predator taxa, and the % of tolerant taxa observed at the test site. Lastly, spatial co-occurrence indicated that mean quarterly conductivity, TDS, and hardness were elevated at RD relative to the RB site. It should be noted that no proximate stressor data were available for many of the comparator sites (RF, SAP8, SAP11, or SAP14 sites) and consequently the power of the within the case analyses were somewhat diminished.

Temperature was a likely stressor based on two lines of evidence, though this assessment is tempered based on consistency of evidence (i.e. mean temperature vs. temperature range). First, spatial temporal co-occurrence indicated that RD had elevated mean temperature and reduced temperature range compared to all of the comparator sites, with the exception of RB (RB is also located near a water reclamation plant outfall like RD). Second, there was a strong stressor-response relationship between increasing mean temperature (both monthly and diel) and increasing % of non-insect taxa. There were no stressor response relationships observed among temperature range and the different biological endpoints, which may imply that the temperature range may not be as important to the biota as the overall mean temperature. Unfortunately, there was no data from elsewhere to contextualize the magnitude of temperature range or mean against environmentally similar streams, so the diagnosis for temperature is weaker than for elevated conductivity.

Table 3. Table 3 Summary score sheets for RD and each of the comparator sites in the Santa Clara River assessment. Each candidate cause score is the integration of the component proximate stressor scores, which are detailed in the supplemental material. The continuity line of evidence evaluates the continuity of each line of evidence for each of the four biological endpoints: % collector-gatherer abundance/% non-insect taxa/% tolerant taxa/# of predator taxa.

					RD vs. RB			
Candid	ate Cause	Heavy Metals	Elevated Conductivity	River Discontinuity	Habitat Simplification	Increased Nutrients	Pesticides	Temperature
Spatial Co	-Occurrence	+	+					0
	Collector Abundance §	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Stressor	Non-Insect Taxa	+	-	0	0	-		+
Response	Tolerant Taxa	+	0	0	0	-	- (	0
	Predator Taxa	+	0	0	0	0		0
	e Condition parison	NE	+	-	-	NE	NE	NE
Stressor	Collector Abundance §					NE	NE	NE
Response From	Non-Insect Taxa	0	+	+	+	NE	NE	NE
Outside the Case	Tolerant Taxa	0	+	+	ŧ	NE	NE	NE
	Predator Taxa	0	+	0	0	NE	NE	NE
	Response Laboratory		NE	NE	NE	NE	-	NE
Con	tinuity	-/-/-/-	-/-/+/+	+/-/-/+	+/-/-/+	0/+/+/0	+/+/+/+	0/0/0/0
Candid	ate Cause	Heavy Metals	Elevated Conductivity	River Discontinuity	RD vs RC Habitat Simplification	Increased Nutrients	Pesticides	Temperature
Spatial Co	-Occurrence	+		0	0			+
	Collector Abundance §	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Stressor	Non-Insect Taxa	+		0	0	-		+
Response	Tolerant Taxa	+	0	0	0	-		0
	Predator Taxa	+	0	0	0	0		0
	e Condition parison	NE	+	-	-	NE	NE	NE
Stressor	Collector Abundance §					NE	NE	NE
Response From	Non-Insect Taxa	0	+	+	+	NE	NE	NE
Outside the Case	Tolerant Taxa	0	+	+	+	NE	NE	NE
	Predator Taxa	0	+	0	0	NE	NE	NE
	r Response Laboratory		NE	NE	NE	NE	-	NE
Con	tinuity	-/-/-/-	-/-/-/-	+/-/-/0	+/-/-/0	0+/+/0	+/+/+/+	0/+/0/0

§ Collector abundance were not at problematic levels and thusly were not scored for stressor response from the field and scored -- where there were data for stressor response from outside the case

Candid	late Cause	Heavy Metals	Elevated Conductivity	River Discontinuity	RD vs RE Habitat Simplification	Increased Nutrients	Pesticides	Temperature
Spatial Co	o-Occurrence			0				+
	Collector Abundance §	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Stressor	Non-Insect Taxa	+	-	0	0	-		+
Response	Tolerant Taxa	+	0	0	0	-		0
	Predator Taxa	+	0	0	0	0		0
	ce Condition	NE	+	-	-	NE	NE	NE
Stressor	Collector Abundance §					NE	NE	NE
Response From Outside the Case	Non-Insect Taxa	0	+	+	+	NE	NE	NE
	Tolerant Taxa	0	+	+	+	NE	NE	NE
	Predator Taxa	0	+	0	0	NE	NE	NE
	r Response e Laboratory		NE	NE	NE	NE	-	NE
Cor	ntinuity	+/-/-/-	-/-/-	+/-/-/0	+/-/-/0	0/+/+/0	+/+/+/+	0/+/0/0
	late Cause	Heavy Metals	Elevated Conductivity	River Discontinuity	RD vs RF Habitat Simplification	Increased Nutrients		Temperature
Spatial Co	o-Occurrence	NE	NE	0	0	+	NE	+
	Collector Abundance §	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Stressor	Non-Insect Taxa	+		0	0	-		+
Response	Tolerant Taxa	+	0	0	0	-		0
	Predator Taxa	+	0	0	0	0		0
	ce Condition	NE	+	-	-	NE	NE	NE
Stressor	Collector Abundance §	-				NE	NE	NE
Stressor Response From	Abundance §	0	 +	 +	 +	NE NE	NE NE	NE NE
Response From Outside	Abundance § Non-Insect	0	 + +	 + +	 + +			
Response From Outside the Case	Abundance § Non-Insect Taxa Tolerant Taxa Predator Taxa					NE	NE	NE
Response From Outside the Case Stresso	Abundance § Non-Insect Taxa Tolerant Taxa	0	+	+	+	NE NE	NE NE	NE NE

§ Collector abundance were not at problematic levels and thusly were not scored for stressor response from the field and scored - where there were data for stressor response from outside the case

					RD vs. SAP8			
Candid	ate Cause	Heavy Metals	Elevated Conductivity	River Discontinuity	Habitat Simplification	Increased Nutrients	Pesticides	Temperature
Spatial Co	-Occurrence	NE	NE	0	0	0	NE	+
	Collector Abundance §	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Stressor	Non-Insect Taxa	+	-	0	0	-		+
Response	Tolerant Taxa	+	0	0	0	-		0
	Predator Taxa	+	0	0	0	0		0
	e Condition parison	NE	+	-	-	NE	NE	NE
Stressor	Collector Abundance §					NE	NE	NE
Response From	Non-Insect Taxa	0	+	+	+	NE	NE	NE
Outside the Case	Tolerant Taxa	0	+	+	+	NE	NE	NE
	Predator Taxa	0	+	0	0	NE	NE	NE
	Response Laboratory		NE	NE	NE	NE	-	NE
Con	tinuity	+/-/-/-	-/-/-	+/-/-/0	+/-/-/0	0/0/0/0	+/+/+/+	0/+/0/0
					RD vs SAP11			
Candid	ate Cause	Heavy Metals	Elevated Conductivity	River Discontinuity	Habitat Simplification	Increased Nutrients	Pesticides	Temperature
Spatial Co	-Occurrence	NE	NE	0	+	0	NE	+
	Collector Abundance §	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Stressor	Non-Insect Taxa	+	-	0	0	-		+
Response	Tolerant Taxa	+	0	0	0	-		0
	Predator Taxa	+	0	0	0	0		0
	e Condition parison	NE	+	-	-	NE	NE	NE
Stressor	Collector Abundance §					NE	NE	NE
Response From	Non-Insect Taxa	0	+	+	+	NE	NE	NE
Outside the Case	Tolerant Taxa	0	+	+	+	NE	NE	NE
	Predator Taxa	0	+	0	0	NE	NE	NE
Stressor Response From the Laboratory			NE	NE	NE	NE	-	NE
From the	Laboratory							

§ Collector abundance were not at problematic levels and thusly were not scored for stressor response from the field and scored - where there were data for stressor response from outside the case

				l	RD vs SAP1	4		
Candid	Candidate Cause		Elevated Conductivity	River Discontinuity	Habitat Simplification	Increased Nutrients	Pesticides	Temperature
Spatial Co	Spatial Co-Occurrence		NE		0		NE	+
	Collector Abundance §	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Stressor	Non-Insect Taxa	+	-	0	0	-		+
Response	Tolerant Taxa	+	0	0	0	-		0
	Predator Taxa	+	0	0	0	0	-	0
	e Condition parison	NE	+	-	-	NE	NE	NE
Stressor	Collector Abundance §					NE	NE	NE
Response From	Non-Insect Taxa	0	+	+	+	NE	NE	NE
Outside the Case	Tolerant Taxa	0	+	+	+	NE	NE	NE
	Predator Taxa 0 + 0 0		0	NE	NE	NE		
	r Response Laboratory		NE	NE	NE	NE	-	NE
Con	tinuity	+/-/-/-	-/-/+/+	+/-/-/+	+/-/-/0	0/+/+/0	+/+/+/+	0/+/0/0

§ Collector abundance were not at problematic levels and thusly were not scored for stressor response from the field and scored - where there were data for stressor response from outside the case

Metals, specifically dissolved metals in the water column, were not diagnosed as a potential cause for the observed biological degradation at RD. There were a few dissolved metals that were higher at RD than the comparator sites (e.g., copper or zinc) and there were strong correlations between different elements (arsenic, selenium, or zinc) and the biological endpoints. However, none of the correlations were consistent across the different biological endpoints (stressor response from the field) and none of the concentrations observed at the RD site were high enough to cause the biological degradation observed at the site (stressor response from laboratory studies). All of the evidence was based upon water column dissolved metals. No data were available to evaluate sediment-bound or periphyton-accumulated metals. The water column measurements were made in the three months (July-September) prior to biotic sampling. These dry season concentrations and loadings of metals are likely lower than during wet weather. However, the fauna observed at the target and comparator sites (Table 1) are primarily ephemeral, multivoltine taxa and the previous quarter's water measurements.

Pesticides, specifically non-pyrethroid compounds in the water column, were likely not the cause of biological impacts because no detectable amounts of 24 different non-pyrethroid pesticides and 3 herbicides were observed at RD or the comparator sites where samples were collected (RB, RC, and RE) in the 12 months prior to collection of the macroinvertebrates. Synthetic pyrethroids were not measured at any of the sites, so that evidence could not be evaluated. Similarly, no measurements of any pesticide were made in sediments of the Santa Clara River. Consequently, investigation of sediment-bound compounds would be recommended in future

analyses to more definitively rule out the influence of pesticides in the degraded benthic communities observed at RD.

Increased nutrients were not likely stressors at the RD site because none of the proximate stressors within the conceptual diagram were elevated at RD compared to the comparator sites and there were inverse relationships between all of the biological endpoints and the measures of nutrient impact. Nutrient-related stressors were difficult to tie into macroinvertebrate community structure as most of the effects of increased nutrients are indirect; translated through algal growth, primary production, and oxygen consumption. However, relatively high quality data were available for evaluating the presence and effects of net productivity and night time periods of net respiration. Although these temporally detailed measurements were only available for a 24-hr period, they provide better insight than many daytime point measures made once a month.

River discontinuity and habitat simplification were unresolved candidate causes. These two candidate causes shared a number of component proximate stressors (e.g., loss of woody debris, loss of cobbles, etc.) that capture different aspects of stream physical habitat. The differences in the proximate stressors were small between test and comparator sites (often within the perceived error of the method). Similarly, there was no consistent stressor response relationship with any of the biological endpoints. However, none of the comparator sites had particularly good biological condition. Hence, all of the sites in the middle Santa Clara River may be impacted by sands and fine sediments. This ambiguity was further compounded by a lack of data, or inconsistent data, from elsewhere for many of the component proximate stressors to provide context to the conditions at RD. For example, the increase in sands and fine sediments observed at RD were within the range observed at similar low elevation, low gradient reference sites, but those same values of sands and fine sediments were also linked to degraded community structure in biogeographically similar non-reference sites. These kinds of ambiguities illustrate a need to better understand the influence physical habitat on community structure, a better characterization of expectation in low gradient/elevation streams, and the development of more precise measures of stream habitat.

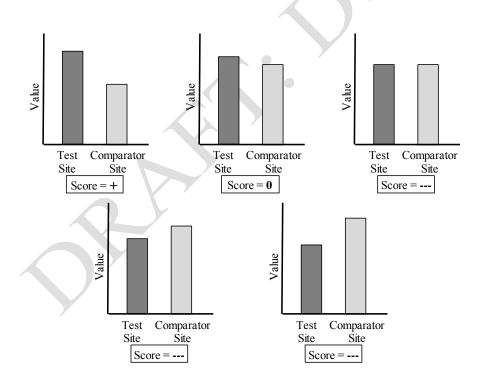
There were several lessons learned from this causal assessment. First, diagnosing candidate cause in this assessment was difficult because much of the upper Santa Clara River was equally degraded. There were marginal differences among the biological endpoints at RD and comparator sites making traditional causal assessment approaches such as spatial temporal co-occurrence difficult. Second, since the use of within case evidence was hampered by widespread impacts at comparator sites, valuable evidence was gained by examining evidence from elsewhere. Additional data assessment tools should be developed utilizing the statewide data set for future causal assessments plagued with this same problem. Third, candidate causes comprised of complex interactions of proximate stressors such as nutrients or habitat alteration might be better served by separating into their respective stressors. For many of these stressors, additional research into the complex interactions with biological response should be explored. This research can then be used for future causal assessments as stressor response from elsewhere.

The Santa Clara River case study provides an instructive point about the careful and purposeful selection of biological endpoints. Four biological endpoints were originally selected when this case was constructed, but one of them - % collector-gatherer taxa – was actually not observed at a degraded level as measured by the Southern California IBI. Certain lines of evidence (i.e., stressor response from the field and stressor response from elsewhere) implicitly work upon the notion that the condition of the biological endpoints at the test case site are worse than the within case comparator sites. For the % collector-gatherer endpoint, this was not the case. This oversight speaks to the need to carefully consider what biological endpoints are selected for use in future causal analyses, with potential emphasis placed upon those endpoints which capture the biological degradation at the site and whose remediation may improve condition at the site.

### Data Analysis from within the Case

#### Spatial Co-Occurrence

Spatial co-occurrence was one of the analyses with the most coverage of sites and proximate stressors for all of the different candidate causes in the Santa Clara River assessment. The analysis was set up as a comparison of the value of a potential stressor at the RD site versus each of the comparator sites (RB, RC, RE, RF, SAP8, SAP11, and SAP14). In scoring these comparisons, a series of guidelines were created to assist in making consistent evaluations across the large dataset. Summarized in Figure 10 and assuming the presence of a variable was considered as having a negative impact on a macrobenthic community structure: if the test site had a higher value than the comparator and that difference was greater than the detection limit of that variable, the data were scored "+"; if the test site had a higher value than the comparator site and the difference was less than the detection limit, the data were scored "0"; if the target and comparator sites had equal values, the data were scored "---"; if the test site had a lower value than the comparator site and the difference was less than the detection limit, the data were scored "---"; and if the test site had a lower value than the comparator site and that difference was greater than the detection limit, the data were scored as "---". If the variable was a positive variable, i.e., reducing its value would negatively affect macrobenthic community structure, the guidelines were reversed. The spatial co-occurrence comparisons (observed values, differences, and individual scores) between RD and the comparator sites for all of the individual analyses are presented in Table 4 and the scores for each candidate cause and their proximate stressors are summarized in Table 5.



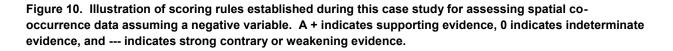


Table 4. Detailed spatial co-occurrence score sheet for calculating and scoring the differences of each proximate stressor and the components therein between RD and each comparator site. Data are scored + for supporting evidence, --- for strongly weakening evidence, 0 for indeterminate evidence, or NE for no evidence. bdl = below detection limit nd = no data n/a = not applicable.

Candidate Cause	Proximate Stressor Measuremen	t Components (units)	RD Value	RE Value	Difference	Component Score	Proximate Stressor Score	Comment
Heavy Met								
	Increase in Dissolved Meta							Antimony and Nickel
	Mean of Previou	s Quarter (BDL = $1/2$ MDL)						were ambivilent
		Antimony ( $\mu g L^{-1}$ )	0.63	0.53	0.10	0		
		Arsenic (μg L <sup>-1</sup> )	0.82	1.36	-0.54			
		Barium (μg L <sup>-1</sup> )	41.70	47.50	-5.80			
		Beryllium (μg L <sup>-1</sup> ) Cadmium (μg L <sup>-1</sup> )	0.13	0.13	0.00			
			0.09	0.13	-0.04			
		Chromium (µg L <sup>-1</sup> ) Copper (µg L <sup>-1</sup> )	0.23	0.70	-0.47			
		Hexavalent Chromium (mg L <sup>-1</sup> )	3.42 0.01	3.72 0.00	-0.30 0.00			X
		Iron (mg L <sup>-1</sup> )						
		Lead (µg L <sup>-1</sup> )	0.10	0.53	-0.43			
		Mercury (µg L <sup>-1</sup> )	0.10	0.31	-0.21			
		Nickel (µg L <sup>-1</sup> )	0.02	0.02	0.00			
			6.86	5.92	0.95	0		
		Selenium (µg L <sup>-1</sup> )	1.33	1.90	-0.57			
		Silver ( $\mu$ g L <sup>-1</sup> )	0.13	0.01	0.12			
		Thallium ( $\mu g L^{-1}$ )	0.13	0.13	0.00			
	la sus sus la Denticulata Deve	Zinc ( $\mu g L^{-1}$ )	27.97	29.53	-1.57		NE	
	Increase in Particulate Bour	nd Metals		No	Data Available		INE	
	Increase in Metals in Peripl	auton		NO	Data Available	2	NE	
	increase in wetais in Peripi	lyton		No	Data Available		INL.	
Elovated C	onductivity			NO		-		
Lievateu C	Increase in Conductivity							
	Mean of Previou	s Quarter						
	Meditorrevioe	Conductivity mmhos cm <sup>-1</sup>	1207	1232.3	-25.00			
	Increase in Total Dissolved		1207	1252.5	25.00			
	Mean of Previou							Lower TDS and Hardness
	Meditorrevioe	TDS (mg L <sup>-1</sup> )	788	815	-27.00			but elevated Chloride
		Chloride (mg L <sup>-1</sup> )	128.5	116.5	12.00	+		
		Hardness (mg L <sup>-1</sup> )		380.67	-30.67			
River Disco	ntinuity		550	500.07	50.07			
	Decrease in Recruitment						NE	
				No	Data Available	2		
	Decrease in Woody Debris							
	Length of Reach	Where Present						
		Small (<0.3m length) Woody Debris (m)	5	5	0			
		Large (>0.3m length) Woody Debris (m)	0.5	0	0.5			
	Decrease in Cobbles			-			+	
	% of Reach Area	Where Present						
		Cobbles (%)	0.0	4.0	-4	+		
	Increase in Sands and Fines							
	% of Reach Area							
		Sands and Fines (%)	19.1	23.3	-4.3			
	Burial of Cobbles	x /					NE	Few if any cobbles
		les Embeddedness						observed, so
		Cobble Embeddedness (%)		No	Data Available	2		mesurements unreliable
	Increase in Simplified Habi	tat					0	
	nMDS Comparis	on of Sites Based on Habitat Types Present						
	/	Euclidean Distance from RD				0		

Habitat Sin	Proximate Stressor	Measurement	Components (units)	RD Value	RE Value	Difference	Component Score	Proximate Stressor Score	Comment
	nplification								
	Change in A	Available Food						0	
		nMDS Comparison of Sit	tes Based Upon Food Type Availability						
			lean Distance from RD				0		
	Increase in	Channel Deepening							
	D		Thalweg Depth (cm)	26.5	28.3	-1.7		NE	
	Decrease in	Riffles			Ne	Data Available		NE	
	Docroaco in	Noody Debris			NO	Data Available	2		
	Decrease in	Length of Reach When	re Present						
			(<0.3m length) Woody Debris (m)	5	5	0			
			(>0.3m length) Woody Debris (m)	0.5	0	0.5		1	
	Decrease in							+	
		% of Reach Area Where F	Present						
		Cobbl	es (%)	0.0	4.0	-4	+		
	Increase in	Sands and Fines							
		% of Reach Area Where F	resent						1
		Sands	and Fines (%)	19.1	23.3	-4.3			
	Decrease in	n Undercut Banks							
		Length of Reach Where P							
			cut banks (m)	5	5	0			
	Increase in	Simplified Habitat						0	
			tes Based on Habitat Types Present						
		Euclid	lean Distance from RD				0		
ncreased N									
	Change in A	Algal Community	es Based on Diatom Communty Structure				, Y		
	Incroase in	Algal Toxins	Curtis Similarity to RD					NE	
	increase in	Algai TOXITIS			No	Data Available	0		
	Increase in	nH							
	increase in	Mean of Previous Quart	er						
		pH	-	nd	8.10	n/a		0	nly based upon diel da
		Mean of 24 Hours				.,=			
		pH		7.77	8.64	-0.87			
	Increased F	requency of Hypoxia		×					
		Count of Observations in	n Daytime Point Measures						
			n Daytime Point Measures Hypoxia (2-5 mg L <sup>-1</sup> Dissolved Oxygen)	0	0	0			
		Mild		0 0	0	0 0			
		Mild Hypox	Hypoxia (2-5 mg L <sup>-1</sup> Dissolved Oxygen)			-			
		Mild H Hypox Count of Observations in	Hypoxia (2-5 mg L <sup>-1</sup> Dissolved Oxygen) kia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)			-			
		Mild H Hypox Count of Observations in Mild H	Hypoxia (2-5 mg L <sup>-1</sup> Dissolved Oxygen) kia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen) n Diel Measures (24hrs)	0	0	0			
	Increased A	Mild H Hypox Count of Observations in Mild H	Hypoxia (2-5 mg L <sup>-1</sup> Dissolved Oxygen) (ia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen) n Diel Measures (24hrs) Hypoxia (2-5 mg L <sup>-1</sup> Dissolved Oxygen) (ia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)	0	0	0	  	÷	
	Increased A	Mild H Hypox Count of Observations in Mild H Hypox	Hypoxia (2-5 mg L <sup>-1</sup> Dissolved Oxygen) (ia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen) n Diel Measures (24hrs) Hypoxia (2-5 mg L <sup>-1</sup> Dissolved Oxygen) (ia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen) 15	0	0	0	  	÷	

Candidate Cause	Proximate Stressor	Measurement	Components (units)	RD Value	RE Value	Dittoronco	Component Score	Proximate Stressor Score	Comment
Pesticides									
	Increased Se	ediment Non-pyr	ethroid Pesticides					NE	
					N	lo Data Available	2		
	Increased W		n-pyrethroid Pesticides						All measurements
		Maximum Value o				,			below detection limit a both sites
			4,4'-DDD (mg L <sup>-1</sup> )	bdl	bdl	n/a			Dotti sites
			4,4'-DDE (μg L <sup>-1</sup> ) Acrolein (μg L <sup>-1</sup> )	bdl	bdl	n/a			
			Acrylonitrile (µg L <sup>-1</sup> )	bdl	bdl	n/a			
			Acryson true ( $\mu g L^{-1}$ ) Aldrin ( $\mu g L^{-1}$ )	bdl	bdl	n/a			
			alpha-BHC ( $\mu g L^{-1}$ )	bdl	bdl	n/a			
			cis-1,3-Dichloropropene (µg L <sup>-1</sup> )	bdl	bdl	n/a			
			delta-BHC (µg L <sup>-1</sup> )	bdl	bdl	n/a			
			Diazinon (μg L <sup>-1</sup> )	bdl	bdl	n/a			
			Diazmon (µg L <sup>-1</sup> )	bdl	bdl	n/a			
			Endosulfan I (µg L <sup>-1</sup> )	bdl	bdl	n/a			
			Endosulfan II (µg L <sup>-1</sup> )	bdl	bdl	n/a			
			Endosulfan sulfate (µg L <sup>-1</sup> )	bdl bdl	bdl	n/a			
			Endrin aldehyde ( $\mu$ g L <sup>-1</sup> )	bdl	bdl bdl	n/a n/a			
			Endrin (μg L <sup>-1</sup> )	bdl	bdl	n/a			
			Heptachlor Epoxide (Isomer B) (µg L <sup>-1</sup> )	bdl	bdl	n/a n/a			
			Heptachlor ( $\mu g L^{-1}$ )	bdl	bdl	n/a n/a			
			Methoxychlor (µg L <sup>-1</sup> )	bdl	bdl	n/a			
			o,p'-DDD (μg L <sup>-1</sup> )	bdl	bdl	n/a			
			o,p'-DDE (μg L <sup>-1</sup> )	bdl	bdl	n/a			
			o,p'-DDT (μg L <sup>-1</sup> )	bdl	bdl	n/a			
			$p,p'-DDT (\mu g L^{-1})$	bdl	bdl	n/a	/		
			Technical Chlordane (µg L <sup>-1</sup> )	bdl	bdl	n/a			
			Toxaphene ( $\mu g L^{-1}$ )	bdl	bdl	n/a			
		Detection of Any C	compound Above Detection Limit	bui	bui	11/4			
		Detterion of any e	Frequency of Detection (# observed/# measured)	0		0 0			
	Increased W	/ater Column Pyr	ethroid Pesticides	, and a second se		0 0		NE	
	indicaded i	ater column ,			N	lo Data Available	<b>a</b>		
	Increased S	ediment Pyrethro	nid Pesticides				-	NE	
					N	lo Data Available	2		
	Increased W	/ater Column Her	bicides				-		All measurements
		Maximum Value o							below detection limit a
			2,3,7,8-TCDD (pg L <sup>-1</sup> )	bdl	bdl	n/a			both sites
			2,4,5-TP (Silvex) (μg L <sup>-1</sup> )	bdl	bdl	n/a			
			2,4'-D (µg L <sup>-1</sup> )	bdl	bdl	n/a			

Candidate Cause	Proximate Stressor	Measurement	Components (units)	RD Value	RE Value	Difference	Component Score	Proximate Stressor Score	Comment
Temperatu		Vater Temperature						0	Ambivilent in quarterly
		Mean of Previous Quart	er					Ŭ	data, but higher in 24
			Temperature (C)	26.39	25.738	0.65	0		hour diel data
		Mean of Diel Measurem	ents (24hr) <sup>.</sup> Temperature (C)	24.6	23.2	1.4	+		
	Decreased	Variability in Water Ter		2110	20.2	1.1		+	
		Range of Previous Quart							
		Water Range of Diel Measurem	· Temperature (C) ents (24hr)	9.06	18.61	-9.56	+		
			Temperature (C)	3.27	6.37	-3.1	+		
									X
							, <b>X</b>		
				(					
						)			
				×					
	4								

Candidate Cause	Proximate Stressor	Measurement	Components (units)	RD Value	RB Value	Difference	Component Score	Proximate Stressor Score	Comment
leavy Meta	als								
	Increase in Di	ssolved Metals						+	
		Mean of Previous	Quarter (BDL = 1/2 MDL)						
			Antimony (μg L <sup>-1</sup> )	0.63	0.30	0.33	0		
			Arsenic (μg L <sup>-1</sup> )	0.82	0.30	0.52	+		
			Barium (µg L <sup>-1</sup> )	41.70	16.00	25.70	+		
			Beryllium (μg L⁻¹)	0.13	0.13	0.00			
			Cadmium (µg L <sup>-1</sup> )	0.09	0.02	0.07	0		
			Chromium (µg L <sup>-1</sup> )	0.23	0.23	0.00			
			Copper (µg L <sup>-1</sup> )	3.42	3.11	0.31	0		
			Hexavalent Chromium (mg L <sup>-1</sup> )	0.01	0.01	0.00			
			Iron (mg L <sup>-1</sup> )	0.10	0.10	0.00			
			Lead (µg L <sup>-1</sup> )	0.10	0.08	0.02	0		
			Mercury (µg L <sup>-1</sup> )	0.02	0.02	0.00			
			Nickel (µg L <sup>-1</sup> )	6.86	5.11	1.75	+		
			Selenium (µg L <sup>-1</sup> )	1.33	0.50	0.83	+		
			Silver (µg L <sup>-1</sup> )	0.13	0.13	0.00			
			Thallium (µg L <sup>-1</sup> )	0.13	0.13	0.00			
			Zinc (µg L <sup>-1</sup> )	27.97	40.40	-12.43			
	Increase in Pa	rticulate Bound	Metals					NE	
					No	Data Available			
	Increase in M	etals in Periphyt	on					NE	
					No	Data Available			
	onductivity Increase in Co	ب مار ب مغز بر زغر ب							
	increase in CC	Mean of Previous	Quester					+	
		Weatt of Previous	Conductivity mmhos cm <sup>-1</sup>	1233.9	1076	158.23	+		
	Incroase in To	tal Dissolved Sol		1255.9	1070	156.25	т		
		Mean of Previous						+	
		Wearr of Freelous	TDS (mg L <sup>-1</sup> )	788	631.3	156.67	+		
			Chloride (mg L <sup>-1</sup> )	128.5	126	2.50	+		
			Hardness (mg L <sup>-1</sup> )	350	195	155.00	+		
River Disco	ntinuity			350	195	155.00			
	Decrease in R	ecruitment						NE	
	beenedbe in it	conditionent			No	Data Available	2		
	Decrease in V	Voody Debris							
		Length of Reach W	here Present						
		-	Small (<0.3m length) Woody Debris (m)	5	4.1	0.9			
			Large (>0.3m length) Woody Debris (m)	0.5	0	0.5			
	Decrease in C	obbles							
		% of Reach Area W	/here Present						
			Cobbles (%)	0.0	0.0	0			
	Increase in Sa	nds and Fines							
		% of Reach Area W	/here Present						
			Sands and Fines (%)	19.1	39.5	-20.4			
	Burial of Cobl	oles						NE	
		Mean % of Cobble	s Embeddedness						
			Cobble Embeddedness (%)		No	Data Available	2		
	Increase in Si	mplified Habitat						0	
		nMDS Comparison	n of Sites Based on Habitat Types Present						
			Euclidean Distance from RD				0		
		<b>Y</b>							
		7							
		<b>X</b>							
	$\mathbf{)}$								
		<b>Y</b>							

Change in Available Food          NMDS Comparison of Sites Based Upon Food Type Availability          Euclidean Distance from RD          Increase in Channel Deepening          Mean Thalweg Depth (cm)       26.5       2.8.5      2          Decrease in Riffles        NE         Decrease in Riffles        NE         Decrease in Woody Debris        NE         Small (<0.3m length) Woody Debris (m)       5       4.1       0.9          Small (<0.3m length) Woody Debris (m)       0.5       0       0.5          Decrease in Cobbles             % of Reach Area Where Present            Length of Reach Where Present            Length of Reach Where Present            So f Reach Area Where Present </th <th>1005 Comparison of Shes Based Upon Root Type Availability</th> <th>Cause</th> <th>Proximate Stressor</th> <th>Measurement</th> <th>Components (units)</th> <th>RD Value</th> <th>RB Value</th> <th>Difference</th> <th>Component Score</th> <th>Proximate Stressor Score</th> <th>Comment</th>	1005 Comparison of Shes Based Upon Root Type Availability	Cause	Proximate Stressor	Measurement	Components (units)	RD Value	RB Value	Difference	Component Score	Proximate Stressor Score	Comment
mid3 Comparison of site. Based upon food "ype Awailability buildean Distance from RO	1005 Comparison of Shes Based Upon Root Type Availability	Habitat Sir	nplification								
Increase in Channel Deepening	Increase in Channel Deepening		Change in Av	ailable Food							
Increase in Channel Deepening         د	Increase in RhTines         د         د         د         د         د         د         د         د         k			nMDS Compariso							
Mean Thalwag Depth (m)26.526.5Decrease in RifflesDecrease in Moody DebrisSmall (0.3m length) Woody Debris (m)0.54.10.9Barge (0.3m length) Woody Debris (m)0.54.00.0Decrease in CobblesBarge (0.3m length) Woody Debris (m)0.50.00.0Decrease in Cobbles (%)<	Mean Thalwage Depth (cm)         26.5         2.6          NE           Decrease in Riffles         NE         NE         NE           Decrease in Woody Debris         NE         NE         NE           Length of Rach Where Present         Small (<0.3m length) Woody Debris (m)										
Decrease in Woody Debris       الحالية العالية العا	Decrease in Riffles       الله الله الله الله الله الله الله الله		Increase in C	hannel Deepenii							
Note::::::::::::::::::::::::::::::::::::					Mean Thalweg Depth (cm)	26.5	28.5	-2			
Decrease in Woody Debris	Decrease in Woody Debris Length of Reach Mree Present ت المree (-0.3m length) Woody Debris (m) 5 Decrease in Cobble (%) Cobble (%)		Decrease in I	Riffles						NE	
Length of Reach Where Present	Length of Reach Where Present		D	Marada Dahaia			No	Data Available	2		
Small (c0.3m length) Woody Debris (m)       5       4.1       0.9          Large (v0.3m length) Woody Debris (m)       0.5       0       0.5          So f Reach Area Where Present            Length of Reach Where Present            Length of Reach Where Present            Undercut Banks         0          Length of Reach Where Present        0			Decrease in V		Mara Dresent						
Large (>0.3m length) Woody Debris (m) 0.5 0, 0 0.5 Decrease in Cobbiles (%) 0.0 0.0 0, 0 % of Reach Area Where Present So of Reach Area Where Present So of Reach Area Where Present Length of Reach Marea Present Undercut Banks Undercut Banks (m) 5 5 0, Undercut Banks (m) 5 5 0, Length of Reach Where Present Length of Reach Where Present Leucidean Distance from RD Change in Algal Community nMDS Comparison of Sites Based on Habitat Types Present Euclidean Distance from RD Ray-Curtis Similarity to RD Ray Curtis Similar	Large (>0.3m length) 'Woody Debris (m) 0.5 0.0 0.5			Length of React		F	4.1	0.0			
Decrease in Cobbles	Decrease in Cobbles									,	
No fixed Area Where Present Cobbles (%) 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.	So of Reach Areas Where Present         المالية المحالية ال		Decrease in (	obbles		0.5	0	0.5			
Cobbles (%)         0.0         0.0         0.0         0.0         0.0         0.0         0.0           Increase in Sands and Fines         Sands and Fines (%)         19.1         39.5         -20.4            Becrease in Undercut Banks         Increase in Simplified Habitat         No             Increase in Simplified Habitat         S         5         0          0           Increase in Simplified Habitat         Sites Based on Habitat Types Present          0            Euclidean Distance from RD          0          0           reased Nutrients          0          0           Increase in Algal Community         Sites Based on Diatom Community Structure          0            Bray-Curtis Similarity to RD         No Data Available          0             Mean of Previous Quarter         pH         nd         7.42         n/a              Mean of 24 Hours	Cobbies (%)     O		Decieuse in t		Where Present						
% of Reach Area Where Present	% of Reach Area Where Present           Decrease in Undercut Banks           Undercut banks (m)       5       5       0          Increase in Simplified Habitat         0         Increase in Simplified Habitat        0          Change in Algal Community       Euclidean Distance from RD        0         creased Nutrients        0          Change in Algal Community       Similarity to RD        0         Increase in Algal Community       Similarity to RD        0         Increase in Algal Community        0          Mean of Previous Quarter        0          Mean of Previous Quarter         0         pH       nd       7.77       7.24       0.53          Count of Observations in Daytime Point Measures             Count of Observations in Daytime Point Measures             Count of Observations in Daytime Point Measures            Mild Hypoxia				Cobbles (%)	0.0	0.0	0			
Sands and Fines (%)       19.1       39.5       -20.4          Decrease in Undercut Banks            Length of Reach Where Present            Undercut banks (m)       5       5       0        0         Increase in Simplified Habitat        0        0         reased Nutrients        0        0         Increase in Algal Toxins        0         0          Mean of Previous Quarter                Mean of 24 Hours </td <td>Sands and Fines (%)       19.1       39.5       -20.4          Decrease in Undercut Banks           Length of Reach Where Present           Undercut banks (m)       5       5       0          Increase in Simplified Habitat        0          nMDS Comparison of Sites Based on Habitat Types Present        0         creased Nutrients      </td> <td></td> <td>Increase in Sa</td> <td>ands and Fines</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>	Sands and Fines (%)       19.1       39.5       -20.4          Decrease in Undercut Banks           Length of Reach Where Present           Undercut banks (m)       5       5       0          Increase in Simplified Habitat        0          nMDS Comparison of Sites Based on Habitat Types Present        0         creased Nutrients		Increase in Sa	ands and Fines							
Decrease in Undercut Banks          Length of Reach Where Present          Undercut banks (m)       5       5       0          Increase in Simplified Habitat       0       0       0         reased Mutrients       0        0         reased Nutrients       0       0       0       0         Change in Algal Community       rmMDS Comparison of Sites Based on Diatom Communty Structure       0       0         mMDS Comparison of Sites Based on Diatom Communty Structure       0       0       0       0         Increase in Algal Toxins       0       0       0       0       0       0         Mean of Previous Quarter       0       0       0       0       0       0       0         pH       nd       7.42       n/2        Ne       available         Increased Frequency of Hypoxia       0       0       0       0           Gount of Observations in Daytime Point Measures              Increased Frequency of Hypoxia (2-5 mg L <sup>12</sup> Dissolved Oxygen)       0       0       0           Gount of Observations in Day	Length of Reach Where Present Length of Reach Where Present Undercut banks (m) 5 5 0 0 0 Increase in Simplified Habitat Euclidean Distance from RD Creased Nutrients Change in Algal Community Change in Algal Community Mos Comparison of Sites Based on Diatom Community Structure Bray-Curtis Similarity to RD Increase in Algal Toxins Increase in Algal Toxins Increase in pH Mean of Previous Quarter pH Mean of 24 Hours pH Mean of 24 Hours pH Mean of 24 Hours pH Count of Observations in Digtime Point Measures Count of Observations in Digtime Point Measures Mild Hypoxia (2-5 mg L <sup>1</sup> Dissolved Oxygen) Count of Observations in Digtime Point Measures (24hrs) Mild Hypoxia (2-5 mg L <sup>1</sup> Dissolved Oxygen) Mild Hypoxia (2-5 mg L <sup>1</sup> Dissolved Oxygen) M M M M M M M M M M M M M			% of Reach Area	Where Present						× ·
Length of Reach Where Present         السطورين banks (m)         5         5         0          0           Increase in Simplified Habitation         Euclidean Distance from RD         0 <t< td=""><td>Length of Reach Where Present Under cut banks (m) 5 5 6</td><td></td><td></td><td></td><td>Sands and Fines (%)</td><td>19.1</td><td>39.5</td><td>-20.4</td><td></td><td></td><td></td></t<>	Length of Reach Where Present Under cut banks (m) 5 5 6				Sands and Fines (%)	19.1	39.5	-20.4			
Undercut banks (m)550Increase in Simplified Habitat nMDS Comparison of Sites Based on Habitat Types Present Euclidean Distance from RD000reased Nutrients00 <t< td=""><td>Undercut banks (m)         5         5         0          0           Increase in Simplified Habitat         Euclidean Distance from RD         0         0         0         0           creased Nutrients         0         0         0         0         0         0           creased Nutrients         0         <t< td=""><td></td><td>Decrease in l</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></t<></td></t<>	Undercut banks (m)         5         5         0          0           Increase in Simplified Habitat         Euclidean Distance from RD         0         0         0         0           creased Nutrients         0         0         0         0         0         0           creased Nutrients         0 <t< td=""><td></td><td>Decrease in l</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></t<>		Decrease in l								
Increase in Simplified Habitat       0       0         nMDS Comparison of Sites Based on Habitat Types Present       0       0         Euclidean Distance from RD       0       0         reased Nutrients       0       0         Change in Algal Community       5       0         MDS Comparison of Sites Based on Diatom Communty Structure       0       0         Bray-Curtis Similarity to RD       0       0         Increase in Algal Toxins       0       0         Mean of Previous Quarter	Increase in Simplified Habitat NMDS Comparison of Sites Based on Habitat Types Present Euclidean Distance from RD creased Nutrients Change in Algal Community nMDS Comparison of Sites Based on Diatom Communty Structure Bray-Curtis Similarity to RD Increase in Algal Toxins Mean of Previous Quarter pH Mean of 24 Hours pH Mean of 24 Hours pH Mean of 24 Hours pH Mean of 24 Hours pH Mean of 24 Hours Count of Dbservations in Daytime Point Measures Count of Observations in Daytime Point Measures Mild Hypoxia (2-5 mg L <sup>-1</sup> Dissolved Oxygen) Mild Hypoxia (			Length of Reach V							
nMDS Comparison of Sites Based on Habitat Types Present Euclidean Distance from RD	nMDS Comparison of Sites Based on Habitat Types Present Euclidean Distance from RD         0           Creased Nutrients           O           NDDS Comparison of Sites Based on Diatom Communty Structure Bray-Curtis Similarity to RD         0           Increase in Algal Toxins           Mean of Previous Quarter         0           pH         nd         7.42         n/3            Mean of 24 Hours              pH         nd         7.77         7.24         0.53            Increased Frequency of Hypoxia               Count of Observations in Daytime Point Measures               Mild Hypoxia (2-5 mg L <sup>1</sup> Dissolved Oxygen)         0         0         0             Mild Hypoxia (2-5 mg L <sup>1</sup> Dissolved Oxygen)         0         0         0             Mild Hypoxia (2-5 mg L <sup>1</sup> Dissolved Oxygen)         0         0         0             Mild Hypoxia (2-5 mg L <sup>1</sup> Dissolved Oxygen)         0         0         0					5	5	0			
Euclidean Distance from RD       0         reased Nutrients       0         Change in Algal Community       Bray-Curtis Similarity to RD       0         Bray-Curtis Similarity to RD       0         Increase in Algal Toxins       0         Increase in pH       No Data Available         Mean of Previous Quarter          pH       nd       7.42         Mean of 24 Hours          pH       7.77       7.24       0.53         Increased Frequency of Hypoxia           Count of Observations in Daytime Point Measures           Count of Observations in Diel Measures (24ms)       0       0       0          Mild Hypoxia (2.5 mg L <sup>-1</sup> Dissolved Oxygen)       0       7.4       -7.4           Mild Hypoxia (2.6 mg L <sup>-1</sup> Dissolved Oxygen)       0       0       0           Hypoxia (-2.0 mg L <sup>-1</sup> Dissolved Oxygen)       0       7.4       -7.4           Mild Hypoxia (2.6 mg L <sup>-1</sup> Dissolved Oxygen)       0       7.4       -7.4           Hypoxia (-2.0 mg L <sup>-1</sup> Dissolved Oxygen)       0       7.4       -7.4	Euclidean Distance from RD         0           creased Nutrients         0           Change in Algal Community         Bray-Curtis Similarity to RD         0           Bray-Curtis Similarity to RD         0         0           Increase in Algal Toxins         No Data Available            Increase in pH         No Data Available            Mean of Previous Quarter             pH         nd         7.42 n/a         NE         available           Increased Frequency of Hypoxia              Count of Observations in Daytime Point Measures              Count of Observations in Daytime Point Measures		Increase in Si							0	
reased Nutrients Change in Algal Community Change in Algal Community Bray-Curtis Similarity to RD Bray-	creased Nutrients Change in Algal Community Increase in Algal Community Increase in Algal Toxins Increase Antimoting Concentrations Increased Ammonia Concentrations Increase Increased Ammonia Concentrations Increase Increa			nMDS Compariso					0		
Change in Algal Community IMDS Comparison of Sites Based on Diatom Community Structure Bray-Curtis Similarity to RD O Increase in Algal Toxins O O O O O O O O O O O O O O O O O O O	Change in Algal Community MDS Comparison of Sites Based on Diatom Communty Structure Bray-Curtis Similarity to RD Bray-Curtis Simi	ncreased I	Nutrients								
nMDS Comparison of Sites Based on Diatom Community Structure       0         Bray-Curtis Similarity to RD       O         Increase in Algal Toxins       No Data Available         Increase in Algal Toxins        Only 24hr measurements         Mean of Previous Quarter         Only 24hr measurements         Mean of 24 Hours        NE       available         Mean of 24 Hours        Only 24hr measurements         Mean of 24 Hours         Only 24hr measurements         Mean of 24 Hours         Only 24hr measurements         Mean of 24 Hours            Mean of 24 Hours           Mild Hypoxia (-2.0 mg L <sup>1</sup> Dissolved Oxygen)       0       0          Mild Hypoxia (-2.0 mg L <sup>1</sup> Dissolved Oxygen)       0          Mild Hypoxia (-2.0 mg L <sup></sup>	nMDS Comparison of Sites Based on Diatom Community Structure Bray-Curtis Similarity to RD Increase in Algal Toxins  Increase in Algal Toxins  Increase in pH Increase in P			gal Community						0	
Increase in Algal Toxins          Increase in Algal Toxins       No Data Available        Only 24hr measurements         Increase in pH       nd       7.42       n/a        Only 24hr measurements         Mean of Previous Quarter       pH       nd       7.42       n/a        NE       available         Mean of 24 Hours       pH       7.77       7.24       0.53           Increased Frequency of Hypoxia       count of Observations in Daytime Point Measures	Increase in Algal Toxins           Increase in Algal Toxins         No Data Available				on of Sites Based on Diatom Communty Structure				/		
Increase in pH        Only 24hr measurements         Mean of Previous Quarter        NE       available         pH       nd       7.42       n/3           Mean of 24 Hours              pH       7.77       7.24       0.53           Increased Frequency of Hypoxia             Count of Observations in Daytime Point Measures             Mild Hypoxia (-2.5 mg L <sup>1</sup> Dissolved Oxygen)       0       0       0           Count of Observations in Diel Measures (24hrs)              Mild Hypoxia (-2.0 mg L <sup>1</sup> Dissolved Oxygen)       0       7.4       -7.4           Mild Hypoxia (-2.0 mg L <sup>1</sup> Dissolved Oxygen)       0       0       0	Increase in pH         No bata Available          Only 24hr measurements           Mean of Previous Quarter          NE         available           pH         nd         7.42 n/s         NE         available           Mean of 24 Hours          NE         available           pH         7.77         7.24         0.53             Increased Frequency of Hypoxia                Count of Observations in Daytime Point Measures				Bray-Curtis Similarity to RD				0		
Increase in pHOnly 24hr measurementspHnd7.42n/aNEavailablepH7.777.240.53pH7.777.240.53Increased Frequency of HypoxiaCount of Observations in Daytime Point MeasuresMild Hypoxia (2-5 mg L <sup>1</sup> Dissolved Oxygen)00Mypoxia (-2.00 mg L <sup>1</sup> Dissolved Oxygen)07.4-7.4Hypoxia (-2.00 mg L <sup>1</sup> Dissolved Oxygen)00Mild Hypoxia (2-5 mg L <sup>1</sup> Dissolved Oxygen)07.4-7.4Hypoxia (-2.00 mg L <sup>1</sup> Dissolved Oxygen)000Hypoxia (-2.00 mg L <sup>1</sup> Dissolved Oxygen)<	Increase in pH        Only 24hr measurements         pH       nd       7.42 n/a       NE       available         Mean of 24 Hours         NE       available         pH       7.77       7.24       0.53           Increased Frequency of Hypoxia             Count of Observations in Daytime Point Measures             Mild Hypoxia (c2.5 mg L <sup>-1</sup> Dissolved Oxygen)       0       0       0           Count of Observations in Daytime Point Measures (24hrs)		Increase in A	lgal Toxins							
Mean of Previous Quarter       measurements         pH       nd       7.42       n/a       NE       available         Mean of 24 Hours             pH       7.77       7.24       0.53           Increased Frequency of Hypoxia             Count of Observations in Daytime Point Measures            Mild Hypoxia (2-5 mg L <sup>1</sup> Dissolved Oxygen)       0       0           Count of Observations in Diel Measures (24hrs)             Count of Observations in Diel Measures (24hrs)             Hypoxia (<2.0 mg L <sup>1</sup> Dissolved Oxygen)       0       7.4       -7.4           Hypoxia (<2.0 mg L <sup>1</sup> Dissolved Oxygen)       0       0       0            Hypoxia (<2.0 mg L <sup>1</sup> Dissolved Oxygen)       0       7.4       -7.4           Hypoxia (<2.0 mg L <sup>1</sup> Dissolved Oxygen)       0       0       0	Mean of Previous Quarter       measurements         pH       nd       7.42 n/a       NE       available         Mean of 24 Hours             pH       7.77       7.24       0.53           Increased Frequency of Hypoxia             Count of Observations in Daytime Point Measures             Mild Hypoxia (2-5 mg L <sup>-1</sup> Dissolved Oxygen)       0       0            Count of Observations in Diel Measures (24hrs)       0       0       0           Kild Hypoxia (2-5 mg L <sup>-1</sup> Dissolved Oxygen)       0       7.4       -7.4           Hypoxia (2-0 mg L <sup>-1</sup> Dissolved Oxygen)       0       0       0						No	Data Available	2		
pH       nd       7.42       n/a       NE       available         Mean of 24 Hours	рН         nd         7.42 п/а         NE         available           Mean of 24 Hours		Increase in p	Н							
Mean of 24 Hours        pH     7.77     7.24     0.53        Increased Frequency of Hypoxia         Count of Observations in Daytime Point Measures        Mild Hypoxia (2-5 mg L <sup>1</sup> Dissolved Oxygen)     0     0        Hypoxia (<2.0 mg L <sup>1</sup> Dissolved Oxygen)     0     0        Count of Observations in Diel Measures (24hrs)         Mild Hypoxia (<2.0 mg L <sup>1</sup> Dissolved Oxygen)     0     7.4     -7.4       Hypoxia (<2.0 mg L <sup>1</sup> Dissolved Oxygen)     0     0        Increased Ammonia Concentrations         Mean of Previous Quarter	Mean of 24 Hours     Increased       pH     7.77     7.24     0.53        Increased Frequency of Hypoxia         Count of Observations in Daytime Point Measures        Mild Hypoxia (2-5 mg L <sup>-1</sup> Dissolved Oxygen)     0     0        Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)     0     0        Count of Observations in Diel Measures (24hrs)         Mild Hypoxia (<2.5 mg L <sup>-1</sup> Dissolved Oxygen)     0     7.4     -7.4       Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)     0     0        Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)     0     0        Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)     0     0        Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)     0     0        Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)     0     0        Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)     0     0        Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)     0     0			Mean of Previous							
pH7.777.240.53Increased Frequency of HypoxiaCount of Observations in Daytime Point MeasuresMild Hypoxia (2-5 mg L <sup>1</sup> Dissolved Oxygen)00Hypoxia (<2.0 mg L <sup>1</sup> Dissolved Oxygen)00Count of Observations in Diel Measures (24hrs)Mild Hypoxia (<2.5 mg L <sup>1</sup> Dissolved Oxygen)07.4-7.4Hypoxia (<2.0 mg L <sup>1</sup> Dissolved Oxygen)00Hypoxia (<2.0 mg L <sup>1</sup> Dissolved Oxygen)00Increased Ammonia ConcentrationsMean of Previous Quarter	pH7.777.240.53Increased Frequency of HypoxiaCount of Observations in Daytime Point MeasuresMild Hypoxia (2-5 mg L <sup>-1</sup> Dissolved Oxygen)00Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)00Count of Observations in Diel Measures (24hrs)Mild Hypoxia (<2.5 mg L <sup>-1</sup> Dissolved Oxygen)07.4-7.4Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)00Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)00Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)00Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)00Mean of Previous Quarter					nd	7.42	n/a			available
Increased Frequency of Hypoxia Count of Observations in Daytime Point Measures Mild Hypoxia (2-5 mg L <sup>1</sup> Dissolved Oxygen) 0 0 Hypoxia (<2.0 mg L <sup>1</sup> Dissolved Oxygen) 0 0 Count of Observations in Diel Measures (24hrs) Mild Hypoxia (<2.5 mg L <sup>1</sup> Dissolved Oxygen) 0 7.4 -7.4 Hypoxia (<2.0 mg L <sup>1</sup> Dissolved Oxygen) 0 0 Hypoxia (<2.0 mg L <sup>1</sup> Dissolved Oxygen) 0 Mean of Previous Quarter	Increased Frequency of Hypoxia			Mean of 24 Hour							
Count of Observations in Daytime Point Measures         Mild Hypoxia (2-5 mg L <sup>1</sup> Dissolved Oxygen)       0       0          Hypoxia (<2.0 mg L <sup>1</sup> Dissolved Oxygen)       0       0          Count of Observations in Diel Measures (24hrs)       0       7.4       -7.4          Mild Hypoxia (<2.5 mg L <sup>1</sup> Dissolved Oxygen)       0       7.4       -7.4          Hypoxia (<2.0 mg L <sup>1</sup> Dissolved Oxygen)       0       0           Hypoxia (<2.0 mg L <sup>1</sup> Dissolved Oxygen)       0       0           Increased Ammonia Concentrations             Mean of Previous Quarter	Count of Observations in Daytime Point Measures         Mild Hypoxia (2-5 mg L <sup>-1</sup> Dissolved Oxygen)       0       0          Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)       0       0          Count of Observations in Diel Measures (24hrs)           Mild Hypoxia (<2.5 mg L <sup>-1</sup> Dissolved Oxygen)       0       7.4       -7.4          Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)       0       0           Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)       0       0           Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)       0       0           Mean of Previous Quarter			<i>c</i>		7.77	7.24	0.53			
Mild Hypoxia (2-5 mg L <sup>-1</sup> Dissolved Oxygen)       0       0          Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)       0       0          Count of Observations in Diel Measures (24hrs)           Mild Hypoxia (2-5 mg L <sup>-1</sup> Dissolved Oxygen)       0       7.4       -7.4          Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)       0       0           Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)       0       0           Increased Ammonia Concentrations            Mean of Previous Quarter	Mild Hypoxia (2-5 mg L <sup>-1</sup> Dissolved Oxygen)       0       0          Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)       0       0          Count of Observations in Diel Measures (24hrs)           Mild Hypoxia (<2.5 mg L <sup>-1</sup> Dissolved Oxygen)       0       7.4       -7.4          Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)       0       0           Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)       0       0           Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)       0       0           Mean of Previous Quarter		Increased Fre								
Hypoxia (<2.0 mg L <sup>1</sup> Dissolved Oxygen)       0       0          Count of Observations in Diel Measures (24hrs)           Mild Hypoxia (2-5 mg L <sup>1</sup> Dissolved Oxygen)       0       7.4       -7.4         Hypoxia (<2.0 mg L <sup>1</sup> Dissolved Oxygen)       0       0          Hypoxia (<2.0 mg L <sup>1</sup> Dissolved Oxygen)       0       0          Increased Ammonia Concentrations           Mean of Previous Quarter	Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)       0       0       0          Count of Observations in Diel Measures (24hrs)       Mild Hypoxia (2-5 mg L <sup>-1</sup> Dissolved Oxygen)       0       7.4       -7.4          Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)       0       0       0          Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)       0       0       0          Increased Ammonia Concentrations            Mean of Previous Quarter			Count of Observa			_				
Count of Observations in Diel Measures (24hrs) Mild Hypoxia (2-5 mg L <sup>-1</sup> Dissolved Oxygen) 0 7.4 -7.4 Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen) 0 0 0 Increased Ammonia Concentrations Mean of Previous Quarter	Count of Observations in Diel Measures (24hrs) Mild Hypoxia (2-5 mg L <sup>-1</sup> Dissolved Oxygen) 0 7.4 -7.4 Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen) 0 0 0 Increased Ammonia Concentrations Mean of Previous Quarter										
Mild Hypoxia (2-5 mg L <sup>1</sup> Dissolved Oxygen) 0 7.4 -7.4 Hypoxia (<2.0 mg L <sup>1</sup> Dissolved Oxygen) 0 0 0 Increased Ammonia Concentrations Mean of Previous Quarter	Mild Hypoxia (2-5 mg L <sup>-1</sup> Dissolved Oxygen)       0       7.4       -7.4          Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)       0       0       0          Increased Ammonia Concentrations            Mean of Previous Quarter			Count of Observe		0	0	0			
Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen) 0 0 0 Increased Ammonia Concentrations Mean of Previous Quarter	Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen) 0 0 0 Increased Ammonia Concentrations Mean of Previous Quarter			count of Observa		0	7 4	7 4	_		
Increased Ammonia Concentrations Mean of Previous Quarter	Increased Ammonia Concentrations Mean of Previous Quarter										
Mean of Previous Quarter	Mean of Previous Quarter		Increased An	monia Concent		0	0	U			
			ma cascu All								
				incan of Frenou.		0.34	1.03	-0.69			
						0.34	1.03	-0.69			
						0.34	1.03	-0.69			
		$\boldsymbol{\langle}$									

Candidate Cause	Proximate Stressor	Measurement	Components (units)	RD Value	RB Value	Difference	Component Score	Proximate Stressor Score	Comment
Pesticides									
	Increased Se	diment Non-pyrei	throid Pesticides					NE	
					No	Data Available	e		
	Increased Wa	ater Column Non-	pyrethroid Pesticides						
		Maximum Value of	Previous Year						
			4,4'-DDD (mg L <sup>-1</sup> )	bdl	bdl	n/a			
			4,4'-DDE (μg L <sup>-1</sup> )	bdl	bdl	n/a			
			Acrolein (μg L <sup>-1</sup> )	bdl	bdl	n/a			
			Acrylonitrile (μg L <sup>-1</sup> )	bdl	bdl	n/a			
			Aldrin (μg L <sup>-1</sup> )	bdl	bdl	n/a			
			alpha-BHC (μg L <sup>-1</sup> )	bdl	bdl	n/a			
			cis-1,3-Dichloropropene (μg L <sup>-1</sup> )	bdl	bdl	n/a			
			delta-BHC (μg L <sup>-1</sup> )	bdl	bdl	n/a		•	
			Diazinon (µg L <sup>-1</sup> )	bdl	bdl	n/a			
			Dieldrin (μg L <sup>-1</sup> )	bdl	bdl	n/a			
			Endosulfan I (μg L <sup>-1</sup> )	bdl	bdl	n/a			Y
			Endosulfan II (μg L <sup>-1</sup> )	bdl	bdl	n/a			
			Endosulfan sulfate (μg L <sup>-1</sup> )	bdl	bdl	n/a			
			Endrin aldehyde (µg L⁻¹)	bdl	bdl	n/a			
			Endrin (μg L <sup>-1</sup> )	bdl	bdl	n/a			
			Heptachlor Epoxide (Isomer B) (µg L <sup>-1</sup> )	bdl	bdl	n/a			
			Heptachlor (µg L <sup>-1</sup> )	bdl	bdl	n/a			
			Methoxychlor (µg L <sup>-1</sup> )	bdl	bdl	n/a	/		
			o,p'-DDD (μg L <sup>-1</sup> )	bdl	bdl	n/a			
			o,p'-DDE (μg L <sup>-1</sup> )	bdl	bdl	n/a			
			o,p'-DDT (μg L <sup>−1</sup> )	bdl	bdl	n/a	/		
			p,p'-DDT (μg L⁻¹)	bdl	bdl	n/a			
			Technical Chlordane (μg L⁻¹)	bdl	bdl	n/a			
			Toxaphene (μg L <sup>-1</sup> )	bdl	bdl	n/a			
		Detection of Any Co	ompound Above Detection Limit						
			Frequency of Detection (# observed/# measured)	(	0 0	0			
	Increased Wa	ater Column Pyret	hroid Pesticides					NE	
					No	Data Available	e		
	Increased Se	diment Pyrethroid	d Pesticides					NE	
					No	Data Available	e		
	Increased Wa	ater Column Herbi	cides						
		Maximum Value of							
			2,3,7,8-TCDD (pg L <sup>-1</sup> )	bdl	bdl	n/a			
			2,4,5-TP (Silvex) (μg L <sup>-1</sup> )	bdl	bdl	n/a			
			2,4'-D (μg L <sup>-1</sup> )	bdl	bdl	n/a			

Candidate Cause	Proximate Stressor	Measurement	Components (units)	RD Value	RB Value	Difference	Component Score	Proximate Stressor Score	Comment
Temperatu				Value			00010		
		iter Temperature							
		Mean of Previous Quar							
		Wat Mean of Diel Measurer	er Temperature (C)	26.39	27.42	-1.03			
			er Temperature (C)	24.6	26.4	-1.8			
	Decreased Va	ariability in Water Ter						+	
		Range of Previous Qua							
			er Temperature (C)	9.06	6.72	2.33	+		
		Range of Diel Measure	ments (24hr) er Temperature (C)	3.27	4.29	-1.02	+		
		Wat		5.27	4.25	1.02			
	5								

Candidate Cause	Proximate Stressor	Measurement	Components (units)	RD Value	RC Value	Difference	Component Score	Proximate Stressor Score	Comment
Heavy Met	als								
	Increase in D	issolved Metals						+	
		Mean of Previous	Quarter (BDL = 1/2 MDL)						Elevated levels of Copper and Zinc. Ambigious levels of
			Antimony (μg L <sup>-1</sup> )	0.63	0.27	0.36	0		Antimony
			Arsenic (µg L <sup>-1</sup> )	0.82	1.51	-0.69			
			Barium (µg L <sup>-1</sup> )	41.70	79.00	-37.30			
			Beryllium (μg L <sup>-1</sup> )	0.13	0.13	0.00			
			Cadmium (µg L <sup>-1</sup> )	0.09	0.13	-0.04			
			Chromium (μg L <sup>-1</sup> )	0.23	0.25	-0.02			
			Copper (µg L <sup>-1</sup> )	3.42	2.48		+		
			Hexavalent Chromium (mg L <sup>-1</sup> )	0.01	0.01	0.00			
			Iron (mg L <sup>-1</sup> )	0.10	0.10	0.00			
			Lead (µg L <sup>-1</sup> )	0.10	0.07	0.03			
			Mercury (µg L <sup>-1</sup> )	0.02	0.02	0.00			
			Nickel (µg L <sup>-1</sup> )	6.86	11.40	-4.54			
			Selenium ( $\mu$ g L <sup>-1</sup> )	1.33	2.87	-1.54			
			Silver (µg L <sup>-1</sup> ) Thallium (µg L <sup>-1</sup> )	0.13	0.13	0.00			
				0.13	0.13	0.00			
	la sus sus in D		Zinc (μg L <sup>-1</sup> )	27.97	7.40	20.57	+	NE	
	Increase in P	articulate Bound	Metals			Data Available		INE	
	Increase in M	letals in Periphyt	on		NO	Data Available		NE	
	increase in w	letais in renpinyt			No	Data Available			
Elevated Co	onductivity				NO				
	Increase in C	onductivity							
	increase in o	Mean of Previous	Quarter						
			Conductivity mmhos cm <sup>-1</sup>	1207.33	1295.7	-88.33			
	Increase in To	otal Dissolved So							
		Mean of Previous	Quarter						
			TDS (mg L <sup>-1</sup> )	788	866.67	-78.67			Lower TDS and hardness, but
			Chloride (mg L <sup>-1</sup> )	128.5	118.33	10.17	+		higher chloride
			Hardness (mg L <sup>-1</sup> )	350	472.67	-122.67			
River Disco	ntinuity								
	Decrease in F	Recruitment						NE	
					No	Data Available			
	Decrease in \	Voody Debris							
		Length of Reach W	here Present						
			Small (<0.3m length) Woody Debris (m)	5	5	0			
			Large (>0.3m length) Woody Debris (m)	0.5	0	0.5			
	Decrease in O	Cobbles						+	
		% of Reach Area W	/here Present						
			Cobbles (%)	0.0	2.0	-2	+		
	Increase in Sa	ands and Fines							
		% of Reach Area W							
			Sands and Fines (%)	19.1	45.1	-26.0			
	Burial of Cob							NE	Few if any cobbles observed, s
		Mean % of Cobble							mesurements unreliable
			Cobble Embeddedness (%)		No	Data Available		~	
	Increase in Si	mplified Habitat						0	
		nMDS Comparisor	of Sites Based on Habitat Types Present				C		
			Euclidean Distance from RD				0		

 $\mathbf{O}^{\mathbf{Y}}$ 

In De	hange in Available Food	on of Sites Based Upon Food Type Availability Euclidean Distance from RD ning				Score	Stressor Score	
In De	nMDS Comparis	Euclidean Distance from RD						
De	ncrease in Channel Deepen	Euclidean Distance from RD						
De								
De		ing						
	ecrease in Riffles	-					+	
	ecrease in Riffles	Mean Thalweg Depth (cm)	26.5	16.7	9.8	+		
De							NE	
De				No	Data Available			
	ecrease in Woody Debris							
	Length of Read	ch Where Present						
		Small (<0.3m length) Woody Debris (m)	5	5	0			
		Large (>0.3m length) Woody Debris (m)	0.5	0	0.5			
De	ecrease in Cobbles							
	% of Reach Area						+	
		Cobbles (%)	0.0	2.0	-2	+		
In	crease in Sands and Fines							
	% of Reach Area							
		Sands and Fines (%)	19.1	45.1	-26.0			
De	ecrease in Undercut Banks							
	Length of Reach		-	_				
		Undercut banks (m)	5	5	0		<u>^</u>	
In	crease in Simplified Habit						0	
	nMDS Comparis	on of Sites Based on Habitat Types Present				0		
avaaad Nud	hulanda	Euclidean Distance from RD				0	7	
creased Nut								
Cr	hange in Algal Community							
	nivius comparis	on of Sites Based on Diatom Communty Structure						
		Bray-Curtis Similarity to RD					NE	
In	crease in Algal Toxins						NE	
1				No	Data Available			
In	icrease in pH						(	Only 24 hour data available
	Mean of Previou							
		рН	nd	nd	n/a			
	Mean of 24 Hou			7.72	0.05			
In	crossed Frequency of Hun	pH	7.77	1.12	0.05			
	creased Frequency of Hyp							
	Count of Observ	ations in Daytime Point Measures Mild Hypoxia (2-5 mg L <sup>-1</sup> Dissolved Oxygen)						
			0	0	0			
		Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)	0	0	0			
	Count of Observ	rations in Diel Measures (24hrs)						
		Mild Hypoxia (2-5 mg L <sup>-1</sup> Dissolved Oxygen)	0	0	0			
		Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)	0	0	0			
In	creased Ammonia Concen						+	
	Mean of Previou							
		Ammonia (mg L <sup>-1</sup> )	0.34	0.05	0.29	+		

Candidate Cause	Proximate Stressor	Measurement	Components (units)	RD Value	RC Valu	Dittoronco	Component Score	Proximate Stressor Score	Comment
Pesticides									
	Increased Se	diment Non-pyre	ethroid Pesticides					NE	
	Increased W	ater Column Non-	-pyrethroid Pesticides			No Data Available			All measurements below
	mercuscu w	Maximum Value of							detection limit at both sites
			4,4'-DDD (mg L <sup>-1</sup> )	bdl	bdl	n/a			
			4,4'-DDE (µg L <sup>-1</sup> )	bdl	bdl	n/a			
			Acrolein ( $\mu g L^{-1}$ )	bdl	bdl	n/a			
			Acrylonitrile (μg L <sup>-1</sup> ) Aldrin (μg L <sup>-1</sup> )	bdl bdl	bdl bdl	n/a n/a			
			alpha-BHC (µg L <sup>-1</sup> )	bdl	bdl	n/a			
			cis-1,3-Dichloropropene (µg L <sup>-1</sup> )	bdl	bdl	n/a			
			delta-BHC (μg L <sup>-1</sup> )	bdl	bdl	n/a			
			Diazinon (μg L <sup>-1</sup> )	bdl	bdl	n/a			
			Dieldrin (μg L <sup>-1</sup> ) Endosulfan I (μg L <sup>-1</sup> )	bdl bdl	bdl bdl	n/a			
			Endosulfan II ( $\mu g L^{-1}$ )	bdl	bdl	n/a n/a			
			Endosulfan sulfate (µg L <sup>-1</sup> )	bdl	bdl	n/a			
			Endrin aldehyde (μg L <sup>-1</sup> )	bdl	bdl	n/a			
			Endrin (μg L <sup>-1</sup> )	bdl	bdl	n/a			
			Heptachlor Epoxide (Isomer B) (μg L <sup>-1</sup> ) Heptachlor (μg L <sup>-1</sup> )	bdl	bdl	n/a			
			Methoxychlor ( $\mu g L^{-1}$ )	bdl bdl	bdl bdl	n/a n/a			
			o,p'-DDD (μg L <sup>-1</sup> )	bdl	bdl	n/a			
			o,p'-DDE (μg L <sup>-1</sup> )	bdl	bdl	n/a			
			o,p'-DDT (µg L <sup>-1</sup> )	bdl	bdl	n/a			
			p,p'-DDT (μg L <sup>-1</sup> )	bdl	bdl	n/a			
			Technical Chlordane (μg L <sup>-1</sup> ) Toxaphene (μg L <sup>-1</sup> )	bdl bdl	bdl bdl	n/a			
		Detection of Any C	ompound Above Detection Limit	Dui	bui	n/a			
			Frequency of Detection (# observed/# measured)		0	0 0			
	Increased W	ater Column Pyre	throid Pesticides					NE	
		diama na Barata at				No Data Available		NE	
	Increased Se	diment Pyrethroi	dPesticides			No Data Available		NE	
	Increased W	ater Column Herb	bicides	$\bigvee$					
		Maximum Value of	f Previous Year	7					All measurements below
			2,3,7,8-TCDD (pg L <sup>-1</sup> )	bdl	bdl	n/a			detection limit at both sites
			2,4,5-TP (Silvex) (μg L <sup>-1</sup> )	bdl	bdl	n/a			
			2,4'-D (μg L <sup>-1</sup> )	bdl	bdl	n/a			
	5								

ise Stresson erature Increased		Components (units)	RD Value	RC Value	Difference	Componen Score	t Proximate Stressor Score	Comment
Increased			Value	Vulue		50010		
	Water Temperature Mean of Previous Quarter						+	
	Water Mean of Diel Measuremer	Temperature (C) nts (24hr)	26.39	24.96	1.43	+		
Decreases		Temperature (C)	24.6	18.36	6.24	+	+	
Decreased	Range of Previous Quarter	r					т	
	Water Range of Diel Measureme	Temperature (C) nts (24hr)	9.06	13.83	-4.78	+		
	Water	Temperature (C)	3.27	4.73	-1.46	+		<u> </u>

Cause	Proximate Stressor	Measurement	Components (units)	RD Value N	RF Value	Difference	Component Score	t Proximate Stressor Score	Comment
Heavy Me	tals								
	Increase in	Dissolved Meta	ls					NE	
		Mean of Previous	s Quarter (BDL = 1/2 MDL)						
			Antimony (μg L <sup>-1</sup> )	0.63 r	nd	n/a			
			Arsenic (µg L <sup>1</sup> )	0.82 r	nd	n/a			
			Barium (μg L <sup>-1</sup> )	41.70 r	nd	n/a			
			Beryllium (µg L <sup>-1</sup> )	0.13 r	nd	n/a			
			Cadmium (μg L <sup>-1</sup> )	0.09 r	nd	n/a			
			Chromium (µg L <sup>-1</sup> )	0.23 r	nd	n/a			
			Copper (µg L <sup>-1</sup> )	3.42 r		n/a			
			Hexavalent Chromium (mg L <sup>-1</sup> )	0.01 r		n/a			
			Iron (mg L <sup>1</sup> )	0.10 r		n/a			
			Lead (µg L <sup>-1</sup> )	0.10 r		n/a			
			Mercury (µg L <sup>-1</sup> )	0.02 r		n/a			
			Nickel (µg L <sup>-1</sup> )	6.86 r		n/a			
			Selenium (µg L <sup>-1</sup> )	1.33 r		n/a			X
			Silver (µg L <sup>-1</sup> )	0.13 r		n/a			
			Thallium (µg L <sup>-1</sup> )	0.13 r		n/a			
			Zinc (μg L <sup>-1</sup> )	27.97 r	nd	n/a			
	Increase in	Particulate Bour	nd Metals					NE	
					No	Data Availabl	e		
	Increase in	Metals in Periph	nyton					NE	
					No	Data Availabl	e		
levated C	Conductivit	-							
	Increase in	Conductivity	0					NE	
		Mean of Previous	Conductivity mmhos cm <sup>-1</sup>	1207.33 r					
	Increase in	Total Dissolved		1207.55 1	iu	n/a		NE	
	increase in							INE	
		Mean of Previous	TDS (mg $L^{-1}$ )	788 r					
			Chloride (mg $L^{-1}$ )	128.5 r		n/a			
			Hardness (mg L <sup>-1</sup> )	128.5 r 350 r		n/a			
River Disco	ontinuitu		naruness (ng L )	350 1	iù	n/a			
liver Discu		Recruitment						NE	
	Decrease II	Recruitment			No	Data Availabl	0	INE	
	Decrease in	Woody Debris			NO		c		
	Decrease in	Length of Reach V	Where Present						
		Lengur of ficuent	Small (<0.3m length) Woody Debris (m)	5	5	0			
			Large (>0.3m length) Woody Debris (m)	0.5	0.5				
	Decrease ir	Cobbles	Large (volsmittingar) woody bebits (m)	0.5	0.5	0		+	
	Decrease in	% of Reach Area	Where Present						
		/o of Reacti Area	Cobbles (%)	0	2.0	-2	+		
	Increase in	Sands and Fines		0	2.0	-2			
	merease m	% of Reach Area							
		Nor Reaction Area	Sands and Fines (%)	19.1	37.6	-18.6			
	Burial of Co	hhles	Salus and Thes (76)	15.1	57.0	-10.0		NE	Few if any cobbles
	buildi of co		es Embeddedness						observed, so mesurement
		Micall 70 of Cobbi	Cobble Embeddedness (%)		No	Data Availabl	e		unreliable
	Increase in	Simplified Habi			-				
		nMDS Compariso	on of Sites Based on Habitat Types Present						
			Euclidean Distance from RD				0		
		7							

tressor lification ange in Available Food nMDS Compari rease in Channel Deep	son of Sites Based Upon Food Type Availability	Value			Score	Stressor Sco	
ange in Available Food nMDS Compari							
	son of Sites Based Upon Food Type Availability						
rease in Channel Deep							
rease in Channel Deep	Euclidean Distance from RD						
	Mean Thalweg Depth (cm)	26.5	20.5	6	+		
crease in Riffles							
			No [	Data Available	2		
crease in Woody Debri							
Length of Rea							
				-			
crosco in Cobbloc	Large (>0.3 m length) woody Debris (m)	0.5	0.5	0			
	Whore Present					+	
% OF REACTE AFE		0	2.0	-2	+		
rease in Sands and Fin		0	2.0	-2			
		19.1	37.6	-18.6			
crease in Undercut Ban							
						K	
U U	Undercut banks (m)	5	5	0			
rease in Simplified Hal	bitat						
nMDS Compari	son of Sites Based on Habitat Types Present						
	Euclidean Distance from RD				0		
trients							
ange in Algal Communi	ty					+	
nMDS Compari	son of Sites Based on Diatom Communty Structur	e					
	Bray-Curtis Similarity to RD			. 7	+		
rease in Algal Toxins						NE	
			No [	Data Available	2		
rease in pH							Only 24 hour diel data
Mean of Previo	us Quarter						,
	рН	nd	nd i	n/a			
Mean of 24 Ho							
		7.77	9.3	-1.53			
							Only 24 hour diel data
Count of Obser							
		0	nd i	n/a			
Count of Obser		-	~	-			
				-			
		0	0	0			
						+	
Mean of Previo	us Quarter Ammonia (mg L <sup>-1</sup> )		0.05				
	Annionia (ing E )	0.34	0.05	0.29	+		
	crease in Cobbles % of Reach Area rease in Sands and Fine % of Reach Area crease in Undercut Ban Length of Reach rease in Simplified Hal nMDS Compari ange in Algal Communi nMDS Compari rease in Algal Toxins rease in Algal Toxins rease in pH Mean of 24 Hor Mean of 24 Hor reased Frequency of H Count of Obser count of Obser	% of Reach Area Where Present Cobbles (%) rease in Sands and Fines % of Reach Area Where Present Sands and Fines (%) crease in Undercut Banks Length of Reach Where Present Undercut banks (m) rease in Simplified Habitat nMDS Comparison of Sites Based on Habitat Types Present Euclidean Distance from RD trients ange in Algal Community nMDS Comparison of Sites Based on Diatom Community Structur Bray-Curtis Similarity to RD rease in Algal Toxins rease in pH Mean of Previous Quarter	Small (<0.3m length) Woody Debris (m)	Small (<0.3m length) Woody Debris (m)	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	Small (<0.3m length) Woody Debris (m)         5         5         0            Large (<0.3m length) Woody Debris (m)

Candidate Cause	Proximate Stressor	Measurement	Components (units)	RD Value	RF Valu	Dittoronco	Component Score	t Proximate Stressor Score	Comment
esticides									
	Increased S	ediment Non-pyre	throid Pesticides					NE	
					Ν	No Data Available	e		
	Increased V		pyrethroid Pesticides					NE	
		Maximum Value of P							
			4'-DDD (mg L <sup>-1</sup> )	bdl	nd	n/a			
			4'-DDE (μg L <sup>-1</sup> )	bdl	nd	n/a			
			crolein (μg L <sup>-1</sup> )	bdl	nd	n/a			
			crylonitrile (µg L <sup>-1</sup> )	bdl	nd	n/a			
			drin (μg L <sup>-1</sup> )	bdl	nd	n/a			
			pha-BHC (μg L <sup>-1</sup> )	bdl	nd	n/a			
			s-1,3-Dichloropropene (μg L <sup>-1</sup> )	bdl	nd	n/a			
			elta-BHC (μg L <sup>-1</sup> )	bdl	nd	n/a			
			azinon (μg L <sup>-1</sup> )	bdl	nd	n/a			
			ieldrin (μg L <sup>-1</sup> )	bdl	nd	n/a			
			ndosulfan I (μg L <sup>-1</sup> )	bdl	nd	n/a			
			ndosulfan II (μg L <sup>-1</sup> )	bdl	nd	n/a			
			ndosulfan sulfate (μg L <sup>-1</sup> )	bdl	nd	n/a			
			ndrin aldehyde (μg L <sup>-1</sup> )	bdl	nd	n/a			
			ndrin (μg L <sup>-1</sup> )	bdl	nd	n/a			
			eptachlor Epoxide (Isomer B) (μg L <sup>-1</sup> )	bdl	nd	n/a			
			eptachlor (μg L <sup>-1</sup> )	bdl	nd	n/a			
			lethoxychlor (μg L <sup>-1</sup> )	bdl	nd	n/a		)	
			p'-DDD (μg L <sup>-1</sup> )	bdl	nd	n/a			
			p'-DDE (μg L <sup>-1</sup> )	bdl	nd	n/a			
			p'-DDT (μg L <sup>-1</sup> )	bdl	nd	n/a			
		p,	p'-DDT (μg L <sup>-1</sup> )	bdl	nd	n/a			
		Te	echnical Chlordane (μg L <sup>-1</sup> )	bdl	nd	n/a			
		Тс	oxaphene (μg L <sup>-1</sup> )	bdl	nd	n/a			
		Detection of Any Con	npound Above Detection Limit						
		Fr	requency of Detection (# observed/# measured)	0	nd	n/a			
	Increased V	Vater Column Pyret	throid Pesticides					NE	
					N	No Data Availabl	e		
	Increased S	ediment Pyrethroi	d Pesticides					NE	
				<b>X</b>	Ν	No Data Available	e		
	Increased V	Vater Column Herb	icides					NE	
		Maximum Value of P							
			3,7,8-TCDD (pg L <sup>-1</sup> )	bdl	nd	n/a			
			4,5-TP (Silvex) (μg L <sup>-1</sup> )	bdl	nd	n/a			
		2,	4'-D (μg L <sup>-1</sup> )	bdl	nd	n/a			

C	Proximate	Measurement	Components (units)	RD RF	erence	Component		Comment
Cause	Stressor			Value Value		Score	Stressor Score	
-		Vater Temperature					+	
		Mean of Previous Quart	er					Only 24 hour diel data
			r Temperature (C)	26.39 nd n/a				-
		Mean of Diel Measurem	ents (24hr)					
			r Temperature (C)	24.6 21.18	3.42	+		
	Decreased	Variability in Water Te					+	
		Range of Previous Quar		0.00 ad				Only 24 hour diel data
		Range of Diel Measuren	r Temperature (C)	9.06 nd n/a				
			r Temperature (C)	3.27 9.2	-5.93	+		

Candidate Cause	Proximate Stressor	Measurement	Components (units)	RD S Value V	SAP8 Zalue	Oifference	Component Score	<ul> <li>Proximate</li> <li>Stressor Score</li> </ul>	Comment
leavy Met				value v	aiue		score	Stressor Scon	e
		issolved Metals						NE	
	indicuse in E		Quarter (BDL = 1/2 MDL)						
			Antimony (µg L <sup>-1</sup> )	0.63 no	d n,	/a			
			Arsenic (μg L <sup>-1</sup> )	0.82 no					
			Barium (μg L <sup>-1</sup> )	41.70 no					
			Beryllium (μg L <sup>-1</sup> )	0.13 no					
			Cadmium (μg L <sup>-1</sup> )	0.09 no					
			Chromium (μg L <sup>-1</sup> )	0.23 no					
			Copper (µg L <sup>-1</sup> )	3.42 no	d n,	/a			
			Hexavalent Chromium (mg L <sup>-1</sup> )	0.01 no	d n,	/a			
			Iron (mg L <sup>-1</sup> )	0.10 no	d n,	/a			
			Lead (µg L <sup>-1</sup> )	0.10 no	d n,	/a			
			Mercury (µg L <sup>-1</sup> )	0.02 no	d n,	/a			
			Nickel (µg L <sup>-1</sup> )	6.86 no	d n,	/a			
			Selenium (μg L <sup>-1</sup> )	1.33 no	d n,	/a			
			Silver (µg L <sup>-1</sup> )	0.13 no	d n,	/a			
			Thallium (μg L <sup>-1</sup> )	0.13 no	d n,	/a			
			Zinc (μg L <sup>-1</sup> )	27.97 no	d n,	/a	1		
	Increase in P	articulate Bound	Metals					NE	
					No Da	ata Available			
	Increase in N	Netals in Periphy	ton			ata Available		NE	
lovated C	onductivity				NO Da	ita Availabie	2		
	Increase in C	onductivity						NE	
	increase in c	Mean of Previous	Quarter					NL	
		Wearr of Frevious	Conductivity mmhos cm <sup>-1</sup>	1207.3 no	d n,	/2			
	Increase in T	otal Dissolved Sc	•	1207.5 1	,	ů		NE	
		Mean of Previous					<b>X</b>		
			TDS (mg L <sup>-1</sup> )	788 no	d n,	/a			
			Chloride (mg L <sup>-1</sup> )	128.5 no					
			Hardness (mg L <sup>-1</sup> )	350 no					
River Disco	ontinuity								
	Decrease in	Recruitment						NE	
					No Da	ata Available	2		
	Decrease in	Woody Debris							
		Length of Reach W							
			Small (<0.3m length) Woody Debris (m)	5	1.8	3.2			
			Large (>0.3m length) Woody Debris (m)	0.5	0	0.5			
	Decrease in							+	
		% of Reach Area V							
			Cobbles (%)	0	2.0	-2	+		
	Increase in S	ands and Fines							
		% of Reach Area V			24.0				
	Burial of Cob	blac	Sands and Fines (%)	19.1	31.0	-11.9		NE	
	burial of Col	Mean % of Cobble	or Emboddodnorr					NL	Few if any cobbles observed, s
		Mean % of Couble	Cobble Embeddedness (%)		No Da	ata Available			mesurements unreliable
	Increase in S	implified Habitat						0	
			n of Sites Based on Habitat Types Present						
			Euclidean Distance from RD				0		

Cause	Proximate Stressor	Measurement	Components (units)	RD Value	SAP8 Value	Difference	Compone Score	nt Proximate Stressor Score	Comment
	mplification								
	Change in Av	ailable Food							
		nMDS Compariso	n of Sites Based Upon Food Type Availability						
			Euclidean Distance from RD						
	Increase in C	nannel Deepeni	-					0	
			Mean Thalweg Depth (cm)	26.5	24.4	2.2	0		
	Decrease in F	iffles				D. I. A. 1914.14		NE	
	Decrease in V	loody Dobric			NO	Data Availabl	e		
	Decrease III V		Where Present						
		Length of Keaci	Small (<0.3m length) Woody Debris (m)	5	1.8	3.2			
			Large (>0.3m length) Woody Debris (m)	0.5	1.0				$(Z_{\lambda})$
	Decrease in O	obbles		0.5	0	0.5		+	
		% of Reach Area V	Vhere Present						
			Cobbles (%)	0	2.0	-2	+		
	Increase in Sa	nds and Fines							
		% of Reach Area V	Vhere Present						
			Sands and Fines (%)	19.1	31.0	-11.9			
	Decrease in U	Indercut Banks							
		Length of Reach V						N T	
			Undercut banks (m)	5	5	0			
	Increase in Si	mplified Habita						0	
		nMDS Compariso	n of Sites Based on Habitat Types Present				0		
n ana a a a d	Nutriente		Euclidean Distance from RD				0		
ncreased		al Community						0	
	Change in Alg							0	
		nivios compariso	n of Sites Based on Diatom Communty Structure Bray-Curtis Similarity to RD				0		
	Increase in A	gal Toyins	bray-curus similarity to to				0	NE	
	increase in A	gai ioxins			No	Data Availabl	<u> </u>	NL	
	Increase in p	4			INO.		c .	0	Only 24 hour diel data
	indicase in p	Mean of Previous	Quarter			)			
		incari or ricerious	рН	nd r	nd	n/a			
		Mean of 24 Hours				.,=			
			рН	7.77	8.71	-0.94			
	Increased Fre	quency of Hypo						0	Only 24 hour diel data
			tions in Daytime Point Measures						
			Mild Hypoxia (2-5 mg L <sup>-1</sup> Dissolved Oxygen)	0 r	nd	n/a			
			Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)	0 r	nd	n/a			
		Count of Observa	tions in Diel Measures (24hrs)						
			Mild Hypoxia (2-5 mg L <sup>-1</sup> Dissolved Oxygen)	0	0	0			
			Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)	0	0	0			
	Increased Am	monia Concent	rations					+	
		Mean of Previous	Quarter						
			Ammonia (mg L <sup>-1</sup> )	0.34	0.05	0.29	+		
		2							
	5	2							
	5	7							
	5	F							
	5	Z							
	5								

andidate Cause	Proximate Stressor	Measurement	Components (units)	RD Value	SAP Valu	Difforence	Component Score	Proximate Stressor Score	Comment
sticides									
	Increased Se	diment Non-pyreth	nroid Pesticides					NE	
						No Data Available			
	Increased Wa		yrethroid Pesticides					NE	
		Maximum Value of F							
			,4'-DDD (mg L <sup>-1</sup> )	bdl	nd	n/a			
			,4'-DDE (μg L <sup>-1</sup> )	bdl	nd	n/a			
			crolein (μg L <sup>-1</sup> )	bdl	nd	n/a			
			crylonitrile (µg L <sup>-1</sup> )	bdl	nd	n/a			
			$Jdrin(\mu g L^{-1})$	bdl	nd	n/a			
			lpha-BHC (μg L <sup>-1</sup> )	bdl	nd	n/a			$(Z_{\Lambda})$
			is-1,3-Dichloropropene (μg L <sup>-1</sup> )	bdl	nd	n/a			
			elta-BHC (μg L <sup>-1</sup> ) Viazinon (μg L <sup>-1</sup> )	bdl	nd	n/a			
			viazinon (μg L <sup>-1</sup> )	bdl	nd	n/a			
			ndosulfan I (µg L <sup>-1</sup> )	bdl bdl	nd nd	n/a			
			ndosulfan II (µg L <sup>-1</sup> )	bdl	nd	n/a n/a			
			ndosulfan sulfate (µg L <sup>-1</sup> )	bdl	nd				
			ndrin aldehyde (μg L <sup>-1</sup> )	bdl	nd	n/a n/a			
			ndrin ( $\mu$ g L <sup>-1</sup> )	bdl	nd	n/a			
			leptachlor Epoxide (Isomer B) (µg L <sup>-1</sup> )	bdl	nd	n/a			
			leptachlor (µg L <sup>-1</sup> )	bdl	nd	n/a			
			Aethoxychlor ( $\mu g L^{-1}$ )	bdl	nd	n/a			
			,p'-DDD (μg L <sup>-1</sup> )	bdl	nd	n/a		7	
			,ρ'-DDE (μg L <sup>-1</sup> )	bdl	nd	n/a			
			,p'-DDT (μg L <sup>-1</sup> )	bdl	nd	n/a			
			,p'-DDT (μg L <sup>-1</sup> )	bdl	nd	n/a			
			echnical Chlordane (μg L <sup>-1</sup> )	bdl	nd	n/a			
			oxaphene (μg L <sup>-1</sup> )	bdl	nd	n/a			
		Detection of Any Cor	npound Above Detection Limit						
		F	requency of Detection (# observed/# measured)		) nd	n/a			
	Increased Wa	ater Column Pyreth	nroid Pesticides					NE	
						No Data Available			
	Increased Se	diment Pyrethroid	Pesticides					NE	
						No Data Available			
	Increased Wa	ater Column Herbio	ides					NE	
		Maximum Value of F	Previous Year						
		2	,3,7,8-TCDD (pg L <sup>-1</sup> )	bdl	nd	n/a			
		2	,4,5-TP (Silvex) (μg L <sup>-1</sup> )	bdl	nd	n/a			

Cause Temperati	Stressor	Measurement	Components (units)	RD SAP8 Value Value		ence	omponent Score	Proximate Stressor Score	Comment
	ure								
	Increased W	ater Temperature						+	Only 24 hour diel data
		Mean of Previous Quart							
			er Temperature (C)	26.39 nd	n/a				
		Mean of Diel Measurem		671 7.0	~	1 15			
	Decreased		er Temperature (C)	6.71 7.86	5	-1.15	+	+	Only 24 hours dial data
	Decreased v	ariability in Water Tem Range of Previous Quart						+	Only 24 hour diel data
			er Temperature (C)	9.06 nd	n/a				
		Range of Diel Measurem		5.00 114	n/u				
			er Temperature (C)	3.27 8.45	5	-5.18	+		
						S	Ç		

Cause	Proximate Stressor	Measurement	Components (units)	RD Value	SAP11 Value	Difference	Component Score	Proximate Stressor Score	Comment
Heavy Met				value	value		5000	50123301 50012	
,		Dissolved Metal	5					NE	
		Mean of Previous	Quarter (BDL = 1/2 MDL)						
			Antimony (μg L <sup>-1</sup> )	0.63	nd	n/a			
			Arsenic (µg L <sup>-1</sup> )	0.82	nd	n/a			
			Barium (µg L <sup>-1</sup> )	41.70	nd	n/a			
			Beryllium (µg L <sup>-1</sup> )	0.13	nd	n/a			
			Cadmium (μg L <sup>-1</sup> )	0.09	nd	n/a			
			Chromium (μg L <sup>-1</sup> )	0.23	nd	n/a			
			Copper (µg L <sup>-1</sup> )	3.42	nd	n/a			
			Hexavalent Chromium (mg L <sup>-1</sup> )	0.01		n/a			
			Iron (mg L <sup>-1</sup> )	0.10		n/a			
			Lead (µg L <sup>-1</sup> )	0.10		n/a			
			Mercury (μg L <sup>-1</sup> )	0.02		n/a			
			Nickel (μg L <sup>-1</sup> )	6.86		n/a			
			Selenium ( $\mu$ g L <sup>-1</sup> )	1.33		n/a			
			Silver ( $\mu g L^{-1}$ )	0.13		n/a			
			Thallium ( $\mu$ g L <sup>-1</sup> )	0.13		n/a			
		Dantiaulata Daun	Zinc (μg L <sup>-1</sup> )	27.97	nd	n/a		NE	
	increase in	Particulate Boun	dimetals		No	Data Available		NE	
	Increase in	Metals in Periph	vton		INU			NE	
	increase in	wetais in Feripi	yton		No	Data Available		INL	
Elevated C	onductivity	,			110		-		
		Conductivity						NE	
	inci cube in	Mean of Previous	Quarter						
			Conductivity mmhos cm <sup>-1</sup>	1207.3	nd	n/a			
	Increase in	Total Dissolved S	Solids					NE	
		Mean of Previous	Quarter						
			TDS (mg L <sup>-1</sup> )	788	nd	n/a			
			Chloride (mg L <sup>-1</sup> )	128.5	nd	n/a			
			Hardness (mg L <sup>-1</sup> )	350	nd	n/a			
River Disco	ontinuity								
	Decrease in	Recruitment						NE	
					No	Data Available	2		
	Decrease in	Woody Debris							
		Length of Reach W							
			Small (<0.3m length) Woody Debris (m)	5	5				
			Large (>0.3m length) Woody Debris (m)	0.5	0.5	0			
	Decrease in								
		% of Reach Area V							
	Increase in	Sands and Finas	Cobbles (%)	0.0	16.0	-16	+		
	increase in	Sands and Fines							
		% of Reach Area V		19.1	36.5	-17.4			
	Burial of Co	bblos	Sands and Fines (%)	19.1	30.5	-17.4		NE	
	Buildi Of CO	Mean % of Cobble	s Embeddedpers					NL	Few if any cobbles observed, s
		With the of cobbit	Cobble Embeddedness (%)		No	Data Available	e		mesurements unreliable
	Increase in	Simplified Habit						+	
		nMDS Compariso	n of Sites Based on Habitat Types Present						
			Euclidean Distance from RD				+		
	1								
	×								

Cause	Proximate Stressor	Measurement	Components (units)	RD Value	SAP11	Difference	Componen Score	t Proximate Stressor Score	Comment
	nplification	1		value	value		JUIE	20162201 20016	
		vailable Food						+	
			n of Sites Based Upon Food Type Availability						
			Euclidean Distance from RD				+		
	Increase in	Channel Deepen	ing					+	
			Mean Thalweg Depth (cm)	26.5	18.8	7.	7 +		
	Decrease in	Riffles						NE	
					No	Data Availab	le		
	Decrease in	Woody Debris							
		Length of Reach		_	_				
			Small (<0.3m length) Woody Debris (m) Large (>0.3m length) Woody Debris (m)	5 0.5	5 0.5		)		$C_{\Lambda}$
	Decrease in	Cobbles	Large (20.511 length) woody Debits (iii)	0.5	0.5	,	)	+	
	Decrease in	% of Reach Area V	/here Present						
			Cobbles (%)	0.0	16.0	-10	5 +		
	Increase in	Sands and Fines							
		% of Reach Area V	/here Present						
			Sands and Fines (%)	19.1	36.5	-17.4	4		
	Decrease in	Undercut Banks							
		Length of Reach W						K	
			Undercut banks (m)	5	5	(	)		
	increase in	Simplified Habita						+	
		nivius comparisoi	n of Sites Based on Habitat Types Present Euclidean Distance from RD						
ncreased N	Nutrionts		Euclidean Distance from RD				Ŧ		
		lgal Community						+	
	change in /		n of Sites Based on Diatom Communty Structure					·	
			Bray-Curtis Similarity to RD				+		
	Increase in	Algal Toxins						NE	
		-			No	Data Availab	le		
	Increase in	рН						(	Only 24 hour diel data
		Mean of Previous	Quarter						
			рН	nd	nd	n/a			
		Mean of 24 Hours							
			рН	7.77	8.31	-0.54	4		
	Increased F	requency of Hyp						(	Only 24 hour diel data
		Count of Observat	tions in Daytime Point Measures	1					
			Mild Hypoxia (2-5 mg L <sup>-1</sup> Dissolved Oxygen)		nd	n/a			
			Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)	0	nd	n/a			
		Count of Observat	tions in Diel Measures (24hrs)						
			Mild Hypoxia (2-5 mg L <sup>-1</sup> Dissolved Oxygen) Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)	0	0		-		
	Increased A	mmonia Concen		0	0	(	)	+	
	increased A							т	
						0.2	· +		
		Mean of Previous	1			0.2	9 +		
		Mean of Previous	Ammonia (mg L <sup>-1</sup> )	0.34	0.05				
		Mean of Previous	Ammonia (mg L <sup>-1</sup> )	0.34	0.05				
			Ammonia (mg L <sup>-1</sup> )	0.34	0.05				
			Ammonia (mg L <sup>-1</sup> )	0.34	0.05				
			Ammonia (mg L <sup>-1</sup> )	0.34	0.05				
			Ammonia (mg L <sup>-1</sup> )	0.34	0.05				
			Ammonia (mg L <sup>-1</sup> )	0.34	0.05				
			Ammonia (mg L <sup>-1</sup> )	0.34	0.05				
			Ammonia (mg L <sup>-1</sup> )	0.34	0.05				
			Ammonia (mg L <sup>-1</sup> )	0.34	0.05				
	5		Ammonia (mg L <sup>*</sup> )	0.34	0.05				
	5		Ammonia (mg L <sup>*</sup> )	0.34	0.05				
	5		Ammonia (mg L <sup>-1</sup> )	0.34	0.05				

eased Sediment Non-pr eased Water Column No Maximum Value	, on-pyrethroid Pesticides	bdi bdi bdi bdi bdi	nd nd nd nd	No Data Available n/a n/a n/a	Score	Stressor Score NE NE	
eased Water Column N	, on-pyrethroid Pesticides of Previous Year 4,4'-DDD (mg L <sup>-1</sup> ) 4,4'-DDE (μg L <sup>-1</sup> ) Acrolein (μg L <sup>-1</sup> ) Acrylonitrile (μg L <sup>-1</sup> ) Aldrin (μg L <sup>-1</sup> )	bdi bdi bdi	nd nd nd	n/a n/a			
	of Previous Year 4,4'-DDD (mg L <sup>1</sup> ) 4,4'-DDE (µg L <sup>1</sup> ) Acrolein (µg L <sup>1</sup> ) Acrylonitrile (µg L <sup>1</sup> ) Aldrin (µg L <sup>1</sup> )	bdi bdi bdi	nd nd nd	n/a n/a		NE	
	of Previous Year 4,4'-DDD (mg L <sup>1</sup> ) 4,4'-DDE (µg L <sup>1</sup> ) Acrolein (µg L <sup>1</sup> ) Acrylonitrile (µg L <sup>1</sup> ) Aldrin (µg L <sup>1</sup> )	bdi bdi bdi	nd nd	n/a		NE	
Maximum Value	4,4'-DDD (mg L <sup>-1</sup> ) 4,4'-DDE (μg L <sup>-1</sup> ) Acrolein (μg L <sup>-1</sup> ) Acrylonitrile (μg L <sup>-1</sup> ) Aldrin (μg L <sup>-1</sup> )	bdi bdi bdi	nd nd	n/a			
	4,4'-DDE (μg L <sup>-1</sup> ) Acrolein (μg L <sup>-1</sup> ) Acrylonitrile (μg L <sup>-1</sup> ) Aldrin (μg L <sup>-1</sup> )	bdi bdi bdi	nd nd	n/a			
	Acrolein (μg L <sup>-1</sup> ) Acrylonitrile (μg L <sup>-1</sup> ) Aldrin (μg L <sup>-1</sup> )	bdl bdl	nd				
	Acrylonitrile (μg L <sup>-1</sup> ) Aldrin (μg L <sup>-1</sup> )	bdl		n/a			
	Aldrin (µg L <sup>-1</sup> )		nd				
		bdl		n/a			
	alpha-BHC (µg L °)		nd	n/a			
	sia 1.2 Diablassassas (up.1 <sup>-1</sup> )	bdl	nd	n/a			(Z)
	cis-1,3-Dichloropropene (µg L <sup>-1</sup> ) delta-BHC (µg L <sup>-1</sup> )	bdl	nd	n/a			
		bdl	nd	n/a			
							) `
	Heptachlor Epoxide (Isomer B) (µg L <sup>-1</sup> )	bdl	nd				
	Heptachlor (µg L <sup>-1</sup> )	bdl	nd	n/a			
	Methoxychlor (µg L <sup>-1</sup> )	bdl	nd	n/a			
	o,p'-DDD (μg L <sup>-1</sup> )	bdl	nd	n/a		)	
	o,p'-DDE (μg L <sup>-1</sup> )	bdl	nd	n/a			
	o,p'-DDT (μg L <sup>-1</sup> )	bdl	nd	n/a			
	p,p'-DDT (μg L <sup>-1</sup> )	bdl	nd	n/a			
		bdl	nd	n/a			
		bdl	nd	n/a			
Detection of Any							
		easured)	0 n/a	nd			
eased Water Column Py	rethroid Pesticides					NE	
				No Data Available			
eased Sediment Pyreth	rold Pesticides					NE	
	- ultisid			No Data Available		NE	
						INE	
waxiniuni varue		bdl	nd	n/2			
e	eased Water Column Py eased Sediment Pyreth eased Water Column He	Heptachlor (µg L <sup>-1</sup> ) Methoxychlor (µg L <sup>-1</sup> ) o,p <sup>1</sup> -DDD (µg L <sup>-1</sup> ) o,p <sup>1</sup> -DDE (µg L <sup>-1</sup> ) o,p <sup>1</sup> -DDT (µg L <sup>-1</sup> ) p,p <sup>1</sup> -DDT (µg L <sup>-1</sup> ) Technical Chlordane (µg L <sup>-1</sup> ) Toxaphene (µg L <sup>-1</sup> )	Dieldrin (µg L <sup>-1</sup> )bdlEndosulfan I (µg L <sup>-1</sup> )bdlEndosulfan II (µg L <sup>-1</sup> )bdlEndosulfan sulfate (µg L <sup>-1</sup> )bdlEndosulfan sulfate (µg L <sup>-1</sup> )bdlEndrin aldehyde (µg L <sup>-1</sup> )bdlHeptachlor Epoxide (Isomer B) (µg L <sup>-1</sup> )bdlMethoxychlor (µg L <sup>-1</sup> )bdlo,p'-DDD (µg L <sup>-1</sup> )bdlo,p'-DDT (µg L <sup>-1</sup> )bdlo,p'-DDT (µg L <sup>-1</sup> )bdlo,p'-DDT (µg L <sup>-1</sup> )bdlp,p'-DDT (µg L <sup>-1</sup> )bdlo,p'-DDT (µg L <sup>-1</sup> )bdlc,p'-DDT (µg L <sup>-1</sup> )bdlc,aseed Water Column Pyrethroid Pesticidesseased Sediment Pyrethroid Pesticideseaseed Sediment Pyrethroid Pesticidesmaximum Value of Previous Year2,3,7,8-TCDD (pg L <sup>-1</sup> )bdl2,4,5-TP (Silvex) (µg L <sup>-1</sup> )bdl	Dieldrin (µg L <sup>1</sup> ) bdl nd Endosulfan I (µg L <sup>1</sup> ) bdl nd Endosulfan II (µg L <sup>1</sup> ) bdl nd Endosulfan sulfate (µg L <sup>1</sup> ) bdl nd Endosulfan sulfate (µg L <sup>1</sup> ) bdl nd Endrin aldehyde (µg L <sup>1</sup> ) bdl nd Heptachlor Epoxide (Isomer B) (µg L <sup>1</sup> ) bdl nd Heptachlor (µg L <sup>1</sup> ) bdl nd o,p <sup>1</sup> -DDD (µg L <sup>1</sup> ) bdl nd o,p <sup>1</sup> -DDD (µg L <sup>1</sup> ) bdl nd o,p <sup>1</sup> -DDT (µg L <sup>1</sup> ) bdl nd rechnical Chlordane (µg L <sup>1</sup> ) bdl nd Toxaphene (µg L <sup>1</sup> ) bdl nd Toxaphene (µg L <sup>1</sup> ) bdl nd Toxaphene (µg L <sup>1</sup> ) bdl nd Detection of Any Compound Above Detection Limit Frequency of Detection (# observed/# measured) 0 n/a eased Water Column Herbicides Pasaed Sediment Pyrethroid Pesticides Pasaed Sediment Pyrethroid Pesticides Pasaed Sediment Pyrethroid Pesticides	Dieldrin (µg L <sup>1</sup> )bdlndn/aEndosulfan I (µg L <sup>1</sup> )bdlndn/aEndosulfan II (µg L <sup>1</sup> )bdlndn/aEndosulfan sulfate (µg L <sup>1</sup> )bdlndn/aEndrin aldehyde (µg L <sup>1</sup> )bdlndn/aEndrin (µg L <sup>1</sup> )bdlndn/aHeptachlor Epoxide (Isomer B) (µg L <sup>1</sup> )bdlndn/aMethoxychlor (µg L <sup>1</sup> )bdlndn/ao,p'-DDE (µg L <sup>1</sup> )bdlndn/ap,p'-DDT (µg L <sup>1</sup> )bdlndn/acased Water Column Pyrethroid PesticidesNo Data Availableeased Sediment Pyrethroid PesticidesNo Data Availableeased Water Column HerbicidesNo Data AvailableMaximum Value of Previous Year2,3,7,8-TCDD (pg L <sup>1</sup> )bdld,2,4,5-TC (Silves) (µg L <sup>1</sup> )bdlndn/aa,4,5-TF (Silves) (µg L <sup>1</sup> )bdlndn/a	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	$ \begin{array}{c c c c c c } \text{Dieldrin}(\mug L^1) & bdl & nd & n/a \\ \hline \text{Endosulfan l}(\mug L^1) & bdl & nd & n/a \\ \hline \text{Endosulfan l}(\mug L^1) & bdl & nd & n/a \\ \hline \text{Endosulfan sulfate}(\mug L^1) & bdl & nd & n/a \\ \hline \text{Endrin aldehyde}(\mug L^1) & bdl & nd & n/a \\ \hline \text{Endrin}(\mug L^1) & bdl & nd & n/a \\ \hline \text{Endrin}(\mug L^1) & bdl & nd & n/a \\ \hline \text{Heptachlor Epoxide (Isomer B)}(\mug L^1) & bdl & nd & n/a \\ \hline \text{Heptachlor (\mug L^1)} & bdl & nd & n/a \\ \hline \text{Methoxychlor (\mug L^1)} & bdl & nd & n/a \\ \hline \text{O,p^+DDE}(\mug L^1) & bdl & nd & n/a \\ \hline \text{O,p^+DDE}(\mug L^1) & bdl & nd & n/a \\ \hline \text{O,p^+DDE}(\mug L^1) & bdl & nd & n/a \\ \hline \text{O,p^+DDE}(\mug L^1) & bdl & nd & n/a \\ \hline \text{O,p^+DDT}(\mug L^1) & bdl & nd & n/a \\ \hline \text{O,p^+DDT}(\mug L^1) & bdl & nd & n/a \\ \hline \text{O,p^+DDT}(\mug L^1) & bdl & nd & n/a \\ \hline \text{O,p^+DDT}(\mug L^1) & bdl & nd & n/a \\ \hline \text{O,p^+DDT}(\mug L^1) & bdl & nd & n/a \\ \hline \text{Detection of Any Compound Above Detection limit \\ \hline \text{Frequency of Detection limit } \\ \hline \text{Available } \\ \hline \text{Maximum Value of Previous Vear } \\ \hline \text{Maximum Value of Previous Vear } \\ \hline \text{Maximum Value of Previous Vear } \\ \hline \text{Maximum Value of Previous (\mug L^1) & bdl & nd \\ \hline \text{Aximum Value of Previous (\mug L^1) & bdl & nd \\ \hline \text{Aximum Value of Previous (\mug L^1) & bdl & nd \\ \hline \text{Aximum Value of Previous Vear } \\ \hline \text{Maximum Value of Previous Vear } \\ \hline \text{Maximum Value of Previous Vear } \\ \hline \text{Maximum Value of Previous (\mug L^1) & bdl & nd \\ \hline \text{Aximum Value of Previous (\mug L^1) & bdl & nd \\ \hline \text{Aximum Value of Previous Vear } \\ \hline \ \text{Maximum Value of Previous Vear } \\ \hline \ \text{Aximum Value of Previous Vear } \\ \hline \ \ \text{Aximum Value of Previous Vear } \\ \hline \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \$

Cause Stressor	e Measurement	Components (units)	RD Value	SAP11 Value	Diffe	erence	Component Score	Proximate Stressor Score	Comment
emperature									
Increased	Water Temperature								
	Mean of Previous Quarte	r						+	Only 24 hour diel data
		Temperature (C)	26.39	nd	n/a				
	Mean of Diel Measureme		24.6	14 70		0.00			
Decrease	d Variability in Water Ter	Temperature (C)	24.6	14.72		9.88	+	+	Only 24 hour diel data
Decreases	Range of Previous Quarte								
		Temperature (C)	9.06	nd	n/a				
	Range of Diel Measureme	ents (24hr)							
	Water	Temperature (C)	3.27	5.35		-2.08	+		

NE	andidate Pr Cause S	roximate Stressor	Measurement	t Components (units)	RD Value	SAP14 Value	Ditterence	Component Score	Proximate Stressor Score	Comment
Mean of Previous Quarter (80 i - 1/2 MQL)       0.5 nd       n/2   <	eavy Metals	s								
Antimory up: 1°)       0.63 ad       n/s         Arsenic (up: 1°)       0.62 ad       n/s         Beryllium (up: 1°)       0.31 nd       n/s         Beryllium (up: 1°)       0.32 nd       n/s         Chromium (up: 1°)       0.32 nd       n/s         Lead (up: 1°)       0.32 nd       n/s         Lead (up: 1°)       0.32 nd       n/s         Lead (up: 1°)       0.32 nd       n/s         Mex.ury (up: 1°)       0.32 nd       n/s         Selmium (up: 1°)       0.33 nd       n/s         Selmium (up: 1°)       0.33 nd       n/s         Tanitum (up: 1°)       0.33 nd       n/s         Increase in Metals in Periphyton       No bata Available       NE         Man of Precious Quarter       NE       NE         Chordiac (up: 1°)       1.28 5 nd       n/s         Man of Precious Quarter       NE       NE         Man of Precious Quarter       NE       NE         Decrease in Metals in Periphyton       1.207.33 nd       n/s         Mean of Prec	Inc	crease in [	Dissolved Metal	s					NE	
Arsenic (ug L <sup>1</sup> )       0.32 nd       n/a         Bartum (ug L <sup>1</sup> )       0.03 nd       n/a         Cdomium (ug L <sup>1</sup> )       0.09 nd       n/a         Chromium (ug L <sup>1</sup> )       0.09 nd       n/a         Coper (ug L <sup>1</sup> )       0.20 nd       n/a         Coper (ug L <sup>1</sup> )       0.20 nd       n/a         Coper (ug L <sup>1</sup> )       0.20 nd       n/a         Lead (ug L <sup>1</sup> )       0.00 nd       n/a         Lead (ug L <sup>1</sup> )       0.00 nd       n/a         Mercur (ug L <sup>1</sup> )       0.01 nd       n/a         Selenum (ug L <sup>1</sup> )       0.03 nd       n/a         Selenum (ug L <sup>1</sup> )       0.03 nd       n/a         Tan (ug L <sup>1</sup> )       0.03 nd       n/a         Tan (ug L <sup>1</sup> )       0.03 nd       n/a         Increase in Particulate Bound Metals       NE         Increase in Metals in Periphyton       No Data Available       NE         Man of Previous Quarter       Ne       Ne         Conductivity       1207.33 nd       n/a       NE         Man of Previous Quarter       Ne       NE         Conductivity mmbos cm <sup>-1</sup> 1207.33 nd       n/a       NE         Man of Previous Quarter       Ne       NE       NE <td></td> <td></td> <td>Mean of Previou</td> <td>s Quarter (BDL = 1/2 MDL)</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>			Mean of Previou	s Quarter (BDL = 1/2 MDL)						
Bary Himm (pgt <sup>1</sup> )       41.20 od       n/s					0.63	nd	n/a			
Benyllum (ug L <sup>1</sup> )         0.33 nd         n/a           Gamum (ug L <sup>1</sup> )         0.09 nd         n/a           Cooper (ug L <sup>1</sup> )         3.42 nd         n/a           Cooper (ug L <sup>1</sup> )         3.42 nd         n/a           Heavalet Chromium (mg L <sup>1</sup> )         0.10 nd         n/a           Increase (ug L <sup>1</sup> )         0.10 nd         n/a           Mercury (ug L <sup>1</sup> )         0.20 nd         n/a           Silver (ug L <sup>1</sup> )         0.33 nd         n/a           Silver (ug L <sup>1</sup> )         0.33 nd         n/a           Silver (ug L <sup>1</sup> )         0.33 nd         n/a           Tin (ug L <sup>1</sup> )         0.33 nd         n/a           Silver (ug L <sup>1</sup> )         0.33 nd         n/a           Tin (ug L <sup>1</sup> )         0.33 nd         n/a           Tin (ug L <sup>1</sup> )         7.27 nd         n/a           Tin (ug L <sup>1</sup> )         7.27 nd         n/a           Increase in Particulate Bound Metals         No bata Available         NE           Mean of Previous Quarter         No         NE           Mean of Previous Quarter         No         NE           Mean of Previous Quarter         Na         Na           Decrease in Recruitment         Ne         Ne           Ne					0.82	nd	n/a			
Candimin (ug L <sup>1</sup> )         0.09 nd         n/a           Chromium (ug L <sup>1</sup> )         0.23 ad         n/a           Copper (ug L <sup>1</sup> )         0.21 ad         n/a           Heavalent Chromium (ug L <sup>1</sup> )         0.01 nd         n/a           Lead (ug L <sup>1</sup> )         0.01 nd         n/a           Lead (ug L <sup>1</sup> )         0.02 nd         n/a           Mercury (ug L <sup>1</sup> )         0.02 nd         n/a           Selenium (ug L <sup>1</sup> )         0.01 nd         n/a           Selenium (ug L <sup>1</sup> )         0.02 nd         n/a           Selenium (ug L <sup>1</sup> )         0.03 nd         n/a           Steve (ug L <sup>1</sup> )         0.33 nd         n/a           Thallium (g L <sup>1</sup> )         0.31 nd         n/a           Increase in Particulate Bound Metals         NE           Increase in Metals in Periphyton         NE           Maan of Previous Quarter         NE           Conductivity mmbrs cm <sup>3</sup> 1207.33 nd         n/a           Man of Previous Quarter         NE           Man of Previous Quarter         NE           Martenes (ng L <sup>2</sup> )         788 nd         n/a           Using to fleach Where Present         NE           Lung to fleach Where Present         NE           Lung to fle				Barium (µg L⁻¹)	41.70	nd	n/a			
Chronium (ug. L <sup>1</sup> )       0.23 nd       n/a         Copper (ug. L <sup>1</sup> )       3.42 ad       n/a         Heravalet Chronium (mg. L <sup>1</sup> )       0.01 nd       n/a         tron (mg. L <sup>1</sup> )       0.00 nd       n/a         Mercury (ug. L <sup>1</sup> )       0.02 nd       n/a         Mercury (ug. L <sup>1</sup> )       0.02 nd       n/a         Nickel (ug. L <sup>1</sup> )       0.03 nd       n/a         Silver (ug. L <sup>1</sup> )       0.33 nd       n/a         Silver (ug. L <sup>1</sup> )       0.33 nd       n/a         Tincrease in Particulate Bound Metals       No       No         Increase in Particulate Bound Metals       No       No         Increase in Metals in Periphyton       No       No       No         Man of Previous Quarter       No       No       No         Decrease in Recruitment       No       No       No         Decrease in Recruitment					0.13	nd	n/a			
Copper (ug L <sup>1</sup> )       3.42 nd       n/a         Hexavalent Chromium (mg L <sup>1</sup> )       0.10 nd       n/a         Lead (ug L <sup>1</sup> )       0.10 nd       n/a         Lead (ug L <sup>1</sup> )       0.10 nd       n/a         Mercury (ug L <sup>1</sup> )       0.20 nd       n/a         Selenum (ug L <sup>1</sup> )       0.31 nd       n/a         Silver (ug L <sup>1</sup> )       0.33 nd       n/a         Thailtum (ug L <sup>1</sup> )       0.33 nd       n/a         Thailtum (ug L <sup>1</sup> )       0.33 nd       n/a         Thailtum (ug L <sup>1</sup> )       0.33 nd       n/a         Increase in Particulate Bound Metals       NE       NE         Increase in Conductivity       No Data Available       NE         Increase in Conductivity numbos cm <sup>-1</sup> 1207.33 nd       n/a         Increase in Total Dissolved Solids       NE       NE         Mean of Previous Quarter       NE       NE         Cholorde (mg L <sup>1</sup> )       128.5 nd       n/a       NE         Mean of Previous Quarter       NE       NE       NE         Cholorde (mg L <sup>1</sup> )       128.5 nd       n/a       NE         Decrease in Recruitment       Snall (-0.3 m length) Woody Debris (m)       0.5       0          Lengt of Reach Area Wher				Cadmium (µg L⁻¹)	0.09	nd	n/a			
Heavaent Chromium (mg L <sup>1</sup> )       0.01 nd       n/a         Iron (mg L <sup>1</sup> )       0.00 nd       n/a         Lead (ug L <sup>1</sup> )       0.02 nd       n/a         Mercury (ug L <sup>1</sup> )       0.02 nd       n/a         Selemin (ug L <sup>1</sup> )       0.33 nd       n/a         Silver (ug L <sup>1</sup> )       0.33 nd       n/a         Thailium (ug L <sup>1</sup> )       0.33 nd       n/a         Increase in Particulate Bound Metals       NE       NE         Increase in Metals in Periphyton       Na       NE         Mean of Previous Quarter       NE       NE         Conductivity mnhos cn <sup>-1</sup> 1207.33 nd       n/a         Mean of Previous Quarter       NE       NE         Mean of Previous Quarter       NE       NE         Conductivity mnhos cn <sup>-1</sup> 1207.33 nd       n/a         Mean of Previous Quarter       NE       NE         Mean of Previous Quarter       NE       NE         Longth of Reach Where Present       No Data Available					0.23	nd	n/a			
lron (ng L <sup>1</sup> ) Lad (µg L <sup>1</sup> ) Mer curv (µg L <sup>1</sup> ) Nickel (µg L <sup>1</sup> ) Selver (µg L <sup>1</sup> ) Silver (µg L <sup>1</sup>					3.42	nd	n/a			
Lead (ug L <sup>1</sup> )       0.0 n od       n/a         Mercury (ug L <sup>1</sup> )       6.8 n of       n/a         Selenium (ug L <sup>1</sup> )       1.3 and       n/a         Silver (ug L <sup>1</sup> )       0.3 and       n/a         Thallium (ug L <sup>1</sup> )       0.3 and       n/a         Zinc (ug L <sup>1</sup> )       0.3 and       n/a         Thallium (ug L <sup>1</sup> )       0.3 and       n/a         Zinc (ug L <sup>1</sup> )       27.97 nd       n/a         Increase in Particulate Bound Metals       NE       NE         Increase in Conductivity       No Data Available       NE         Increase in Conductivity mmhos cm <sup>-1</sup> 1207.93 nd       n/a       NE         Mean of Previous Quarter       NE       NE       NE         Man of Previous Quarter       NE       NE       NE         Man of Previous Quarter       NE       NE       NE         Decrease in Total Dissolved Solids       NE       NE       NE         Decrease in Moody Debris (m)       128.5 nd       n/a       NE         Decrease in Woody Debris (m)       0.5       0           Single for Ach Areal Where Present             Sof Reach Mere Mere Present <td< td=""><td></td><td></td><td></td><td></td><td>0.01</td><td>nd</td><td>n/a</td><td></td><td></td><td></td></td<>					0.01	nd	n/a			
Marcury (µg L <sup>1</sup> )         0.02 nd         n/a           Nickel (µg L <sup>1</sup> )         6.86 nd         n/a           Selenium (µg L <sup>1</sup> )         0.13 nd         n/a           Thallium (µg L <sup>1</sup> )         0.13 nd         n/a           Tanting (µg L <sup>1</sup> )         0.13 nd         n/a           Tanting (µg L <sup>1</sup> )         0.27 97 nd         n/a           Timerase in Particulate Bound Metals         NE         NE           Increase in Metals in Periphyton         NE         NE           Increase in Metals in Periphyton         NE         NE           Conductivity         Ne         NE           Increase in Total Dissolved Solids         NE         NE           Conductivity mmhos cm <sup>-1</sup> 1207.33 nd         n/a         NE           Mean of Previous Quarter         NE         NE         NE           Conductivity mmhos cm <sup>-1</sup> 1207.33 nd         n/a         NE           Mean of Previous Quarter         NE         NE         NE           Coloride (mg L <sup>1</sup> )         128.5 nd         n/a         NE           Mean of Previous Quarter         NE         NE         NE           Decrease in Noody Debris         So 0 nd         n/a         NE           Large (-0.3m					0.10	nd	n/a			
Nicket (ug L <sup>1</sup> )         6.86 nd         n/a           Selenium (ug L <sup>1</sup> )         1.33 nd         n/a           Silver (ug L <sup>1</sup> )         0.31 nd         n/a           Thallium (ug L <sup>1</sup> )         0.31 nd         n/a           Zinc (ug L <sup>1</sup> )         27.97 nd         n/a           Increase in Particulate Bound Metals         NE         NE           Increase in Metals in Periphyton         No Data Available         NE           Increase in Conductivity         No Data Available         NE           Mean of Previous Quarter         NE         NE           Conductivity mmhos cm <sup>-1</sup> 1207.33 nd         n/a           Mean of Previous Quarter         NE         NE           Chloride (ng L <sup>2</sup> )         128.5 nd         n/a           Hardness (ng L <sup>1</sup> )         788 nd         n/a           Mean of Previous Quarter         NE         NE           Mean of Previous Quarter         No         NE           Decrease in Recruitment         No         Ne         NE           Mean of Previous Quarter         No         NE         NE           Silver Discontinuity         No         Na Available         NE           Decrease in Recruitment         NE         NE         NE <td></td> <td></td> <td></td> <td></td> <td>0.10</td> <td>nd</td> <td>n/a</td> <td></td> <td></td> <td></td>					0.10	nd	n/a			
Selenium (ug L <sup>3</sup> )       1.33 nd       n/a         Silver (ug L <sup>3</sup> )       0.13 nd       n/a         Thallium (ug L <sup>3</sup> )       27.97 nd       n/a         Zinc (ug L <sup>3</sup> )       27.97 nd       n/a         Increase in Particulate Bound Metals       Ne       Ne         Mean of Previous Quarter       Ne       Ne         Conductivity mmhos cm <sup>-1</sup> 1207.33 nd n/a       n/a       Ne         Mean of Previous Quarter       NE       NE         Conductivity mmhos cm <sup>-1</sup> 1207.33 nd n/a       n/a       NE         Mean of Previous Quarter       Ne       NE       NE         Choride (mg L <sup>1</sup> )       788 nd n/a       n/a       NE         Decrease in Recruitment       So nd n/a       Na       NE         Length of Reach Were Present       So nd Large (0.31 neight) Woody Debris (m)       So S       So Nd          So f Reach Area Mere Pres					0.02	nd	n/a			
					6.86	nd	n/a			
Thailium (ug L <sup>1</sup> )       0.13 nd       n/a         Zinc (ug L <sup>1</sup> )       27.97 nd       n/a         Increase in Particulate Bound Metals       No       No         Increase in Particulate Bound Metals       No       No         Increase in Particulate Bound Metals       No       No         Increase in Particulate Bound Metals       No       No       No         Increase in Metals in Periphyton       No       No       Ne         Increase in Conductivity       No       No       Ne       Ne         Mean of Previous Quarter       NE       NE       NE       NE       NE         Mean of Previous Quarter       NE       NE       NE       NE       NE       NE         Decrease in Recruitment       NE       No Data Available       NE       NE       NE       NE       <					1.33	nd	n/a			
Zinc (µg L <sup>1</sup> )       27.97 nd       n/a         Increase in Particulate Bound Metals       NE         Increase in Metals in Periphyton       No Data Available       NE         Increase in Metals in Periphyton       No Data Available       NE         Increase in Coductivity       No Data Available       NE         Increase in Coductivity       NE       NE         Mean of Previous Quarter       NE       NE         Conductivity       NE       NE         Mean of Previous Quarter       NE       NE         Choride (mg L <sup>1</sup> )       788 nd       n/a         Choride (mg L <sup>1</sup> )       1285 nd       n/a         Choride (mg L <sup>1</sup> )       1380 nd       n/a         Hardness (mg L <sup>1</sup> )       1380 nd       n/a         Choride (mg L <sup>1</sup> )       1380 nd       n/a         Length of Reach Where Present					0.13	nd	n/a			
Increase in Particulate Bound Metals Increase in Metals in Periphyton Increase in Metals in Periphyton Increase in Conductivity Increase in Conductivity Increase in Conductivity Increase in Conductivity Mean of Previous Quarter Conductivity mmhos cm <sup>-1</sup> Increase in Total Dissolved Solids Increase in Recruitment Increase in Tobules Increase in Cobbles Increase in Cobbles Increase in Sonds and Fines Increase in Increase Incertify Increase Increase Incertify Increase Incertif					0.13	nd	n/a			
No Data         No Data         Ne           Increase in Metals in Periphyton         No Data         Ne         Ne           increase in Conductivity         Increase in Conductivity mmhos cm <sup>-1</sup> 1207.33 nd         n/a         Ne           Mean of Previous Quarter         Ne         Ne         Ne         Ne           Conductivity mmhos cm <sup>-1</sup> 1207.33 nd         n/a         Ne         Ne           Mean of Previous Quarter         NE         NE         NE           Choride (ng L <sup>-1</sup> )         788 nd         n/a         Ne         NE           Mean of Previous Quarter         Ne         NE         NE         NE           Choride (ng L <sup>-1</sup> )         788 nd         n/a         Ne         NE           Decrease in Recruitment         NE         NE         NE         NE           Decrease in Necruitment         NE         NE         NE         NE           Cober (so)         No         S         S         O				Zinc (μg L <sup>-1</sup> )	27.97	nd	n/a			
Increase in Metals in Periphyton         No           Increase in Conductivity         No         No         No           Mean of Previous Quarter         No         No         No           Mean of Previous Quarter         No         No         No           Increase in Total Dissolved Solids         No         No         No           Mean of Previous Quarter         No         No         No           Choride (mg L <sup>1</sup> )         788 nd         n/a         No           Decrease in Recruitment         No         No         No         No           Decrease in Noody Debris         Snall (c0.3m length) Woody Debris (m)         0.5         0            Marge (Aze Where Present	Inc	crease in F	Particulate Bour	nd Metals					NE	
levated Conductivity Increase in Conductivity mmhos cm <sup>-1</sup> 1207.33 nd Increase in Total Dissolved Solids Conductivity mmhos cm <sup>-1</sup> 1207.33 nd Increase in Total Dissolved Solids Mean of Previous Quarter ToS (mg L <sup>-1</sup> ) Chloride (mg L <sup>-1</sup> ) Hardness (mg L <sup>-1</sup> ) Chloride (mg L <sup>-1</sup> ) Hardness (mg L <sup>-1</sup> ) Chloride						No	Data Available	• · · · ·		
Neverated Conductivity Increase in Conductivity mmhos cm <sup>-1</sup> Mean of Previous Quarter Conductivity mmhos cm <sup>-1</sup> 1207.33 nd n/a Increase in Total Dissolved Solids Vert Mean of Previous Quarter TDS (mg L <sup>-1</sup> ) Chloride (mg L <sup>-1</sup> )	Inc	crease in I	Metals in Periph	nyton					NE	
Increase in Conductivity       NE         Mean of Previous Quarter       NE         Increase in Total Dissolved Solids       NE         Mean of Previous Quarter       NE         TDS (mg L <sup>1</sup> )       788 nd       n/a         Chloride (mg L <sup>1</sup> )       128.5 nd       n/a         Ghoride (mg L <sup>1</sup> )       128.5 nd       n/a         Hardness (mg L <sup>1</sup> )       350 nd       n/a         Becrease in Recruitment       NE         Decrease in Woody Debris       NE         Length of Reach Where Present          Large (>0.3m length) Woody Debris (m)       5       5       0          % of Reach Area Where Present						No	Data Available	:		
Mean of Previous Quarter         I207.33 nd         n/a           Increase in Total Dissolved Solids         NE           Mean of Previous Quarter         NE           TDS (mg L <sup>1</sup> )         788 nd         n/a           Chloride (mg L <sup>1</sup> )         128.5 nd         n/a           Hardness (mg L <sup>1</sup> )         350 nd         n/a           Becrease in Recruitment         NE           Decrease in Woody Debris         NE           Length of Reach Where Present            Large (>0.3m length) Woody Debris (m)         0.5         0            So of Reach Area Where Present             Cobble S (%)         0         0         0            % of Reach Area Where Present             So find Cobbles             % of Reach Area Where Present									)	
Conductivity mmhos cm <sup>-1</sup> 1207.33 nd       n/a         Increase in Total Dissolved Solids       NE         Mean of Previous Quarter       TDS (mg L <sup>-1</sup> )       788 nd       n/a         Chloride (mg L <sup>-1</sup> )       788 nd       n/a	Inc	crease in O	•						NE	
Increase in Total Dissolved Solids Mean of Previous Quarter TDS (mg L <sup>3</sup> ) Chloride (mg L <sup>3</sup> ) Hardness (mg L <sup>3</sup> ) Hardness (mg L <sup>3</sup> ) Toter Discontinuity Decrease in Recruitment Decrease in Recruitment Length of Reach Where Present Length of Reach Where Present Small (<0.3m length) Woody Debris (m) Decrease in Cobbles Small (<0.3m length) Woody Debris (m) Cobble S(%) Mean % of Reach Area Where Present Small (<0.3m length) Woody Debris (m) Mean % of Reach Area Where Present Small (<0.3m length) Woody Debris (m) Mean % of Reach Area Where Present Small (<0.3m length) Woody Debris (m) Mean % of Reach Area Where Present Small (<0.3m length) Woody Debris (m) Mean % of Reach Area Where Present Small (<0.3m length) Woody Debris (m) Mean % of Reach Area Where Present Small Signal			Mean of Previou							
Mean of Previous Quarter         TDS (mg L <sup>-1</sup> )         788 nd         n/a           Chloride (mg L <sup>-1</sup> )         128.5 nd         n/a           Hardness (mg L <sup>-1</sup> )         350 nd         n/a           Becrease in Recruitment         Ne         Ne           Decrease in Woody Debris					1207.33	nd	n/a			
TDS (mg L <sup>-1</sup> )       788 nd       n/a         Chloride (mg L <sup>-1</sup> )       128.5 nd       n/a         Hardness (mg L <sup>-1</sup> )       350 nd       n/a         Exter Discontinuity       No Data Available       NE         Decrease in Recruitment       No Data Available       NE         Decrease in Woody Debris       Small (<0.3m length) Woody Debris (m)	Inc	crease in 1							NE	
Chloride (mg L <sup>-1</sup> )       128.5 nd       n/a         Hardness (mg L <sup>-1</sup> )       350 nd       n/a         tiver Discontinuity       Ne       Ne         Decrease in Recruitment       NE       Ne         Decrease in Woody Debris       No Data Available          Decrease in Woody Debris       Small (<0.3m length) Woody Debris (m)			Mean of Previou					-		
Hardness (mg L <sup>-1</sup> )     350 nd     n/a       tiver Discontinuity     Decrease in Recruitment     NE       Decrease in Woody Debris     No Data Available        Decrease in Woody Debris         Length of Reach Where Present         Small (<0.3m length) Woody Debris (m)										
No Decrease in Recruitment  Decrease in Woody Debris Length of Reach Where Present Small (<0.3m length) Woody Debris (m) Cobbles (%) Cobbl										
Decrease in Recruitment       No Data Available         No Data Available          Boercase in Woody Debris          Length of Reach Where Present          Small (<0.3m length) Woody Debris (m)				Hardness (mg L <sup>-1</sup> )	350	nd	n/a			
No Data Available          Decrease in Woody Debris          Length of Reach Where Present          Small (<0.3m length) Woody Debris (m)		•								
Decrease in Woody Debris          Length of Reach Where Present       5       0          Large (>0.3m length) Woody Debris (m)       0.5       0.5       0          Decrease in Cobbles       0.5       0.5       0          % of Reach Area Where Present            Cobbles (%)       0       0       0          Increase in Sands and Fines            % of Reach Area Where Present            Sands and Fines            % of Reach Area Where Present            % of Reach Area Where Present            Sands and Fines (%)       19.1       45.7       -26.7          Burial of Cobbles       Embeddedness       NE       Few if any cob mesurements         Cobble Embeddedness        No Data Available       NE	De	ecrease in	Recruitment						NE	
Length of Reach Where Present Small (<0.3m length) Woody Debris (m) 5 5 0 Large (>0.3m length) Woody Debris (m) 0.5 0.5 0 Decrease in Cobbles % of Reach Area Where Present Cobbles (%) 0 0 0 Hncrease in Sands and Fines % of Reach Area Where Present Sands and Fines (%) 19.1 45.7 -26.7 Burial of Cobbles Embeddedness Mean % of Cobbles Embeddedness Cobble Embeddedness (%) No Data Available						No	Data Available			
Small (<0.3m length) Woody Debris (m)	De	ecrease in	•							
Large (>0.3m length) Woody Debris (m)       0.5       0.5       0          Decrease in Cobbles            % of Reach Area Where Present       0       0       0          Cobbles (%)       0       0       0           More as in Sands and Fines             % of Reach Area Where Present             Burial of Cobbles       19.1       45.7       -26.7        NE         Mean % of Cobbles Embeddedness       Cobble Embeddedness (%)       No Data Available       NE			Length of Reach							
Decrease in Cobbles          % of Reach Area Where Present       0       0       0          Cobbles (%)       0       0       0           Increase in Sands and Fines             % of Reach Area Where Present             Burial of Cobbles       19.1       45.7       -26.7        NE         Mean % of Cobbles Embeddedness       Cobble Embeddedness (%)       No Data Available       Few if any cob mesurements										
% of Reach Area Where Present       0       0       0          Increase in Sands and Fines           % of Reach Area Where Present           Sands and Fines (%)       19.1       45.7       -26.7          Burial of Cobbles       Meed Meeded Meess       NE       Few if any cob mesurements         Mean % of Cobbles Embeddedness       Cobble Embeddedness (%)       No Data Available				Large (>0.3m length) Woody Debris (m)	0.5	0.	5 0			
Cobbles (%)     0     0     0        Increase in Sands and Fines         % of Reach Area Where Present         Sands and Fines (%)     19.1     45.7     -26.7        Burial of Cobbles     Mean % of Cobbles Embeddedness     NE     Few if any cob       Mean % of Cobble Embeddedness     Cobble Embeddedness (%)     No Data Available	De	acrease in								
Increase in Sands and Fines % of Reach Area Where Present Sands and Fines (%) 19.1 45.7 -26.7 Burial of Cobbles Embeddedness Mean % of Cobbles Embeddedness (%) No Data Available			% of Reach Area							
% of Reach Area Where Present Sands and Fines (%) 19.1 45.7 -26.7 Burial of Cobbles Mean % of Cobbles Embeddedness Cobble Embeddedness (%) No Data Available					0		0 0			
Sands and Fines (%) 19.1 45.7 -26.7 Burial of Cobbles Embeddedness (%) No Data Available Few if any cob Mean % of Cobble Embeddedness (%) No Data Available	Inc	crease in S								
Burial of Cobbles Embeddedness Cobble Embeddedness (%) No Data Available NE Few if any cob Cobble Embeddedness (%) No Data Available			% of Reach Area							
Mean % of Cobbles Embeddedness Cobble Embeddedness (%) No Data Available				Sands and Fines (%)	19.1	45.	7 -26.7			
Mean % of Cobbles Embeddedness mesurements Cobble Embeddedness (%) No Data Available	Bu	urial of Col							NE	Few if any cobbles observed, s
			Mean % of Cobb			-/	D. I. A. 11 1.			mesurements unreliable
Increases in Circultured University			Cine and Life is a later of the			No	Data Available			
Increase in Simplified Habitat +	Inc	crease in S							+	
nMDS Comparison of Sites Based on Habitat Types Present Euclidean Distance from RD +			niviDS Compariso							

ble Food S Comparison of Sites Based Upon Food Type. Euclidean Distance from RD nel Deepening Mean Thalweg Depth (cm) es dy Debris th of Reach Where Present Small (<0.3m length) Woody Det Large (>0.3m length) Woody Det large (>0.3m length) Woody Det seach Area Where Present Cobbles (%) s and Fines Reach Area Where Present Sands and Fines (%) ercut Banks th of Reach Where Present Undercut banks (m) ified Habitat S Comparison of Sites Based on Habitat Types Euclidean Distance from RD Community S Comparison of Sites Based on Diatom Comm Bray-Curtis Similarity to RD Toxins n of Previous Quarter pH	ebris (m) bris (m) s Present	Value V 26.5 5 0.5 0 19.1 5	6.2 No Data 5 0.5 0 45.7 5	20.4 a Available 0 0 0 -26.7 0	+ + +	Stressor Score + + NE    +	
S Comparison of Sites Based Upon Food Type. Euclidean Distance from RD Mean Thalweg Depth (cm) 25 dy Debris gth of Reach Where Present Small (<0.3m length) Woody Det Large (>0.3m length) Woody Det Des Reach Area Where Present Cobbles (%) 5 and Fines Reach Area Where Present Sands and Fines (%) ercut Banks th of Reach Where Present Undercut banks (m) ified Habitat S Comparison of Sites Based on Habitat Types Euclidean Distance from RD Community S Comparison of Sites Based on Diatom Comm Bray-Curtis Similarity to RD Toxins	ebris (m) bris (m) s Present	5 0.5 0 19.1	No Data 5 0.5 0 45.7	a Available 0 0 -26.7		+	
Euclidean Distance from RD hel Deepening Mean Thalweg Depth (cm) 25 dy Debris th of Reach Where Present Small (<0.3m length) Woody Det Large (>0.3m length) Woody Det Large (>0.3m length) Woody Det Cobles Reach Area Where Present Sands and Fines Reach Area Where Present Sands and Fines (%) ercut Banks th of Reach Where Present Undercut banks (m) ified Habitat S Comparison of Sites Based on Habitat Types Euclidean Distance from RD Community S Comparison of Sites Based on Diatom Comm Bray-Curtis Similarity to RD Toxins	ebris (m) bris (m) s Present	5 0.5 0 19.1	No Data 5 0.5 0 45.7	a Available 0 0 -26.7			
nel Deepening Mean Thalweg Depth (cm) es dy Debris th of Reach Where Present Small (<0.3m length) Woody Del Large (>0.3m length) Woody Del Large (>0.3m length) Woody Del Large (>0.3m length) Woody Del Seach Area Where Present Cobbles (%) s and Fines Reach Area Where Present Sands and Fines (%) ercut Banks th of Reach Where Present Undercut banks (m) ified Habitat S Comparison of Sites Based on Habitat Types Euclidean Distance from RD Community S Comparison of Sites Based on Diatom Comm Bray-Curtis Similarity to RD Toxins	bris (m) s Present	5 0.5 0 19.1	No Data 5 0.5 0 45.7	a Available 0 0 -26.7			
Mean Thalweg Depth (cm) 25 dy Debris 5 gth of Reach Where Present 5 Small (<0.3m length) Woody Del Large (>0.3m length) Woody Del 1 Large (>0.3m length) Woody Del 1 Sand Fines Reach Area Where Present 5 Sands and Fines (%) ercut Banks th of Reach Where Present Undercut banks (m) ified Habitat 5 Comparison of Sites Based on Habitat Types Euclidean Distance from RD Community 5 Comparison of Sites Based on Diatom Comm Bray-Curtis Similarity to RD Toxins	bris (m) s Present	5 0.5 0 19.1	No Data 5 0.5 0 45.7	a Available 0 0 -26.7	•		
es dy Debris gth of Reach Where Present Small (<0.3m length) Woody Det Large (>0.3m length) Woody Det oles Reach Area Where Present Cobbles (%) is and Fines Reach Area Where Present Sands and Fines (%) ercut Banks th of Reach Where Present Undercut banks (m) ified Habitat S Comparison of Sites Based on Habitat Types Euclidean Distance from RD Community S Comparison of Sites Based on Diatom Comm Bray-Curtis Similarity to RD Toxins	bris (m) s Present	5 0.5 0 19.1	No Data 5 0.5 0 45.7	a Available 0 0 -26.7	-	NE    +	
dy Debris th of Reach Where Present Small (<0.3m length) Woody De Large (>0.3m length) Woody Del les Reach Area Where Present Cobbles (%) and Fines Reach Area Where Present Sands and Fines (%) ercut Banks th of Reach Where Present Undercut banks (m) ified Habitat S Comparison of Sites Based on Habitat Types Euclidean Distance from RD Community S Comparison of Sites Based on Diatom Comm Bray-Curtis Similarity to RD Toxins	bris (m) s Present	0.5 0 19.1	5 0.5 0 45.7	0 0 -26.7		NE	
th of Reach Where Present Small (<0.3m length) Woody De Large (<0.3m length) Woody De Des Reach Area Where Present Cobbles (%) s and Fines Reach Area Where Present Sands and Fines (%) ercut Banks th of Reach Where Present Undercut banks (m) ified Habitat S Comparison of Sites Based on Habitat Types Euclidean Distance from RD Community S Comparison of Sites Based on Diatom Comm Bray-Curtis Similarity to RD Toxins	bris (m) s Present	0.5 0 19.1	5 0.5 0 45.7	0 0 -26.7			
th of Reach Where Present Small (<0.3m length) Woody De Large (<0.3m length) Woody De Des Reach Area Where Present Cobbles (%) s and Fines Reach Area Where Present Sands and Fines (%) ercut Banks th of Reach Where Present Undercut banks (m) ified Habitat S Comparison of Sites Based on Habitat Types Euclidean Distance from RD Community S Comparison of Sites Based on Diatom Comm Bray-Curtis Similarity to RD Toxins	bris (m) s Present	0.5 0 19.1	0.5 0 45.7	0 0 -26.7			
Small (<0.3m length) Woody Det Large (>0.3m length) Woody Det Reach Area Where Present Cobbles (%) s and Fines Reach Area Where Present Sands and Fines (%) ercut Banks th of Reach Where Present Undercut banks (m) ified Habitat S Comparison of Sites Based on Habitat Types Euclidean Distance from RD Community S Comparison of Sites Based on Diatom Comm Bray-Curtis Similarity to RD Toxins	bris (m) s Present	0.5 0 19.1	0.5 0 45.7	0 0 -26.7			
Large (>0.3m length) Woody Det oles Reach Area Where Present Cobbles (%) s and Fines Reach Area Where Present Sands and Fines (%) ercut Banks th of Reach Where Present Undercut banks (m) ified Habitat S Comparison of Sites Based on Habitat Types Euclidean Distance from RD Community S Comparison of Sites Based on Diatom Comm Bray-Curtis Similarity to RD Toxins	bris (m) s Present	0 19.1	0.5 0 45.7	0-26.7			
Reach Area Where Present Cobbles (%) s and Fines Reach Area Where Present Sands and Fines (%) ercut Banks th of Reach Where Present Undercut banks (m) ified Habitat S Comparison of Sites Based on Habitat Types Euclidean Distance from RD Community S Comparison of Sites Based on Diatom Comm Bray-Curtis Similarity to RD Toxins		19.1	45.7	-26.7			
Cobbles (%) s and Fines Reach Area Where Present Sands and Fines (%) ercut Banks th of Reach Where Present Undercut banks (m) ified Habitat S Comparison of Sites Based on Habitat Types Euclidean Distance from RD Community S Comparison of Sites Based on Diatom Comm Bray-Curtis Similarity to RD Toxins		19.1	45.7	-26.7			
s and Fines Reach Area Where Present Sands and Fines (%) ercut Banks th of Reach Where Present Undercut banks (m) ified Habitat S Comparison of Sites Based on Habitat Types Euclidean Distance from RD Community S Comparison of Sites Based on Diatom Comm Bray-Curtis Similarity to RD Toxins		19.1	45.7	-26.7			
Reach Area Where Present Sands and Fines (%) ercut Banks th of Reach Where Present Undercut banks (m) ified Habitat S Comparison of Sites Based on Habitat Types Euclidean Distance from RD Community S Comparison of Sites Based on Diatom Comm Bray-Curtis Similarity to RD Toxins							
Sands and Fines (%) ercut Banks th of Reach Where Present Undercut banks (m) ified Habitat S Comparison of Sites Based on Habitat Types Euclidean Distance from RD Community S Comparison of Sites Based on Diatom Comm Bray-Curtis Similarity to RD Toxins						(	
ercut Banks th of Reach Where Present Undercut banks (m) ified Habitat S Comparison of Sites Based on Habitat Types Euclidean Distance from RD Community S Comparison of Sites Based on Diatom Comm Bray-Curtis Similarity to RD Toxins							
th of Reach Where Present Undercut banks (m) ified Habitat S Comparison of Sites Based on Habitat Types Euclidean Distance from RD Community S Comparison of Sites Based on Diatom Comm Bray-Curtis Similarity to RD Toxins		5	5	0		+	
Undercut banks (m) ified Habitat S Comparison of Sites Based on Habitat Types Euclidean Distance from RD Community S Comparison of Sites Based on Diatom Comm Bray-Curtis Similarity to RD Toxins		5	5	0		+	
ified Habitat S Comparison of Sites Based on Habitat Types Euclidean Distance from RD Community S Comparison of Sites Based on Diatom Comn Bray-Curtis Similarity to RD Toxins		,	c	5		+	
S Comparison of Sites Based on Habitat Types Euclidean Distance from RD Community S Comparison of Sites Based on Diatom Comn Bray-Curtis Similarity to RD Toxins							
Euclidean Distance from RD Community S Comparison of Sites Based on Diatom Comm Bray-Curtis Similarity to RD Toxins n of Previous Quarter							
Community S Comparison of Sites Based on Diatom Comn Bray-Curtis Similarity to RD Toxins n of Previous Quarter	munty Structure				+		
S Comparison of Sites Based on Diatom Comm Bray-Curtis Similarity to RD Toxins n of Previous Quarter	munty Structure					J	
Bray-Curtis Similarity to RD Toxins n of Previous Quarter	munty Structure					+	
Toxins n of Previous Quarter							
n of Previous Quarter					+		
						NE	
			No Data	a Available			
						NE	
pH							
		nd nd	n/	a			
n of 24 Hours							
pH		7.77 nd	i n/	а			Only 24 hour dial data and
ency of Hypoxia							Only 24 hour diel data and data are questionable
t of Observations in Daytime Point Measures		0.00		5			uata are questionable
	exysen/	0 10	. 17	u			
	lved Oxygen)	0	50.4	-50.4			
		0	0.1	-0.1			
nia Concentrations		-		-			
n of Previous Quarter	Ψ						
Ammonia (mg L <sup>-1</sup> )		0.34	0.55	-0.21			
nia	Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Observations in Diel Measures (24hrs) Mild Hypoxia (2-5 mg L <sup>-1</sup> Disso Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Concentrations Previous Quarter	Mild Hypoxia (2-5 mg L <sup>-1</sup> Dissolved Oxygen) Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen) Concentrations Previous Quarter	Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)     0 nc       Observations in Diel Measures (24hrs)     0       Mild Hypoxia (<2.5 mg L <sup>-1</sup> Dissolved Oxygen)     0       Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)     0       Concentrations     0       Previous Quarter     0	Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)     0 nd     n/       Observations in Diel Measures (24hrs)     0     50.4       Mild Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)     0     50.4       Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)     0     0.1       Concentrations     Previous Quarter     0	Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)     0 nd     n/a       Observations in Diel Measures (24hrs)     0     50.4     -50.4       Mild Hypoxia (2.5 mg L <sup>-1</sup> Dissolved Oxygen)     0     0.1     -0.1       Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)     0     0.1     -0.1       Concentrations     Previous Quarter	Hypoxia (<2.0 mg l <sup>-1</sup> Dissolved Oxygen)     0 nd     n/a       Observations in Diel Measures (24hrs)     0     50.4     -50.4       Mild Hypoxia (2-5 mg L <sup>-1</sup> Dissolved Oxygen)     0     50.1     -0.1       Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)     0     0.1     -0.1       Concentrations     Previous Quarter	Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)         0 nd         n/a           Observations in Diel Measures (24hrs)

Candidate Cause	Proximate Stressor	Measurement	Components (units)	R Val		P14 Differen	Component Score	Proximate Stressor Score	Comment
Pesticides									
	Increased S	ediment Non-pyr	ethroid Pesticides					NE	
	Increased W	/ater Column Nor	n-pyrethroid Pesticides					NE	
	increased w	Maximum Value of						NL	
			4,4'-DDD (mg L <sup>-1</sup> )	bdl	nd	n/a			
			4,4'-DDE (μg L <sup>-1</sup> )	bdl	nd	n/a			
			Acrolein (μg L <sup>-1</sup> )	bdl	nd	n/a			
			Acrylonitrile (μg L <sup>-1</sup> )	bdl	nd	n/a			
			Aldrin (µg L <sup>-1</sup> )	bdl	nd	n/a			
			alpha-BHC (μg L <sup>-1</sup> )	bdl	nd	n/a			
			cis-1,3-Dichloropropene (μg L <sup>-1</sup> )	bdl	nd	n/a			
			delta-BHC (µg L <sup>-1</sup> )	bdl	nd	n/a			
			Diazinon (μg L <sup>-1</sup> ) Dieldrin (μg L <sup>-1</sup> )	bdl	nd	n/a			
			Endosulfan I (µg L <sup>-1</sup> )	bdl bdl	nd	n/a		/	
			Endosulfan II (µg L <sup>-1</sup> )	bdi	nd nd	n/a n/a			
			Endosulfan sulfate (µg L <sup>-1</sup> )	bdl	nd	n/a			
			Endrin aldehyde (µg L <sup>-1</sup> )	bdl	nd	n/a			
			Endrin (µg L <sup>-1</sup> )	bdl	nd	n/a			
			Heptachlor Epoxide (Isomer B) (µg L <sup>-1</sup> )	bdl	nd	n/a	, , , , , , , , , , , , , , , , , , ,		
			Heptachlor (µg L <sup>-1</sup> )	bdl	nd	n/a			
			Methoxychlor (µg L <sup>-1</sup> )	bdl	nd	n/a			
			o,p'-DDD (μg L <sup>−1</sup> )	bdl	nd	n/a		)	
			o,p'-DDE (μg L <sup>-1</sup> )	bdl	nd	n/a			
			o,p'-DDT (μg L <sup>-1</sup> )	bdl	nd	n/a			
			p,p'-DDT (μg L <sup>-1</sup> )	bdl	nd	n/a			
			Technical Chlordane (µg L <sup>-1</sup> )	bdl	nd	n/a			
			Toxaphene (µg L <sup>-1</sup> ) ompound Above Detection Limit	bdl	nd	n/a			
			Frequency of Detection (# observed/# me	asured)	0 nd	n/a			
	Increased W		ethroid Pesticides	usurea,	0 114	,u		NE	
						No Data Availa	ble		
	Increased S	ediment Pyrethro	id Pesticides					NE	
						No Data Availa	ble		
	Increased W	/ater Column Her						NE	
		Maximum Value of							
			2,3,7,8-TCDD (pg L <sup>-1</sup> ) 2,4,5-TP (Silvex) (μg L <sup>-1</sup> )	bdl	nd	n/a			
			2,4,5-1P (Silvex) (μg L ) 2,4'-D (μg L <sup>-1</sup> )	bdl bdl	nd nd	n/a n/a			
			2,4 Β (με Ε )	bui	nu	II/d			
			/ /						
			Y						
		3							
	Y								
	/								

Course Chur	e Measurement	Components (units)		SAP 14 Value	Differenc	e Component		Comment
Cause Stresso Temperature	I		Value	vaiue		Score	Stressor Score	
	Water Temperature						+	Only 24 hour diel data
	Mean of Previous Quart	er						·
	Wate	er Temperature (C)	26.39	nd	n/a			
	Mean of Diel Measurem							
		r Temperature (C)	24.6	18.7	5	.9 +		
Decrease	d Variability in Water Te						+	Only 24 hour diel data
	Range of Previous Quar				,			
		r Temperature (C)	9.06	nd	n/a			
	Range of Diel Measuren	er Temperature (C)	3.27	16.04	-12.7	7 +		
	Wate		5.27	10.04	-12.7	/		

 Table 5. Summary of spatial co-occurrence comparisons between RD and each comparator site for the candidate causes and their component proximate stressors.
 Data are scored + for supporting evidence, --- for strongly weakening evidence, 0 for indeterminate evidence, or NE for no evidence.

Candidate			RB vs RD		RC vs RD	
Cause	Proximate Stressor	Proximate	Comment	Proximate	Comment	
	-	Stressor Score		Stressor Score		
leavy Metal	S				Elevated levels of Copper and	
	Increase in Dissolved Metals	+		+	Zinc. Ambigious levels of Antimony	
	Increase in Particulate Bound Metals	NE		NE		
	Increase in Metals in Periphyton	NE		NE		
Elevated Cor	nductivity					
	Increase in Conductivity	+				
	Increase in Total Dissolved Solids	+			Lower TDS and hardness, but higher chloride	
River Discon	tinuity					
	Decrease in Recruitment	NE		NE		
	Decrease in Woody Debris					
	Decrease in Cobbles			+		
	Increase in Sands and Fines					
	Burial of Cobbles	NE	Few if any cobbles observed, so mesurements unreliable	NE	Few if any cobbles observed, so mesurements unreliable	
	Increase in Simplified Habitat	0		0		
labitat Simp	olification					
	Change in Available Food					
	Increase in Channel Deepening			+		
	Decrease in Riffles	NE	× 1	NE		
	Decrease in Woody Debris					
	Decrease in Cobbles			+		
	Increase in Sands and Fines					
	Decrease in Undercut Banks					
	Increase in Simplified Habitat	0		0		
ncreased Nu	ıtrients					
	Change in Algal Community	0				
	Increase in Algal Toxins	NE		NE		
	Increase in pH		Only 24hr measurements available		Only 24 hour data available	
	Increased Frequency of Hypoxia					
	Increased Ammonia Concentrations			+		
Pesticides	Increased Sediment Non-pyrethroid Pesticides	NE		NE		
	increased sediment Non-pyrethroid Pesticides	INE		INE		
	Increased Water Column Nen nursthreid Destisides		All measurements below detection limit at both sites		All measurements below detection limit at both sites	
	Increased Water Column Non-pyrethroid Pesticides Increased Water Column Pyrethroid Pesticides	NE	accession million both sites	NE	acted on million bour sites	
	Increased Sediment Pyrethroid Pesticides	1		NE		
	nicreased seatherit Pyrethrold Pesticides	NE	All managements to be a	INE	All managements by the start	
	Increased Water Column Herbicides		All measurements below detection limit at both sites		All measurements below detection limit at both sites	
ſemperature						
	Increased Water Temperature			+		
	Decreased Variability in Water Temperature	+		+		
	Decreased variability in water reinberature	; +		+		

Candidate			RE vs RD	RF vs RD		
Cause	Proximate Stressor	Proximate Stressor Score	Comment	Proximate Stressor Score	Comment	
Heavy Metals						
	Increase in Dissolved Metals		Antimony and Nickel were ambibilent	NE		
	Increase in Particulate Bound Metals	NE		NE		
	Increase in Metals in Periphyton	NE		NE		
Elevated Cond	uctivity					
	Increase in Conductivity			NE		
	Increase in Total Dissolved Solids		Lower TDS and Hardness, but elevated Chloride	NE		
River Disconti	nuity					
	Decrease in Recruitment	NE		NE		
	Decrease in Woody Debris					
	Decrease in Cobbles	+		+		
	Increase in Sands and Fines					
	Burial of Cobbles	NE	Few if any cobbles observed, so mesurements unreliable	NE	Few if any cobbles observed, so mesurements unreliable	
	Increase in Simplified Habitat	0		0		
Habitat Simpli						
	Change in Available Food	0				
	Increase in Channel Deepening			+		
	Decrease in Riffles	NE		NE		
	Decrease in Woody Debris					
	Decrease in Cobbles	+		+		
	Increase in Sands and Fines					
	Decrease in Undercut Banks					
	Increase in Simplified Habitat	0		0		
ncreased Nut						
	Change in Algal Community			+		
	Increase in Algal Toxins	NE		NE		
	Increase in pH		Only based upon diel data		Only 24 hour diel data	
	Increased Frequency of Hypoxia				Only 24 hour diel data	
	Increased Ammonia Concentrations	+		+		
Pesticides						
	Increased Sediment Non-pyrethroid Pesticides	NE	All measurements below	NE		
	Increased Water Column Non-pyrethroid Pesticides		detection limit at both sites	NE		
	Increased Water Column Pyrethroid Pesticides	NE		NE		
	Increased Sediment Pyrethroid Pesticides	NE		NE		
	Increased Water Column Herbicides		All measurements below detection limit at both sites	NE		
Temperature						
		_	Ambivilent in quarterly data, but		Only 24 hours diel dete	
	Increased Water Temperature	0	higher in 24 hour diel data	+	Only 24 hour diel data	
	Decreased Variability in Water Temperature	+		+	Only 24 hour diel data	

Candidate			SAP8 vs RD		SAP11 vs. RD
Cause	Proximate Stressor	Proximate Stressor Score	Comment	Proximate Stressor Score	Comment
Heavy Metals					
	Increase in Dissolved Metals	NE		NE	
	Increase in Particulate Bound Metals	NE		NE	
	Increase in Metals in Periphyton	NE		NE	
Elevated Cond	uctivity				
	Increase in Conductivity	NE		NE	
	Increase in Total Dissolved Solids	NE		NE	
River Disconti	nuity				
	Decrease in Recruitment	NE		NE	
	Decrease in Woody Debris				
	Decrease in Cobbles	+		+	
	Increase in Sands and Fines				
	Burial of Cobbles	NE	Few if any cobbles observed, so mesurements unreliable	NE	Few if any cobbles observed, so mesurements unreliable
	Increase in Simplified Habitat	0	mesurements unrenable	+	mesurements unrenable
labitat Simpli				C	
	Change in Available Food			+	
	Increase in Channel Deepening	0		+	
	Decrease in Riffles	NE		NE	
	Decrease in Woody Debris				
	Decrease in Cobbles	+		+	
	Increase in Sands and Fines				
	Decrease in Undercut Banks				
	Increase in Simplified Habitat	0		+	
ncreased Nut					
	Change in Algal Community	0		+	
	Increase in Algal Toxins	NE		NE	
	Increase in pH		Only 24 hour diel data		Only 24 hour diel data
	Increased Frequency of Hypoxia	)	Only 24 hour diel data		Only 24 hour diel data
	Increased Ammonia Concentrations	+		+	
Pesticides	Increased Sediment Non-pyrethroid Pesticides	NE		NE	
	Increased Water Column Non-pyrethroid Pesticides	NE		NE	
	Increased Water Column Pyrethroid Pesticides	NE		NE	
	Increased Sediment Pyrethroid Pesticides	NE		NE	
	Increased Water Column Herbicides	NE		NE	
Temperature					
	Increased Water Temperature	+	Only 24 hour diel data	+	Only 24 hour diel data
	Decreased Variability in Water Temperature	+	Only 24 hour diel data	+	Only 24 hour diel data

Condidate			SAP14 vs. RD	
Candidate Cause	Proximate Stressor	Proximate Stressor Score	Comment	
Heavy Metals				
	Increase in Dissolved Metals	NE		
	Increase in Particulate Bound Metals	NE		
	Increase in Metals in Periphyton	NE		
Elevated Cond	uctivity			
	Increase in Conductivity	NE		
	Increase in Total Dissolved Solids	NE		
River Disconti	nuity			
	Decrease in Recruitment	NE		
	Decrease in Woody Debris			
	Decrease in Cobbles			
	Increase in Sands and Fines			
	Burial of Cobbles	NE	Few if any cobbles observed, so mesurements unreliable	
	Increase in Simplified Habitat	+		
Habitat Simpli	fication			
	Change in Available Food	+		
	Increase in Channel Deepening	+		
	Decrease in Riffles	NE		
	Decrease in Woody Debris			
	Decrease in Cobbles			
	Increase in Sands and Fines			
	Decrease in Undercut Banks			
	Increase in Simplified Habitat	+	Y	
Increased Nut				
	Change in Algal Community	+		
	Increase in Algal Toxins	NE		
	Increase in pH	NE		
			Only 24 hour diel data and SAP	
	Increased Frequency of Hypoxia		14 data are questionable	
	Increased Ammonia Concentrations			
Pesticides				
	Increased Sediment Non-pyrethroid Pesticides	NE		
	Increased Water Column Non-pyrethroid Pesticides	NE		
	Increased Water Column Pyrethroid Pesticides	NE		
	Increased Sediment Pyrethroid Pesticides	NE		
	Increased Water Column Herbicides	NE		
Temperature				
	Increased Water Temperature		Only 24 hours dial data	
	Increased Water Temperature	+	Only 24 hour diel data	
	Decreased Variability in Water Temperature	+	Only 24 hour diel data	
	S. C.			

## Stressor-Response from the Field

The stressor-response line of evidence also had relatively good coverage across all of the candidate causes and nearly all of the proximate stressors could be evaluated. Stressor response relationships were evaluated by calculating Spearman's rank correlations between the different proximate stressors and the four biological response variables: % non-insect taxa, % tolerant taxa, % collector-gatherer abundance, and the number of predator taxa observed at RD and the seven comparator sites. The % non-insect taxa, % tolerant taxa, and % collector-gatherer abundance are negative measures of community structure and habitat quality, where as a habitat is degraded these biological measures would be expected to increase. Conversely, the number of predator taxa is a positive measure of community structure and habitat quality, where as a habitat is degraded the number of predator taxa would be expected to decrease.

Data were scored based upon the rho ( $\rho$ ) value of the correlation and the direction of the expected relationship between the biological endpoints and the different proximate stressors – a negative variable (e.g., % sands and fines) with negative biology would be a direct relationship, while a positive variable (% woody debris) with a negative biology would be an inverse relationship. As an example of an expected direct relationship:  $\rho = -1 - -0.9$  would be scored --,  $\rho < -0.9 - -0.75$  would be scored -,  $\rho < -0.75 - <0.75$  would be scored 0,  $\rho = 0.75 - <0.9$  would be scored +, and  $\rho = 0.9 - 1.0$  would be scored ++. This pattern would be reversed for any expected inverse relationship. Any relationship scored ++ or -- was investigated visually by plotting the proximate stressor and the biological endpoint and looking for spurious or less compelling relationships. If there was a question about the pattern of the correlation versus the  $\rho$ -value, the ++ or -- was changed to + or -. Additionally, if a chemical compound (i.e., metals or pesticides) was below detection limit at RD, it was scored --.

The % abundance of collector-gatherers observed at the test site was not at levels typically though to be indicative of degraded biological conditions. Consequently, though originally targeted as a potential biological endpoint of interest, it was excluded from evaluation in the stressor-response line of evidence. The other three biological endpoints (% tolerant taxa, % of non-insect taxa, and # of predator taxa) observed at the RD site were at levels typically associated with degraded conditions and were retained for the stressor-response evaluation. The correlation coefficients for the three biological endpoints and the different components of each candidate cause are presented in Table 6. The scores from these evaluations are presented in Table 7.

Table 6. Detailed correlation and scoring of within the case stressor-response data across the four biological endpoints for each proximate stressors and their candidate causes. Data are scored ++ for a strongly supporting response, + for a supporting response, 0 for ambivalent response, - for a weakening response, -- for a strongly weakening response, and NE for no evidence. bdl = below detection limit. Collector-gather abundance at RD was not at a level indicative of degradation, so the stressor-response relationships were not used in the assessment.

Candidata	Proximate		% Collector-Gatherer Abundance							% Non- Insect Taxa		
	Measurement	Components (units)	Dha	Coore	Proximate	commont.		Dha	C	Proximate		
Cause	Stressor		Rho	Score	Stressor Score	comment		Rho	Score	Stressor Score	comment	
Heavy Meta	als					Collector-gatherers at						
	Increase in Dissolved Meta	ls			n/a	RD were not at a level				+	Support for Antimony,	
	Mean of Previous	s Quarter (BDL = 1/2 MDL)				indicative of degradation and not					counter suport for	
		Antimony (μg L <sup>-1</sup> )	-0.800			used in the final		0.800	+		Arsenic, Barium,	
		Arsenic (μg L <sup>-1</sup> )	0.800			assessment		-0.800	-		Beryllium, and Mercur	
		Barium (μg L <sup>-1</sup> )	bdl					bdl				
		Beryllium (μg L <sup>-1</sup> )	bdl					bdl				
		Cadmium (μg L <sup>-1</sup> )	0.738					-0.738	0			
		Chromium (µg L <sup>-1</sup> )	0.738			<b>Y</b>		-0.738	0			
		Copper ( $\mu g L^{-1}$ )	-0.400		C			0.400	0			
		Hexavalent Chromium (mg L <sup>-1</sup> )	-0.258					0.258	0			
		Iron (mg L <sup>-1</sup> )	0.258					-0.258	0			
		Lead (µg L <sup>-1</sup> )	-0.400					0.400	0			
		Mercury (μg L <sup>-1</sup> )	bdl					bdl				
		Nickel (µg L <sup>-1</sup> )	0.400					-0.400	0			
		Selenium (µg L <sup>-1</sup> )	0.800		×			-0.800	-			
		Silver (µg L <sup>-1</sup> )	-0.258					0.258	0			
		Thallium (µg L <sup>-1</sup> )										
		Zinc (μg L <sup>-1</sup> )	-0.400					0.400	0			
	Increase in Particulate Bou	nd Metals			NE					NE		
			No Data	Availab	e			No Data	Availab	le		
	Increase in Metals in Perip	hyton			NE					NE		
			No Data	Availab	e			No Data	Availab	le		
Elevated Co	onductivity					Collector-gatherers at						
	Increase in Conductivity				n/a	RD were not at a level				-		
	Mean of Previous	s Quarter				indicative of degradation and not						
		Conductivity mmhos cm <sup>-1</sup>	0.800			used in the final		-0.800	-			
	Increase in Total Dissolved	Solids			n/a	assessment				-		
	Mean of Previous	5 Quarter										
		TDS (mg L <sup>-1</sup> )	0.800					-0.800	-			
		Chloride (mg L <sup>-1</sup> )	-0.800					0.800	+			
		Hardness (mg L <sup>-1</sup> )	0.800					-0.800	-			

Candidate	Proximate				% Coll	ector-Gathere	r Abundance				% Non- Insect Taxa
Cause	Stressor	Measurement	Components (units)	Rho	Score	Proximate Stressor Score	comment		Rho	Score	Proximate comment Stressor Score
River Disco	ntinuity						Collector-gatherers at				
	Decrease ir	n Recruitment					RD were not at a level indicative of				
				No Data	Available	2	degradation and not		No Data	Availabl	e
	Decrease ir	n Woody Debris					used in the final				
		Length of Reach V				n/a	assessment				0
			Small (<0.3m length) Woody Debris (m) Large (>0.3m length) Woody Debris (m)	0.265 -0.109					-0.203 0.000	0	
	Decrease ir		Large (20.5111 length) woody Debris (iii)	-0.105		n/a			0.000	0	0
		% of Reach Area V	Nhere Present			ny a				1	0
			Cobbles (%)	0.175					-0.576	0	
	Increase in	Sands and Fines				n/a				-	0
		% of Reach Area V				•					
			Sands and Fines (%)	0.690					-0.429	0	
	Burial of Co	obbles				NE					NE
		Mean % of Cobble	es Embeddedness				<b>Y</b>				
			Cobble Embeddedness (%)	0.342		(			-0.559	0	
	Increase in	Simplified Habi	tat			n/a					0
		nMDS Compariso	n of Sites Based on Habitat Types Present								
			Euclidean Distance from RD	0.714			Collector of the second		-0.464	0	
labitat Sin	nplification						Collector-gatherers at RD were not at a level				0
	-	Available Food				n/a	indicative of				0
		nivius compariso	n of Sites Based Upon Food Type Availability Euclidean Distance from RD	0.464		- X	degradation and not		-0.500	0	
	Incroaco in	Channel Deepe		0.464		n/a	used in the final assessment		-0.500	0	0
	increase in	channel beepe	Mean Thalweg Depth (cm)	-0.619		ny a	assessment		0.738	0	0
	Decrease ir	Riffles	wear marweg bepar (em)	0.015		NE			0.750	0	NE
	Decreasen			No Data	Available				No Data	Availabl	
	Decrease ir	woody Debris				n/a					0
		-	n Where Present								
		-	Small (<0.3m length) Woody Debris (m)	0.265					-0.203	0	
			Large (>0.3m length) Woody Debris (m)	-0.109					0.000	0	
	Decrease ir	n Cobbles				n/a					0
		% of Reach Area V	Where Present								
			Cobbles (%)	0.175					-0.576	0	
	Increase in	Sands and Fines				n/a					0
		% of Reach Area V									
	<b>.</b> .		Sands and Fines (%)	0.690		,			-0.429	0	
	Decrease ir	Undercut Bank				n/a					
		Length of Reach V		0					0		
	Incroase in	Simplified Habi	Undercut banks (m)	0		n/a			U		0
	mcrease In	Simplified Habi	tat n of Sites Based on Habitat Types Present			n/a					U
		nimos compariso	Euclidean Distance from RD	0.714					-0.464	0	

Candidato	Proximate				% Coll	ector-Gatherer	Abundance				% Non- Insec	t Taxa
Cause	Stressor	Measurement	Components (units)	Rho	Score	Proximate	comment		bo	Score	Proximate	comment
Cause	30,63301			KIIU	SCOLE	Stressor Score	comment	'	NIIO	30016	Stressor Score	comment
ncreased I	Nutrients						Collector-gatherers at				XX	
	Change in A	Algal Community				n/a	RD were not at a level indicative of				0	
		nMDS Comparison of	Sites Based on Diatom Communty Structure				degradation and not					
		Bray	y-Curtis Similarity to RD	0.214			used in the final	-	0.179	0		
	Increase in	Algal Toxins				NE	assessment				NE	
												based primarily on 2
	Increase in	рН				n/a					0	hour data
		Mean of Previous Qua	arter						$\bigcup$			
		pН		1.000				-	1.000	0		
		Mean of 24 Hours										
		pН		-0.357				-	0.143	0		
	Increased F	requency of Hypoxi	a			n/a					0	based primarily on 2 hour data
			s in Daytime Point Measures			iiy u					0	nour data
			d Hypoxia (2-5 mg L <sup>-1</sup> Dissolved Oxygen)	0					0			
			oxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)	0					0			
			s in Diel Measures (24hrs)									
		Milo	d Hypoxia (2-5 mg L <sup>-1</sup> Dissolved Oxygen)	0.436					0.062	0		
		Нуре	oxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)	0.577				-	).247	0		
	Increased A	mmonia Concentral	tions			n/a					0	
		Mean of Previous Qua	arter			×						
		Amn	nonia (mg L <sup>-1</sup> )	0.027					0.464	0		

Candidata	Drovimato		% Colle	ctor-Gatherer	Abundance		% Non- Insect Taxa					
Cause	Proximate Stressor Measurement Components (units)	Rho	Score	Proximate Stressor Score	comment	Rho	Score	Proximate Stressor Score	comment			
esticides					Collector-gatherers at							
	Increased Sediment Non-pyrethroid Pesticides			NE	RD were not at a level			NE				
		No Data	a Availabl		indicative of	No Dat	a Availat					
	Increased Water Column Non-pyrethroid Pesticides			n/a	degradation and not used in the final							
	Maximum Value of Previous Year			ii, a	assessment		(					
	4,4'-DDD (mg L <sup>-1</sup> )	bdl				bdl						
	4,4'-DDE (μg L <sup>-1</sup> )	bdl				bdl						
	Acrolein (μg L <sup>-1</sup> )	bdl				bdl						
	Acrylonitrile (μg L <sup>-1</sup> )	bdl				bdl						
	Aldrin (µg L <sup>-1</sup> )	bdl				bdl						
	alpha-BHC (μg L <sup>-1</sup> )	bdl				bdl						
	cis-1,3-Dichloropropene (µg L <sup>-1</sup> )	bdl				bdl						
	delta-BHC ( $\mu$ g L <sup>-1</sup> )	bdl				bdl						
	Diazinon ( $\mu g L^{-1}$ )	bdl				bdl						
	Dieldrin ( $\mu$ g L <sup>-1</sup> )	bdl				bdl						
	Endosulfan I (µg L <sup>-1</sup> )	bdl				bdl						
	Endosulfan ΙΙ (μg L <sup>-1</sup> )	bdl				bdl						
	Endosulfan sulfate ( $\mu g L^{-1}$ )	bdl				bdl						
	Endrin aldehyde ( $\mu g L^{-1}$ )	bdl				bdl						
	Endrin (μg L <sup>-1</sup> )	bdl				bdl						
	Heptachlor Epoxide (Isomer B) ( $\mu$ g L <sup>-1</sup> )											
	Heptachlor ( $\mu$ g L <sup>-1</sup> )	bdl bdl				bdl bdl						
	Methoxychlor ( $\mu g L^{-1}$ )	bdl				bdl						
	$o,p'-DDD (\mu g L^{-1})$					bdl						
	ο,p'-DDE (μg L <sup>-1</sup> )	bdl bdl				bdl						
	o,p'-DDT (µg L <sup>-1</sup> )	bdl				bdl						
	p,p'-DDT (µg L <sup>-1</sup> )	bdl				bdl						
	Technical Chlordane ( $\mu g L^{1}$ )	bdl				bdl						
	Toxa phene ( $\mu g L^{-1}$ )	bdl				bdl						
	Detection of Any Compound Above Detection Limit	bui				bui						
	Frequency of Detection (# observed/# measured)	nd				nd	0					
	Increased Water Column Pyrethroid Pesticides	nu		NE		nu	U	NE				
	increased water cordinin' yretinold'r esticides	No Data	a Availabl			No Dat	a Availat					
	Increased Sediment Pyrethroid Pesticides			NE				NE				
	increased sediment ryrethrold resticides	No Data	a Availabl			No Dat	a Availat					
	Increased Water Column Herbicides			n/a		1.0 500						
	Maximum Value of Previous Year			iiy a								
	2,3,7,8-TCDD (pg L <sup>-1</sup> )	bdl				bdl						
	2,3,7,8-1Cb0 (bg L ) 2,4,5-TP (Silvex) (μg L <sup>-1</sup> )	bdl				bdl						
	2,4,5-1P (SITVEX) (µg L ) 2,4'-D (µg L <sup>1</sup> )	bdl				bdl						

Candidata	Proximate				% Coll	ector-Gatherer	Abundance			% Non- Insect T	аха
Cause	Stressor	Measurement Comp	Components (units)	Rho	Score	Proximate Stressor Score	comment	Rho	Score	Proximate Stressor Score	comment
Temperatu	ire						Collector-gatherers at				
	Increased N	Nater Temperature				n/a	RD were not at a level indicative of			+	
		Mean of Previous Qua	rter				degradation and not				
		Wat	er Temperature (C)	-0.800			used in the final	0.800	+		
		Mean of Diel Measure	ments (24hr)				assessment				
		Wat	er Temperature (C)	-0.619				0.905	i ++		
	Decreased	Variability in Water	Temperature			n/a				0	
		Range of Previous Qua	irter								
		Wat	er Temperature (C)	0.600				-0.600	0 (		
		Range of Diel Measure	ements (24hr)								
		Wat	er Temperature (C)	0.310				-0.357	0		

Candidate	Proximate					% Tolerant	Таха			Predator 1	Гаха
Cause	Stressor	Measurement	Components (units)	Rho	Score	Proximate Stressor Score	comment	Rho	Score	Proximate Stressor Score	comment
Heavy Met	als									<b>N</b> C	
	Increase in	Dissolved Metal	S			+	Support for Chromium			+	Supporting evidence
		Mean of Previous	s Quarter (BDL = 1/2 MDL)				(VI) and Selenium, but counter support for				for Zinc, but weakening evidece for Beryllium,
			Antimony (μg L <sup>-1</sup> )	0.200	0		Barium, Beryllium,	0.400	0		Mercury, Nickel, and
			Arsenic (µg L <sup>-1</sup> )	0.000	0		Iron, and Mercury	0.400	0		Thallium
			Barium (μg L <sup>-1</sup> )	bdl				0.400	0		
			Beryllium (µg L⁻¹)	bdl							
			Cadmium (µg L <sup>-1</sup> )	-0.211	0			0.316	0		
			Chromium (μg L <sup>-1</sup> )	-0.632	0			-0.105	0		
			Copper (µg L <sup>-1</sup> )	-0.400	0			0.000	0		
			Hexavalent Chromium (mg L <sup>-1</sup> )	0.775	+			0.258	0		
			Iron (mg L <sup>-1</sup> )	-0.775	-			-0.258	0		
			Lead (µg L <sup>-1</sup> )	-0.400	0			0.000	0		
			Mercury (μg L <sup>-1</sup> )	bdl							
			Nickel (µg L <sup>-1</sup> )	0.600	0			0.800	-		
			Selenium (µg L <sup>-1</sup> )	0.000	0			0.400	0		
			Silver (µg L <sup>-1</sup> )	0.775	+			0.258	0		
			Thallium (µg L <sup>-1</sup> )								
			Zinc (μg L <sup>-1</sup> )	-0.600	0			-0.800	+		
	Increase in	Particulate Bour	nd Metals			NE				NE	
				No Data	Availab	e		No Dat	a Availa		
	Increase in	Metals in Periph	nyton			NE				NE	
Elevated Co	anductivity			No Data	Availab	e		No Dat	a Availa	ble	
Elevated Cl	-	Conductivity				0				0	
	increase in	Mean of Previous	Quarter			0				0	
		Weatt of Frevious	Conductivity mmhos cm <sup>-1</sup>	0.000	0			0.400	0		
	Incroaco in	Total Dissolved		0.000	0	0		0.400	0	0	
	increase in	Mean of Previous		/		0				0	
		Weatt of Frevious	TDS (mg $L^{-1}$ )	0.000	0			0.400	0		
			Chloride (mg L <sup>-1</sup> )	0.800	+			0.400	0		
			Hardness (mg L <sup>-1</sup> )	0.000				0.400	0		
			5					ł			

Candidate Cause	Proximate Stressor	Measurement	Components (units)	Rho	Score	% Tolerant Tax Proximate Stressor Score	ka comment	Rho	P	Predator Taxa roximate essor Score	comment
River Disco	ntinuity								_		
	Decrease in	Recruitment				NE			•	NE	
				No Data	Availabl	e		No Da	ta Available		
		Woody Debris								0	
		Length of Reach W		0.010	0	0		0.354			
			Small (<0.3m length) Woody Debris (m)	0.016 0.000	-			0.254			
	Decrease in	Cobbles	Large (>0.3m length) Woody Debris (m)	0.000	0	0		0.000	0	0	
		% of Reach Area V	Where Present			0				0	
			Cobbles (%)	-0.300	0			-0.12	, 0		
	Increase in S	ands and Fines				0				0	
		% of Reach Area V	Vhere Present								
			Sands and Fines (%)	-0.310	0			-0.376	5 0		
	Burial of Cob	obles				NE				0	
		Mean % of Cobble	es Embeddedness								
			Cobble Embeddedness (%)	-0.667	0			-0.25	0		
		implified Habit				0				0	
		nMDS Compariso	n of Sites Based on Habitat Types Present								
			Euclidean Distance from RD	-0.571	0			-0.67	8 0		
abitat Sin	nplification									0	
	-	vailable Food	- Contraction - Exception - A stability			0				0	
		nivius compariso	n of Sites Based Upon Food Type Availability Euclidean Distance from RD	-0.536	0	X		-0.32	, 0		
	Increase in (	Channel Deepen		-0.536	0	0		-0.32	0	0	
		Liaimei Deepen	Mean Thalweg Depth (cm)	0.333	0	0		0.279	0	0	
	Decrease in	Riffles	Wear marweg Depth (cm)	0.555	U	NE		0.275	0		
	Decrease in	inities		No Data	Availabl			No Da	ta Available		
	Decrease in	Woody Debris				0				0	
		-	Where Present								
		0	Small (<0.3m length) Woody Debris (m)	0.016	0			0.254	0		
			Large (>0.3m length) Woody Debris (m)	0.000	0			0.000	0		
	Decrease in	Cobbles				0				0	
		% of Reach Area V	Vhere Present								
			Cobbles (%)	-0.300	0			-0.12	0		
	Increase in S	ands and Fines				0				0	
		% of Reach Area V									
	_		Sands and Fines (%)	-0.310	0			-0.376	5 0		
		Undercut Banks									
		Length of Reach W		-							
	Incrosses in C	implified Use to	Undercut banks (m)	0		0				0	
		Simplified Habit				0				U	
		unvius compariso	n of Sites Based on Habitat Types Present Euclidean Distance from RD	-0.571	0			-0.67	3 0		

Condidate	Ducuinsata					% Tolerant	Таха			Predator T	аха
	Proximate	Measurement	Components (units)		<i>c</i>	Proximate			<i>c</i>	Proximate	
Cause	Stressor			Rho	Score	Stressor Score	comment	Rho	Score	Stressor Score	comment
Increased N	Nutrients										
	Change in A	Igal Community				0				0	
		nMDS Comparisor	n of Sites Based on Diatom Communty Structure								
			Bray-Curtis Similarity to RD	0.107	0			0.218	0		
	Increase in	Algal Toxins				NE				NE	
							based primarily on 24			0	
	Increase in	•				0	hour data			Ũ	
		Mean of Previous									
			рН	-1.000	0			1.000	NE		
		Mean of 24 Hours							_		
			рН	-0.107	0		based primarily on 24	0.164	0		based primarily on 24
	Increased F	requency of Hyp	oxia			0	hour data			0	hour data
	mercuscur		ions in Daytime Point Measures			Ū	· · · · ·				
			Mild Hypoxia (2-5 mg L <sup>-1</sup> Dissolved Oxygen)	C	0						
			Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)	C			)				
			tions in Diel Measures (24hrs)		, in the second s						
			Mild Hypoxia (2-5 mg L <sup>-1</sup> Dissolved Oxygen)	-0.436	0			-0.540	0		
			Hypoxia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)	-0.577				-0.504	0		
	Increased A	mmonia Concen				0				0	
		Mean of Previous	Quarter			Y					
			Ammonia (mg L <sup>-1</sup> )	-0.027	0			-0.222	0		

Candidato	Proximate					% Tolerant Ta	xa			Predator Taxa	1
Cause	Stressor	asurement	Components (units)	Rho	Score	Proximate Stressor Score	comment	Rhc	Score	Proximate Stressor Score	comment
esticides											
	Increased Sedin	nent Non-pyrethr	oid Pesticides			NE			•	NE	
				No Data	Availabl	e		No Da	ata Availa	ble	
	Increased Wate	r Column Non-pyi	rethroid Pesticides								
		imum Value of Prev								×	
		4,4'-[	DDD (mg L <sup>-1</sup> )	bdl							
		4,4'-[	DDE (µg L <sup>-1</sup> )	bdl							
		Acrol	ein (μg L <sup>-1</sup> )	bdl							
		Acryl	onitrile (µg L⁻¹)	bdl							
		Aldri	n (µg L <sup>-1</sup> )	bdl							
		alpha	a-BHC (μg L <sup>-1</sup> )	bdl							
		cis-1	,3-Dichloropropene (μg L <sup>-1</sup> )	bdl							
		delta	-BHC (μg L <sup>-1</sup> )	bdl							
		Diazi	non (μg L <sup>-1</sup> )	bdl							
		Dield	rin (µg L <sup>-1</sup> )	bdl							
		Endo	sulfan I (μg L <sup>-1</sup> )	bdl							
		Endo	sulfan II (μg L <sup>-1</sup> )	bdl	-						
		Endo	sulfan sulfate (µg L⁻¹)	bdl							
		Endri	n aldehyde (µg L <sup>-1</sup> )	bdl							
		Endri	n (μg L <sup>-1</sup> )	bdl							
		Hepta	achlor Epoxide (Isomer B) (μg L <sup>-1</sup> )	bdl		<b>X</b>					
		Hepta	achlor (μg L <sup>-1</sup> )	bdl							
		Meth	oxychlor (μg L <sup>-1</sup> )	bdl							
		o,p'-[	DDD (μg L <sup>-1</sup> )	bdl							
		o,p'-[	DDE (µg L <sup>-1</sup> )	bdl							
		o,p'-[	DDT (μg L <sup>-1</sup> )	bdl							
		p,p'-[	DDT (μg L <sup>-1</sup> )	bdl							
		Techr	nical Chlordane (μg L <sup>-1</sup> )	bdl							
		Тоха	phene (µg L <sup>-1</sup> )	bdl							
	Dete	ection of Any Compo	ound Above Detection Limit								
		Frequ	uency of Detection (# observed/# measured)	nd	0						
	Increased Wate	r Column Pyrethr				NE				NE	
				No Data	Availabl	e		No Da	ata Availa	ble	
	Increased Sedin	nent Pyrethroid P	esticides			NE				NE	
				No Data	Availabl	e		No Da	ata Availa	ble	
	Increased Wate	r Column Herbicio	les								
	Max	imum Value of Prev	ious Year								
		2,3,7	,8-TCDD (pg L <sup>-1</sup> )	bdl							
		2,4,5	-TP (Silvex) (μg L <sup>-1</sup> )	bdl							
			Ο (μg L <sup>-1</sup> )	bdl							

Candidate	Proximate					% Tolerant Tax	a			Predator Taxa	
Cause	Stressor	Measurement	Components (units)	Rho	Score	Proximate Stressor Score	comment	Rho	Score	Proximate Stressor Score	comment
Temperatu	re										
	Increased V	/ater Temperature				0				0	
		Mean of Previous Qua	rter								
		Wat	ter Temperature (C)	0.000	0			-0.400	0		
		Mean of Diel Measure	ments (24hr)								
		Wat	ter Temperature (C)	0.405	0			0.339	0		
	Decreased V	/ariability in Water T	Temperature			0				0	
		Range of Previous Qua	arter								
		Wat	ter Temperature (C)	-0.400	0			0.200	0		
		Range of Diel Measure	ements (24hr)								
		Wat	ter Temperature (C)	-0.524	0			-0.315	0		

Table 7. Summary within the case stressor-response scores across the three biological endpoints for each proximate stressor in the candidate causes.

		9	6 Non- Insect Taxa		% Tolerant Taxa		Predator Taxa
Candidate Cause /	Proximate Stressor	Proximate		Proximate		Proximate	
Conceptual Model		Stressor Scor	Comment	Stressor Score	Comment	Stressor Score	Comment
Heavy Metals							
	la service de Dissolve d'Matala		Supporting evidence for Antimony,		Supporting evidence for Chromium (VI)		Supporting evidence for Zinc, but
	Increase in Dissolved Metals	+	counter suport for Arsenic, Barium, Beryllium, and Mercury	+	and Selenium, but counter support for Barium, Beryllium, Iron, and Mercury	+	weakening evidece for Beryllium Mercury, Nickel, and Thallium
	Increase in Particulate Bound Metals	NE		NE		NE	,,,,
	Increase in Metals in Periphyton	NE		NE		NE	
Elevated Conduct	ivity						
	Increase in Conductivity	-		0		0	
	Increase in Total Dissolved Solids	-		0			
<b>River Discontinuit</b>	у						
	Decrease in Recruitment	NE		NE		NE	
	Decrease in Woody Debris	0		0		0	
	Decrease in Cobbles	0		0		0	
	Increase in Sands and Fines	0		0		0	
	Burial of Cobbles	NE		NE		0	
	Increase in Simplified Habitat	0		0		0	
Habitat Simplifica							
	Change in Available Food	0		0		0	
	Increase in Channel Deepening	0		0		0	
	Decrease in Riffles	NE		NE		NE	
	Decrease in Woody Debris	0		0		0	
	Decrease in Cobbles	0		0		0	
	Increase in Sands and Fines	0		0		0	
	Decrease in Undercut Banks	-					
	Increase in Simplified Habitat	0		0		0	
Increased Nutrien			× ×				
	Change in Algal Community	0		0		0	
	Increase in Algal Toxins	NE		NE		NE	
	Increase in pH	0	based primarily on 24 hour data	0	based primarily on 24 hour data	0	based primarily on 24 hour data
	Increased Frequency of Hypoxia		based primarily on 24 hour data	-	based primarily on 24 hour data	0	based primarily on 24 hour data
<b>.</b>	Increased Ammonia Concentrations	0		0		0	
Pesticides	la sur d'Ordina et Neu sur thaild Dratisides					NE	
	Increased Sediment Non-pyrethroid Pesticides	NE		NE		NE	
	Increased Water Column Non-pyrethroid Pesticides						
	Increased Water Column Pyrethroid Pesticides	NE		NE		NE	
	Increased Sediment Pyrethroid Pesticides	NE		NE		NE	
Tomporature	Increased Water Column Herbicides						
Temperature	Increased Water Temperature					0	
	Increased Water Temperature	+		0		0	
	Decreased Variability in Water Temperature	0		0		0	

## Data Analysis from Outside the Case

## Reference Condition Comparison

The idea of this line of evidence was to provide context for the level of a given proximate stressor at the test site and to determine how different the observed value was from that seen in geographically similar reference sites. This comparison was made by characterizing the distribution of the proximate stressor values in the pool of reference sites, calculating the median, upper quartile, lower quartile, upper fence values (the upper quartile + 1.75X the interquartile range), and lower fence values. These types of data can be plotted in a schematic box and whisker plot (Tukey 1977) overlaid with the RD value for ease of display and interpretation (Figure 11). Reference sites from the large bioassessment database available in California. (see Ode et al in prep for reference definition) were selected as similar based upon slope (<1.5%) and elevation (<333 m). Data from the RD site were scored as follows (assuming a negative stressor): if the RD value was less than the upper quartile, then score = -; if the RD value was greater than the upper fence, then score = +. If the proximate stressor was the loss of a positive variable, then the same rules would apply, but with reference to the lower quartile and fence values.

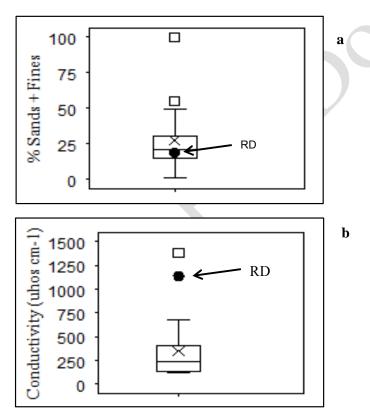


Figure 11. Examples of reference condition comparisons for outside of the case portions of the assessment. The box plot describes the reference site distribution of conductivity (a), and % Sands + Fines (b). The components of the plot are the solid line representing the median, the span of the box illustrating the upper and lower quartile, the whiskers are 1.75X the interquartile range, the cross representing the mean, and the hollow squares show outlier values. The dark circle overlaid represents the observed value at the test site.

Not every bioassessment program has collected the same data and after filtering from the larger pool of sites the only variables where there was enough data coverage were conductivity and % sands&fines,. Within the elevated conductivity candidate cause, the monthly mean conductivity value at RD from the previous quarter (1207  $\mu$ mhos cm<sup>-1</sup>) was well above the upper fence value (683  $\mu$ mhos cm<sup>-1</sup>), scoring the proximate stressor +. Consequently, the overall candidate cause score for elevated conductivity was also scored +. Data were available to evaluate % sands&fines, which was part of both the river discontinuity and habitat simplification candidate causes. The observed % sands&fines (19.1) at RD was between the 1<sup>st</sup> and 3<sup>rd</sup> quartile value of the reference sites (15.2 – 30.5), was scored -. As % sands&fines were the only proximate stressor that could be evaluated in either candidate cause, both river discontinuity and habitat simplification were scored - as well.

## Stressor-Response from Other Field Studies

A relative risk approach (Van Sickle et al. 2006, Agresti 2007) was used to characterize and provide context to the observed relationships between the different biological endpoints and different proximate stressors at RD. These analyses were designed to assess whether the degraded biological condition captured in each biological endpoint could be the result of the observed level of the proximate stressor based upon patterns seen in other, environmentally similar sites within the State of California. Like the reference condition comparisons, sites were selected based upon slope (<1.5%) and elevation (<333 m) from the large bioassessment database available in California. An important difference however, was that both reference and non-reference sites (540 samples from 515 sites) were selected to span the range of potential biological and stressor conditions.

For these analyses, semi-continuous relative risk values were calculated for all proximate stressors where enough data were available. The relative risk of observing degraded biology with 95% confidence intervals was calculated at 50+ increments of the proximate stressors observed across the environmentally similar sites from the state's biomonitoring database. Proximate stressor data from the RD site were scored based upon the risk (+/- the 95% confidence interval) of the observed level of the stressor causing the degraded biological conditions (Figure 12). If the observed biological endpoint was not at impaired levels (a SoCal IBI metric score of 4 in this case), the line of evidence was scored "--" regardless of the level of stressor observed. If impaired biology was observed and the relative risk +/- CI was less than 1, then the data would be scored as -. If impaired biology was observed and relative risk +/- CI was relative risk +/- CI was between 1 or 1.2 then the data would be scored 0.

Data for calculation of relative risks were not available for any of the proximate stressors associated with the increased nutrients, pesticides, or temperature candidate causes (consequently scored NE). Values of the different proximate stressors observed at RD and the relative risk associated with that value to each of the four biological endpoints are presented in Table 8. A summary of all the scores for each proximate stressor are presented in Table 9.

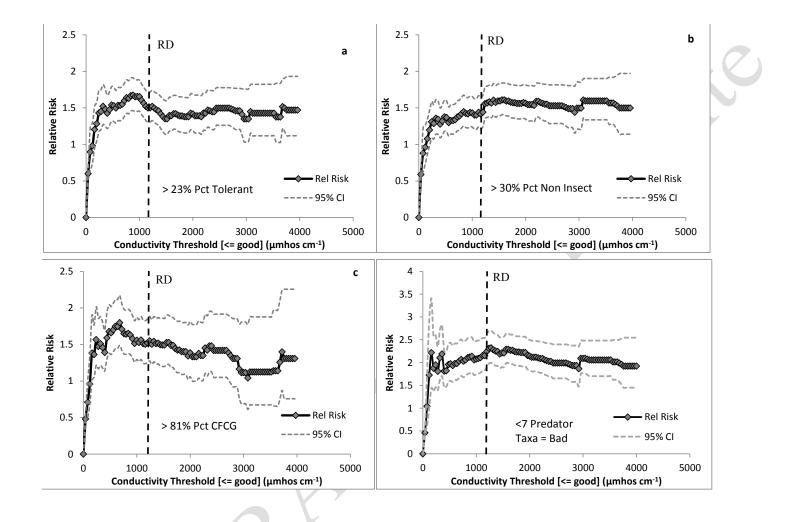


Figure 12. Examples of continuous relative risk plots using conductivity as the stressor and % tolerant taxa (a), % non-insect taxa (b), % abundance of collector-gatherers (c) and number of predator taxa (d) as biological endpoints. The solid dark line with grey diamonds represent the relative risk of observing biological impact at each respective value of the stressor, the dashed line represents the 95% confidence interval in that relative risk estimate, and the vertical dashed line represents the observed level of the stressor at the test site. Each panel describes the level of each biological endpoint above which was considered indicative of impaired conditions.

Table 8. Detailed scoring sheet for the outside of the case stressor-response from other field studies across each of the four biological endpoints for each proximate stressors and the components therein. For those components where they could be calculated, relative risk (Rel Risk) and 95% confidence intervals (UCI and LCI) are provided. Collector-gather abundance at RD was not at a level indicative of degradation, so this line of evidence was scored "--".

Candidate	Proximate	urement	Components (units)	RD	% N	lon Insect Ta	xa	Proximate	Comment	% Т	olerant T	axa	Proximate
Cause	Stressor	urement	Components (units)	Value	Rel Ris	k LCI UCI	Score	Stressor Score	Comment	Rel Risk	LCI UC	Score	Stressor Score
Heavy Meta	als												
	Increase in Dissolve	ed Metals						0	Only evaluated				0
	Mean o	f Previous Quarter	(BDL = 1/2 MDL)						Copper, Lead,				
		Antimon	ιγ (μg L <sup>-1</sup> )	0.63	:				and Zinc				
		Arsenic	(μg L <sup>-1</sup> )	0.82									
		Barium (	(μg L <sup>-1</sup> )	41.70	)								
		Berylliur	m (μg L <sup>-1</sup> )	0.13	;								
		Cadmiur	m (μg L <sup>-1</sup> )	0.09	)								
		Chromiu	ım (μg L <sup>-1</sup> )	0.23	;								
		Copper (	(μg L <sup>-1</sup> )	3.42	1.	00 0.73 1.38	0			0.9	4 0.75 1.	19 0	
		Hexaval	ent Chromium (mg L <sup>-1</sup> )	0.01									
		Iron (mg	; L <sup>-1</sup> )	0.10									
		Lead (µg	L <sup>-1</sup> )	0.10	1.	40 0.48 4.04	0			1.0	7 0.56 2.	0 80	
		Mercury	ν (μg L <sup>-1</sup> )	0.02	:								
		Nickel (µ	µg L <sup>-1</sup> )	6.86	;								
		Seleniun	n (μg L <sup>-1</sup> )	1.33									
		Silver (µ	g L <sup>-1</sup> )	0.13									
		Thallium	n (µg L <sup>-1</sup> )	0.13									
		Zinc (µg	L <sup>-1</sup> )	27.97	1.	08 0.72 1.61	0			0.9	4 0.65 1.	37 0	
	Increase in Particula	ate Bound Metals						NE					NE
				No Data A	wailable								
	Increase in Metals i	n Periphyton						NE					NE
				No Data A	wailable								
Elevated Co	onductivity												
	Increase in Conduct	tivity						+					+
	Mean o	f Previous Quarter											
		Conduct	ivity mmhos cm <sup>-1</sup>	1233.88	s 1.	44 1.24 1.67	+			1.5	0 1.31 1.	72 +	
	Increase in Total Dis	ssolved Solids						NE					NE
	Mean o	f Previous Quarter											
		TDS (mg	L <sup>-1</sup> )	788	;								
		Chloride	e (mg L <sup>-1</sup> )	128.5	;								
		Hardnes	s (mg L <sup>-1</sup> )	350	)								

Candidate Cause	Proximate Measurement Components (units)	RD Value		on Insect <sup>-</sup> LCI UCI		Proximate Stressor Score	Comment	% Tolerant Taxa Rel Risk LCI UCI Scor	Proximate e Stressor Score
River Disco	ntinuity								
	Decrease in Recruitment					NE			NE
	Ν	o Data Avai	able						
	Decrease in Woody Debris					0		Y	0
	Length of Reach Where Present								
	Length w/ Small + Large Woody Debris	5.45	5 0.7	1 0.48 1.0	50			0.86 0.62 1.19 0	
	Decrease in Cobbles					NÊ			NE
	% of Reach Area Where Present								
	Cobbles (%)	0.0	)						
	Increase in Sands and Fines					+			+
	% of Reach Area Where Present								
	Sands and Fines (%)	19.1	1.8	36 1.39 2.5	0 +			1.68 1.28 2.20 +	
	Burial of Cobbles					NE			NE
	Mean % of Cobbles Embeddedness								
	Cobble Embeddedness (%)	(	)						
	Increase in Simplified Habitat					NE			NE
	nMDS Comparison of Sites Based on Habitat Types Present								
	Euclidean Distance from RD								
Habitat Sin	nplification								
	Change in Available Food					NE			NE
	nMDS Comparison of Sites Based Upon Food Type Availability								
	Euclidean Distance from RD								
	Increase in Channel Deepening					0			0
	Mean Thalweg Depth (cm)	26.5	5 1.3	85 0.98 1.8	60			1.03 0.77 1.37 0	
	Decrease in Riffles					NE			
		No Data A	wailable						
	Decrease in Woody Debris					0			0
	Length of Reach Where Present								
	Length w/ Small + Large Woody Debris	5.5	5 0.7	1 0.48 1.0	50			0.86 0.62 1.19 0	
	Decrease in Cobbles					0			
	% of Reach Area Where Present								
	Cobbles (%)	0.0	)						
	Increase in Sands and Fines					+			+
	% of Reach Area Where Present								
	Sands and Fines (%)	19.1	1.8	36 1.39 2.5	0 +			1.68 1.28 2.20 +	
	Decrease in Undercut Banks					-			0
	Length of Reach Where Present								
	Undercut banks (m)		5 0.6	5 0.49 0.8	7 -			0.82 0.59 1.13 0	
	Increase in Simplified Habitat					NE			NE
	nMDS Comparison of Sites Based on Habitat Types Present								
	Euclidean Distance from RD								

Candidate Cause	Proximate Stressor	Measurement	Components (units)	RD Value	<b>% N</b> Rel Rist	sect Ta	Proximate Stressor Score	Comment		<b>it Taxa</b> UCI Score	Proximate Stressor Score
Increased N	lutrients								K		
	Change in A	lgal Community					NE				NE
		nMDS Comparison of Sit	tes Based on Diatom Communty Structure								
		Bray-0	Curtis Similarity to RD								
	Increase in A	Algal Toxins					NE				NE
				No Data /	Available						
	Increase in						NE				NE
		Mean of Previous Quarte									
		рН		No Data /	Available						
		Mean of 24 Hours			_						
	In are as a d F	pH		7.77	/		NE				NE
	increased Fi	requency of Hypoxia	n Daytime Point Measures				INE				INE
			Hypoxia (2-5 mg L <sup>-1</sup> Dissolved Oxygen)	(							
			xia (<2.0 mg $L^{-1}$ Dissolved Oxygen)	(			/				
		Count of Observations in		Ì	,						
			Hypoxia (2-5 mg L <sup>-1</sup> Dissolved Oxygen)	(							
			xia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)		)						
	Increased A	mmonia Concentratior	ns				NE				NE
		Mean of Previous Quarte	er								
		Ammo	onia (mg L <sup>-1</sup> )	0.34	1 X						
				•							

Candidate Cause	Proximate Measurement Components (units)	RD         % Non Insect Taxa         Proximate         Comment         % Tolerant Taxa           Value         Rel Risk         LCI         UCI         Score         Rel Risk         LCI         UCI         Score	Proximate e Stressor Score
Pesticides			
	Increased Sediment Non-pyrethroid Pesticides	NE	NE
		No Data Available	
	Increased Water Column Non-pyrethroid Pesticides	NE	NE
	Maximum Value of Previous Year		
	4,4'-DDD (mg L <sup>-1</sup> )	bdl	
	4,4'-DDE (μg L <sup>-1</sup> )	bdl	
	Acrolein (μg L <sup>-1</sup> )	bdl	
	Acrylonitrile (μg L <sup>-1</sup> )	bdl	
	Aldrin (µg L <sup>-1</sup> )	bdl	
	alpha-BHC ( $\mu$ g L <sup>-1</sup> )	bdl	
	cis-1,3-Dichloropropene (µg L <sup>-1</sup> )	bdl	
	delta-BHC (µg L <sup>-1</sup> )	bdl	
	Diazinon (μg L <sup>-1</sup> )	bdl	
	Dieldrin (µg L <sup>-1</sup> )	bdl	
	Endosulfan I (µg L <sup>-1</sup> )	bdl	
	Endosulfan ΙΙ (μg L <sup>-1</sup> )	bdl	
	Endosulfan sulfate (µg L <sup>-1</sup> )	bdl	
	Endrin aldehyde (µg L <sup>-1</sup> )	bdl	
	Endrin (μg L <sup>-1</sup> )	bdl	
	Heptachlor Epoxide (Isomer B) ( $\mu$ g L <sup>-1</sup> )	bdl	
	Heptachlor (µg L <sup>-1</sup> )	bdl	
	Methoxychlor (μg L <sup>-1</sup> )	bdl 🔴	
	o,p'-DDD (μg L⁻¹)	bdl	
	о,р'-DDE (µg L <sup>-1</sup> )	bdl	
	о,р'-DDT (µg L <sup>-1</sup> )	bdl	
	р,р'-DDT (µg L <sup>-1</sup> )	bdl	
	Technical Chlordane (µg L <sup>-1</sup> )	bdl	
	Toxaphene (μg L <sup>-1</sup> )	bdl	
	Detection of Any Compound Above Detection Limit		
	Frequency of Detection (# observed/# measured)	0	
	Increased Water Column Pyrethroid Pesticides	NE	NE
		No Data Available	
	Increased Sediment Pyrethroid Pesticides	NE	NE
		No Data Available	
	Increased Water Column Herbicides	NE	NE
	Maximum Value of Previous Year		
	2,3,7,8-TCDD (pg L <sup>-1</sup> )	bdl	
	2,4,5-TP (Silvex) (µg L <sup>-1</sup> )	bdl	
	2,4'-D (µg L <sup>-1</sup> )	bdl	

Candidate Cause	Proximate Stressor	Measurement	Components (units)	RD Value	<b>% Non</b> Rel Risk L	Insect T	Proximate Stressor Score	Comment	<b>% To</b> Rel Risk	lerant Ta	Proximate Stressor Score
Temperatu	re										
	Increased W	/ater Temperature					NE				NE
		Mean of Previous Quar	rter								
		Wat	er Temperature (C)	26.39	1						
		Mean of Diel Measurer	ments (24hr)						1		
		Wat	er Temperature (C)	24.6	i						
	Decreased \	/ariability in Water Te	emperature				NE				NE
		Range of Previous Qua	rter					1			
		Wat	er Temperature (C)	9.06	i						
		Range of Diel Measure	ments (24hr)								
		Wat	er Temperature (C)	3.27							

Candidate Cause	Proximate Stressor	Measurement	Components (units)	RD Value	% Collector-Gath Individuals Rel Risk LCI UCI	Proximate Stressor Score	Comment		Predator Taxa	Proximate Stressor Score	Comment
Heavy Meta	als										
	Increase in D	Dissolved Metals					Only evaluated	• )		0	Only evaluated
			uarter (BDL = 1/2 MDL)				Copper, Lead,				Copper and
			ntimony (μg L <sup>-1</sup> )	0.63			and Zinc				Zinc
			senic (μg L <sup>-1</sup> )	0.82			(	1	Y		
			arium (μg L <sup>-1</sup> )	41.70							
			eryllium (μg L <sup>-1</sup> )	0.13							
			admium (µg L <sup>-1</sup> )	0.09							
			nromium (μg L <sup>-1</sup> )	0.23							
			ppper (µg L <sup>-1</sup> )	3.42				1.0	9 0.97 1.22 0		
			exavalent Chromium (mg L <sup>-1</sup> )	0.01							
			on (mg $L^{-1}$ )	0.10							
			ad (μg L <sup>-1</sup> )	0.10							
			ercury ( $\mu g L^{-1}$ )	0.02							
			ckel ( $\mu g L^{-1}$ )	6.86							
			$lenium (\mu g L^{-1})$	1.33							
			lver ( $\mu g L^{-1}$ )	0.13		)					
			hallium ( $\mu$ g L <sup>-1</sup> )	0.13							
			nc (μg L <sup>-1</sup> )	27.97	0.97 0.66 1.43	 NE		1.0	9 0.99 1.21 0	NE	
	Increase in P	Particulate Bound N	vietais	No Data	Available	NE				NE	
	Increase in M	Metals in Periphyto	n	NO Data	Available	NE				NE	
				No Data	Available						
Elevated Co	onductivity										
	Increase in C	Conductivity								+	
		Mean of Previous Qu									
		Co	onductivity mmhos cm <sup>-1</sup>	1233.9	1.52 1.25 1.85			2.2	4 1.91 2.63 +		
	Increase in T	otal Dissolved Soli	ds			NE					
		Mean of Previous Qu	Jarter								
			DS (mg L <sup>-1</sup> )	788							
			nloride (mg L <sup>-1</sup> )	128.5							
		Ha	ardness (mg L <sup>-1</sup> )	350							
		5									

Candidate Cause	Proximate Stressor	nent Components (units)	RD Value		Collector-Ga Individua isk LCI UC	s	Proximate Stressor Score	Comment		dator Taxa	Proximate Stressor Score	Comment
				Kel K	ISK LCI U	I Score			REI RISK LU	CI UCI Score		
liver Disco	Decrease in Recruitmer	at the second					NE				NE	
	Decrease in Recruitmen		No Data	Availa	hla		IN E				INC	
	Decrease in Woody Deb	nris		Availa	bie		0				0	
		ach Where Present					Ū			1	0	
	8	Length w/ Small + Large Woody Debris	5.45	5	1.19 0.75 1.	87			1.23 0	.78 1.93 0		
	Decrease in Cobbles						NE				NE	
		Area Where Present										
		Cobbles (%)	0.0	D								
	Increase in Sands and F	ines					0				0	
	% of Reach A	Area Where Present										
		Sands and Fines (%)	19.1	1	1.30 0.98 1.	73			1.00 0	.77 1.28 0		
	Burial of Cobbles						NE				NE	
	Mean % of C	Cobbles Embeddedness										
		Cobble Embeddedness (%)	C	D								
	Increase in Simplified H	labitat					NE				NE	
	nMDS Comp	arison of Sites Based on Habitat Types Present										
		Euclidean Distance from RD					)					
abitat Sin	nplification											
	Change in Available Foo	bd					NE				NE	
	nMDS Comp	arison of Sites Based Upon Food Type Availability										
		Euclidean Distance from RD										
	Increase in Channel Dee	epening					-				0	
		Mean Thalweg Depth (cm)	26.5	5	0.66 0.46 0.	95 -			0.90 0	.61 1.32 0		
	Decrease in Riffles						NE				NE	
			No Data	ı Availa	ble							
	Decrease in Woody Deb	pris					NE				0	
	Length of F	Reach Where Present										
		Length w/ Small + Large Woody Debris	5.5	5	1.19 0.75 1.	87			1.23 0	.78 1.93 0		
	Decrease in Cobbles						NE				NE	
	% of Reach A	Area Where Present										
		Cobbles (%)	0.0	D								
	Increase in Sands and F	ines									0	
	% of Reach A	Area Where Present										
		Sands and Fines (%)	19.1	1	1.30 0.98 1.	73			1.00 0	.77 1.28 0		
	Decrease in Undercut B										-	
	Length of Re	ach Where Present										
		Undercut banks (m)	5	5	0.46 0.32 0.	57			0.56 0	.38 0.81 -		
	Increase in Simplified F						NE					
	nMDS Comp	arison of Sites Based on Habitat Types Present										
		Euclidean Distance from RD										

Candidate Cause	Proximate Stressor	Measurement	Components (units)	RD Value	h	ector-Gath ndividuals LCI UCI	Proximate Stressor Score	Comment		lator Taxa	Proximate Stressor Score	Comment
creased N	Nutrients											
	Change in A	lgal Community					NE		0 K		NE	
		nMDS Comparison of Si	tes Based on Diatom Communty Structure									
		Bray-	Curtis Similarity to RD									
	Increase in A	Algal Toxins					NE	(	$\sim \sqrt{2}$		NE	
				No Data	Available							
	Increase in p	рН					NE				NE	
		Mean of Previous Quar	ter					X				
		pН		No Data	Available							
		Mean of 24 Hours					C					
		pН		7.7	7			)				
	Increased Fr	requency of Hypoxia					NE				NE	
			n Daytime Point Measures									
			Hypoxia (2-5 mg L <sup>-1</sup> Dissolved Oxygen)		)							
		Нуро	xia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)		)		×					
			n Diel Measures (24hrs)									
			Hypoxia (2-5 mg L <sup>-1</sup> Dissolved Oxygen)		)		)					
		Нуро	xia (<2.0 mg L <sup>-1</sup> Dissolved Oxygen)		)							
	Increased A	mmonia Concentratio	ns				NE				NE	
		Mean of Previous Quar										
		Amm	onia (mg L <sup>-1</sup> )	0.3	1							

Ammonia (mg L<sup>-1</sup>)

Candidate Cause	Proximate Stressor	Measurement	Components (units)	RD Value		llector-Ga Individua	le	Proximate Stressor Score	Comment		dator Taxa CI UCI Score	Proximate Stressor Score	Comment
esticides				i									
	Increased Se	ediment Non-pyre	throid Pesticides					NE		• X		NE	
				No Data	Availabl	2							
	Increased W	/ater Column Non-	-pyrethroid Pesticides					NE				NE	
		Maximum Value of	Previous Year						(				
		4	,4'-DDD (mg L <sup>-1</sup> )	bdl									
		4	-,4'-DDE (μg L <sup>-1</sup> )	bdl									
		Α	crolein (μg L <sup>-1</sup> )	bdl					K				
		Α	crylonitrile (μg L <sup>-1</sup> )	bdl									
		Α	ldrin (μg L <sup>-1</sup> )	bdl				C					
		а	lpha-BHC (μg L <sup>-1</sup> )	bdl									
		c	is-1,3-Dichloropropene (μg L⁻¹)	bdl									
		d	lelta-BHC (μg L <sup>-1</sup> )	bdl									
		C	Diazinon (μg L <sup>-1</sup> )	bdl									
		C	Dieldrin (μg L <sup>−1</sup> )	bdl									
		E	ndosulfan I (μg L <sup>-1</sup> )	bdl									
		E	ndosulfan II (μg L <sup>-1</sup> )	bdl									
		E	ndosulfan sulfate (μg L <sup>-1</sup> )	bdl									
		E	ndrin aldehyde (μg L <sup>-1</sup> )	bdl									
		E	ndrin (μg L <sup>-1</sup> )	bdl									
		F	leptachlor Epoxide (Isomer B) (μg L <sup>-1</sup> )	bdl									
		F	leptachlor (μg L <sup>-1</sup> )	bdl									
		Ν	Λethoxychlor (μg L <sup>-1</sup> )	bdl									
		C	p,p'-DDD (μg L <sup>-1</sup> )	bdl									
		C	p,p'-DDE (μg L <sup>-1</sup> )	bdl									
		C	,p'-DDT (μg L <sup>-1</sup> )	bdl									
		p	p,p'-DDT (μg L <sup>-1</sup> )	bdl									
		т	echnical Chlordane (μg L <sup>-1</sup> )	bdl									
		т	oxaphene (μg L <sup>-1</sup> )	bdl									
		Detection of Any Co	mpound Above Detection Limit										
		F	requency of Detection (# observed/# measured)	(	)								
	Increased W	/ater Column Pyre	throid Pesticides					NE				NE	
				No Data	Availabl	2							
	Increased Se	ediment Pyrethroi	d Pesticides					NE				NE	
				No Data	Availabl	2							
	Increased W	/ater Column Herb	icides					NE				NE	
		Maximum Value of	Previous Year										
		2	2,3,7,8-TCDD (pg L <sup>-1</sup> )	bdl									
		2	2,4,5-TP (Silvex) (μg L <sup>-1</sup> )	bdl									
		2	,4'-D (μg L <sup>-1</sup> )	bdl									

Candidate Cause	Proximate Stressor	Measurement	Components (units)	КD	1	<b>ctor-Gathere</b> <b>lividuals</b> LCI UCI Scc	Proxii		Comment	Predator Taxa	Proximate Stressor Score	Comment
Temperature								_				
I		/ater Temperature					Ν	IE			NE	
		Mean of Previous Quarte	er • Temperature (C)	26.39								
		Mean of Diel Measureme		20.59								
			Temperature (C)	24.6								
ſ	Decreased V	/ariability in Water Ten		24.0			N	IE			NE	
-		Range of Previous Quart						-	K			
			Temperature (C)	9.06								
		Range of Diel Measurem										
			Temperature (C)	3.27								
					•							

Table 9. Summary of scores for outside the case stressor-response from other field studies across the four biological endpoints for each proximate stressor in the candidate causes. Data are scored + for supporting evidence, - for weakening evidence, 0 for indeterminate evidence, -- if the biological endpoint is not below the degradation threshold, or NE for no evidence.

		% Non In	sect Taxa	% Tolera	ant Taxa	% CFCG I	ndividuals	Number of F	Predator Taxa
Candidate Cause	Proximate Stressor	Proximate Stressor Score	Comment						
Heavy Me	etals								
	Increase in Dissolved Metals	0	Only evaluated	0	Only evaluated		Only evaluated	0	
	Increase in Particulate Bound Metals	NE	Copper, Lead,	NE	Copper, Lead,	NE	Copper, Lead,	NE	Only evaluated Copper and Zinc
	Increase in Metals in Periphyton	NE	and Zinc	NE	and Zinc	NE	and Zinc	NE	copper and zinc
Elevated (	Conductivity								
	Increase in Conductivity	+		+		(		+	
	Increase in Total Dissolved Solids	NE		NE		NE		NE	
River Disc	ontinuity								
	Decrease in Recruitment	NE		NE		NE	1	NE	
	Decrease in Woody Debris	0		0				0	
	Decrease in Cobbles	NE		NE		NE		NE	
	Increase in Sands and Fines	+		+				0	
	Burial of Cobbles	NE		NE		NE		NE	
	Increase in Simplified Habitat	NE		NE		NE		NE	
Habitat Si	implification								
	Change in Available Food	NE		NE		NE		NE	
	Increase in Channel Deepening	0		0				0	
	Decrease in Riffles	NE		NE		NE		NE	
	Decrease in Woody Debris	0		0				0	
	Decrease in Cobbles	NE		NE		NE		NE	
	Increase in Sands and Fines	+		+				0	
	Decrease in Undercut Banks	-		0				-	
	Increase in Simplified Habitat	NE		NE		NE		NE	
Increased	Nutrients								
	Change in Algal Community	NE		NE		NE		NE	
	Increase in Algal Toxins	NE		NE		NE		NE	
	Increase in pH	NE	1	NE		NE		NE	
	Increased Frequency of Hypoxia	NE		NE		NE		NE	
	Increased Ammonia Concentrations	NE		NE		NE		NE	
Pesticides	5								
	Increased Sediment Non-pyrethroid Pesticides	NE		NE		NE		NE	
	Increased Water Column Non-pyrethroid Pesticides	NE		NE		NE		NE	
	Increased Water Column Pyrethroid Pesticides	NE		NE		NE		NE	
	Increased Sediment Pyrethroid Pesticides	NE		NE		NE		NE	
	Increased Water Column Herbicides	NE		NE		NE		NE	
Temperat									
-	Increased Water Temperature	NE		NE		NE		NE	
	Decreased Variability in Water Temperature	NE		NE		NE		NE	

#### Laboratory Data from Outside the Case

The laboratory data from outside the case line of evidence was evaluated by using species sensitivity distribution (SSD) curves to assess the relative toxicity of the observed heavy metal and pesticide compounds measured at the RD site. Species sensitivity distribution curves synthesize compound-specific laboratory toxicity tests, expressing the number of different taxa that show a toxic effect at different concentrations of that compound (e.g., Figure 13). Curves were available for Arsenic, Cadmium, Chromium, Copper, Nickel, Selenium, Zinc, and diazinon. Data were scored -- if the observed RD concentration was below any observed toxic level, - if the concentration produced less than a 10% species loss, 0 if the concentration was equivalent to between 10 - 30% species loss, + if the concentration was between 30 - 60% species loss, and ++ if the concentration produced greater than 60% species loss. All of the elements observed at RD that had applicable SSD curves were scored --, so dissolved metals were scored -- and consequently, so was the heavy metal candidate cause. The pesticides candidate cause was scored -- based upon the scores of water column non-pyrethroid pesticides. Increased water column non-pyrethroid pesticides was scored --, with diazinon scoring -- (Table 10). It should be noted that all of the SSD curves constructed for pesticides were still in draft form and have yet to undergo formal peer review (S. Hagerthey, *pers comm*).

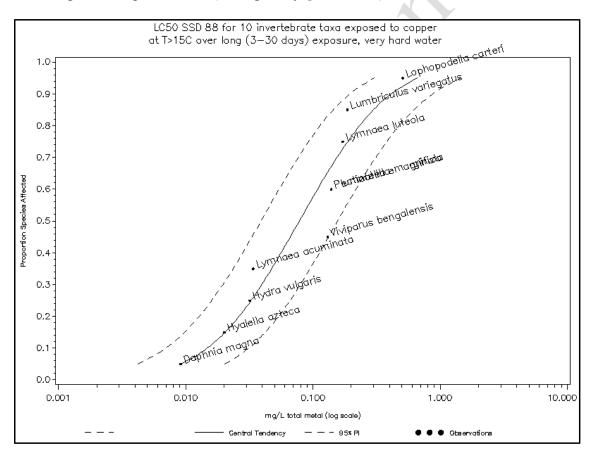


Figure 13. An example of a species sensitivity distribution curve (USEPA 2013) illustrating the different taxa where potential mortality would be expected from different concentrations of copper in water >15°C and >180 mg L<sup>-1</sup> CaCO<sub>3</sub> (i.e., warm, very hard water). The dashed line represents the mean monthly observed concentration of copper at the RD site (3.42  $\mu$ g L<sup>-1</sup>).

Table 10 Scoring of the laboratory data from outside the case line of evidence. Data from the test site were compared to published (metals) or draft (pesticides) species sensitivity distribution curves. Data are scored ++ for moderately strong supporting evidence, + for strongly supporting evidence, -- for moderately weakening evidence, - for weakening evidence, 0 for indeterminate evidence, or NE for no evidence. bdl = below detection limit.

Candidate	Proximate	Components (units)		Component	Comment	Proximate
Cause	Stressor		Value	Score		Stressor Score
avy Metal						
	Increase in Dissolve					
	Me	ean of Previous Quarter (BDL = $1/2$ MDL)				
		Antimony ( $\mu g L^{-1}$ )	0.63	NE	Not Londonce connected	
		Arsenic (μg L <sup>-1</sup> ) Barium (μg L <sup>-1</sup> )	0.82		Not Hardness corrected	X
		Barium (µg L) Beryllium (µg L <sup>-1</sup> )	41.70	NE		
		Cadmium ( $\mu g L^{-1}$ )	0.13	NE		
		Chromium (μg L <sup>-1</sup> )	0.09			
		Copper (µg L <sup>-1</sup> )	0.23			
		Hexavalent Chromium (mg $L^{-1}$ )	3.42	NE		
		From $(mg L^{-1})$	0.01 0.10	NE		
		Lead (µg L <sup>-1</sup> )	0.10	NE		
		Mercury ( $\mu g L^{-1}$ )	0.02	NL		
		Nickel ( $\mu g L^{-1}$ )	6.86			
		Selenium (µg L <sup>-1</sup> )	1.33		Not Hardness corrected	
		Silver (µg L <sup>-1</sup> )	0.13	NE	Not naraness corrected	
		Thallium ( $\mu g L^{-1}$ )	0.13	NE		
		Zinc ( $\mu g L^{-1}$ )	27.97	INE .		
	Increase in Particula		27.97			NE
	increase in randouid		No Data Availa	able		
	Increase in Metals i	in Periphyton				NE
			No Data Availa	able		
esticides						
	Increased Sediment No	n-pyrethroid Pesticides				NE
			No Data Availa	able		
	Increased Water Colum	nn Non-pyrethroid Pesticides				
	Ma	aximum Value of Previous Year				
		4,4'-DDD (μg L <sup>-1</sup> )	bdl	NE		
		4,4'-DDE (µg L <sup>-1</sup> )	bdl	NE		
		Acrolein (μg L <sup>-1</sup> )	bdl	NE		
		Acrylonitrile (μg L <sup>-1</sup> )	bdl	NE		
		Aldrin (μg L <sup>-1</sup> )	bdl	NE		
		alpha-BHC (µg L <sup>-1</sup> )	bdl	NE		
		cis-1,3-Dichloropropene (µg L <sup>-1</sup> )	bdl	NE		
		delta-BHC (µg L <sup>-1</sup> )	bdl	NE		
		Diazinon (µg L <sup>-1</sup> )	bdl			
		Dieldrin (µg L <sup>-1</sup> )	bdl	NE		
		Endosulfan I (µg L <sup>-1</sup> )	bdl	NE		
		Endosulfan II (µg L <sup>-1</sup> )	bdl	NE		
		Endosulfan sulfate (µg L <sup>-1</sup> )	bdl	NE		
		Endrin aldehyde (µg L <sup>-1</sup> )	bdl	NE		
		Endrin (µg L <sup>-1</sup> )	bdl	NE		
		Heptachlor Epoxide (Isomer B) (µg L <sup>-1</sup> )	bdl	NE		
		Heptachlor (µg L <sup>-1</sup> )	bdl	NE		
		Methoxychlor ( $\mu g L^{-1}$ )	bdl	NE		
		o,p'-DDD (μg L <sup>-1</sup> )	bdl	NE		
		o,p'-DDE (μg L <sup>-1</sup> )	bdl	NE		
		o,p'-DDT (μg L <sup>-1</sup> )	bdl	NE		
		p,p'-DDT (μg L <sup>-1</sup> )	bdl	NE		
		Technical Chlordane (µg L <sup>-1</sup> )	bdl	NE		
		Toxaphene (µg L <sup>-1</sup> )	bdl	NE		
	Increased Water Co	lumn Pyrethroid Pesticides				NE
			No Data Availa	able		
	increased Sediment	Pyrethroid Pesticides	N- D-t- A	, hi a		NE
	Increased Materia	Jump Llovbicidos	No Data Availa	able		NE
	Increased Water Co					NE
	Ma	aximum Value of Previous Year		NE		
		2,3,7,8-TCDD (pg L <sup>-1</sup> )	bdl	NE		
		2,4,5-TP (Silvex) (μg L <sup>-1</sup> ) 2,4'-D (μg L <sup>-1</sup> )	bdl bdl	NE NE		

## **Multi-Year Assessments**

Traditionally, causal assessments using the CADDIS framework have focused on a spatially and temporally constrained case definition (i.e., one test site and a single sampling event). These constraints have been both practical and philosophical. Practically, many sites that may need a causal assessment often have a limited amount of data at the test and comparator sites; especially data that are collected uniformly and concurrently at all of the sites. Philosophically, the constrained case definition can reduce complexity in the assessment as well as limit the number of candidate causes and their potential interaction. It can also make data management easier.

For all of the benefits, constraining the case definition in an assessment to a single point in time can also be problematic. Any biotic measurement used as the endpoint to an assessment is going to be prone to year-to-year variation independent of anthropogenic disturbance (e.g., variable recruitment, predation, or productivity rates). This natural biotic variability can be further exacerbated in environmentally variable systems like small streams in Mediterranean climates found through much of coastal southern California. The natural biotic variability may potentially obscure or distort the perceived impacts of stressors on stream biota, especially if the stressorresponse dynamics are subtle and non-acute. Given the chronic, non-point source nature of the impacts experienced by many of the streams throughout California, as well as the inherent yearto-year variability in stream macrobenthos, defining the case for a causal assessment so as to incorporate multiple years of data could potentially improve the accuracy of an assessment and improve the confidence in the results of the causal assessment.

Following convention, a spatially-temporally constrained framework was used for the assessment of the Santa Clara River (RD site in 2006). However, as noted in the main body of this report, the biomonitoring efforts along the upper Santa Clara River were part of their NPDES monitoring efforts. Consequently there was biological, chemical, water quality, and physical habitat data collected at multiples sites regularly for almost a decade. As such, the stakeholders and analysts felt that the Santa Clara River causal assessment provided a great opportunity for preliminary investigation into the utility of using a multi-year case definition in diagnosing the biotic conditions in a stream.

Conducting a meaningful causal assessment over multiple years will be dependent upon at least two assumptions. First is that all of the years under consideration are similar and free of natural stochastic events (i.e., anomalously wet or dry years or fires) that may also impact the biology observed at a site. If those events can be detected, the data from those years should not be included in a multi-year assessment. There are number of potential approaches for the detection of these kinds of anomalies including plotting of fire occurrence, rainfall, or flow data through time to look for outliers (e.g., Fig 14). From the biological perspective, plots of multivariate (e.g., non-metric Multi-Dimensional Scaling [nMDS]) or univariate (e.g., species richness, diversity, dominance) community characterizations from the test and comparator sites over the multiple years can be used to highlight any potentially anomalous years and to ensure relative comparability (e.g., Figures 15 and 16). A second assumption is that there is relatively consistent pressure from the same stressor(s) and a relatively similar biological response over the time period of interest. This assumption is probably best tested after the data analysis of the assessment has been conducted. If there is a lack of consistency in the stressor-biology patterns through the years or a large amount of variance in year-to-year data, then the assessment should not be done in the multi-year framework.

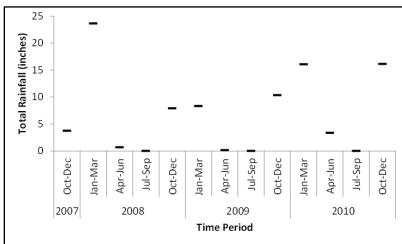


Figure 14 Total rainfall at US Geological Survey rain gauge located near the upper Santa Clara River (Fillmore, CA; Station ID 343120118533301) from October 2007-Decmeber 2010. No value was deemed anomalous and consequently no associated data were excluded from the assessment.

Once appropriate data are gathered and organized, there are a number of potential approaches to utilizing the stressor and biological data from multiple years. The goal of any of these approaches would be to incorporate the year-to-year variability in all of the data and the relationships between the biology and the stressors. The basic unit of data will vary from assessment to assessment, but uniformity should be used across all of the different years being incorporated into the assessment. As an example, for the Santa Clara River assessment it was decided among the stakeholders and analysts to use the biological and physical habitat data collected at the time of bioassessment and the mean or maximum observed values over the three months prior to bioassessment for water quality and chemistry data (where available). These data can then be synthesized across multiple years using an estimate of central tendency (e.g., means or median values across years), or the most frequently observed relationships from the individual years across the period of interest. The choice of which approach to use could vary from assessment to assessment, but should be a decision made by the data analyst in conjunction with the stakeholders involved in the case during the case definition process.

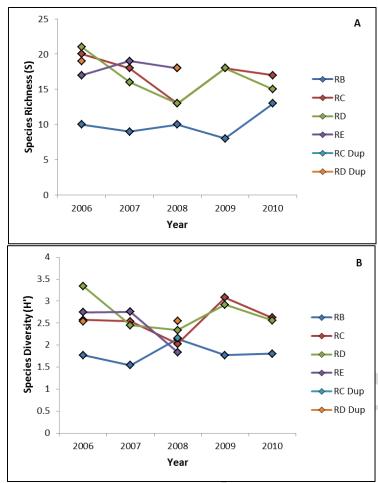


Figure 15 Species richness (A) and Shannon Weiner Diversity (B) of the macrobenthic community collected at the test site RD and comparator sites RB, RC, and RE in 2006 -2010. No particular year appears to be an outlier, so no data were excluded from the assessment. Note that a duplicate sample was collected at RC in 2008 and RD in 2006 and 2008

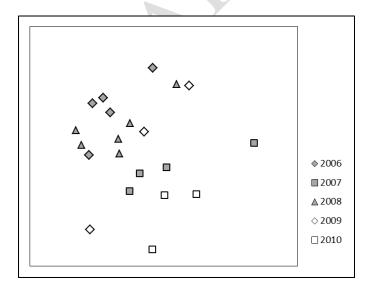


Figure 16 Non-metric multidimensional scaling (n-MDS) plot based upon Bray-Curtis similarity of macrobenthic community structure at the test site RD and the comparator sites RB, RC, and RE from 2006-2010. No single year appears to be an outlier, so no data were excluded from the assessment. Synthesizing and scoring data using measures of central tendency is relatively straight forward and most similar to the traditional evidence evaluation/scoring process. The arithmetic mean or median value for the appropriate time periods should be calculated from all of the data observations for each proximate stressor and biological endpoint used in the assessment. These mean or median values can then be evaluated using the different lines of evidence in the assessment and scored like any other data. It may be useful to look at the variance and heteroscedasticity of each proximate stressor/biotic endpoint to ensure that the data are indeed relatively comparable and therefore appropriate to be combined.

Several estimates of data distributions can be used, some are calculated relatively simply, but the lines of evidence using these data will have to be scored in a modified process. Example data distribution metrics can include the maximum and minimum observation, 25th, 50th, and 75th percentiles of all observations across the time period of interest. Once these values are calculated for each proximate stressor and biotic endpoint, they are scored individually for each line of evidence in the assessment (e.g., a separate score for each percentile). These individual scores will then be synthesized into a single score for each candidate cause.

Using the most frequently observed pattern across years will also require an additional scoring of evidence step. In this approach, stressor and biology data from each year are evaluated and scored independently for each time period of record. The scores are then synthesized by evaluating the frequency of supporting evidence across all time periods for that line of evidence. Frequent support can lead towards diagnosing the candidate cause and infrequency leads towards weakening the cause.

The Santa Clara River causal assessment provided a good opportunity to test these approaches for using multiple years of data in an assessment and to evaluate if they produced a different result than the single-year approach. The results of the single-year approach (Fall 2006) indicated elevated conductivity and temperature as potential causes to the biological impairment observed in the Santa Clara River (Figs 3 and 9). However, data for biological condition, conductivity, and temperature collected over a five year period (2006-2010). We used these data to evaluate the frequency approach to using multi-year data in a Causal Assessment. This analysis focused on assessing the temperature and elevated conductivity candidate causes from the test (RD) and comparator sites (RB, RC, and RE). The details of the frequency scoring and synthesis are presented, and then used to compare to the single year assessment (2006). Finally, we repeat the assessment using the mean of measures across years (mean), the median of measures observed across years (median), and the 25th, 50th, and 75th percentile measurements observed across years (percentiles), to compare assessments across the four different approaches to using multi-year data.

The 2006-2010 data synthesized with the frequency approach were used for within case lines of evidence (spatial co-occurrence and stressor response) and outside the case lines of evidence (reference comparison and stressor-response) in an evaluation of the biological impairment observed at the RD site in the upper Santa Clara River (Table 11). Both elevated conductivity and temperature were evaluated as likely causes for the degraded biologic condition observed at the RD site of the Santa Clara River. Elevated conductivity was a likely cause based upon multiple lines of evidence. Levels of conductivity observed at the RD site in each year were

higher than measures observed at environmentally similar reference sites. Furthermore, these levels were high enough to potentially cause degraded levels of three of the four biological endpoints based upon a relative risk approach to outside of the case stressor response. There was mixed evidence supporting elevated conductivity as a cause at some comparator sites and for some biological endpoints but weakening for others (Table 11). Though there were no outside of the case data available for evaluation for the temperature candidate cause, the spatial cooccurrence data at two sites and the stressor response relationships with non-insect taxa indicated that temperature was a likely candidate cause. It should be noted that both aspects of the temperature candidate cause, elevated mean temperature and decreased temperature range, tended to score in the same fashion across the different lines of evidence.

One of the primary differences between this multi-year assessment and the single year assessment is the use of comparator sites. Beyond the "baseline" comparator sites (RB, RC, and RE) used in the multi-year assessment, the single year assessment took advantage of a special study that occurred only in 2006 that provided an additional four comparator sites. In fact, that is why 2006 was originally chosen; data were not available for these additional sites for the 2007-2010 time period. As a result the additional comparator sites were not utilized for the multi-year assessment. Data completeness is another variable to consider when deciding if multi-year assessment is warranted.

Table 12 provides an example scoresheet for conductivity when applying spatial co-occurrence lines of evidence using the frequency-based approach to multi-year assessments. For the spatial co-occurrence line of evidence, elevated conductivity was scored "+" for RD vs. RB, "---" for RD vs. RC, and "0" for RD vs. RE. Conductivity and RD was always higher than at RB (scored "+") and lower or equivalent to measurements at RC and RE (scored "---" or "0"). Total dissolved solids (TDS) at RD – measured as TDS, hardness, and chloride – were most frequently higher than at RB and RE, while most frequently lower than measures from RC.

Table 13 provides an example scoresheet for conductivity when applying stressor-response lines of evidence using the frequency-based approach to multi-year assessments. Within the case stressor response was scored "+" for % abundance of collector-gatherers, "-" for % non-insect taxa, and "0" for % tolerant taxa and number of predator taxa. The individual proximate stressor of conductivity was most frequently scored "+" for collector-gatherer abundance, "-" for non-insect taxa, and "0" for tolerant and predator taxa. The proximate stressor of TDS was most frequently scored 0 for all four of the biological endpoints.

For the reference comparison and outside the case stressor response lines of evidence, data were only available for the proximate stressor of conductivity, so all elevated conductivity scores were the same as those for the proximate stressor. Conductivity at RD was greater in all years than the outer fence value of similar reference sites (683  $\mu$ mhos cm<sup>-1</sup>) and were consequently scored "+" (Table 14). Stressor response from outside the case was most frequently scored "--" for abundance of collector-gatherers, as this biological endpoint was most frequently not at a level indicative of degradation. Non-insect taxa, tolerant taxa, and predator taxa were all most frequently scored "+" (Table E).

Table 11 Comparison of summary score sheets for RD and each of the comparator sites in the Santa Clara River assessment using a single year and multiple years of data. Each candidate cause score is the integration of the component proximate stressor scores. The continuity line of evidence evaluates the continuity of each line of evidence for each of the four biological endpoints: % collector-gatherer abundance/% non-insect taxa/% tolerant taxa/# of predator taxa.

			RD ۷	/s RB	RD v	vs RC	RD v	's RE
	Candic	late Cause	Elevated Conductivity	Temperature	Elevated Conductivity	Temperature	Elevated Conductivity	Temperature
	Spatial Co	o-Occurrence	+	0		+		+
		Collector Abundance §	n/a	n/a	n/a	n/a	n/a	n/a
	Stressor	Non-Insect Taxa	-	+	-	+	-	+
Single	Response	Tolerant Taxa	0	0	0	0	0	0
Year		Predator Taxa	0	0	0	0	0	0
(2006)		e Condition parison	+	NE	+	NE	+	NE
	Stressor	Collector Abundance §		NE		NE	-	NE
	Response	Non-Insect Taxa	+	NE	+	NE	+	NE
		Tolerant Taxa	+	NE	+	NE	+	NE
		Predator Taxa	+	NE	+	NE	+	NE
	Con	itinuity	-/-/+/+	0/0/0/0	- - -	0/+/0/0	-/-/-/-	0/+/0/0
			RD v	/s RB	RD v	/s RC	RD v	's RE
	Candid	late Cause	Elevated Conductivity	Temperature	Elevated Conductivity	Temperature	Elevated Conductivity	Temperature
	Spatial Co	o-Occurrence	+			+	0	+
		Collector Abundance	+	-	+	-	+	-
	Stressor	Non-Insect Taxa	-	+	-	+	-	+
Multi-	Response	Tolerant Taxa	0	0	0	0	0	0
Year		Predator Taxa	0	0	0	0	0	0
(2006- 2010)		e Condition parison	+	NE	+	NE	+	NE
		Collector Abundance		NE		NE		NE
	Stressor Response	Non-Insect Taxa	+	NE	+	NE	+	NE
	From	Tuxu					,	
	From Outside the Case	Tolerant Taxa	+	NE	+	NE	+	NE
	Outside the		+ +	NE NE	+ +	NE NE	+ +	NE NE

§ Collector abundance in 2006 was not at a problematic level and thusly were not scored for stressor response from the field and scored -- where there were data for stressor response from outside the case

Candidate Cause	Proximate Stressor	Measure	Component	year	RD	RB	Difference	Score	Most Frequent Score	Proximate Stressor Score
Increased Conduc	•									
	Elevated Co	,								+
		Mean of pre	vious quarter point measures					Κ.		
			Conductivity (umhos/cm @25C)	2006	1207.3	1031.7	175.7	+	+	
			Conductivity (umhos/cm @25C)	2007	1236.7	1056.7	180.0	+		
			Conductivity (umhos/cm @25C)	2008	1210.0	1140.0	70.0	+		
			Conductivity (umhos/cm @25C)	2009	1230.0	1196.7	33.3	+		
			Conductivity (umhos/cm @25C)	2010	1240.0	1151.7	88.3	+		
	Elevated T	DS			(					+
		Mean of pre	vious quarter point measures							
			TDS (mg/l)	2005	758.3	626.0	132.3	+	+	
			TDS (mg/l)	2006	788.0	631.3	156.7	+		
			TDS (mg/l)	2007	761.0	620.7	140.3	+		
			TDS (mg/l)	2008	773.3	710.3	63.0	+		
			TDS (mg/l)	2009	787.3	726.0	61.3	+		
			TDS (mg/l)	2010 🔵	789.3	742.0	47.3	+		
			TDS (mg/l)	2011	743.3	724.7	18.7	+		
			Hardness (mg/l)	2005	306.7	204.0	102.7	+	+	
			Hardness (mg/l)	2006	350.0	195.0	155.0	+		
			Hardness (mg/l)	2007	336.0	182.0	154.0	+		
			Hardness (mg/l)	2008	342.3	259.0	83.3	+		
			Hardness (mg/l)	2009	317.7	219.0	98.7	+		
			Hardness (mg/l)	2010	344.2	249.3	94.9	+		
			Hardness (mg/l)	2011	351.2	228.5	122.7	+		
			Chloride (mg/l)	2005	128.9	130.2	-1.3			
			Chloride (mg/l)	2006	128.5	124.4	4.1	+		
			Chloride (mg/l)	2007	146.0	144.7	1.3	+		
			Chloride (mg/l)	2008	135.8	152.4	-16.6			
			Chloride (mg/l)	2009	127.7	146.2	-18.5			
			Chloride (mg/l)	2010	120.3	131.3	-11.0			
		/	Chloride (mg/l)	2011	107.3	118.3	-11.0			

Table 12. Detailed spatial-co-occurrence scoring sheet using the multi-year frequency approach for the increased conductivity and temperature candidate causes.

Candidate Cause	Proximate Stressor	Measure	Component	year	RD	RB	Difference	Score	Most Frequent Proximate Score Stressor Score
Temperature									
	Increased N	<i>l</i> ean Tempe	rature						
		Mean of pre	vious quarter point measures						
			Water Temperature (deg F)	2005	79.2	80.1	-0.9		
			Water Temperature (deg F)	2006	79.5	81.4	-1.9		
			Water Temperature (deg F)	2007	78.2	82.3	-4.1	A	
			Water Temperature (deg F)	2008	75.2	76.5	-1.3	· ,	
			Water Temperature (deg F)	2009	73.4	74.2	-0.7		
			Water Temperature (deg F)	2010	72.6	72.9	-0.3		
			Water Temperature (deg F)	2011	71.6	73.5	-1.8		
	Decreased	Range							
		Range of pre	evious quarter point measures						
			Water Temperature (deg F)	2005	4.1	6.3	-2.2	+	
			Water Temperature (deg F)	2006	6.9	3.1	3.8		
			Water Temperature (deg F)	2007	4.1	3.7	0.4		
			Water Temperature (deg F)	2008	15.1	9.2	5.9		
			Water Temperature (deg F)	2009	12.3	6.3	6.0		
			Water Temperature (deg F)	2010	9.0	7.9	1.1		
			Water Temperature (deg F)	2011	10.2	5.7	4.5		

-

Candidate Cause	Proximate Stressor	Measure	Component	year	RD	RC	Difference	Score	Most Frequent Score	Proximate Stressor Score
ncreased Conduc	ctivity								·XX	
	Elevated Co	onductivity								
		Mean of pre	evious quarter point measures							
			Conductivity (umhos/cm @25C)		1207.3	1295.7	-88.3			
			Conductivity (umhos/cm @25C)		1236.7	1383.3	-146.7			
			Conductivity (umhos/cm @25C)	2008	1210.0	1256.7	-46.7	,		
			Conductivity (umhos/cm @25C)	2009	1230.0	1293.3	-63.3			
			Conductivity (umhos/cm @25C)	2010	1240.0	1250.0	-10.0	)		
	Elevated TD									
		Mean of pre	evious quarter point measures							
			TDS (mg/l)	2005	758.3	890.0	-131.7			
			TDS (mg/l)	2006	788.0	866.7	-78.7			
			TDS (mg/l)	2007	761.0	917.0	-156.0			
			TDS (mg/l)	2008	773.3	867.0	-93.7			
			TDS (mg/l)	2009	787.3	846.0	-58.7			
			TDS (mg/l)	2010	789.3	828.7	-39.3			
			TDS (mg/l)	2011	743.3	783.3	-40.0			
			Hardness (mg/l)	2005	306.7	443.3	-136.7			
			Hardness (mg/l)	2006	350.0	472.7	-122.7			
			Hardness (mg/l)	2007	336.0	503.3	-167.3			
			Hardness (mg/l)	2008	342.3	465.7	-123.3			
			Hardness (mg/l)	2009	317.7	427.7	-110.0			
			Hardness (mg/l)	2010	344.2	437.3	-93.2			
			Hardness (mg/l)	2011	351.2	390.8	-39.7			
			Chloride (mg/l)	2005	128.9	118.5	10.4	+	+	
			Chloride (mg/l)	2006 2007	128.5 146.0	118.3	10.2 31.0	+		
			Chloride (mg/l)			115.0		+		
			Chloride (mg/l) Chloride (mg/l)	2008 2009	135.8 127.7	110.3 106.3	25.6 21.3	+		
			Chloride (mg/l)	2009 2010	127.7	106.3	21.3 18.9	+ +		
			Chloride (mg/l)	2010 2011	120.3	101.4 97.1	18.9	++		
				2011	101.2	51.1	10.2	т		

Candidate Cause	Proximate Stressor	Measure	Component	year	RD	RC	Difference	Score	Most Frequent Score S	Proximate tressor Score
Temperature									• X V	
	Increased N	Vlean Tempe	rature							+
		Mean of pre	vious quarter point measures							
			Water Temperature (deg F)	2005	79.2	76.7	2.5	+	+	
			Water Temperature (deg F)	2006	79.5	76.9	2.6	+		
			Water Temperature (deg F)	2007	78.2	70.6	7.6	+		
			Water Temperature (deg F)	2008	75.2	73.2	2.0	+ ,		
			Water Temperature (deg F)	2009	73.4	72.7	0.8	+		
			Water Temperature (deg F)	2010	72.6	70.7	1.8	+		
			Water Temperature (deg F)	2011	71.6	73.0	-1.4			
	Decreased	Temperature	e Range							+
		Range of pre	evious quarter point measures							
			Water Temperature (deg F)	2005	4.1	11.2	-7.1	+	+	
			Water Temperature (deg F)	2006	6.9	15.6	-8.7	+		
			Water Temperature (deg F)	2007	4.1	7.8	-3.7	+		
			Water Temperature (deg F)	2008	15.1	12.6	2.5			
			Water Temperature (deg F)	2009	12.3	16.2	-3.9	+		
			Water Temperature (deg F)	2010	9	15.9	-6.9	+		
			Water Temperature (deg F)	2011	10.2	16.5	-6.3	+		

Candidate Cause	Proximate Stressor	Measure	Component	year	RD	RE	Difference	Score	Most Frequent Proximate Score Stressor Scor
ncreased Condu	ctivity								
	Elevated Co	onductivity							
		Mean of pre	evious quarter point measures						
			Conductivity (umhos/cm @25C)	2006	1207.3	1232.3	-25.0		
			Conductivity (umhos/cm @25C)	2007	1236.7	1243.3	-6.7		
			Conductivity (umhos/cm @25C)	2008	1210.0	1253.3	-43.3		1
			Conductivity (umhos/cm @25C)	2009	1230.0	1213.3		0	
			Conductivity (umhos/cm @25C)	2010	1240.0	717.2	522.8	+	
	Elevated TD								+
		Mean of pre	evious quarter point measures						
			TDS (mg/l)	2005	758.3	716.7		+	+
			TDS (mg/l)	2006	788.0	815.0			
			TDS (mg/l)	2007	761.0	781.7			
			TDS (mg/l)	2008	773.3	711.3	62.0	+	
			TDS (mg/l)	2009	787.3	767.3	20.0	+	
			TDS (mg/l)	2010	789.3	550.0	239.3	+	
			TDS (mg/l)	2011	743.3	573.3	170.0	+	
			Hardness (mg/l)	2005	306.7	326.3	-19.7		
			Hardness (mg/l)	2006	350.0	380.7	-30.7		
			Hardness (mg/I)	2007	336.0	354.0	-18.0		
			Hardness (mg/l)	2008	342.3	401.0	-58.7		
			Hardness (mg/l)	2009	317.7	343.0	-25.3		
			Hardness (mg/I)	2010	344.2	215.0	129.2	+	
			Hardness (mg/l)	2011	351.2	220.3	130.8	+	
			Chloride (mg/l)	2005	128.9	97.8	31.1	+	+
			Chloride (mg/l)	2006	128.5	116.5	12.0	+	
			Chloride (mg/l)	2007	146.0	126.7	19.3	+	
			Chloride (mg/l)	2008	135.8	108.8	27.0	+	
			Chloride (mg/l)	2009	127.7	115.0	12.7	+	
			Chloride (mg/l)	2010	120.3	92.3	28.0	+	
			Chloride (mg/l)	2011	107.3	86.0	21.3	+	

Candidate Cause	Proximate Stressor	Measure	Component	year	RD	RE	Difference	Score	Most Frequent Proximate Score Stressor Score
Temperature									. XU
	Increased N	<i>l</i> ean Tempe	rature						+
		Mean of pre	vious quarter point measures						
			Water Temperature (deg F)	2005	79.2	76.5	2.6	+	+
			Water Temperature (deg F)	2006	79.5	78.3	1.2	+	
			Water Temperature (deg F)	2007	78.2	76.3	1.8	+	
			Water Temperature (deg F)	2008	75.2	72.4	2.8	+	
			Water Temperature (deg F)	2009	73.4	68.2	5.2	+	
			Water Temperature (deg F)	2010	72.6	65.5	7.1	+	
			Water Temperature (deg F)	2011	71.6	65.4	6.2	+	
	Decreased	Range						,	+
		Range of pre	vious quarter point measures						
			Water Temperature (deg F)	2005	4.1	13.18	-9.1	+	+
			Water Temperature (deg F)	2006	6.9	12.5	-5.6	+	
			Water Temperature (deg F)	2007	4.1	6.2	-2.1	+	
			Water Temperature (deg F)	2008	15.1	21.1	-6.0	+	
			Water Temperature (deg F)	2009	12.3	18.5	-6.2	+	
			Water Temperature (deg F)	2010	9	14.8	-5.8	+	
			Water Temperature (deg F)	2011	10.2	16.2	-6.0	+	

# Table 13. Detailed within the case stressor-response scoring sheet using the multi-year frequency approach for the increased conductivity and temperature candidate causes and the four biological endpoints.

Candidate Cause	Proximate	Measure	Component	year	% C	ollector	Abundance	Proximate			int Taxa	Proximate
canuluate cause	Stressor	weasure	component	уса	rho	score	freq score	Stressor Score	rho	score	freq score	Stressor Score
ncreased Condu	,											
	Elevated C							+				0
		Mean of p	previous quarter point measures									
			Conductivity (umhos/cm @25C)		0.82	+	+		-0.15		0	
				2007		0			0.95	+		
				2008 2009		+			-0.72 -0.50			
				2009		+ 0			-0.50 -1.00			
	Elevated T	סס		2010	0.50	0		0	-1.00			0
	Lievaleu i		previous quarter point measures					0				0
		Wicdin of p	TDS (mg/l)	2006	0.82	+	0		-0.15	0	0	
				2007		0	Ŭ		0.95		Ū	
				2008		0			-0.33			
				2009		+			-0.50			
				2010	0.50	0			-1.00	-		
			Hardness (mg/l)	2006	0.82	+	+		-0.15	0	0	
				2007	0.20	0			0.95	+		
				2008	0.79	+			-0.72	0		
				2009	1.00	+			-0.50	0		
				2010		0			-1.00	-		
			Chloride (mg/l)	2006		0	0		0.87	+	+	
				2007		0			-0.95	-		
				2008					0.93			
				2009		-			0.50			
				2010	-0.50	0			1.00	+		
Temperature	to an a second s											0
	Increased		previous quarter point measures					-				0
		wear or p	Water Temperature (deg F)	2006	-0.82				0.15	0	0	
			water remperature (deg r)		-0.20	0	-		-0.95		0	
					-0.79	-			0.93			
					-1.00	-			0.50			
					-0.50	0			1.00			
	Decreased	Range		0		-		0				0
		0	previous quarter point measures					-				-
		5	Water Temperature (deg F)	2006	0.82	-	0		-0.15	0	0	
				2007	0.20	0			0.95	-		
				2008		0			-0.57	0		
			Y	2009	1.00	-			-0.50	0		
			1	2010	0.50	0			-1.00	+		

Candidate	Proximate	Measure	Component	year	%	Non-Inse		Proximate		Predator Taxa		Proximate	
Cause	Stressor	weasure	component	year	rho	score	freq score	Stressor Score	rho	score	freq score	Stressor Score	
ncreased	Conductivity											O	
	Elevated Co	onductivity						-				0	
		Mean of p	revious quarter point measures										
			Conductivity (umhos/cm @25C)	2006	-0.82	-	-		0.50	0	0		
				2007	-0.40	0			0.95	-			
				2008	-0.72	0			-0.38	0			
				2009	-1.00	-			1.00	-			
				2010	-1.00	-			0.50	0			
	Elevated TD	S						0				0	
		Mean of p	revious quarter point measures										
			TDS (mg/l)	2006	-0.82	-	-		0.50	0	0		
				2007	-0.40	0			0.95	- )			
				2008	-0.33	0			-0.38	0			
				2009	-1.00	-			1.00				
				2010	-1.00	-			0.50	0			
			Hardness (mg/l)	2006	-0.82	-	-		0.50	0	0		
				2007	-0.40	0			0.95	-			
				2008	-0.72	0			-0.38	0			
				2009	-1.00	-			1.00	-			
				2010	-1.00	-			0.50	0			
			Chloride (mg/l)	2006	0.72	0	+		0.24	0	0		
				2007	0.00	0			-0.74	0			
				2008	0.93	+	X		0.19	0			
				2009	1.00	+			-1.00	+			
				2010	1.00	+			-0.50	0			
emperatu													
	Increased N							+				0	
		Mean of p	revious quarter point measures										
			Water Temperature (deg F)	2006	0.82	+	+		-0.50	0	0		
				2007	0.40	0			-0.95	-			
				2008	0.93	+			0.19	0			
				2009	1.00	+			-1.00	-			
				2010	1.00	+			-0.50	0			
	Decreased							+				0	
		Range of p	revious quarter point measures										
			Water Temperature (deg F)	2006		+	+		0.50	0	0		
				2007	-0.40	0			0.95	-			
				2008	-0.57	0			0.19	0			
				2009	-1.00	+			1.00	-			
				2010	-1.00	+			0.50	0			

Candidate	Proximate	Measure	Component	Year	RD	Score	Most Frequent	
Cause	Stressor	Medsure		icui	Value	50010	Score	Stressor Score
Increased Cor								
	Elevated Co	-						+
		Mean of pre-	vious quarter point measures	2000	4207.2			
			Conductivity (µmhos/cm @25C)		1207.3 1236.7		+	
					1230.7			
					1210.0			
					1230.0			
	Elevated T	05		2010	1240.0			NE
			vious quarter point measures					
		incuir of pre	TDS (mg/l)	2006	788.0	NE	NE	
				2007	761.0			
				2008	773.3			
				2009	787.3			
				2010				
			Hardness (mg/l)	2006	350.0			
				2007	336.0			
				2008	342.3	NE		
				2009	317.7	NE		
				2010	344.2	NE		
			Chloride (mg/l)	2006	128.5	NE		
				2007	146.0	NE		
				2008	135.8	NE		
				2009	127.7	NE		
				2010	120.3	NE		
Temperature								
		Aean Tempe						NE
		Mean of pre-	vious quarter point measures					
			Water Temperature (deg F)	2006	79.5		NE	
				2007	78.2			
		$\mathbf{V}$		2008	75.2			
		V		2009	73.4			
	Deerseed	Danga		2010	72.6	NE		
	Decreased	-	wigus quarter point measures					NE
	<b>Y</b>	nange of pre	vious quarter point measures Water Temperature (deg F)	2006	6.9	NE	NE	
				2008	4.1			
				2007	4.1 15.1			
				2008	12.3			
				2005	9			
				2010	5			

Table 14. Detailed scoring table of the reference condition comparison line of evidence for the increased conductivity and temperature candidate causes using the frequency approach to synthesizing multiple years of data.

					,								
					RD	% Col	ector-Ga	atherer Abu			% Non-	Insect Taxa	
Candidate Cause	Proximate Stressor	Measure	Component	Year	Stressor Value	Biotic Value	Score	Most Frequent	Proximate Stressor Score	Biotic Value	Score	Most Frequent	Proximat Stressor Score
ncreased Cond													
Ele	evated Conduct	tivity											+
		Mean of pre	vious quarter point measures										
			Conductivity (umhos/cm @25C)	2006	1207.3	66.4				35.2	+	+	
				2006	1207.3	82.2	+			23.7			
				2007	1236.7	86.0	+			5.5			
				2008	1210.0	70.9				38.5	+		
				2008	1210.0	53.7				33.3	+		
				2009	1230.0	66.8	/			38.9	+		
				2010	1240.0	90.8	+			30.8	+		
	Elevated TD	S							NE				NE
		Mean of pre	vious quarter point measures										
			TDS (mg/l)	2006	788.0		NE	NE			NE	NE	
				2007	761.0		NE				NE		
				2008	773.3		NE				NE		
				2009	787.3		NE				NE		
				2010	789.3		NE				NE		
			Hardness (mg/l)	2006	350.0		NE				NE		
				2007	336.0		NE				NE		
				2008	342.3		NE				NE		
				2009	317.7		NE				NE		
				2010	344.2		NE				NE		
			Chloride (mg/l)	2006	128.5		NE				NE		
				2007	146.0		NE				NE		
				2008	135.8		NE				NE		
				2009	127.7		NE				NE		
				2010	120.3		NE				NE		
		$\bigcirc$											

Table 15. Detailed scoring table for outside of the case stressor-response for increased conductivity and temperature candidate causes and the four biological endpoints using the frequency approach to synthesizing multiple years of data.

					RD	% Col	llector-Ga	therer Abu	ndance		% Non-	Insect Taxa	
Candidate Cause	Proximate Stressor	Measure	Component	Year	Stressor Value	Biotic Value	Score	Most Frequent	Proximate Stressor Score	Biotic Value	Score	Most Frequent	Proximate Stressor Score
Temperature		lean Temperatu Mean of previo	re us quarter point measures						NE				NE
			ater Temperature (deg F)	2006	79.5		NE	NE			NE	NE	
				2007	78.2		NE	K			NE		
				2008	75.2		NE				NE		
				2009	73.4		NE				NE		
				2010	72.6		NE				NE		
	Decreased R	Range							NE				NE
		Range of previo	ous quarter point measures										
		W	ater Temperature (deg F)	2006	6.9		NE	NE			NE	NE	
				2007	4.1		NE				NE		
				2008	15.1		NE				NE		
				2009	12.3		NE				NE		
				2010	9		NE				NE		

					RD		% Tole	erant Taxa			# Pred	ator Taxa	
Candidate Cause	Proximate Stressor	Measure	Component	Year	Stressor Value	Biotic Value	Score	Most Frequent	Proximate Stressor Score	Biotic Value	Score	Most Frequent	Proximate Stressor Score
Increased C	Conductivity												
Eleva	ated Conduc	-							+				+
			revious quarter point measures							) (		+	
			Conductivity (umhos/cm @25C)	2006			+	+		8			
				2006						5	+		
				2007	1236.7					3	+		
				2008			+			4	+		
				2008			+			8			
				2009		1	+			7			
				2010	1240.0	16.7				3	+		
	Elevated TI								NE				NE
		-	revious quarter point measures										
			TDS (mg/l)	2006			NE	NE			NE	NE	
				2007	761.0		NE				NE		
				2008			NE				NE		
				2009			NE				NE		
				2010			NE				NE		
			Hardness (mg/l)	2006			NE				NE		
				2007	336.0		NE				NE		
				2008			NE				NE		
				2009			NE				NE		
				2010			NE				NE		
			Chloride (mg/l)	2006			NE				NE		
				2007	146.0		NE				NE		
				2008			NE				NE		
				2009			NE				NE		
				2010	120.3		NE				NE		

				RD	0	% Tole	rant Taxa			# Pred	ator Taxa	
Candidate Cause	Proximate Stressor	Component	Year	Stressor Value	Biotic Value	Score	Most Frequent	Proximate Stressor Score	Biotic Value	Score	Most Frequent	Proximate Stressor Score
Temperatu	re											
	Increased Mean Tempera	ture						NE				NE
	Mean of previ	ous quarter point measures							) 1			
	Wa	ter Temperature (deg F)	2006	79.5		NE	NE			NE	NE	
			2007	78.2		NE				NE		
			2008	75.2		NE				NE		
			2009	73.4		NE				NE		
			2010	72.6		NE				NE		
	Decreased Range							NE				NE
	Range of prev	ious quarter point measures										
	Wa	ter Temperature (deg F)	2006	6.9		NE	NE			NE	NE	
			2007	4.1		NE				NE		
			2008	15.1		NE				NE		
			2009	12.3		NE				NE		
			2010	9		NE				NE		

 The temperature candidate cause was scored "---" for spatial co-occurrence for RD vs. RB and "+" for RD vs. RC and RD vs. RE. The temperature candidate cause was comprised of two proximate stressors: elevated mean temperature across the 3 months prior to bioassessment and decreased range across the 3 months prior to bioassessment. Both temperature proximate stressors were most frequently scored "---" comparing RD to RB and both were most frequently scored "+" comparing RD to RC and RE (Table B).

The within the case stressor response line of evidence for temperature was scored "-" for % collector-gatherer abundance; most frequently scored "-" for elevated mean temperature and "0" for decreased temperature range. The % non-insect taxa was scored "+", with both increased mean temperature and decreased temperature range most frequently scored "+". Both % tolerant taxa and number of predator taxa were scored "0", as were both of the respective proximate stressors (Table 13).

No data were available for evaluation of either of the temperature proximate stressors using reference site comparison or stressor response from outside the case lines of evidence. Consequently, they were scored "NE" for all of the biological endpoints.

Table 16 details the scoring for each of the median, mean, percentiles, and frequency multi-year methods for within the case stressor-response for each of the biological endpoints. The different approaches to synthesizing the multi-year data produced relatively comparable patterns in the proximate stressor scores (and their constituent components), as well as the candidate causes. Temperature and elevated conductivity remained likely candidate causes.

The outcome of the causal assessment evaluating the temperature and elevated conductivity candidate causes was essentially the same whether the assessment was based only on the 2006 single-year data or all of the multi-year data from 2006-2010 (Table 11). In both approaches, the elevated conductivity assessment was driven by the pattern in the data from elsewhere and temperature was driven by the spatial co-occurrence and stressor-response patterns for within the case data.

The similarities in conclusions for conductivity and temperature candidate causes between the single-year and multi-year approaches to Casual Assessment, and the similarities in outcome regardless of the different approaches to scoring, synthesizing and assessing the multi-year data, provides increased confidence in the final conclusions. This type of multi-year evidence helps dissuade issues related to year-to-year variability.

Table 16. Summary score sheet for the within case stressor-response line of evidence comparing scoring results the frequency, percentile, median, and means approaches to synthesizing multiple years of data. Proximate stressor (PS Score) and candidate cause (CC Score) scores are presented for the increased conductivity and temperature candidate causes and their component proximate stressors.

		Frequenc	у								Perce	entiles			
Candidate Cause	Proximate Stressor	% Collector Abundance	% Tolerant Taxa		% Non-Inse	ct Taxa	# of Predator Taxa		 % Collector Abundance	% Tolerant Taxa		% Non-Insect Taxa		# of Pred	ator Taxa
		PS Score CC Score	PS Score	CC Score	PS Score C	C Score	PS Score	CC Score	PS Score CC Score	PS Score	CC Score	PS Score	CC Score	PS Score	CC Score
Increased Conduc	tivity	+		0		-		0	+		0		-		-
	Elevated Conductivity	+	0		-		0	_	+	0		-		-	
	Elevated TDS	0	0		0		0	_	+	+		0		-	
Temperature		-		0		+		0			0		+		0
	Increased Mean Temperature	-	0		+		0	_	-	0		+		0	
	Decreased Range	0	0		+		0			0		+		-	
		1	1	Med	lians		8				Me	ans		1	
Candidate Cause	Proximate Stressor	% Collector Abundance	% Tolerant Taxa		% Non-Insect Taxa		# of Predator Taxa		<ul> <li>% Collector</li> <li>Abundance</li> </ul>	% Tolerant Taxa		% Non-Insect Tax		xa # of Predator Ta	
		PS Score CC Score	PS Score	CC Score	PS Score C	C Score	PS Score	CC Score	PS Score CC Score	PS Score	CC Score	PS Score	CC Score	PS Score	CC Score
Increased Conduc	tivity	0		0		0		1	0		0		0		0
	Elevated Conductivity	0	0		0				0	0		0		0	
	Elevated TDS	0	0		0		-	_	0	0		0		0	
Temperature		0		0		+		0	-		+		0		0
	Increased Mean Temperature	0	0		++		0	_	-	+		+		+	
	Decreased Range	0	0		+		-	_	-	+		-		-	

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