Friends of the Napa River

Institute for Conservation Advocacy Research and Education

Results from Phase I (2000-2004) Multi-metric Monitoring Project for Benthic Macro Invertebrates in the Napa River Basin.

Final Report

Prepared by T.C. Dewberry
Florence, Oregon

For: Friends of Napa River, Napa California
Project Manager
Chris Malan

June 20, 2005

Final Report from the Multi-metric Benthic Invertebrate Monitoring Project for the Napa River Basin (2000-2004).

Abstract

This report summarizes Phase I (2000-2004) of the Friends of Napa River's Benthic invertebrate monitoring program. Sample methods followed the state of California's California Stream Bioassessment Procedure. The samples were analyzed by Aquatic Biology Associates, Inc, Corvallis, Oregon. The laboratory analyzed the samples from the Napa River using a 500 individual sampling scheme including large rare individuals. The taxonomic effort (STE) used for this project are higher than the CSBP STE and other projects in the Bay area.

A total of 173 samples were collected over the 5-year period. For the first phase analysis 5 metrics were selected: taxa richness, EPT taxa, Plecoptera taxa, % predators, and number of intolerant taxa. The range of values of the attributes of the macro-invertebrate community was very high. Taxa richness ran as high as the 90's. Several rare and possibly new species were collected. The high quality sites in Napa have some of the highest aquatic biodiversity reported in the Pacific Northwest. An old-growth site from Oregon or Washington might have a maximum richness of approximately 60 taxa. Because of the higher taxonomic effort in the Napa project, we did not compare our richness results to other bay area projects.

The annual total richness for the 5 year period from 2000-2004 were: 62.9, 59.1, 48.8, 44.6, and 53.5 respectively. This is a high variance from year-to-year. As a result the 5 years of samples were not lumped to create a standard IBI. However, an exploratory IBI was constructed using 5 candidate metrics. Exploratory IBI scores for selected sites ranged from 5- 25. The Napa IBI is very sensitive to natural events and management activities.

The average exploratory IBI scores for the Napa Basin as a whole for the 5 years were: 18.2 (2000), 17.5 (2001), 13.6 (2002), 12.1 (2003), and 15.8 (2004). There was a dramatic decline over the first 4 years. The fifth year increased to about the average for the 5 years of survey. No obvious explanation accounts for the decline during the first 4 years of survey. It is likely that the 2003 sample was affected by a major storm in March 2003 about a month before the samples were collected. It is possible that the decline reflects a combination of factors that will be identified during the next phase of the analysis.

Introduction

The use of benthic invertebrates for determining the health and integrity of aquatic systems is well accepted. For example, the Environmental Protection Agency (EPA) recognizes benthic invertebrate monitoring as a means of establishing the biological integrity of aquatic systems under the Clean Water Act. In California, the California Stream Bioassessment Procedure (CSBP) is a regional collection method which can be adapted to the national EPA Rapid Bioassessment Protocols. The method is a sensitive, cost-effective means of determining a stream's biological and physical integrity.

In December 1998, the Institute of Fisheries Resources (1998) finished a study of the Napa River basin. One of their conclusions was that information about benthic invertebrates within the Napa River basin was non-existent.

In 1999, the Friends of Napa River (FONR) obtained a grant from the Mennen Environmental Foundation with the goal of establishing a long-term biological monitoring program for the Napa River. They organized a Scientific Oversight Panel and hired Charley Dewberry, Ph.D., of Ecotrust to provide technical assistance. FONR identified three objectives for the Napa River benthic invertebrate study:

1) To establish a benthic invertebrate monitoring program for assessing the biological/ecological condition and trends within the Napa River basin. This program is specifically aimed at tracking water quality for supporting native fish populations.
2) Establish a benthic invertebrate program to help identify causal relationships between land use decisions and the response of the benthic invertebrate communities in the streams.
3) To develop and disseminate materials for educational use.

This report summarizes the five years of collections and synthesizes the information into a preliminary IBI for the Napa basin. A total of 173 samples were collected during the five year period at sites throughout the basin. This collection is the largest aquatic macro-invertebrate survey undertaken in the Napa basin. This information was then used to identify 5 metrics which are then synthesized into the preliminary Index of Biological Integrity (IBI) for the basin. This preliminary IBI is then used to track the trajectory of biological change in the basin. The index is also used to help identify the causal relationships between land use decisions and the response of the benthic invertebrate communities in the streams of the Napa basin.

Methods

The California Stream Bioassessment Procedure was selected as the collection technique because it is the method recognized by the State of California as suitable for use in the Napa basin. The California Procedure has been recently modified to a single replicate sub-sample of 500 individuals rather than 3 replicates of 300 individuals, which was the previously standard. All our sampling from the beginning was based on a single replicate 500 individuals because of the absence of macro-invertebrate sampling in the Napa basin. As a result, all of our sample collections were the same from 2000 through 2004.

Sampling Scheme

A sampling scheme needs to be carefully crafted in order to accomplish the goals and objectives of the project because the best strategy for accomplishing each of the first two objectives is different. Therefore, the overall sampling scheme must balance the needs of both of these objectives. The best strategy for accomplishing the first objective is a random strategy. The locations are determined by a method that makes the selection of any particular site equally likely within the Napa River basin. In this strategy no assumption about causal relationships or inference is made. The advantage of this strategy is that the results can be extrapolated to the entire watershed. This strategy can be used to say something about the entire Napa River basin. The major disadvantage of this strategy is that a large number of samples are necessary to draw causal inferences

To accomplish the second objective, causal inference, samples need to represent the whole range of a particular variable. It is important that representatives of the best sites and the worst sites for the particular variable are included. Here certain assumptions are made and sample locations are selected based on particular factors or categories of interest. The classical sampling scheme for establishing causal inference is the upstream-downstream paired collection. It is assumed that a particular activity results in a change in the stream macro-invertebrate communities. An upstream site is selected to represent the control or “natural” condition and a downstream site is selected to determine the response of an action taken between the sites. For example, the question could be asked, “Does activity X affect the health of a stream?” We could identify 10 sites where activity X is occurring at varying levels and we could collect 10 paired upstream-downstream samples to examine the question of interest. The advantage of this approach is that a relatively few number of sites are necessary to establish a relationship between the activity and the response, when compared to a randomized strategy. This method works best for activities that affect streams at a single point. The main disadvantage of this sampling strategy is that no conclusion can be extrapolated from the samples to say anything about the health of the watershed as a whole or about general long-term trends.

Another modification of this strategy is to collect samples from throughout the basin based on the range of the variable of interest and examine the trends in the biological communities of these sites. This method, which we selected for this study, is more appropriate for activities that are distributed throughout a watershed rather than at a single point.

The strategy that we selected balances the needs of the two objectives of this study. During each of the five years, we sampled 30-40 sites. All sample locations for this study were wadable streams greater than 1 meter in width with gravel riffles.

The random sites were selected by the following procedure: The name of all tributaries were placed in a container and drawn out until the necessary number of sites had been collected. The specific location for each sample tributary was determined by drawing a location from the pool of possible candidate locations where we could sample. In addition two reference sites (Mill and Ritchey) were sampled in four of the five years.

Method at a site

The California Stream Bioassessment Procedure (CSBP) is a standardized protocol for collecting biological and physical/habitat conditions of wadable streams in California. We used the non-point sources sample design (see the CSBP web site for more information). During the spring sampling there were two teams under the supervision of a team leader. The team leaders were experienced at sampling benthic invertebrates using the procedure. The spring sampling began with both teams working together to standardize the procedures.

One sample was collected from the upstream third of 3 randomly chosen riffles. Within each randomly selected riffle, starting from the downstream riffle, a measuring tape is placed along one of the banks for the full length of the riffle. The number of transects at 1 meter intervals that are within the upper third of the riffle are identified and the transect for sampling is determined using a random number table. Three sub-samples are collected along the transect. If the substrate is homogeneous, the two samples are taken from near each side of the channel and the third from the center of the channel. If the stream substrates vary, then the three sub-samples are collected from distinct habitat types.

Once the location of the riffle has been made and the sites along the transect determined, then the samples are taken by placing a D-ring kick net (with a .5mm mesh) at the downstream end of the sample location. A 1’x2’ area and 4-6” deep is disturbed above the net. The insects are allowed to drift into the net. Large cobbles are picked up and their surface scrapped to remove any insects. At each sample site, the collection was taken 2 minutes for each sub-sample.

The contents of the kick net were then placed into a pan or .5mm sieve. Gravel and larger sticks were removed after being carefully scraped for benthic invertebrates. Leaves and all organic material were retained. The sample was then placed in a sample jar and preserved with 95% ethanol. A site label was placed in each jar. If a sample did not fit into a single jar, one or more additional jars were used to store the sample. Labels were placed in all jars.

This procedure was repeated for the other two additional riffles at the site. Sample jars remained in the custody of the team leaders until the end of the day. All samples were stored in a locked cabinet until the conclusion of the sample period. The samples were then transported by C. Dewberry to Aquatic Biology Associates, Inc. in Corvallis, Oregon for analysis. The chain-of-custody forms followed the samples to the laboratory.

At each site the physical habitat was also scored using the California Bioassessment Worksheet. The scores of each section (20) were summed to yield the total site score. The maximum possible score is 200 for the best habitat. Physical/ habitat characteristics included: characterizing the channel, degree of deposition and bank erosion, riparian and canopy characteristics, and the degree of channel alteration.

Sample Analysis

Aquatic Biology Associates, Inc. analyzed the samples using a 500 individual sub-sample including large and rare individuals. The individuals were identified to at least genera and to species where possible. This included the chironomids which were identified to genus. The reasons for this choice were: First, since few benthic invertebrate samples have been collected in the Napa basin we wanted to have a fuller list of species found in the basin. Second, the CSBP has recently increased their subsamples to 500 individuals. By having the laboratory sample 500 specimens, a fuller species list is obtained. In addition beginning in 2000 we used a higher taxonomic effort than was currently then in use by state agencies in the bay area. Also, by including the large and rare taxa, a more accurate picture of the community is obtained. The notion of including large and rare taxa comes from plant ecology. Consider the following example; a random sample of stems is drawn from a 5 m X 5 m plot. There are 5,000 grass and herb stems and one Oak tree stem. If the Oak tree is not included, the description of the plant community is incomplete and gives a false impression. The logic for including large and rare individuals in the aquatic samples is similar.

Results and Discussion

From 2000-2004 (Phase I) a total of 173 samples were collected throughout the Napa basin (see Figure 1 and Table 1). These samples were used to construct a preliminary Index of Biological Integrity (IBI) for the Napa Basin to explore the five years of surveys (see Karr and Chu 1997).

Objective 1. Construct the Napa basin IBI to track the baseline and trends of biological integrity in the Napa Basin.

The objective of the Napa project was to construct a baseline and establish an IBI for use in the Napa basin. We were only partially successful. We established a solid baseline of information and we required a high level of taxonomic effort. However, the taxa richness of the samples over the 5 year period from 2000-2004 were: 62.9, 59.1, 48.8, 44.6, and 53.5 respectively. This is a high variance from year-to-year. As a result the 5 years of samples were not lumped to create a standard IBI, because taxa richness is the major driver of an IBI. However, an exploratory IBI was constructed using 5 candidate metrics.

Exploratory IBI scores for selected sites ranged from 5- 25. The Napa IBI is very sensitive to natural events and management activities.

The macro-invertebrate samples collected during 2000-2004 were used to construct an exploratory Index of Biological Integrity (IBI) for the Napa Basin. The samples are used to develop metrics for the macro-invertebrate which are summarized into the exploratory IBI.

Potential metrics (biological attributes) were graphed with the habitat scores following the CSBP protocol recorded at each site. Figures 2-7 graphically display the results from several possible metrics from the 2004 samples. Figure 2 displays the relationship between the species richness and habitat scores for the sites collected in 2004. It is anticipated the better sites (higher habitat scores) have the highest number of taxa. The range of taxa observed in the samples was from 20-79. Species richness was accepted as a potential metric. There is a general increase in the number of taxa present with increasing habitat scores. Also, the three sites with the lowest habitat scores had a significantly lower range of richness values than those for the three sites with the highest habitat scores. There is no overlap in the range of richness values between the extreme sites.

The relationship between EPT taxa and habitat scores was also analyzed as a possible metric. EPT stands for the total taxa of Ephemeroptera (mayflies), Plecoptera (stoneflies), and Tricoptera (caddisflies). It is anticipated that the total taxa of these groups will increase as habitat scores increase. Figure 3 illustrates the relationship between the EPT taxa and the habitat scores. The range of EPT taxa was from 1 to 37 from the 2004 samples. There was a general increase in EPT taxa as the habitat score increased. Also, the range of values of the three sites with the lowest habitat scores was lower than the range of EPT taxa for the three sites with the highest habitat scores. Therefore, the EPT was accepted as a potential metric.

The analysis of the other candidate metrics was completed in similar fashion. The following candidates were accepted: the number of Plecoptera taxa, percent predators, and number of intolerant taxa. The number of Plecoptera taxa was accepted as a potential metric as well as the EPT taxa because the Plecoptera taxa captures a different dose response than the EPT taxa as a whole. The number of Plecoptera taxa does not track closely the EPT taxa (see Table 2).

The percent dominance was rejected as a potential metric based on the 2004 survey information (see Figure 7). It was anticipated that the percent dominance would decline as the habitat scores increased in the survey. However, the percent dominance did not show the expected result. There was no general decline in percent dominance as the habitat scores rose. Also, the range of percent dominance values overlapped between the high and low site habitat scores. Samples collected in previous years were analyzed in a similar fashion and reported as the lab results were available in the annual reports.

Summaries of the five years of sampling are compiled in Table 2 (A-E). Each table contains the streams sampled, the habitat score, and five possible metrics: richness, EPT, Plecoptera Taxa, percent predator, and number of intolerant taxa. These samples were used to identify and set the values for community metrics in the analysis. In the future, it is likely that the classification of intolerant taxa will be improved.

How accurate and replicable are these samples? During the five years of surveys, two sites, Mill Creek and Ritchey Creek were designated as reference streams. These streams are adjacent to each other and they are both mostly in the State Parks. It is anticipated that these two sites have a high likelihood of continuing with the same management regime for a considerable period of time. This is not to say that they are anticipated to remain constant. They will not. Rather, they will continue along a trajectory given similar land management.

Table 3 includes the results from the samples collected at these two sites over the five year period. They are remarkably consistent with each other. The number of taxa and the EPT [Ephemeroptera (mayflies), Plecoptera (stoneflies), and Tricoptera (caddisflies)] taxa are usually well within 10% of each other. The only exception is the EPT in 2001. The EPT was 30 in Mill Creek and 35 in Ritchey Creek. There are some variations between the years which will be discussed in a later section.

Table 4 is a summary of potential metrics and their scoring derived from the five years of surveys as a whole. The first observation is that the average species richness of Napa samples is high. A number of samples had a richness of the high 80’s and low 90’s. For comparison, old-growth watersheds in the Pacific Northwest have a maximum richness of about 60 taxa. Also, during the surveys several rare and possibly new species were collected. Because of the high taxonomic effort of the Napa project, taxa richness with other bay area projects are not directly comparable. For this exploratory IBI samples with a richness of 60 taxa were considered high. Samples from 40-60 were considered average, and samples less than 40 were considered low. From the potential list of candidates for metrics, five were selected for analysis in Phase I of the project: richness, EPT (mayflies, stoneflies, and caddisflies), Plecoptera taxa, % predators, number of intolerant taxa. All these potential metrics had a wide range of values.

Table 4 is used to convert the raw score to metric scoring and to calculate the exploratory IBIs. Table 4 establishes the range of values for each metric that are considered high, medium, and low. These exploratory values were arbitrarily determined by examining the range of values for each metric. A high value is given a score of 5, medium is given a 3, and low is given a value of 1. Tables 5-9 tabulate the metric scoring for each site for the five years of survey. The IBI is the sum of the values of each metric for a site for that particular year.

The average annual exploratory IBI scores for the Napa Basin as a whole are calculated by averaging the site IBI scores in each year. The results are given in Table 10. During the first 4 years there appears to be a steep decline in the IBI scores for the Napa Basin as a whole. During the last year of the survey there was a significant increase. Are these results right?

Since most of the sites are selected randomly, maybe the results are due to the fact that the average quality of the sites varied greatly from year to year. Maybe the steep drop is the result of poor sites being selected, especially in 2002 and 2003. If this is the case then the average habitat score should track closely with the average trend in IBI score. The average habitat scores for the Napa basin do not track well with average IBI scores (Table 11). The only year that may have been affected by "the luck of the draw" is 2001. The results from 2001 are likely to be elevated from what would be expected, because the average habitat score is higher than for the other years. Therefore, it is unlikely that the results over the five years are due to "the luck of the draw."
Mill Creek, one of the reference streams displayed a similar trend over the four of the five years (Table 3). Mill Creek was not sampled in 2003. Ritchey Creek was sampled in 2003 and the taxa richness was lower than in the other years; however, the sample for Ritchey Creek was taken at a site immediately below the State Park. In all other years the samples were collected at the same site within the State Park.

It is possible that the results are due to annual variation in temperature or rainfall. We compared the average monthly temperature and precipitation with the long-term average for the basin (Table 12 and Figure 8, respectively). We defined the year based on the water year which begins in October and more closely coincides to the life history of many of the aquatic insects. No significant trends were seen in the temperature regimes during these five years. In particular, 2002 and 2003 are near the long-term average.

We also compared the monthly precipitation totals to the long-term average for the basin (Table 13 and Figure 9). The water year begins in October and ends in September. The water year begins and ends when stream flows are usually at their lowest point for the year. Therefore it is a more realistic biological measure of precipitation. The long-term average annual precipitation for the site is 25 inches. Rainfall for 2002 and 2003 both were higher than average and 2003 was approximately 10 inches above normal. This suggests that low precipitation is not a likely candidate to explain the low IBI scores. However, since most of the precipitation falls during winter storms, total annual precipitation may not be the best measure of rainfall to determine if summer low-flows were a problem. A better estimate for stream low-flow is monthly precipitation from February through May. In 2002 precipitation was significantly below the long-term average during the entire period. It is likely that many streams had much lower stream flow during the spring and summer of 2002. In 2003, the story is different. Monthly stream flow was equal to or higher than long-term average during the spring and summer. So it is unlikely that late-winter and early spring rains are affecting the IBI scores.

If it is the case that summer low flows are established during the period February to May, it may be that the most important precipitation characteristic may be the rainfall during that period in the previous year. Since many insects have an annual life-cycle, it is possible that the low flows during the summer before the spring samples are important for determining the abundance and distribution of aquatic insects in the basin. If that is the case, then the precipitation the previous late-winter spring are important for determining the abundance and distribution of aquatic insects in the basin. The low IBI scores in 2002 and 2003 might be due to low precipitation during 2001 and 2002. In 2002 all four months had lower than average precipitation. In 2001, three out of four months had lower than average precipitation. This explanation remains a candidate for explaining the lower than average IBI for 2002 and 2003.

Another possible explanation that might account for the low IBI scores in 2002 and 2003 is that floods during the winter scoured out a considerable number of aquatic insects. We used the maximum 24-hours precipitation to estimate the magnitude of high flows during each year. The highest 24-hour precipitation total observed during the 5 years of sampling occurred in March 2003 (Table 14). It is likely that this storm contributed greatly to the decline in IBI during 2003. In 2002, the highest 24-hour precipitation total was 1.92 inches approximately equal to the long-term average for maximum daily rainfall. Therefore, it is unlikely that floods during 2002 were responsible for the low IBI scores.

In summary, it is likely that the drastic decline in average exploratory IBI scores in the Napa Basin is real and not the result of the random drawing of survey sites. It is likely that the reduced IBI in 2003 was due to the storm in March 2003, which was about a month before the 2003 sampling began. At this point there is no obvious cause for the decline in exploratory IBI scores for 2002. It is likely that the decline is natural because it affected most of the sites in the basin. It may be related to low-flows in 2002 and possibly 2001, but at this point we cannot determine the specific cause.

Summary

A total of 173 macro-invertebrate samples were collected from 2000-2004. Analysis of these samples was used to construct an exploratory IBI for the Napa basin. A total of five metrics were accepted for this first phase (2000-2004) of the Napa macro-invertebrate monitoring project: taxa richness, EPT taxa, Plecoptera taxa, percent predators, and number of intolerant taxa. The high quality sites within the Napa basin average between 70-90 taxa richness. This is very high biodiversity of aquatic insects. The resulting IBI is sensitive to natural events and management related activities.

The average basin scores from the Napa basin from 2000-2004 were: 18.2, 17.5, 13.6, 12.1, and 15.8. The average IBI score declined dramatically during the first 4 years. This trend is real. It is likely that a major storm in March 2003, about month before the 2003 sample was taken, is responsible for considerable amount of the decline in the IBI scores in 2003. The specific reasons for the other declines are not known at this time. We hope that future analysis and data collection helps unravel the mystery.

Objective 2: Initiate an analysis of the causal mechanisms between land use decisions and the aquatic macro-invertebrate communities.

The second part of this project begins to identifying causal relationships between land use decisions and the response of the benthic invertebrate communities in the streams. The primary focus of Phase I of this project is on the response of the macro-invertebrate communities to the whole suite of human actions found in the basin. This step represents the broadest analysis of the dose-response of land use actions on the biological structure of the aquatic macro-invertebrates. Does development a suite of different kinds of development result in changes in the macro-invertebrates communities in streams? If there is little response in the macro-invertebrate communities then land use actions are having little impact on the aquatic communities. However, if the suite of actions is causing significant changes in the biological communities in the streams then the individual land use actions can be investigated individually.
The process for completing the analysis is to first create an a priori classification system of streams. This classification should allow ranking of the watersheds by the level human action within the watersheds. Second, tabulate and average the exploratory IBI scores for the sites within each class. IBI's from various years can be standardized to aid in the comparison.

The watershed sites were divided into four classes based on the level of development in them. Class I watersheds have little development. The typical watershed in this class is Ritchey Creek which is primarily in the Bothe-Napa State Park. Class II watersheds have some development. The development includes both houses and agriculture mostly grapes. However, the character of the landscape is still maintained. The paradigm examples of this class in the Napa basin are Redwood and Dry creeks. Class IIIa watersheds are those that are primarily agricultural basins. The dominant agricultural activities are grapes and/or cattle grazing. Class IIIs watersheds are those where suburban/ urban development is the dominant land use within the watershed.

The watersheds where survey sites from 2000, 2001, and 2004 are located are then placed into their respective classifications based on field surveys, maps and the 2002 orthoquads. Years 2002 and 2003 were not used in the analysis because the average basin exploratory IBI scores for the sites during those two years was considerably less than those of the other three years of survey. All survey sites were tallied. Some sites were included in all three years of surveys.

The exploratory IBI scores were then tallied and averaged for each land use class. A total of 13 survey sites were included in the undeveloped class. The range of exploratory IBI scores is from 21-25 and the average was 24.1. This class characterizes the biological integrity of the Napa basin. The IBI upper and lower limits of the IBI for Napa are 25 and 5, respectively.

The second class of land use sites includes those basins with some development but the character of the landscape is still generally retained. The paradigm cases are Dry and Redwood Creek. A total of 13 sites were surveyed in this class. The average IBI for this class is 21.2, which is about 15% less than the class I sites. The range of IBI score observed was from 15 to 25.

The third class of land use has two categories: agricultural and suburban/ urban. A total of 22 sites were primarily agricultural sites. The range of values was the maximum possible from 5 to 25. The average exploratory IBI value for these sites was 14.1 or a reduction of 50% from the Class I sites. There are number of explanations for the wide variation in IBI scores in these basins: one is the extent and intensity of the management activities; another is the time since initial development; it also makes a different where the development is in the basin relative to the sample site; the extend of riparian zone modification can greatly affect the IBI scores; it also is dependent on the amount of water withdrawal and ground water pumping in the basin; the amount and location of roads and lanes can affect the quality of the stream habitat; the amount and types of herbicides and pesticides applied and how close to waterways the application activities were; the last factor is how much of the development is on steep and unstable slopes.

The fourth class is Class III suburban/urban. A total of 13 sites were in this class of watershed. The range of values for this class of sites is from 9 to 17 with an average of 11.5. This represents a 65% reduction from the class I sites. A number of factors are responsible for the decline: The number and extent of the developments; the location of the development with regard to the location of the sample site; the amount of impervious surfaces created in the basin; the amount and types of herbicides and pesticides applied and how close to waterways the application activities were completed; the amount and types of herbicides and pesticides applied and how close to waterways the application activities were; and the number and location of roads in the basin.

Summary

The Phase I analysis of land use and biological response documents that land use has an important effect on the biology of the streams and rivers in Napa. Some development, like that found in Dry Creeks and Redwood Creeks results in about a 15% reduction in the exploratory IBI from the undeveloped streams. Also the range of IBI scores in these Class II streams are from 16-25. Several sites had the maximum exploratory IBI score for the basin. Class IIIa, predominantly agricultural streams, had an average exploratory IBI score of 14.3. This represents a 50% reduction in the IBI scores from the undeveloped sites. The range of values is the maximum possible from 5- 25. One watershed had the maximum IBI score found in the basin. This wide range of IBI scores indicate that agricultural management practices differ considerably from site to site. Or that similar management practices on different sites results in significantly different effects on the aquatic macro-invertebrate communities. At this point we do not know what the specific differences in agricultural activities are that resulted in the wide range of values found. That question should be a high priority in the next phase of our work.

The average exploratory IBI score for the Class III suburban/urban watersheds is 11.5 or a 65% reduction from the values observed in the undeveloped watersheds. The range of values is from 9- 19. This is a considerable narrower range of values than those found in the agricultural watersheds. Urban and suburban management activities have a more predictable effect on the aquatic macro-invertebrates than does the agricultural watersheds.

Acknowledgments: We are grateful for the collaborative partnerships over the years from the Resource Conservation District, The Napa Flood and Water Conservation District and the Department of Fish and Game. The numerous volunteers who helped collect the samples were invaluable to the project. We are also grateful to the many land owners who were gracious enough to let us collect samples on their property.

Literature Cited:

Institute of Fisheries Resources. 1998. Determine the feasibility and cost of developing a KRIS program to support the Napa River watershed community's Living River Initiative. San Francisco, CA.

Karr, J.R. and E.W. Chu. 1997. Biological Monitoring and Assessment: *Using Multimetric Indexes Effectively*. EPA 235-R97-001. University of Washington, Seattle.

ATTACHMENT

Answer to SOP Questions

[from M. Cover and S. Moore]

1. **The surveys should be reported in raw form.**

It is a good suggestion to tabulate and report the raw data. However, in 2000 we established the format that we would record and report the data. To tabulate and convert the five years of data at this late stage is a time consuming step. We will work with state agencies and others to convert the data but at this stage we do not have the resources to accomplish it**.**

2. **Statements about richness are misleading.**

We clarified in the text that the richness of Napa samples is high from a Pacific Northwest Regional perspective. However, because of the higher taxonomic effort that we use in Napa the results are not comparable to other bay area projects.

3. **Annual variability should be examined using statistical approaches.**

We established prior to 2000 that we would construct an IBI using a graphic approach (e.g. Karr and Chu 1999). This approach is as appropriate as a statistical approach and has the additional benefit that a graphic analysis allows for exploration of the distribution of the sites. At the beginning of a project a graphic analysis is probably of greater benefit than statistic approaches. We do not object to statistical methods and believe that if others want to explore the survey information with it great, but it was not our objective.

4. **Pg. 4, Paragraph 5: CSBP was changed from 3 replicates of 300 organisms to one replicate of 500 organisms. The answer is in the text of the final report.**

5. **5:5: The description of site selection is unclear. How were sites randomly chosen? How many sites were chosen based on access limitations and how many were chosen randomly? The answer is in the text of the final report.**

6. **6:5: The taxonomic levels used for the Napa River project are different than when describing taxa richness in the Bay Area. This should be acknowledged when describing taxa richness and other metric scores.** The answer is in the text of the final report.

7. **7:1: What is the CSBP version of an IBI? CSBP is a collection method, not an analytical method.** The answer is in the text of the final report.

8. Why are graphs of habitat vs. metrics done for only the 2004 survey?

The large annual variation precluded lumping the surveys together. Therefore, 2004 was used to show how the exploratory IBI is constructed. Any of the years could have been chosen to illustrate how the graphic approach is done.

9. Was the P-Hab score the only variable used?

The physical habitat score was the only one used in this preliminary analysis. It reflects only one factor that influences biological community at a site. As discussed at length in the presentation land use has an important effect on the biological structure of a site. However, as discussed in the text and in the presentation we were not able to identify a technique that we believed accurately captured accurate and precise land use rankings. The broad three categories of land use were as accurate as we believed that a site could be cataloged. Therefore, we could not develop more accurate land use variable at this time. We hope in the future to devise such method. At the presentation a grad student from Davis, M. Cover, indicated that he had come to a similar conclusion with regard to the analysis of land use.

10. Table 10 was added to the CD.

11. How were the scoring categories in Table 4 calculated?

They were arbitrarily determined from the range and the distribution of the survey information for the purposes of exploring the survey information using the graphic IBI approach.

12. IBI scores which reflect biology should not necessarily reflect habitat scores. Therefore the luck of the draw can not be ruled out. A better approach would be to examine annual changes only at reference sites such as Mill Creek.

It is correct that habitat scores are not the only factor affecting the structure of the biological community therefore, habitat scores may not be the major driver affecting the structure of biological communities. It is true that the "luck of the draw" cannot be completely ruled out, but to have a water quality factor that is not identified affecting 35 randomly drawn sample sites throughout the basin is far less likely. It is also true that an analysis of reference sites sampled in each year to examine the annual variation would be preferred, however, we only have two sites and they are good to excellent sites. Reference sites which have poorer biological community structure would be much more sensitive to annual variations than the good sites. We did not set up a series of reference sites in locations with poor biological community structure.

13. Annual variability should not be described as a "dramatic decline in IBI scores" unless this is demonstrated statistically.

We were using a graphic analysis not a statistical analysis. A graphic analysis is an acceptable method of comparison.

14. Calculated percent reductions do not make sense. A 50% reduction should result in a value ½ of the reference value.

That is true if the range is from 0-25. In our case the range is 5-25 (potential exploratory IBI scores). Therefore the maximum range is 20. A reduction of 10 is a 50% reduction.

15. Can accuracy of physical scoring be assessed by examining residuals of regression of physical score against richness or EPT?

No. Not yet. The score for community structure reflect influences from both local site conditions and an integration of the watershed above the sample site. During year 5 we will analyze the condition of the watershed above each sample site and regress the resulting watershed variable with the biological attributes (dependent variables). Once we have this step wise regression done then we can regress the physical score vs. the biological measures (dependent variables). But it will be the second step wise stage.

16. Does the BMI method support estimates of BMI biomass?

It can with some assumptions, but it is really not designed to do that. Biomass has never been a good community measure of health. (Downstream of high organic matter sources, biomass can be very high but it could all be a couple of species).

Future Directions

1) Establish at least 3 good sites and 3 poor sites as reference sites.
2) Convert the existing survey information into raw form.
3) Devise an effective measure of land use.
4) Explore the existing state agency work such as the TMDL sediment, SWAMP, and other bay area projects to better synthesize this work into the existing interaction.
5) Facilitate others having access to the surveys so that a number of different analytical approaches can be used to examine the survey information.

“**Funding for this project has been provided in part by the U.S. Environmental Protection Agency (USEPA) pursuant to Assistance Agreement No. C9-98998901-0 and any amendments thereto which has been awarded to the State Water Resources Control Board (SWRCB) for the implementation of California’s Non-point Source Pollution Control Program. The contents of this document do not necessarily reflect the views and policies of the USEPA or the SWRCB, nor does mention of trade names or commercial products constitute endorsement of recommendation for use.**”