SOUTHERN COASTAL SANTA BARBARA CREEKS BIOASSESSMENT PROGRAM

2010 REPORT

Prepared for:

City of Santa Barbara,
Creeks Division

County of Santa Barbara,
Project Clean Water

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Executive Summary

Introduction

This report summarizes the results of the 2010 Southern Coastal Santa Barbara Creeks Bioassessment Program, an effort funded by the City of Santa Barbara and County of Santa Barbara. Ecology Consultants, Inc. (Ecology) prepared the report, and serves as the City and County's consultant for the Program. This is the 11th year of the Program, which began in 2000. The purpose of the Program is to assess and monitor the biological integrity of creeks in the study area as they respond through time to natural and human influences. The Program involves annual collection and analysis of benthic macroinvertebrate (BMI) samples and other pertinent physiochemical and biological data in study creek reaches using U.S. Environmental Protection Agency (USEPA) endorsed rapid bioassessment techniques. BMI samples are analyzed in the laboratory to determine BMI abundance, composition, and diversity. Scores and classifications of biotic integrity are determined for study streams using the Index of Biological Integrity (IBI) that was developed for the study area by Ecology. The IBI is a system that yields a numeric score and classifies the biological integrity of a stream as Very Poor, Poor, Fair, Good, or Excellent based on the BMI community present in the stream, as determined by completing a bioassessment survey and associated laboratory and analytical work. Seven "core BMI metrics" are calculated and used to determine the IBI score. Each core metric is highly sensitive to human disturbance, and collectively they represent different aspects of the BMI community including diversity, composition, and trophic group representation. By condensing complex biological data into an easily understood score and classification of biological integrity, the IBI serves as an effective tool for the City and County in monitoring the overall condition of local creeks, and taking appropriate watershed management actions.

Study Area

The study area encompasses approximately 60 km of the southern Santa Barbara County coast from the Rincon Creek watershed at the Santa Barbara/Ventura County line west to Gaviota Creek. There are approximately 40 1st to 5th order coastal streams along this stretch of coast, all of which drain the southern face of the Santa Ynez Mountains. A total of 51 stream study reaches in 20 watersheds have been surveyed on one or more occasions during the springs and summers from 2000 to 2010. 25 stream study reaches were surveyed this year.

Methods

Physiochemical and biological data for the study reaches was gathered through a combination of methods including field surveys, laboratory analyses, spatial data analyses using geographic information system software, and review of United States Geological Survey (USGS) 7.5-minute quadrangle maps and recent aerial photographs. The seven IBI core metrics were calculated for each study reach, and IBI scores and classifications of biological integrity were determined.

Results

Overall, IBI scores at the study creeks were similar in range compared to the past four years (2006-2009). However, three recent wildfires (Gap, Tea, and Jesusita) coupled with scouring storm flows the following winters presumably caused noticeable losses in IBI scores at several of the affected study reaches in 2009 and 2010. This was particularly the case at study reaches M3 and M4 in the upper Mission Creek watershed following the Jesusita fire, which burned over

70 percent of the upper Mission Creek watershed. IBI scores at M3 and M4 were in the Good range in May 2009 just days before the fire, and were sharply lower (46 points lower at M4, 32 points lower at M3) and in the Poor range this past spring. The drops in IBI score at these study reaches are attributable to lower insect and EPT family diversity and lower percentage of sensitive BMI taxa and shredders and predators compared to before the fire. It will be interesting to track the recovery of these streams from the impacts of the fires over time.

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I. Introduction

This report summarizes the results of the 2010 Southern Coastal Santa Barbara Creeks Bioassessment Program, an effort funded by the City of Santa Barbara and County of Santa Barbara. 2009 is the 11th year of the Program, which began in 2000. Ecology Consultants, Inc. (Ecology) prepared the report, and serves as the City and County's consultant for the Program. The purpose of the Program is to assess and monitor the "biological integrity" of study creeks as they respond through time to natural and human influences. Karr and Dudley (1981) defined biological integrity as "the ability to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitat of the region." (Miller et al., 1988). Bioassessment is the science of assessing the biological integrity of aquatic ecosystems by evaluating the biological assemblages (e.g., benthic macroinvertebrates, fish, amphibians, vegetation, etc.) that inhabit them. Because different species or groups of species (i.e., genera, families, etc.) have varying habitat requirements and abilities to withstand water pollution and other forms of habitat degradation, the presence, abundance, or absence of particular species or groups of species provides information regarding the biological integrity of a particular water body. In addition, measurements of the biological community relating to overall abundance, diversity, and trophic structure have proven to be reliable indicators of biological integrity in water bodies (Rosenberg and Resh, 1993, Barbour et al., 1999).

The Program involves annual collection and analysis of benthic macroinvertebrate (BMI) samples and other pertinent physiochemical and biological data in study creek reaches using U.S. Environmental Protection Agency (USEPA) endorsed rapid bioassessment techniques. BMI samples are analyzed in the laboratory to determine BMI abundance, composition, and diversity. Scores and classifications of biological integrity are determined for study streams using the BMI based Index of Biological Integrity (IBI) that was developed for the study area by Ecology.

The IBI is a system that yields a numeric score and classifies the biological integrity of a given stream as Very Poor, Poor, Fair, Good, or Excellent based on the BMI community present in the stream, as determined by completing a bioassessment survey and associated laboratory and analytical work. Seven "core BMI metrics" are calculated and used to determine the IBI score. Each core metric is highly sensitive to human disturbance as determined through rigorous statistical analyses, and collectively they represent different aspects of BMI community structure including diversity, composition, and trophic group representation. By condensing complex biological data into an easily understood score and classification of biological integrity, the IBI serves as an effective tool for the City and County in monitoring the condition of local creeks, and taking appropriate watershed management actions.

An IBI was originally developed for study area streams by Ecology in 2004 using data collected from more than 80 study reaches over a four year period from 2000 to 2003. An updated IBI was developed by Ecology last year to use the considerable data set available, which includes more than 190 study reaches surveyed during the 10 year period from 2000 to 2009. Collectively, this group of study streams had wide variability in physiochemical conditions, human impacts, and year to year fluctuations in rainfall and stream flow patterns, which have varied widely from year to year. Because variability in rainfall and stream flow has been linked to considerable differences in BMI community structure, the updated IBI is more representative of the full range of the BMI community compared to its predecessor. More discussion of the IBI is provided in *Southern Coastal Santa Barbara County Creeks Bioassessment Program, 2009 Report and Updated Index of Biological Integrity* (Ecology Consultants, Inc., 2010).

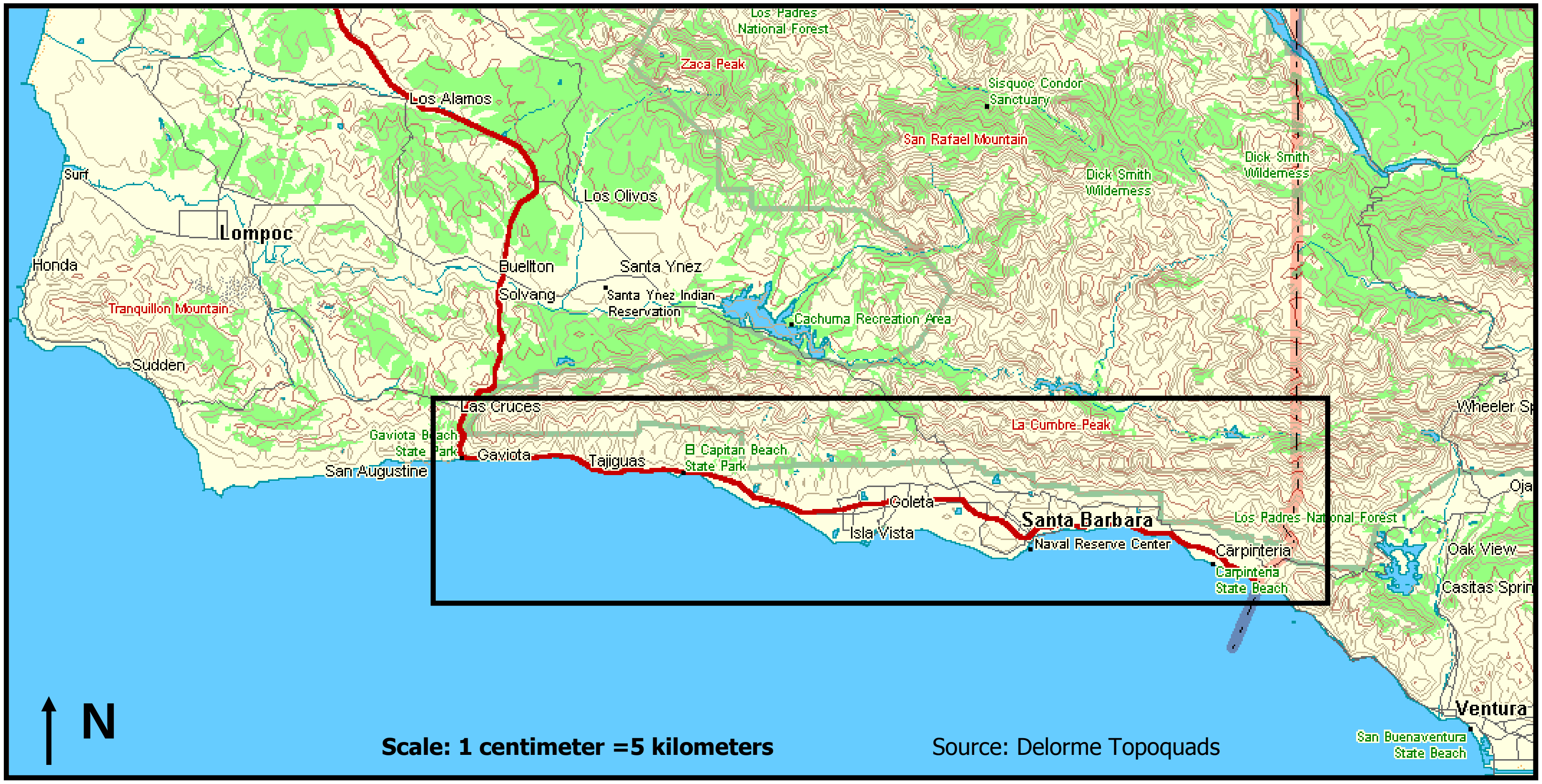
II. Study Area

The study area encompasses approximately 60 km of the southern Santa Barbara County coast from the Rincon Creek watershed at the Santa Barbara/Ventura County line west to Gaviota Creek (see Figure 1). There are approximately 40 1st to 5th order coastal streams along this stretch of coast, all of which drain the southern face of the Santa Ynez Mountains. 51 different stream study reaches in 20 watersheds have been surveyed on one or more occasions from during the 11 years of the Program. 25 study reaches were surveyed this year, including 13 funded by the City, and 12 funded by the County. Table 1 lists this year's study reaches and their locations. Figure 1 shows an overall map of the study area, and Figures 2, 3, and 4 provide more detailed maps and show the locations of all of the study reaches.

Table 1: Study Reaches

Study Reach	Location
City of Santa Barbara Study Reaches	
RIN0	Rincon Creek just upstream of Rincon Rd. crossing
AP1	Arroyo Paredon just below Highway 192 crossing
SY1	Sycamore Creek just below Mason St. bridge
SY3	Sycamore Creek 300m below Highway 192 crossing and Coyote/Sycamore confluence
M1	Mission Creek at De la Guerra St.
M2	Old Mission Creek at Bohnet Park
M3	Mission Creek at upstream end of Rocky Nook Park
M4	Rattlesnake Creek, approx. 0.5 mi. upstream of Las Canovas Rd. crossing
AB1	Arroyo Burro at upstream end of Alan Rd.
AB2	Arroyo Burro just downstream of Torino Rd.
AB3	San Roque Creek, 0.25 mi. upstream of Foothill Rd.
AB5	Mesa Creek at entrance to Arroyo Burro estuary
AB7	Las Positas Creek just above Veronica Springs Rd. crossing
County of Santa Barbara Study Reaches	
RIN1	Rincon Creek, just upstream of Highway 150 crossing at Gobernador Cyn Rd.
C1	Carpinteria Creek, 0.25 mi. downstream of Carpinteria Ave.
C3	Gobernador Creek, approx. 0.25 mi. upstream of County detention basin
MONT2	Montecito Creek just upstream of Hot Springs/Olive Mill Rd.
AT1	Atascadero Creek near Patterson Rd.
AT2	Atascadero Creek just downstream of Cieneguitas Creek confluence
SA2	San Antonio Creek, approx. 0.25 mi. upstream of Highway 154
SJ2	San Jose Creek, approx. 0.25 mile upstream of Patterson Rd. crossing
SJ3	San Jose Creek at San Marcos Trout Club
T3	Tecolote Creek, 100 m downstream from Vereda Parque access
AH1	Arroyo Hondo, approx. 1 mi. upstream of U.S. 101.
GAV1	Gaviota Creek at State Beach/Park, just below access rd./US 101 junction

FIGURE 1: STUDY AREA



Insert Figure 2

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III. Methods

Physiochemical and biological data for the study reaches was gathered through a combination of methods including field surveys, laboratory analyses, spatial data analyses using geographic information system (GIS) software, and review of United States Geological Survey (USGS) 7.5-minute quadrangle maps and recent aerial photographs. Biological parameters including core metrics and IBI scores were calculated using the data. Further discussion of methods is provided below.

A. Field Surveys

As in previous years of the Program, field surveys were conducted in the spring during base stream flow conditions (i.e., low flows). The sampling was conducted in early May by Ecology, City of Santa Barbara, and County of Santa Barbara staff. Sampling in the spring during base flow conditions provides consistency in the sampling from year to year, as the local stream biota is known to undergo seasonal succession (Cooper et al., 1986). The following was completed during each field survey:

- General observations were recorded on a standardized field data sheet, including location, date, time, weather, stream flow conditions, water clarity, and human impacts.
- A 100-meter study reach was delineated along the stream. Stream habitat units (i.e., riffles, runs, pools, etc.) within the study reach were mapped and quantified as a percentage of the total reach length.
- Stream widths (wetted perimeter, channel bottom, and bank full) were measured at three transects in the study reach. Wetted perimeter width is defined as the cross-sectional distance of streambed that is inundated with surface water. Channel bottom width is defined as the cross-sectional distance between the bottoms of the stream banks. Bank full width is defined as the distance from the ordinary high water mark from one stream bank to the other, as evidenced by visible signs of stream flow such as water marks, stream-carried deposits of sediments and debris, and scour features.
- Riparian canopy cover was estimated in the center of the stream channel at the three transects using a spherical densitometer.
- Plant and wildlife species observed in the creek and riparian zone were noted.
- Water temperature, specific conductance, pH, and dissolved oxygen concentration were measured in the field using YSI and Oakton handheld meters. Two measurements of each parameter were made, one in a riffle and the other in a pool, and the two values were averaged.
- One composite BMI sample was collected from each study reach using a standardized method based on the “multi-habitat” approach described in the USEPA’s *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers* (Barbour et al., 1999). Each sample represents approximately one square meter of stream bottom, collected from 10 individual, 0.1-square meter locations (approximately 30 centimeters square). The 10 locations that constituted the sample were selected based on the relative area each stream habitat (i.e., riffles, pools, falls, etc.) covered in the section of stream sampled. For

example, if a given stream reach contained approximately 50 percent riffles and 50 percent pools, five locations in riffles and five in pools were selected and sampled. Samples were collected using a D-frame net with 500 μm mesh. In locations with flowing water (e.g., riffles and runs), the net was held upright against the stream bottom, and substrata immediately upstream within the 0.1-square meter area was scraped and stirred up for approximately 15 seconds using feet and hands. Dislodged BMIs and stream bottom materials were carried into the net by the stream current. In areas with little or no current (e.g., pools), stream bottom material was stirred up by foot, followed by a quick sweep of the net through the water column to capture dislodged BMIs. This was repeated three times in each pool sampling location.

- After each BMI sample was collected, it was rinsed with water in a 500 μm sieve to wash out fine sediments, transferred to a plastic container, and preserved in 70 percent ethanol.
- A semi-quantitative stream habitat assessment was conducted using the protocol provided in the USEPA's *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers*. Per this protocol, habitat components were visually assessed and scored, including stream substrate/cover, sediment embeddedness, stream velocity/depth regime, sediment deposition, channel flow status, human alteration, channel sinuosity, habitat complexity/variability, bank stability, vegetative protection, and width and composition of riparian vegetation. Each study reach was assigned a total score of between zero and 200 based on the sum of scores assigned to each habitat component. Criteria from the USEPA protocol were used to guide the scoring.
- Quality control measures were incorporated into the field surveys to insure accurate and consistent data gathering. Water monitoring equipment was calibrated regularly. Field crew members were trained to properly operate equipment, take measurements, collect BMI samples, and conduct stream habitat assessments. Stream habitat assessment scoring was done as a group by the field crew.

B. Laboratory Analyses

BMI samples were processed in the laboratory to determine BMI community composition (i.e., taxa present and relative abundance) and overall density. Each BMI sample was strained through a 500-μm mesh sieve and washed with water to remove ethanol and fine sediments. The sample was placed in a plastic tray marked with equally-sized squares in a grid pattern. The entire sample was spread out evenly across the squares. Squares of material were randomly selected, and sorted one at a time under a dissecting microscope (7X to 50X magnification) until a specified number of BMIs were located and picked out. The proportion of the sample sorted was noted. 330 specimens were picked out from each sample. 300 of the 330 BMIs picked from each sample were randomly selected for identification. BMIs were identified using standard taxonomic keys. Insect taxa were identified to the family level. Non-insect taxa (e.g., oligochaetes, crustaceans, etc.) were identified to order or class. After processing and identification, sorted BMIs and sample remnants were bottled separately in 70 percent ethanol for storage.

Quality control measures were incorporated into the laboratory analysis to ensure random selection and accurate enumeration and identification of BMIs. BMI sample processing methods were clearly established and strictly followed.

C. GIS Analyses

GIS Arcview software was used to calculate upstream watershed area and watershed land use coverages for each study reach. Watershed area was calculated based on watershed boundaries generated by the GIS with a 30 meter digital elevation model using hydrologic processing tools in Arcview GIS. Watershed land use coverages for each study reach were calculated by superimposing watershed boundaries over a digital land cover GIS layer for the region. The land cover layer was produced the California Department of Forestry and Fire Protection's (CDF) Fire and Resource Assessment Program (FRAP). The land cover layer is titled LCMMP Vegetation Data, 1994 to 1997. The CDF land use map for the region showed coverage by the following eight land use categories: urban, agriculture, herbaceous, hardwood, shrub, conifer, water, and barren/other. Recent aerial photographs (i.e., 2009 and 2010) of the region available on Google Earth were reviewed to check the accuracy of the GIS land use layer. The GIS and aerial photograph land use maps were in close agreement, and only minor adjustments to the GIS-based calculations were necessary.

The parameter "percent watershed disturbed" was calculated for each study reach by using the following equation:

Percent watershed disturbed = percent urban + percent agriculture + 0.5(percent herbaceous)

Herbaceous areas were counted as partially (i.e., half) disturbed to reflect that much of the herbaceous lands in this region are used for livestock grazing or are previously cleared land.

D. Review of Topographic Maps

USGS 7.5 minute quadrangle topographic maps (1:24,000 scale) for the study area were reviewed to determine stream order, elevation, and gradient for each study reach. Gradient was determined by dividing the elevation change between topographic contours immediately upstream and downstream of the study reach by the stream length between the contours. Stream length was determined by tracing a map wheel over the stream path.

E. Study Reach Grouping

The study reaches were placed into three different groups based on their level of human disturbance. These disturbance groups were assigned to study reaches "a priori" (i.e., before the analyses of biological data) based on physical habitat assessment scores and percent watershed disturbed. The following criteria were used to group the study reaches:

REF = Reference stream reaches are minimally disturbed by human activities. Habitat assessment score was 150 out of 200 or greater, and five percent or less of the upstream watershed was disturbed.

MOD DIST = Stream reaches that are lightly to moderately disturbed by human activities. Habitat assessment score was between 120 and 149. This category also includes stream reaches with a habitat assessment score of 150 or greater, but with greater than five percent of the upstream watershed disturbed.

HIGH DIST= Stream reaches that are heavily disturbed by human activities including agricultural and urban/suburban land uses. Habitat assessment score was less than 120.

F. Calculation of Core Metrics

The seven core metrics were calculated for each study reach for use in determining IBI scores and classifications of biological integrity. The core metrics were among the most sensitive to human disturbance as determined by rigorous statistical analyses (Ecology Consultants, Inc., 2010). Collectively, the core metrics are diversified in that they represent different aspects of community structure including diversity, disturbance sensitivity, and trophic structure. Each core metric and its method of calculation are discussed below.

Number of Insect Families was determined by summing the number of insect families found in the sample.

Number of EPT Families was determined by summing the number of families found in the sample from the insect orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Tricoptera (caddisflies), which as a group are generally sensitive to human disturbance.

Percent EPT minus Baetidae was determined by summing individuals from the insect orders Ephemeroptera (except Baetidae), Plecoptera, and Tricoptera, dividing by the total number of BMIs in the sample, and multiplying by 100.

Percent PT was determined by summing individuals from the insect orders Plecoptera and Tricoptera, dividing by the total number of BMIs in the sample, and multiplying by 100.

Tolerance value average and **percent sensitive BMIs** were calculated using disturbance tolerance values for individual BMI taxa of between 0 and 10 based on their ability to withstand human disturbance. A tolerance value of 0 indicates that a BMI is extremely intolerant of human disturbance, with increasing scores indicating greater tolerances to human disturbance. **Tolerance value average** was determined by summing the tolerance values of all the individual BMIs in the sample, and dividing by the total number of BMIs in the sample. **Percent sensitive BMIs** was determined by summing the individuals with a tolerance value of 3 or less, dividing by the total number of BMIs in the sample, and multiplying by 100.

Tolerance values and sensitivity designations for individual BMI taxa are provided in Table A-1 of Appendix A. Last year, new tolerance values were assigned to most of the BMI taxa found in the study area based on the results of statistical analyses of BMI data collected in study area streams from 2000 to 2009. Tolerance values from *List of Californian Macroinvertebrate Taxa and Standard Taxonomic Effort* (California Department of Fish and Game, 2002) were retained for taxa that did not occur in sufficient abundance in study area streams. An additional six taxa did not have tolerance values in *List of Californian Macroinvertebrate Taxa and Standard Taxonomic Effort*, and did not meet abundance criteria established in last year's study, thus no tolerance values are provided for these taxa. For further details on tolerance values, see last year's report (Ecology, 2010).

Percent predators + shredders was determined by summing individual BMIs with a predator or shedder functional feeding group designation, dividing by the total number of BMIs in the sample, and multiplying by 100. Functional feeding group designations were obtained from *An Introduction to the Aquatic Insects of North America* (Merritt and Cummins, 1996).

G. Core Metric Scoring Ranges

The IBI provides scoring ranges of between 0 and 10 for each of the seven core metrics (see Table 2). For core metrics that decrease with increasing human disturbance (e.g., # insect families), higher values corresponded with higher scores. For core metrics that increase with increasing human disturbance (e.g., tolerance value average), lower values corresponded with higher scores.

Table 2
Core Metric Scoring Ranges

Score	# insect families	# EPT families	% EPT-Baetidae	% PT	Tolerance value avg.	% sensitive BMIs	%shredders +predators
10	29+	15	49+	22+	3.21 or less	60+	27+
9	26 to 28	14	37 to 49	15 to 22	3.22 to 3.82	46-59	19 to 26
8	25	12 to 13	32 to 36	12 to 14	3.83 to 4.32	39 to 45	16 to 18
7	24	11	27 to 31	10 to 11	4.33 to 4.81	32 to 38	14 to 15
6	23	10	23 to 26	8 to 9	4.82 to 5.29	26 to 31	12 to 13
5	19 to 22	9	18 to 22	6 to 7	5.30 to 5.68	20 to 25	10 to 11
4	16 to 18	7 to 8	13 to 17	4 to 5	5.69 to 6.07	14 to 19	8 to 9
3	13 to 15	5 to 6	8 to 12	3	6.08 to 6.47	8 to 13	6 to 7
2	10 to 12	3 to 4	2 to 7	2	6.48 to 6.87	2 to 7	4 to 5
1	7 to 10	1 to 2	1	1	6.88 to 7.48	1	2 to 3
0	0 to 6	0 to 1	0	0	7.49+	0	0 to 1

H. IBI Classifications of Biological Integrity and Scoring Ranges

Individual scores for the seven core metrics are summed to provide a total score of between 0 and 70 for the study reach. The IBI provides classifications of biological integrity (i.e., Excellent, Good, Fair, Poor, and Very Poor) based on the total score. IBI classifications and scoring ranges are provided in Table 3.

Table 3
Classifications of Biological Integrity and Scoring Ranges

Category	Scoring Range
Excellent	61 to 70
Good	48 to 60
Fair	31 to 47
Poor	9 to 30
Very Poor	0 to 8

IV. Results and Discussion

A. Physiochemical and Biological Data

Table A-1 in Appendix A provides physiochemical data collected at the study reaches this year. Table A-1 also lists BMI taxa and abundances for each study reach. Tolerance values and functional feeding groups are also provided for individual BMI taxa, as are core metric values and BMI density. Table A-2 provides a list of the plant species observed at the study reaches, and indicates the number of native and introduced plant species observed and percentage of plant species observed that are native at each study reach. The number of years each study reach has been surveyed is provided at the top of the table. Plant observations from multiple years are combined in the table. Table A-3 provides a list of vertebrate species observed at the study reaches. The number of years each study reach has been surveyed is provided at the top of the table. Vertebrate species observations from multiple years are combined in the table.

B. IBI Scores and Classifications

Table A-4 lists core metric values, IBI scores, and classifications of biological integrity for the study reaches in 2010. Table A-4 also provides the range of IBI scores and classifications of biological integrity for the study reaches in all years of study. The following discusses IBI scores at the individual study reaches for 2010, and compares this year's scores to previous years where applicable. Physical habitat conditions and other factors that have likely affected the stream biota are also discussed.

City of Santa Barbara Study Reaches

Sycamore Creek

Stream habitat in SY1 (downstream, HIGH DIST) and SY3 (upstream, MOD DIST) and the entire channel length of Sycamore Creek was significantly impacted by the Tea Fire in November 2008. The fire burned approximately 67 percent of the Sycamore Creek drainage, and nearly all the upper watershed (County of Santa Barbara, 2009). Loss of vegetative cover allowed the erosion of large quantities of sediment into the creek channel during heavy rainfall events the following winter. Dramatic increases in fine sediments and sand in the creek channel were observed at both SY1 and SY3 in May 2009 during the field surveys. Pools were almost completely filled in, measuring six inches or less in depth in places where they were previously 2 to 3 feet deep. This year, less sediment was observed in the creek channel. Some pools were deeper, and more cobble and boulder riffle substrate were exposed compared to the previous year due to scouring from moderately high storm flows last winter. These changes resulted in improved habitat assessment scores at both study reaches this year compared to 2009. Water chemistry at both study reaches was similar to previous years, with high conductivity again being the most notable parameter. IBI score was 8 (Very Poor) at SY1, which was unchanged from last year and at the bottom end of the range from previous years. IBI score at SY3 was 19 (Poor), which is an improvement from last year (12, Poor) and within the range from previous years.

Mission Creek

The Jesusita fire in May of last year burned nearly 70 percent of the Mission Creek watershed above Foothill Road, with both the Rattlesnake Creek and Upper Mission Creek catchments being similarly impacted (County of Santa Barbara, 2009). The Tea fire burned approximately 200 acres in the Rattlesnake Creek drainage the previous November (2008). The loss of vegetative cover from these fires caused increased erosion of topsoil throughout the upper watershed during ensuing rainstorms, especially this past winter. Dramatic increases in sand and finer sediments were observed this year during surveys in Rattlesnake Creek (M4, REF site), upper mainstem Mission Creek (M3, MOD DIST), and in the lower reaches of the Mission Creek (M1, HIGH DIST). Pools that were 2 to 3 feet or greater in depth in previous years were generally less than a foot deep this year due to filling with the fine sediments. The old Mission Creek drainage was not affected by the fires. No major changes in substrate or stream depths were noted at M2 (HIGH DIST). Water chemistry was similar to previous years at all the Mission Creek watershed study reaches.

IBI scores at the upper watershed study reaches M3 and M4 were 18 (Poor) and 13 (Poor) this year, respectively. These scores are a dramatic drop from previous years, when these study reaches have typically scored in the Good to Excellent range. It is obvious that the recent fires had a major impact on the BMI community and overall ecosystem at these study reaches. Rainbow trout (*Oncorhynchus mykiss*), often labeled as a keystone species, were not observed at M3 or M4 for the first time in many years.

IBI scores at the highly impacted downstream study reaches M1 and M2 were Very Poor at 4 and 8, respectively. IBI scores at these study reaches have been Very Poor or Poor in all previous years of study. As mentioned above, the catchment of M2 was unaffected by the fires, and M1 has been highly impacted for decades, thus fire impacts to the BMI community were not obvious at this study reach.

Arroyo Burro

The Jesusita fire originated on the Jesusita trail near San Roque Creek (main Arroyo Burro tributary), and burned approximately 80 percent of Arroyo Burro watershed above Foothill Road. AB3 (MOD DIST), located in San Roque Creek just upstream of Foothill Road, was directly within the burned area. Not surprisingly, AB3 had higher than normal fine sediment and sand deposition in the creek channel, although sediment deposition has been a problem for many years here. The riparian canopy was largely burned out during the fire, resulting in dramatically decreased riparian canopy cover (44 percent) this year compared to previous surveys (over 90 percent every year). Increased light levels in the stream bed would be expected to create higher stream temperatures, and this year's reading of 19.1 ^{o}C was the highest at AB3 in 10 years of study. Water quality parameters were otherwise within the ranges observed in previous years. Overall physical habitat quality was diminished as evidenced by a habitat score of 127, as compared to a range of 153-174 in previous years.

IBI scores at AB3 were relatively high in the first few years of study, ranging from 46 to 62 (Fair to Excellent). IBI score at AB3 began to steadily decline in 2003, and dropped to a low of 11 in 2009. The reasons for this decline have not been determined. This year, the IBI score at AB3 was 12, remaining in the Poor range.

Downstream reaches AB1 (HIGH DIST) and AB2 (HIGH DIST) are miles downstream of the burn area, and normally have a large proportion of sand and finer sediments due to their low gradient. Thus, impacts from increased sediment transport were less obvious compared to at AB3. Habitat assessment scores and water quality were within the ranges from previous years. IBI scores at AB1 (17) and AB2 (9) were Poor and within the ranges from previous years of study.

AB5 (HIGH DIST) is a habitat restoration site along lower watershed tributary Mesa Creek, which was unaffected by the recent fires. Habitat assessment score at this reach rose to 117 (103 last year) due to continued growth and maturation of riparian vegetation planted in 2007. Riparian canopy cover was 83 percent compared to 45 percent last year. Stream temperature was cool at 15.9 °C, and conductivity was again very high presumably mostly due to naturally high mineral concentrations. IBI score was 3 (Very Poor) compared to 12 (Poor) last year and 6 (Very Poor) in 2008.

AB7 (HIGH DIST) is a new study reach on Las Positas Creek, a lower watershed tributary of Arroyo Burro that was unaffected by the recent fires and drains a mix of residential, commercial, and open space uses including the Santa Barbara municipal golf course. In the vicinity of the study reach, this is a 1st order stream with perennial flow in most years. AB7 is just upstream of the Veronica Springs Road crossing, and is tightly abutted by Las Positas Road to the east and single family homes to the west. The creek has soil banks fortified in places with rip rap and concrete chunks, and a bedrock channel with pockets of cobble, gravel, and fine sediments. The channel has been straightened and lacks sinuosity. There is a narrow riparian corridor composed mostly of arroyo willows (*Salix lasiolepis*) that form a closed riparian overstory (100 percent riparian canopy cover). The creek had low stream temperature (16.5 °C), moderately high conductivity, and a habitat assessment score of 107. IBI score was 13 (Poor).

Arroyo Paredon

AP1 (MOD DIST), a 2nd order lowland stream reach located just downstream of the Highway 192 crossing, was studied for the first time this year. While this stream in not in pristine condition, it is in better condition (habitat assessment score 137) than most low to moderate gradient streams in the study area. The upstream watershed is made up of approximately 75 percent undisturbed wilderness and 25 percent agriculture (mostly orchards), with a few rural residences. The reach has a fairly intact riparian corridor composed of approximately 80 percent native cover, and a natural stream bottom and banks composed mostly of boulders, cobble, gravel, and sand. Stream bottom cobble and gravel was cemented in most places by mineral deposits from nearby springs. Water quality was characterized by low water temperature (15.6 °C), and moderately high conductivity (1,560 µS). IBI score for AP1 was 19 (Poor).

Rincon Creek

RIN0 (MOD DIST) located approximately a half mile upstream of the ocean inlet of Rincon Creek, was surveyed for a second time this year. Habitat assessment score (136) similar to last year, as was water quality, with moderately high conductivity (1,396 µS) being the most notable parameter. IBI score was 18 (Poor) this year, compared to 31 (Fair) last year.

County of Santa Barbara Study Reaches

Rincon Creek

RIN1 (MOD DIST), approximately 2 miles upstream of RIN0, had a similar habitat assessment score (128) and good water chemistry (i.e., low stream temperature and conductivity) this year compared to previous years. IBI score this year was 49 (Good), which is within the range from previous years of study (34-58).

Carpinteria Creek

Similar to past years, C1 (HIGH DIST, downstream) had low habitat assessment score (100), high riparian canopy cover (75 percent), and moderate stream temperature and conductivity. IBI score this year was 4 (Very Poor), and within the range from previous years. C3 (REF), a lightly impacted reference stream reach in Gobernador Creek (Carpinteria Creek tributary), had high habitat assessment score (183) and low water temperature and conductivity, as in previous years of study. IBI score was 60 (Good) this year at C3, which is within the range of scores from previous years of study.

Montecito Creek

MONT2 (MOD DIST), located in the Montecito Creek mainstem at low to moderate gradient, had lower habitat assessment score (85) this year compared to previous years, where scores have ranged from 114 to 132. Increased fine sediment in the creek channel was the primary reason for the lower score this year. Water chemistry this year was similar to previous years, with moderate temperature and conductivity. Approximately 10 percent of the MONT2 watershed (upper western portion) was burned by the recent Jesusita fire. IBI score was 11 (Poor), which is the lowest score recorded at MONT2. IBI score has ranged from 23 to 29 at MONT2 in 4 previous years of study.

Atascadero Creek

Highly impacted AT1 (lower Atascadero Creek) and AT2 (upper Atascadero Creek) had similar physiochemical parameter values as in previous years of study, including low habitat assessment score and high conductivity and water temperature. The recent Jesusita Fire burned approximately 20 percent of the upstream watersheds of both AT1 and AT2. The burn area was in the upper watersheds above Foothill Road. IBI score at AT1 (1) and AT2 (5) were both in the Very Poor range, and within the range of scores from previous years of study.

San Antonio Creek

SA2 (MOD DIST) was at the edge of the burn area of the Jesusita fire, and approximately 42 percent of the upstream watershed was burned. Habitat assessment score (138) was similar to previous years of study, while stream temperature was higher, and riparian canopy cover (43 percent) was lower. IBI score was 23 (Poor), which is at the bottom of the range from previous years of study (23 to 62).

San Jose Creek

The Gap fire in July 2008 burned approximately 1,080 acres in the San Jose Creek watershed. SJ3 (REF) in upper San Jose Creek was unaffected, but approximately 28 percent of the watershed of SJ2 (HIGH DIST) in lower San Jose Creek was burned. Habitat assessment score at SJ2 the past two years (81 and 83, respectively) was lower than in any previous year of study, with increased fine sediment being a major factor. Riparian canopy cover and water chemistry parameters at SJ2 the past two years have been similar to previous years of study. IBI score at SJ3 was 55 (Good) this year, which is within the range from previous years. IBI score at SJ2 was 31 (Fair), an improvement from last year (22, Poor).

Tecolote Creek

The Gap fire (July 2008) burned approximately 30 percent of the watershed of T3 (HIGH DIST). Habitat assessment score, riparian canopy cover, and water chemistry parameters at T3 have been similar before and after the fire. IBI score at T3 was 13 (Poor) this year, which is the same as last year and lower than in 2008 (35, Fair) prior to the fire.

Arroyo Hondo

Undisturbed reference reach AH1 (lower Arroyo Hondo Creek) had similar physiochemical parameter values as in previous years of study including high habitat assessment score and riparian canopy cover, and low conductivity and water temperature. IBI score was 67 (Excellent), which is within the range from previous years.

Gaviota Creek

Moderately impacted GAV1 (lower Gaviota Creek) had a habitat assessment score (124) within the range from previous years. Riparian canopy cover (65 percent) was higher than in previous years, while water chemistry was characterized by moderate stream temperature and high conductivity, which has been typical. IBI score was 30 (Poor), which is within the range from previous years of study.

C. Rainfall, Peak Stream Flows, and Fire Effects

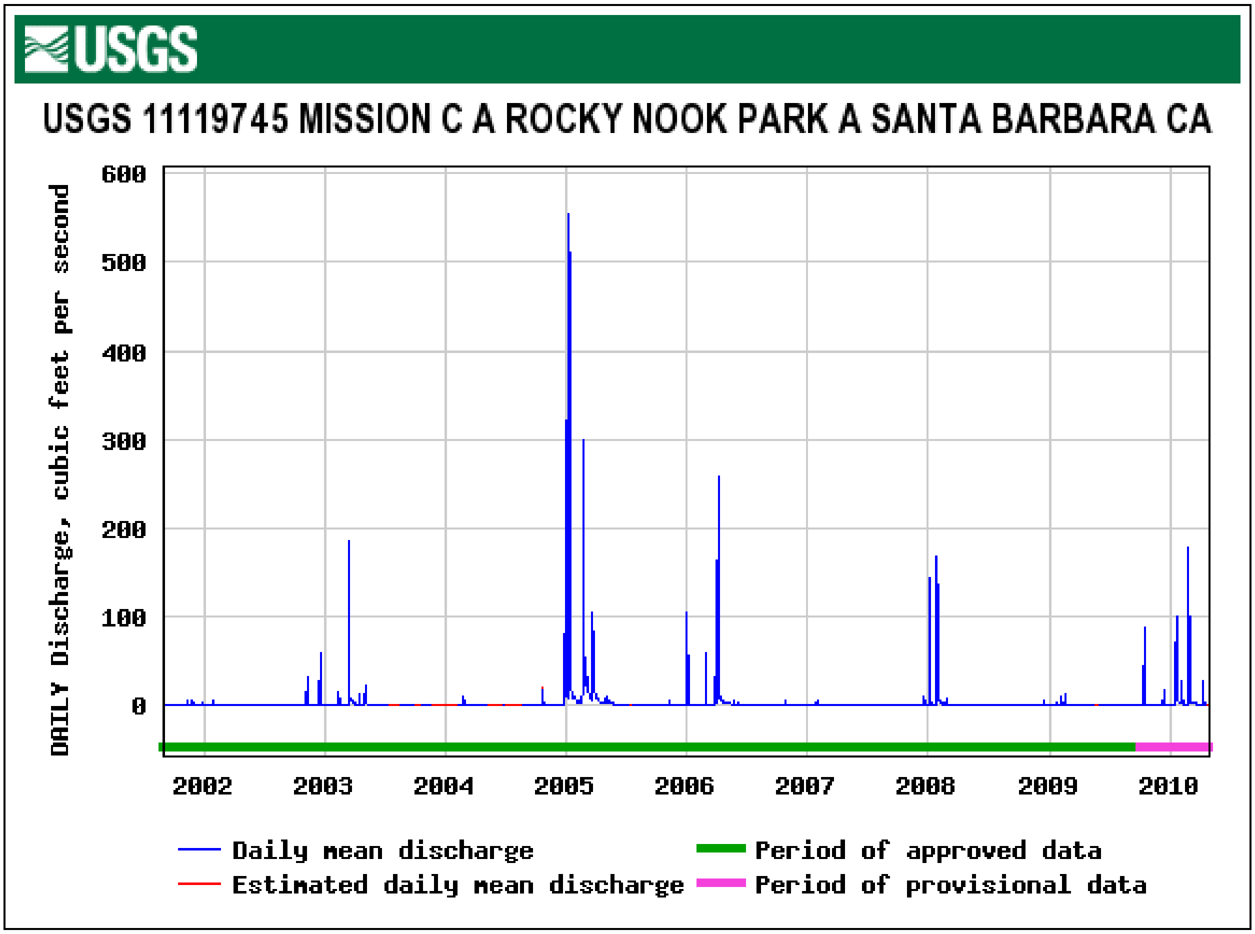
Table 4 provides rainfall data from the Santa Barbara County Flood Control District stations in downtown Santa Barbara (elevation 100 feet) and San Marcos Pass (2,300 feet elevation). As a point of reference, the downtown station has a mean annual rainfall of 17.5" in over 130 years of records, with a high of 45" in the 1997-1998 rainfall year (i.e., September to September). The San Marcos Pass station has a mean annual rainfall of 45" in 45 years of records, and a high of 88" in 1982-1983. Table 4 also provides maximum mean daily discharge data from the USGS gauging station in Mission Creek at Rocky Nook Park (near study reach M3) by year for 2002 through 2010. Daily stream flow data from 2002 to 2010 for the Mission Creek at Rocky Nook Park gauge is illustrated in Figure 5. While discharge varies from creek to creek, the gauging station data from Mission Creek shows similar patterns compared to other local stream gauges (e.g., Carpinteria Creek and San Jose Creek), and serves as a good example of the hydrology of local creeks. As shown in the Table 4 and Figure 5, local rainfall and peak stream discharges in Mission Creek during the winter have varied widely from year to year, as is typical in the region.

Table 4: Average Yearly Rainfall and Peak Daily Discharge				
Year	Prior Season Rainfall, Sept. 1 to April 30, Downtown Santa Barbara	Prior Season Rainfall, San Marcos Pass	Max. Mean Daily Discharge (cfs), Mission Creek Gauge	Days with Max. Mean Daily Discharge 100 cfs or more, Mission Creek Gauge
2002	8.84″	14.28″	5	0
2003	22.78″	35.74″	184	1
2004	10.70″	19.14″	10	0
2005	36.25″	70.02″	555	14
2006	21.07″	35.46″	259	2
2007	6.41″	10.84″	5	0
2008	17.57″	38.09″	167	4
2009	11.38″	18.29″	12	0
2010	20.26″	39.71″	177	2
Note: Rainfall data from Santa Barbara County Flood Control District. Mission Creek discharge data from USGS.				

Table 5 provides yearly IBI scoring ranges and averages for the 12 study reaches that have been surveyed each year since 2002. Figure 6 provides a graphical illustration of IBI scores at the 12 study reaches year by year. Data is unavailable for 2004, when the County did not conduct bioassessment surveys, and the City study reaches were surveyed using different methodology.

For the most part, IBI score ranges and averages have been fairly consistent from year to year at the 12 study reaches. The exception to this was 2005, when the average IBI score was lowest (14), and the scoring range (1 to 29) was smallest by far. All 12 study reaches were in the Very Poor and Poor range, including AH1 and C3, which are in the REF category. 2005 was the second heaviest rainfall year on record since rainfall data was first collected locally in 1867.

Figure 5: Peak Daily Discharge, Mission Creek at Rocky Nook Park, 2002-2010

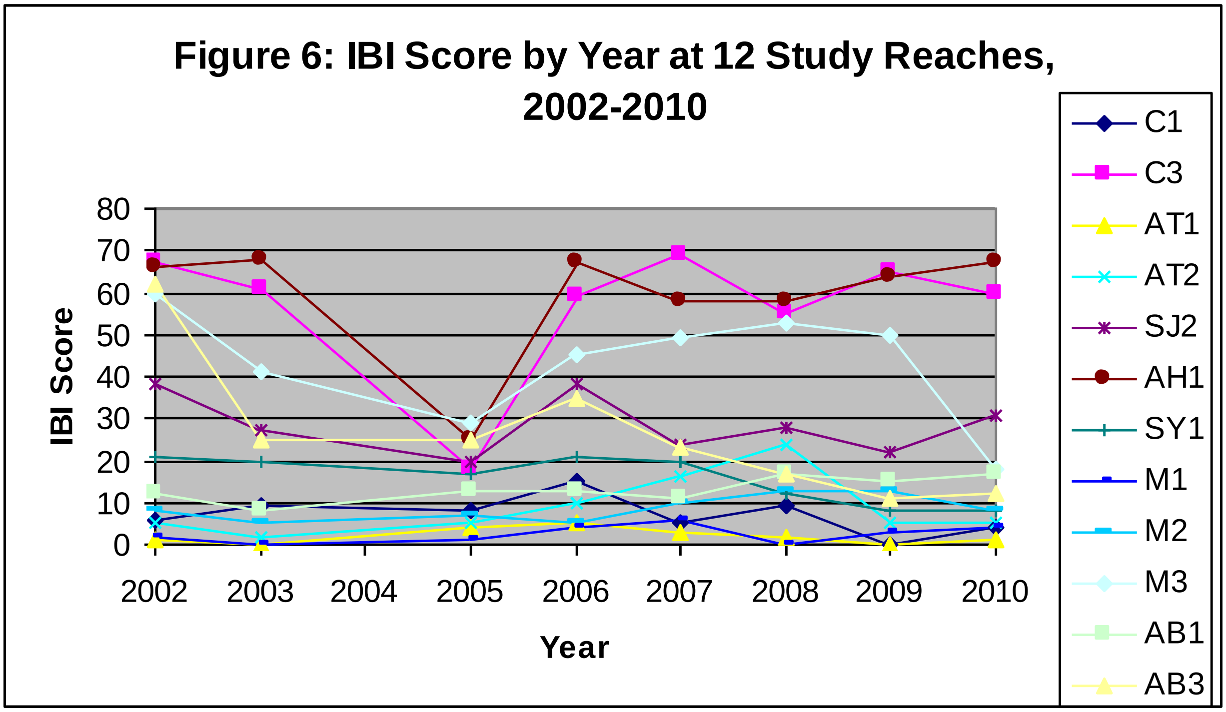


Wet winters such as 2004-2005 with multiple high intensity rainfall events and high stream discharges scour out and transport large quantities of streambed material, and with it most of the invertebrate and vertebrate stream inhabitants. Large deposits of cobble, gravel, sand, and finer material accumulate in portions of the stream channels, particularly large pools, which can be completely filled in. Such events are a major disturbance to the stream community, the effects of which can last well into the spring when the bioassessment surveys are conducted. In 2005, BMI density was the lowest of any year of study, as were insect and EPT family diversity, percent EPT-Baetidae, percent PT, percent sensitive BMIs, and percent predators + shredders (See Table 5). Rapidly colonizing Baetidae mayflies made up over 50 percent of the BMI community in 2005, which is the highest percentage in any year of study. Clearly, the BMI community of the study streams had not recovered from the effects of scouring stream flows when the surveys were conducted in 2005.

Table 5
IBI Score, Core Metrics, BMI Density and Percent Baetidae by Year at Study Reaches Sampled From 2002 to 2010

Study Reach	2002	2003	2005	2006	2007	2008	2009	2010
C1	6	9	8	15	5	9	0	4
C3	67	61	18	59	69	55	65	60
AT1	1	0	4	5	3	2	0	1
AT2	5	2	5	10	16	24	5	5
SJ2	38	27	20	38	24	28	22	31
AH1	66	68	25	67	58	58	64	67
SY1	21	20	17	21	20	12	8	8
M1	2	0	1	4	6	0	3	4
M2	8	5	7	5	10	13	13	8
M3	60	41	29	45	49	53	50	18
AB1	12	8	13	13	11	17	15	17
AB3	62	25	25	35	23	17	11	12
IBI AVERAGE	29	22	14	26	25	24	21	20
IBI RANGE	1 to 67	0 to 68	1 to 29	4 to 67	3 to 69	0 to 58	0 to 65	1 to 67
Avg. # insect families	17	14	11	16	16	16	13	13
Avg. # EPT families	7	6	4	7	6	6	4	5
Avg. % EPT-Baetidae	18	11	3	14	12	11	13	10
Avg. % PT	9	5	2	6	5	5	4	5
Avg. tolerance value average	6.15	6.29	5.95	5.61	6.24	6.39	6.15	6.39
Avg. % sensitive BMIs	21	13	4	17	16	12	16	10
Avg. % predators and shredders	11	8	4	8	9	8	7	7
Avg. % Baetidae	5	23	54	39	10	19	16	19
Avg. BMI Density	2,273	1,312	298	705	2,022	964	388	1,658

BMI communities at the 12 study reaches had recovered from the effects of the scouring flows of 2004-2005 by the time the 2006 surveys were conducted, which followed a season of slightly above average rainfall year. This is shown by substantial improvement in IBI score mean and range, as well as the aforementioned core metrics and BMI density, and lower percent Baetidae. This was particularly notable at the REF study reaches C3 and AH1, which improved in IBI scoring range from Poor to Good and Poor to Excellent, respectively from the previous year.



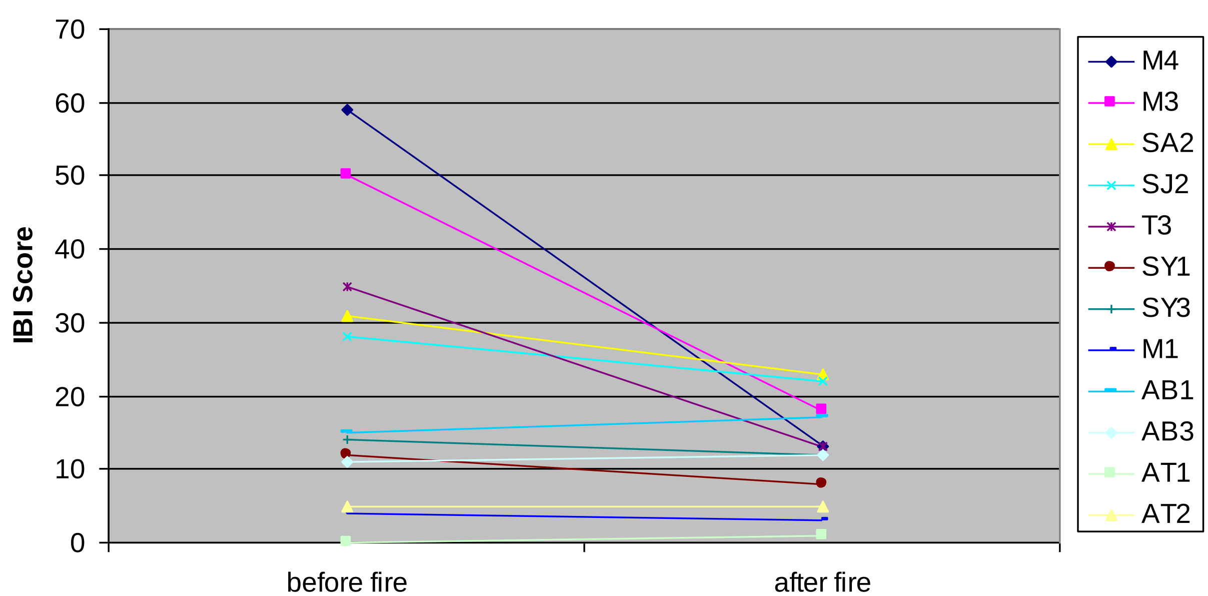
Wildfires such as the recent Gap, Tea, and Jesusita fires are another type of episodic disturbance that, coupled with significant storm flows the following winter, have caused disruption to the geomorphology and ecology of affected creeks. Table 6 lists the study reaches that have been affected by the recent fires, and their disturbance category (i.e., REF, MOD DIST, or HIGH DIST), affecting fire, percentage of the upstream watershed burned, IBI scores the years before and after the fire, and the percent change from year to year. Figure 7 is provided to illustrate the IBI scores of the study reaches for the years before and after the fires.

Table 6: Changes in IBI Score at Study Reaches Affected by Recent Wildfires

Study Reach	Disturbance Group	Fire	% Watershed Burned	IBI score prior to fire	IBI score after fire	Change in IBI Score
M4	REF	Jesusita (5/09)	80	59	13	-46
M3	MOD DIST	Jesusita (5/09)	70	50	18	-32
SA2	MOD DIST	Jesusita (5/09)	42	31	23	-8
SJ2	MOD DIST	Gap (7/08)	28	28	22	-6
T3	HIGH DIST	Gap (7/08)	30	35	13	-22
SY1	HIGH DIST	Tea (11/08)	70	12	8	-4
SY3	HIGH DIST	Tea (11/08)	80	14	12	-2
M1	HIGH DIST	Jesusita (5/09)	44	4	3	-1
AB1	HIGH DIST	Jesusita (5/09)	50	15	17	+2
AB3	MOD DIST	Jesusita (5/09)	80	11	12	+1
AT1	HIGH DIST	Jesusita (5/09)	20	0	1	+1
AT2	HIGH DIST	Jesusita (5/09)	20	5	5	0

As shown in the Table 6, negative impacts to IBI score were most noticeable at M4 and M3 following the Jesusita fire, which burned 80 and 70 percent of their upstream watersheds, respectively. IBI scores at M4 and M3 were in the Good range in May 2009 just days before the fire, and were sharply lower (46 points lower at M4, 32 points lower at M3) and in the Poor range this past spring. The drops in IBI score at these study reaches are attributable to lower insect and EPT family diversity and lower percentage of sensitive BMI taxa and shredders and predators compared to before the fire.

Figure 7: IBI Scores at Study Reaches Before and After Recent Fires



Study reaches that scored in the Fair and upper end of the Poor range of the IBI prior to the fires also had lower IBI scores the following year, but not as noticeably as at M4 and M3. IBI score at T3 dropped by 22 points from before the Gap fire in 2008 (35, Fair) to after the fire in 2009 (13, Poor). IBI score was 13 again in 2010 at T3. The Gap fire burned approximately 30 percent of the upstream watershed of T3. SJ2, which had 28 percent of its watershed burned by the Gap fire, had a modest drop in IBI score of 6 points from 2008 (28, Poor) to 2009 (22, Poor). IBI score improved to 31 at SJ2 in 2010. All of these scores are within the range for previous years at SJ2. SA2, which had 42 percent of its watershed burned by Jesusita fire, had an 8 point drop in IBI score from 2009 (31, Fair) to 2010 (23, Poor). Both scores are on the low end of the range from previous years at SA2. T3, SJ2, and SA2 had lower IBI scores before the fires compared to M4 and M3, and less percentage of watershed area burned. These factors likely explain the smaller drops in IBI score at these study reaches.

At study reaches SY1, SY3, M1, AB1, AB3, AT1, and AT2, all of which scored in the low Poor or Very Poor range of IBI prior to the fires, IBI scores were relatively unchanged the year following the fire. These study reaches were already highly impacted with low biological integrity prior to the fires.

V. Closing

Over the past 11 years, bioassessment data collected through Program has provided a wealth of information on the range of habitat conditions and biota (particularly the BMI community) of streams in the study area. The ways in which study area stream habitat conditions and biota have been influenced by natural variability in rainfall, peak stream flows, watershed area, gradient, and water chemistry has been explored and established to varying degrees. In addition, the manner and extent to which varying types and intensities of human land use have negatively impacted local stream habitat conditions and biota have been established with highly significant statistical test results. Recently, the impacts of three major wildfires to study streams have been characterized. It will be interesting to track the recovery of these streams from the impacts of the fires over time.

The Bioassessment Program and the IBI that has been developed for the study area serve as a reliable tool for classifying the biological condition of local streams, monitoring their condition through time, and determining how they are shaped by natural physiochemical variability and human land uses, including efforts to protect, restore, and reduce impacts to local watersheds, streams, and water quality. Our understanding of local streams and their shaping factors will undoubtedly improve as the Program effort continues in future years. The IBI should be updated every 5 to 10 years to account for the greater range of conditions observed through time.

The Program and IBI serve as excellent tools for assessing and monitoring the biological condition of freshwater streams in the study area. There is no equivalent tool for estuarine waters in the study area, which could be assessed using similar bioassessment methodology as used in this Program. IBIs have been produced for estuarine waters in many regions, and with adequate data it may be possible to produce one for the study area. Given the ecological importance of estuarine waters, and their importance as they relate to commercial and recreational uses and the local economy, the City and County may consider implementing an estuarine bioassessment program as funding allows.

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APPENDIX