Appendix F: Assessing the Biotic and Physical/Habitat Condition of Selected Stream Sites in the Malibu Creek Watershed – Summary of Data Collected from 2000 through 2010

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Introduction

The Santa Monica Mountains are located in southern California within the highly developed urban center of Los Angeles and its surrounding suburbs. Malibu Creek is the largest watershed in the Santa Monica Mountains and has relatively low population density compared to other watersheds in the southern California area. Being located within such a highly populated area of the state and having a popular beach community at the lower end of its reach, activities within the Malibu Creek watershed draws much attention from environmental organizations. One of these organizations, Heal the Bay (HTB) located in Santa Monica, has been involved with the stewardship of Malibu Creek and three nearby watersheds (Arroyo Sequit, Lachusa and Solstice Creeks) within the Santa Monica Mountains since 1995.

HTB has many functions regarding Malibu Creek watershed stewardship including monitoring the quality of its water and biotic community. Since 1998, HTB has maintained a monitoring crew consisting of professional HTB staff and community volunteers. They collect water quality data at selected sites in the Malibu watershed (http://www.healthebay.org/). In 2000, HTB initiated a biological and physical/habitat assessment program with guidance from the Sustainable Land Stewardship International Institute (SLSII). After that initial start-up of the bioassessment program, HTB staff continued to sample permanent sites and intensified the effort and assessment of site conditions culminating in reports on the effects of sediment and nutrients on the biotic communities within the Santa Monica Mountain streams (Luce 2003; Luce and Abramson 2005).

Bioassessment using benthic macroinvertebrates (BMI) is the most common method used to assess the condition of streams and rivers. Combined with the assessments of physical habitat condition and conventional water chemistry, bioassessment can be a cost-effective monitoring technique to assess watershed health (Davis and Simons 1995; Gibson 1996; Karr and Yoder 2004). The most common tool used to determine biotic condition using BMIs is the multi-metric analytical approach referred to as an Index of Biotic Integrity (IBI) (Karr 1981; Resh and Jackson 1993; Rosenberg and Resh 1993; Kerans and Karr 1994; Davis and Simons 1995). In 2005, an IBI was developed for southern California (SoCal IBI) coastal streams (Ode et al. 2005) and was used to evaluate the sites monitored by HTB.

The monitoring sites that were established in the Santa Monica Mountain were designated as upper, mid and lower watershed sites and as either reference or impacted. However, in this report all sites were evaluated independently and compared to regional reference and impacted conditions reported in Mazor et al. (2011). Mazor et al. (2011) evaluated all perennial wadeable streams within southern California costal watersheds using a probabilistic design developed and used nationally by the U.S EPA and described in Stoddard et al. (2005) and US EPA (2006).

Mid way in this 11 year monitoring effort, New Zealand Mud Snails (*Potamopyrgus antipodarum*) (NZMS) became established as some of the monitoring sites. NZMS are invasive aquatic organisms which can displaces the native population and alter the BMI community and the other organisms that feed on them. There are now several streams throughout California with NZMS populations including several in the Santa Monica Mountains. According to Abramson et al. (2009), surveys conducted in 2009 showed that eight streams and 29 sites within the Santa Monica Mountains are invested with NZMS. This was an increase from only three streams and fourteen sites surveyed in 2006. The impact of the snail on the biotic condition of the sites monitored by HTB was addressed in this report. The goal of this 2000 through 2010 summary report was to:

1) Provide baseline information on the macroinvertebrate assemblages within the Malibu Creek and the three nearby watersheds;
2) Determine the biotic condition for permanent bioassessment sites within the Malibu Creek and the three nearby watersheds;
3) Evaluate and comment on the relationship between biotic and habitat condition scores for all sites within the Malibu Creek and the three nearby watersheds; and
4) Make recommendations to guide future diagnostic analysis and potential management actions for all permanent bioassessment sites and make recommendations for future monitoring for the HTB Bioassessment Program.

Materials and methods

Location Description

The Malibu Creek watershed is located in the Santa Monica Mountains of southern California, just north of the City of Malibu, Los Angeles County. Malibu Creek, which enters the Pacific Ocean within the community of Malibu, drains a basin composed of both urban and natural areas. The drainage network includes Malibu Creek and its tributaries, Cold, Las Virgenes, Medea, Chesboro, Stokes and Triunfo Creeks. Other nearby watersheds in the Santa Monica Mountains of interests to the HTB program are Arroyo Sequit, Lachusa and Solstice Creeks.

All the streams in the Santa Monica Mountains are small and vary seasonally in discharge. Flow is intermittent in some stream reaches because of the prevailing Mediterranean-type climate, with hot dry summers and winter rainfall. Import of water into the basin for urban uses over many years has shifted the flow regime in some streams from intermittent to perennial. At least two water impoundments are located in the

Malibu Creek watershed; Century Reservoir and Malibu Lake. Other possible alterations within the watershed include runoff from the urbanized residential areas, wastewater treatment plant discharges, roadway stream crossings, horse ranches, field spraying of treated wastewater effluent in the Las Virgenes Creek sub-basin and an old silted dam (Rindge dam) on lower Malibu Creek. The Malibu Creek watershed has both urban/residential development and undeveloped parklands of the Santa Monica Mountain National Recreation Area.

Bioassessment Monitoring Sites and Sampling Effort

Prior to the bioassessment program in the Malibu watershed, HTB staff established several sites throughout the watershed for their chemical monitoring program. In 2000, twelve sites were chosen for biological monitoring from those previously established for the chemical monitoring program. All but two of the sites from the 2000 sampling were maintained as permanent bioassessment sites. Six sites were added to the biological monitoring program between 2001 and 2002. Table 1 lists the permanent bioassessment monitoring sites by stream system, general site location description and GPS coordinates.

Table 1 also lists the number of sampling events at each site indicating the time of year of the sample collection; Spring (S) occurring during April-May, Fall (F) occurring during September-October and winter (W) occurring in December, followed by the year (2000 through 2009). Each bioassessment sites was sampled between 8 and 13 times during the 11 year period with the exception of SC22 which was only sampled 3 times.

During the first four years of the HTB bioassessment program most of the permanent sites were sampled in both spring and fall. In 2004, there was no bioassessment conducted at any of the permanent sites. Starting in 2005, sites were only sampled once a year; winter in 2005, and then spring during 2006 through 2010, with the exception of 2007 during which no bioassessment was conducted at any of the permanent sites.

Biological Sampling

Between 2000 and 2003, benthic macroinvertebrate (BMI) samples were collected using the California Stream Bioassessment Procedure (CSBPs) for non-point source assessments (Harrington 1996). With this method, three riffles in each monitoring reach were randomly chosen and one sample was collected in the top third of each. Starting with the lowermost riffle, the benthos within a 1 ft^2 area was disturbed upstream of a 1 ft wide, 0.5 mm mesh D-frame kick-net. Three locations along the transect representing the riches habitats were sampled and combined into a composite sample (representing a 3 ft^2 area). Sampling of the benthos was performed manually by rubbing cobble and boulder substrates in front of the net followed by "kicking" the upper layers of substrate to dislodge any invertebrates remaining in the substrates. The duration of sampling ranged from 60-120 seconds, depending on the amount of boulder and cobble-sized substrates that required rubbing by hand; more and larger substrates required more time to process. This procedure was repeated for the three riffles and maintained as three separate samples

for the reach. The three samples were transferred into a 500 ml wide-mouth plastic jar containing approximately 200 ml of 95% ethanol.

In 2005 through 2007, sampling was conducted using the US EPA procedure called the Targeted Riffle Composite (TRC) (Peck et al. 2004) which was adapted by SWAMP and described in Ode (2007). With this procedure, a 1 ft^2 of riffle area of the benthos was disturbed using the method previously described for the CSBP. Eight samples were taken from eight different riffles if available or by collecting more than one sample per reach if less than eight riffles were available. The locations in the riffles were randomly chosen using a number from one to 10 representing 10% increments upstream from the bottom of the riffle and from the right wetted bank. The eight collections from the riffles were composited and transferred into a 500 ml wide-mouth plastic jar containing approximately 200 ml of 95% ethanol.

Starting in 2008, sampling was conducted by HTB staff using the Reach Wide Benthos (RWB) procedure also described in Ode (2007). With this procedure, 11 transects are established equidistant (15 m) along a 150 foot reach. Starting with lowermost transect and on the right side (25% distance from right bank), a 1 ft^2 area of the benthos was disturbed using the method previously describe for the CSBP. After securing the BMIs in the net or sample jar, the next transect upstream was sampled in the center (50% distance for the right bank) in the same manner and then the next transect was sampled on the left (75% distance from the right bank). This pattern was continued until all 11 transects were sampled (representing 11 ft^2). The 11 collections from the transects were composited and transferred into a 500 ml wide-mouth plastic jar containing approximately 200 ml of 95% ethanol.

BMI Laboratory Analysis

The BMI samples throughout the project were processed by Sustainable Land Stewardship International Institute (SLSII) in Sacramento or Chico, California. Each sample was rinsed through a No. 35 standard testing sieve (0.5 mm brass mesh) and transferred into a tray marked with twenty, 25 cm^2 grids. All sample material was removed from one randomly selected grid at a time and placed in a petri dish for inspection under a stereomicroscope. All invertebrates from the grid were separated from the surrounding detritus and transferred to vials containing 70% ethanol and 5% glycerol.

In 2000 through 2006, this process was continued until 300 organisms were removed from each sample and starting in 2008, this process was continued until 500 organisms were removed from one composite sample per site. The material left from the processed grids was transferred into a jar with 70% ethanol and labeled as "remnant" material. Any remaining unprocessed sample from the tray was transferred back to the original sample container with 70% ethanol and archived. BMIs were then identified to the Southwest Association of Freshwater Invertebrate Taxonomists (SAFIT) Standard Taxonomic Effort (STE) Level 1 (SAFIT 2006).

A taxonomic list of all BMIs identified from the samples was entered into a Microsoft Excel© spreadsheet program. Excel© is used to generate a stand alone taxonomic list, and to calculate and summarize the aquatic macroinvertebrate community based metric values. This data format for reporting the BMIs is the basis of the state-wide database being developed by SWAMP and therefore all bioassessment data produced by the HTB program is considered compatible with the SWAMP database.

Determination of Biotic Condition

The SoCal IBI was used to evaluate the biotic integrity of the sites in the HTB Bioassessment Program. Metric values from the Microsoft Excel© spreadsheet program used for BMI data analysis were compared to the values in Table 2 and added for all seven metrics. Three of the seven metrics in the SoCal IBI have separate scoring ranges for the two Omernik Level III Ecoregions in southern coastal California region (6 = Chaparral and Oak Woodlands, 8 = Southern California Mountains). Although all the sites are in the Santa Monica Mountains, Omernik's map shows the entire area in Ecoregion 6; therefore the values in the column titled 6 were used to determine the metric scores. The scores were summed from all seven metrics, multiplied by 1.43 to adjust the scoring range to a 100 point scale, and then categorized as "very good" (100-81), "good" (80-61), "fair" (60-41), "poor" (40-21) and "very poor" (20-0).

Table 2. Scoring ranges for 7 Biological metrics in the SoCal B-IBI (taken from Ode et al. (2005)).

Metric Score	Coleoptera Taxa	EPT Taxa		Predator Taxa	% Collector Individuals		% Intolerant Individuals		% Non-Insect Taxa	% Tolerant Taxa
	All Sites	6	8	All Sites	6	8	6	8	All Sites	All Sites
10	>5	>17	>18	>12	0-59	0-39	25-100	42-100	0-8	0-4
9		16-17	17-18	12	60-63	40-46	23-24	37-41	9-12	5-8
8	5	15	16	11	64-67	47-52	21-22	32-36	13-17	9-12
7	4	13-14	14-15	10	68-71	53-58	19-20	27-31	18-21	13-16
6		11-12	13	9	72-75	59-64	16-18	23-26	22-25	17-19
5	3	9-10	11-12	8	76-80	65-70	13-15	19-22	26-29	20-22
4	2	7-8	10	7	81-84	71-76	10-12	14-18	30-34	23-25
3		5-6	8-9	6	85-88	77-82	7-9	10-13	35-38	26-29
2	1	4	7	5	89-92	83-88	4-6	6-9	39-42	30-33
1		2-3	5-6	4	93-96	89-94	1-3	2-5	43-46	34-37
0	0	0-1	0-4	0-3	97-100	95-100	0	0-1	47-100	38-100

The IBI score was calculated and the biotic condition category determined for each sampling event at a site using the information in Table 2. Additionally, a SoCal IBI score of 39 was used as a threshold value to indicate whether a site was biologically impaired. This critical value for southern California streams came from Ode et al. (2005) and has been used in assessment reports produced for the SWRCB (Ode and Rehn 2005; Ode 2007). The IBI score of 39 for southern California streams is also the value used to develop scientifically defensible Lines of Evidence (LOEs) and 303(d) listing

recommendations (Fact Sheets) during updates to the California Integrated Report and within the requirements provided in the *Water Quality Control Policy For Developing California's Clean Water Act Section 303(d) List* (Listing Policy, SWRCB, 2004). Since the SWAMP bioassessment procedure is a quantitative technique, density estimates provided the opportunity to examine the effect of the NSMS on the BMI community and IBI scores. Densities of NZMS were estimated as percent of the BMI sample where the total number of snails in the subsampled collection at each site was divided by the actual subsample (+/- 500 individuals).

BMI sample calibration and re-verification

To use the SoCal IBI, specific biological metrics had to be calculated based on 500 organisms. Since the version of the CSBP used in 2000 through 2003 required the collection of three samples from which a subsample of 300 organisms per sample were counted, there were a total of 900 organisms identified for each site (according to the CSBP laboratory processing). A Monte-Carlo simulation model provided in the Microsoft Excel© spreadsheet program developed by DFG was used by SLSII staff to reduce the 900 identified organism count from the 2000 through the 2003 samples to 500. The 2005 through 2010 BMI samples were collected using the SWAMP Bioassessment Procedure Ode (2007) and therefore no conversion or use of the Monte-Carlo procedure was necessary.

BMI taxonomy has been standardized over the 10 year period of the HTB Bioassessment Program associated with establishing SAFIT so all the taxonomic list for each year was examined by the ABL taxonomic lab to ensure that all years' taxonomic results were comparable. This was especially important with the New Zealand Mud Snail since its positive identification was only confirmed in 2005.

Quality Assurance and Control

Throughout the 10 years of bioassessment sampling, the HTB staff was regularly field audited by DFG or SLSII to help guarantee that data was collected according to the standardized protocols current at the time. BMI samples were shipped under chain-of-custody to the Chico Laboratory where current laboratory QA procedures were followed.

Between 2005 and 2010, duplicate BMI samples were collected seven times at five different sites to test the in-site variability of the invertebrate community. To collect the duplicate samples, two separate nets were used side-by-side, but far enough away to avoid disturbing either area where the BMI community was collected.

As described previously, HTB staff converted from a riffle based BMI collection procedure (CSBP and TRC) to a multi-habitat method (RWB) in 2008. During that year's sampling season at a special site, duplicate samples were collected using both the TRC and RWB procedures.

Determination of Stream Characteristics

The CSBP physical habitat quality method used exclusively in 2000 and sporadically through 2008 were based on EPA Rapid Bioassessment Protocols (RBPs) (Barbour et al. 1999). The other most-often used method for describing and assessing the physical habitat quality of HTB Bioassessment Program was developed by HTB staff in 2001 and used at all sites through 2003. The information from those assessments were used in two important documents documenting the effects of nutrients and sedimentation on the Santa Monica Mountain bioassessment sites Luce (2003) and Luce and Abramson (2005). Starting in 2008, the HTB Bioassessment Program adopted the SWAMP bioassessment procedures (Ode et al. 2007). With this procedure, 11 transects are established equidistant (15 m) along a 150-foot reach. Only the physical habitat data collecting in 2009 and 2010 using the SWAMP method which is currently considered the state standard was used in this report.

Physical Habitat Stressors

Four of the physical habitat metrics (% Fines/Sand, Instream Habitat Complexity, Riparian Vegetation and Human Disturbance) from the SWAMP method were used to note important stressors at each of the permanent bioassessment sites. The four metrics were chosen based a probabilistic survey of all southern California perennial streams using the same SWAMP bioassessment protocol used in HTB Bioassessment Program (Mazor et al. 2011). In the study, stressors related to biological condition were evaluated using relative risk and correlation analyses. Three of the four highest risk stressors were sandy substrate, low habitat complexity, and high human disturbance which tripled the risk of exceeding the impairment threshold IBI value of 39 at a site and low levels of riparian vegetation which doubled the risk. Table 3 lists the median, 25% quartile and 75% quartile values for all perennial streams in southern California.

Table 3. Median, 25% quartile and 75% quartile values for the four most important physical habitat stressors determined for southern California streams (Mazor et al. 2011). Whether the physical habitat metric value increased or decreased as a response to the stressor is also listed.

Physical Habitat Metric	Response to Stressor	Median	25% Quartile	75% Quartile
Percent Fines/Sand (<0.06-2 mm)	Increase in Value	34.4	11.4	62.8
Instream Habitat Complexity	Decrease in Value	9.5	4.2	13.0
Human Disturbance	Increase in Value	1.6	0.6	4.6
Riparian Vegetation	Decrease in Value	40.7	0	77.8

Recommendations for Future Monitoring

Recommendations for future monitoring were based on current biotic condition in relation to the condition measured throughout the years the site was sampled. Frequent monitoring was recommended for sites needing more data to determine degrading condition or of need of protection such as reference sites. Less frequent monitoring was recommended for sites with consistently low biotic condition and where upstream degraded condition was obvious.

Basic Water Chemistry

Water temperature, dissolved oxygen, pH and specific conductance were measured at each site whenever possible. These parameters are routinely measured at any bioassessment monitoring site and are used in case more detailed chemistry data is not available to assess the monitoring site.

HTB Water Chemistry

Since 1998, HTB has been collecting water quality data monthly at all the permanent bioassessment sites addressed in this report. There are many qualitative observation that are made by HTB staff or volunteers at each site and basic measurements such as air and water temperature, dissolved oxygen, pH, turbidity, conductivity, total nitrogen and total phosphate. Water chemistry was not addressed in this report since HTB has basin-wide data that is summarized in the 2011 Malibu Watershed Report. All statements on water quality at a site were based on chemical data summarized in the 2011 Basin Report.

Results

BMI Communities

Excel spreadsheets of the BMI communities collected at each site for each sample year is contained in taxa lists that are maintained by the HTB staff.

Biotic Condition by Watershed

In 2000 through 2003, BMI samples were collected using the CSBP method which produced three samples per site. These samples were calibrated using procedures described earlier. The lists of metrics and IBI scores produced from the calibration and the full array of biological metrics and IBI scores produced from BMI samples collected from 2005 through 2010 are contained in Excel spreadsheets maintained by the HTB staff. The IBI scores for all sites sampled between 2000 and 2010 are summarized in Table 4.

The three sites on Malibu Creek (MC1, MC12 and MC15) were considered impacted sites when they were establish in 2000. All three sites had poor to very poor biotic

condition scores (Table 4) for all years they were sampled and none of the values were significantly above the impairment IBI threshold value for SoCal streams (39).

Two of the sites on Cold Creek (CC2 and CC11) were considered impacted sites when they were establish in 2000. The CC2 site is currently in poor biotic condition (Table 4) and has not been above the impairment threshold value for SoCal streams since 2005. There is some indication that this site may have been in better condition in the early years, but the pattern is too variable to confirm that it was ever consistently in fair to good stream health. The CC11 site is currently in fair condition (Table 4) and is not below the impairment threshold value of 39. However, the average of the duplicate samples collected in 2010 was 40 so there is some concern for the biotic integrity of this site. CC3 was considered a reference site when it was established in 2000 and its IBI scores reflect a currant biotic condition of excellent. In 2003 through 2008, the IBI value dipped into the good condition category, but then recovered to excellent in 2009 and 2010 indicating that there is not a consistent downward trend in biotic condition.

Two of the three sites on Las Virgenes Creek (LV5 and LV13) were considered impacted sites when they were established in 2000 (LV5) and 2002 (LV13). The two sites had poor to very poor biotic condition scores (Table 4.) for all years they were sampled and never above the impairment threshold value for SoCal streams (39). The LV9 was established as a reference site in 2002, but is currently in poor condition and at the impairment value; however its average IBI value is 40 and has had an IBI value of 42 as recently as 2009.

The Medea Creek site (MD7) was considered an impacted site when it was established in 2000 and had a poor to very poor biotic condition score (Table 4) throughout the 10 years of sampling. It has had a very poor biotic condition score since 2003 and is below the impairment threshold value for SoCal streams.

Both of the Solstice Creek sites (SC14 and SC22) are of special concern because they are both in a reference stream and trending to poorer biotic condition. The SC14 site was established in 2001 as a reference site and was in excellent biotic condition (Table 4) for the first year. In 2002 it was in the upper good category, but has been decreasing in value since then. It is currently in fair condition and still above the impairment threshold value for SoCal streams. The SC22 site was established in 2006 because it was downstream of a concrete removal project and used as a test site to measure the effects of the restoration project on the site's biotic condition. At the first sampling event in 2006, the site had a similar BMI community and IBI score as SC14 but in 2008, NZMS invaded the site and its IBI value decreased (Table 4).

The Arroyo Sequit Creek site (AS19) was established as a reference site in 2001 and is currently in good biotic condition (Table 4). The IBI value for this site dipped below the good condition in 2006 and 2008, but all other years have been in good condition.

The Cheeseboro Creek site (CH6) was established as a reference site in 2001, but was removed from the reference category by HTB staff in 2003. The site was never above a

fair condition for biotic integrity except for spring 2002 when it was barely into the good category (Table 4). The site maintained its fair rating through 2006, but was not sampled until 2010 when its biotic condition score was in the poor category and below the impaired waterbody value.

The Lachusa Creek site (LCH18) was established as a reference site in 2001 and had consistent IBI scores in the good category of biotic condition for the first two years (Table 4). In 2003, the IBI scores dropped to the fair category with an average value of 47 which is its current condition score.

The Triunfo Creek site (TR17) was considered an impacted site when it was established in 2000 and has never had an IBI score above the very poor biotic condition category (Table 4) throughout the 10 year period. With an average IBI score of 10, it is well below the impairment threshold value for SoCal streams.

Quality Assurance and Control for Biotic Samples

Tables 5 and 6 show the results of the duplicate sampling of BMIs over the six years the procedure was practiced. The range of differences in the final 0-100 scale IBI score was 1 to 9 and the average difference was 3.9. There was no notable problematic metric and no difference with the two types of SWAMP sampling procedure (RWB vs. TRC). The duplicate samples using the two sampling procedures produced a difference of 3 points which is lower than the average difference found for all duplicate samples. However, on three of the seven occasions when duplicates samples were taken, there was an IBI categorical change.

Effect of NZMS on Biotic Condition

New Zealand Mud Snail (*Potamopyrgus antipodarum*) occurred at seven of the permanent monitoring sites (MC1, MC12, MC15, LV5, LV13, MD7 and SC22). The snail first appeared in 2005 at MD7, in 2006 at MC1, MC15 and LV5, in 2008 at MC12 and in 2009 at LV13 and SC22. The last two sites were not sampled in 2008 so the snail may have been present then. Table 7 shows the IBI scores (in red) at those sites where it occurred and the percent NZMS found in the samples.

At the Las Virgenes and Madera Creek sites the proportion of NZMS to the rest of the BMIs in the sample was highly variable and ranged from 12% to 95%. The LV13 site had the lightest infestation and MD7 had the highest (Table 7). However, the NZMS infestation had no notable affect on the IBI scores. These sites had poor water chemistry and low IBI scores even before the invasion of the snail so it seems the presence of the snail have no consequence on the biotic integrity. On the other hand, the SC22 site which was in better biotic condition in 2006 did have an IBI value drop from 64 to 45 between then and 2010 with a medium density (23%-33%) of NZMS.

At the Malibu Creek sites, the infestation became severe over time and then in 2010, the numbers of snails dropped dramatically (Table 7). The probable cause of the drop was

higher flows in 2010 either removing the snails by scouring bedload or by providing better habitat for other BMIs. The decrease in NZMS did have a significant effect on the IBI scores, especially at MC1 and MC12 where the score fell to 6 and 3, respectively.

The development of the SoCal IBI was based on data collected between 2000 and 2004 when NZMS were not a known problem in southern California streams. Furthermore, the biotic metrics used in the IBI were chosen based on their response to measures of human land use and not the presence of invasive species. The observation of lower IBI values at sites with less NZMS (MC1 and MC12) resulted from a shift in the functional feeding composition at the site. At these two sites, *Baetis* mayflies dominating the community and since these mayflies are collector/gatherers and the snails are grazers, the sore for that metric of the IBI was 0 instead of 10 (Table 3) when the snail dominated.

Physical Habitat Condition

Individual site summary sheet containing all the physical habitat metrics measured using the SWAMP protocol in 2009 and 2010 are maintained by HTB staff. The summary sheets also have the average values for the two year of sampling that were used to make the individual assessments of each site. Averaging the two years should give better values than using individual years because 2009 was as dry year and 2010 was a wet year. At most sites, especially on the mainstem Malibu Creek sites, the wetted stream channel was larger and deeper in 2010 which was reflected in the flow habitats. However, in most of the smaller stream reaches, the differences were less evident.

Individual Site Assessments

Malibu Creek Bottom of Watershed (MC 1)

Biotic Condition Summary: The MC1 site had a consistently poor biotic integrity score (average value of 25) for all years it was sampled and was never above the impairment threshold value for southern California streams. There was no notable anomalies with the biotic scores except in 2010 when the NZMS numbers were low (<1%) and the IBI score was 6. The 2010 IBI score was probably due to high stream flows changing the physical conditions making it less favorable for the snails and allowing *Baetis* mayflies to dominate (73%) the community. Since these mayflies are collector/gatherers and the snails are grazers, the score for that metric of the IBI was 0 instead of 10 when the snail dominated. The NZMS infestation first appeared in low numbers (3%) in 2006, became heavy in 2008 (78%) and 2009 (81%) in 2009 and then dropped to <1% in 2010.

Stream Characteristics: The MC1 site had a large wetted channel (width of 13.6 m and depth of 18.1 cm) that flowed through a low gradient (1.07%) bankfull channel with a width of 20.8 m and a bank height of 2.0 m. The substrate was moderately embedded (44%), dominated by sands/fines (28%) and boulders (48%) and had a medium average substrate size (35.0 cm). The flow habitats were all present in relatively equal proportion. The stream banks were stable, the channel was well shaded (71%) and there was a moderate accumulation of leaf litter (36% CPOM).

Physical Habitat Stressors: The MC1 site had low percent fines/sands (28%), high instream habitat complexity (16), low human disturbance (0.4) and high riparian vegetation (76) compared to the values determined for all streams in southern California (Table 3). This would indicate that the most important physical habitat stressors contributing to poor IBI scores in southern California streams were not a factor on the observed biotic condition at MC1.

Recommendations for Future Monitoring: The MC1 site is currently in the very poor biotic condition and below the impairment threshold value for southern California streams. Water chemistry is probably the primary stressor at this site since physical habitat stressors do not seem to be an issue. This site will probably not improve until upstream stressors are managed so monitoring could be reduced to every five year or until major watershed improvements are enacted. However, the presence of NZMS should be monitored to determine the status of the infestation.

Malibu Creek in State Park Upstream of Bridge Rock Pool (MC 12)

Biotic Condition Summary: The MC12 site had a consistently poor biotic integrity score (average value of 23) for all years it was sampled and was never above the impairment threshold value for southern California streams. There were no notable anomalies with the biotic scores except in 2010 when the NZMS numbers were low (1%) and the IBI score was 3. The 2010 IBI score was probably due to high stream flows changing the physical conditions making it less favorable for the snails and allowing *Baetis* mayflies to dominate (60%) the community. Since these mayflies are collector/gatherers and the snails are grazers, the sore for that metric of the IBI was 0 instead of 10 when the snail dominated. The NZMS infestation first appeared in low numbers (9%) in 2008, increased notably (65%) in 2009 and then dropped to 1% in 2010. The IBI scores for this site have gone down since the infestation sending the biotic condition from poor to very poor.

Stream Characteristics: The MC12 site had a large wetted channel (width of 7.8 m and depth of 23.0 cm) that flowed through a high gradient (6.46%) bankfull channel with a width of 17.5 m and a bank height of 1.2 m. The substrate had low cobble embeddedness (11%), was dominated by boulders (48%) with an even distribution of sands/fines (19%), gravels (10%) and cobbles (18%) and had a high average substrate size (70.9 cm). The flow habitats were all present, but dominated by slow/shallow glides (68%). The stream banks were stable, the channel was partially shaded (59%) and there was a moderate accumulation of leaf litter (34% CPOM).

Physical Habitat Stressors: The MC12 site had low percent fines/sands (19%), high instream habitat complexity (15), low human disturbance (1.1) and high riparian vegetation (66) compared to the values determined for all streams in southern California (Table 3). This would indicate that the most important physical habitat stressors contributing to poor IBI scores in southern California streams were not a factor on the observed biotic condition at MC12.

Recommendations for Future Monitoring: The MC12 site is currently in the very poor category and below the impairment threshold value for SoCal streams. Water chemistry is probably the primary stressor at this site since physical habitat stressors do not seem to be an issue. This site will probably not improve until upstream stressors are managed so monitoring could be reduced to every five year or until major watershed improvements are enacted. However, the presence of NZMS should be monitored to determine the status of the infestation.

Malibu Creek below Tapia WWTP Discharges (MC 15)

Biotic Condition Summary: The MC15 site had a consistently poor biotic integrity score (average value of 25) for all years it was sampled and was only above the impairment threshold values for southern California streams twice. There were no notable anomalies with the biotic scores except in 2010 when the NZMS numbers were low (13%) and the IBI score was 6. The 2010 IBI score was probably due to high stream flows changing the physical conditions making it less favorable for the snails and allowing the Chironomid midge to dominate (64%) the community. The NZMS infestation first appeared in low numbers (4%) in 2006, became moderate (29%) in 2009 and then dropped to 13% in 2010. The IBI scores for this site have gone down since the infestation sending the biotic condition from poor to very poor.

Stream Characteristics: The MC15 site had a large wetted channel (width of 7.2 m and depth of 30.8 cm) that flowed through a low gradient (0.82%) bankfull channel with a width of 11.4 m and a bank height of 1.0 m. The substrate was moderately embedded (36%), dominated by sands/fines (45%) with an even distribution of gravels (16%), cobble (14%) and boulders (16%) and had a medium average substrate size (34.2 cm). The flow habitats were all present, but dominated by slow/shallow glides (57%). The stream banks were stable, the channel was partially shaded (46%) and there was a moderate accumulation of leaf litter (41% CPOM).

Physical Habitat Stressors: The MC15 site had high percent fines/sands (45%), high instream habitat complexity (17), average human disturbance (1.4) and high riparian vegetation (70) compared to the values determined for all streams in southern California (Table 3). This would indicate that sandy substrate would be a contributor to the observed biotic condition at MC15, but the other three important physical habitat stressors contributing to poor IBI scores in southern California streams were not a factor.

Recommendations for Future Monitoring: The MC15 site is currently in the very poor category and below the impairment threshold value for southern California streams. Water chemistry and sandy substrate are probably the primary stressors at this site since the other physical habitat stressors do not seem to be an issue. This site will probably not dramatically improve until upstream stressors are managed, but since this site is below a WWTP, it should be monitored regularly to assess the effects of the plant's discharge on the biotic community. Additionally, the presence of NZMS should be monitored to determine the status of the infestation.

Cold Creek at Backbone Trail (CC2)

Biotic Condition Summary: The CC2 site is currently in poor biotic condition and has not been above the impairment threshold value for southern California streams since 2005. There is some indication that this site may have been in better condition in the early years, but the pattern is too variable to confirm that it was ever consistently in fair to good stream health. The low IBI scores were consistent over the years with no notable anomalies except in fall 2001 when the IBI score was 73. The 2001 anomaly was produced because only one of three samples (using the CSBP method) was collected during that event and that one sample was dominated (51%) by EPT organisms. A high percent EPT organism produced higher IBI scores and probably would have been averaged out if the other two samples were collected. Snails in the family Hydrobiidae have been present at the CC2 site since 2006, but have not been identified as NZMS.

Stream Characteristics: The CC2 site had a small wetted channel (width of 2.4 m and depth of 11.0 cm) that flowed through a low gradient (1.82%) bankfull channel with a width of 4.7 m and a bank height of 1.5 m. The substrate was moderately embedded (44%), dominated by sands/fines (33%), gravels (21%) and hardpan/bedrock (36%) and had a low average substrate size (23.0 cm). The flow habitats were dominated by slow/shallow glides (60%) and fast/shallow riffles (33%). The stream banks were stable, the channel was heavily shaded (92%) and there was a moderate accumulation of leaf litter (50% CPOM).

Physical Habitat Stressors: The CC2 site had average percent fines/sands (33%), low instream habitat complexity (8), average human disturbance (1.4) and high riparian vegetation (66) compared to the values determined for all streams in southern California (Table 3). This would indicate that low instream habitat complexity would be a contributor to the observed biotic condition at CC2, but the other three important physical habitat stressors contributing to poor IBI scores in southern California streams were not a factor.

Recommendations for Future Monitoring: Although the CC2 site had inconsistent IBI scores in the fair and good category prior to 2003, since 2005 it has been in the poor category and below the impairment threshold value for southern California streams. Water chemistry and lack of instream habitat complexity are probably the primary stressors at this site since the other physical habitat stressors do not seem to be an issue. Cold Creek is an important tributary to Malibu Creek and is in reference condition in the upper reaches. Improvement to the biotic integrity could be measured if upstream stressors are identified and eliminated or managed. There should be special concern at this site for NZMS since Hydrobiid snails were discovered at this site in 2006 and although they have not been identified as NZMS, their presence has been confirmed elsewhere in the watershed. The CC2 site should be monitored regularly to determine the biotic condition and to check for the presence of NZMS.

Cold Creek in Cold Creek Preserve (CC3)

Biotic Condition Summary: The CC3 site was considered a reference site when it was established in 2000 and its IBI scores reflect that it is currently in excellent biotic condition. In 2003 through 2008, the IBI value dipped into the good condition category, but then recovered to excellent in 2009 and 2010 indicating that there is not consistent downward trend in biotic condition. Snails in the family Hydrobiidae have been present at the CC3 site since 2000 and sometimes in significant densities (28% in 2008). They have been identified as the native snail and not the NZMS.

Stream Characteristics: The CC3 site has a very small wetted channel (width of 1.6 m and depth of 3.8 cm) that flowed through a high gradient (8.08%) bankfull channel with a width of 5.2 m and a bank height of 0.5 m. The substrate was moderately embedded (31%), was well distributed, but with a slightly larger proportion of boulders (34%) and had a medium average substrate size (55.3 cm). The flow habitats were dominated by slow/shallow glides (25%) and fast/shallow riffles (38%), but with an adequate amount of pool habitat (13%) for a small stream. The stream banks were 68% stable, the channel was heavily shaded (88%) and there was a moderate accumulation of leaf litter (42% CPOM).

Physical Habitat Stressors: The CC3 site had low percent fines/sands (16%), low instream habitat complexity (8), low human disturbance (0.8) and high riparian vegetation (74) compared to the values determined for all streams in southern California (Table 3). This would indicate that low instream habitat complexity would be a contributor to the observed biotic condition at CC3, but the other three important physical habitat stressors contributing to poor IBI scores in southern California streams were not a factor.

Recommendations for Future Monitoring: The CC3 site has excellent IBI scores and only lacked instream habitat complexity and marginal bank stability. The water chemistry at this site is better than most sites in the Malibu Creek watershed. The CC3 site should be monitored regularly as a reference site to assure that it maintains its excellent biotic condition and to check for the presence of NZMS since they are already established in the watershed.

Cold Creek in Middle Watershed (CC11)

Biotic Condition Summary: The CC11 site is currently in fair condition and is not below the impairment threshold value for southern California streams. However, the average of the duplicate samples collecting in 2010 was 40 so there is some concern for the biotic integrity of this site. Snails in the family Hydrobiidae have always been present at the CC11, but have not been identified as NZMS.

Stream Characteristics: The CC11 site had a small wetted channel (width of 3.0 m and depth of 10.6 cm) that flowed through a high gradient (5.19%) bankfull channel with a width of 6.5 m and a bank height of 0.67 m. The substrate was slightly embedded (26%),

was well distributed with none of the size fractions dominating and had a medium average substrate size (38.8 cm). The flow habitats were dominated by slow/shallow glides (39%) and fast/shallow riffles (27%), but with an adequate amount of pool habitat (19%) for a small stream. The stream banks were stable, the channel was heavily shaded (88%) and there was a moderate accumulation of leaf litter (34% CPOM).

Physical Habitat Stressors: The CC11 site had low percent fines/sands (26%), low instream habitat complexity (8), low human disturbance (0.8) and high riparian vegetation (80) compared to the values determined for all streams in southern California (Table 3). This would indicate that low instream habitat complexity would be a contributor to the observed biotic condition at CC11, but the other three important physical habitat stressors contributing to poor IBI scores in southern California streams were not a factor.

Recommendations for Future Monitoring: Although the CC11 site had consistent IBI scores in the fair category it is currently on the edge of dipping into poor and just above the impairment threshold value for southern California streams. The physical habitat quality and minimal stressors are similar to the reference site CC3. This site could have measurable improvement to the biotic integrity if upstream stressors are identified and eliminated or managed. There should be special concern for NZMS at this site since their presence has been confirmed elsewhere in the watershed. The CC11 site should be monitored regularly to determine the biotic condition and checked for the presence of NZMS.

Las Virgenes Creek at Malibu Creek State Park (LV5)

Biotic Condition Summary: The LV5 site had a consistently poor biotic integrity score (average value of 26) for all years it was sampled and was never above the impairment threshold value established for southern California streams. The NZMS infestation first appeared in moderate numbers (24%) in 2005 peaked at 50% in 2006 and then back down to 20% in 2009 and 24% in 2010. With the exception of 2008, IBI score for this site has gone down since the infestation sending the biotic condition from poor to very poor.

Stream Characteristics: The LV5 site had a moderate sized wetted channel (width of 4.9 m and depth of 16.6 cm) that flowed through a low gradient (0.54%) bankfull channel with a width of 11.9 m and a bank height of 2.7 m. The substrate was slightly embedded (28), was dominated by sands/fines (68%) and gravels (20%) with minimal cobble (8%) and boulders (2%) and had a small average substrate size (16.6 cm). The flow habitats were all present, but dominated by slow/shallow glides (91%). The stream banks were stable, the channel was heavily shaded (88%) and there was a moderate accumulation of leaf litter (46% CPOM).

Physical Habitat Stressors: The LV5 site had high percent fines/sands (68%), high instream habitat complexity (14), low human disturbance (0.7) and high riparian vegetation (88) compared to the values determined for all streams in southern California

(Table 3). This would indicate that sandy substrate would be a contributor to the observed biotic condition at LV5, but the other three important physical habitat stressors contributing to poor IBI scores in southern California streams were not a factor.

Recommendations for Future Monitoring: The LV5 is currently in the very poor category and below the impairment threshold value for southern California streams. Water chemistry and sandy substrate are probably the primary stressors at this site since the other physical habitat stressors do not seem to be an issue. This site will probably not improve until upstream stressors are managed so monitoring could be reduced to every five year or until major watershed improvements are enacted. However, the presence of NZMS should be monitored to determine the status of the infestation.

Las Virgenes Creek on Ahmanson Ranch (LV9)

Biotic Condition Summary: The LV9 was established as a reference site in 2002, but is currently in poor condition and at the impairment threshold value for southern California streams. However, throughout the years of monitoring, its average IBI score is 40 and has had an IBI score of 42 as recently as 2009. There are no NZMS at this site, but they have been identified at other sites in the watershed.

Stream Characteristics: The LV9 site had a very small wetted channel (width of 2.7 m and depth of 3.4 cm) that flowed through a low gradient (1.90%) bankfull channel with a width of 6.6 m and a bank height of 0.4 m. The substrate had low cobble embeddedness (20%), was dominated by sands/fines (94%) with only a minimal amount of boulders (8%) and had a very small average substrate size (3.0 cm). The flow habitats were all present, but dominated by slow/shallow glides (82%). The stream banks were stable, the channel was heavily shaded (95%) and there was a substantial accumulation of leaf litter (59% CPOM).

Physical Habitat Stressors: The LV9 site had high percent fines/sands (94%), average instream habitat complexity (10), low human disturbance (0.5) and high riparian vegetation (86) compared to the values determined for all streams in southern California (Table 3). This would indicate that sandy substrate would be a contributor to the observed biotic condition at LV9, but the other three important physical habitat stressors contributing to poor IBI scores in southern California streams were not a factor.

Recommendations for Future Monitoring: Although the LV9 site was established as a reference site, the IBI scores have only been in the fair to poor category and it is currently at the impairment threshold value for southern California streams. However, this site was the only one of the three Las Virgenes Creek sites that is not infested with NZMS. Water chemistry and sandy substrate are probably the primary stressors at this site since the other physical habitat stressors do not seem to be an issue. The LV9 site should not be considered a reference site, but should be monitored regularly to assess its biotic condition and to check for the presence of NZMS since they are already established in the watershed.

Las Virgenes Creek at Lost Hills Rd (LV13)

Biotic Condition Summary: The LV13 site had a poor biotic integrity score when it was first sampled in 2002 and 2003, but since 2005 the site has been in the very poor category and below the impairment threshold value established for southern California streams. The NZMS infestation was first documented in 2009 at 15% and had a similar level in 2009 (12%), but was probably infested in 2007 or 2008 (there was no sampling at this site). The IBI scores for this site have gone down since the infestation sending the biotic condition from poor to very poor.

Stream Characteristics: The LV13 site had a small wetted channel (width of 2.8 m and depth of 17.0 cm) that flowed through a low gradient (2.51%) bankfull channel with a width of 4.2 m and a bank height of 1.0 m. The substrate was moderately embedded (34%), dominated by sands/fines (72%) and gravels (21%) with minimal cobble (2%) and had a small average substrate size (15.3 cm). The flow habitats were dominated by slow/deep pools (53%) with fast/shallow riffles (18%) and slow/shallow glides (26%). The stream banks were stable, the channel was heavily shaded (96%) and there was a moderate accumulation of leaf litter (36% CPOM).

Physical Habitat Stressors: The LV13 site had high percent fines/sands (72%), high instream habitat complexity (12), average human disturbance (2.0) and high riparian vegetation (76) compared to the values determined for all streams in southern California (Table 3). This would indicate that sandy substrate would be a contributor to the observed biotic condition at LV13, but the other three important physical habitat stressors contributing to poor IBI scores in southern California streams were not a factor.

Recommendations for Future Monitoring: The LV13 site is currently in the very poor category and below the impairment threshold value for southern California streams. Water chemistry and sandy substrate are probably the primary stressors at this site since the other physical habitat stressors do not seem to be an issue. This site will probably not improve until upstream stressors are managed so monitoring could be reduced to every five year or until major watershed improvements are enacted. However, the presence of NZMS should be monitored to determine the status of the infestation.

Medea Creek Downstream of Agora Hills (MD7)

Biotic Condition Summary: The MD7 site was considered an impacted site when it was established in 2000 and had a poor to very poor biotic condition score throughout the 10 years of sampling. It has had a very poor biotic condition score since 2003 and is below the impairment threshold value for southern California streams. The NZMS infestation first appeared in moderate numbers (59%) in 2005 and 2006 peaked at 95% in 2009 and then back down to 57% in 2010. The NZMS infestation had no notable affect to the IBI scores since the values had been low since before the snail appeared.

Stream Characteristics: The MD7 site had a small wetted channel (width of 3.9 m and depth of 31.7 cm) that flowed through a low gradient (1.00%) bankfull channel with a

width of 10.6 m and a bank height of 1.2 m. The substrate was slightly embedded (27%), dominated by sands/fines (51%) and gravels (24%) with minimal cobble (9%), bolder (8%) and hardpan/bedrock (8%) and had a medium average substrate size (26.6 cm). The flow habitats were dominated by slow/deep pools (42%) and slow/shallow glides (41%) with minimal fast/shallow riffles (11%). The stream banks were stable, the channel was heavily shaded (96%) and there was a moderate accumulation of leaf litter (36% CPOM).

Physical Habitat Stressors: The MD7 site had high percent fines/sands (51%), low instream habitat complexity (8), average human disturbance (2.5) and high riparian vegetation (69) compared to the values determined for all streams in southern California (Table 3). This would indicate that sandy substrate and low instream habitat complexity would be contributors to the observed biotic condition at MD7, but the other two important physical habitat stressors contributing to poor IBI scores in southern California streams were not a factor.

Recommendations for Future Monitoring: The MD7 site is currently in the very poor category and below the impairment threshold value for southern California streams. Water chemistry, sandy substrate and lack of instream habitat complexity are probably the primary stressors at this site since the other physical habitat stressors do not seem to be an issue. This site will probably not improve until upstream stressors are managed so monitoring could be reduced to every five year or until major watershed improvements are enacted. However, the presence of NZMS should be monitored to determine the status of the infestation.

Solstice Creek at National Park Service Area (SC14)

Biotic Condition Summary: The SC14 site was established in 2001 as a reference site and was in excellent biotic condition for the first year. In 2002 it was in the upper good category, but has been decreasing in value since then. It is currently in fair condition and still above the impairment threshold value for southern California streams.

Stream Characteristics: The SC14 site had a very small wetted channel (width of 2.2 m and depth of 3.8 cm) that flowed through a moderate gradient (2.23%) bankfull channel with a width of 6.0 m and a bank height of 0.4 m. The substrate had low cobble embeddedness, was dominated by gravels (44%) with equal amounts of fines/sands (18%), cobble (20%) and boulders (18%) and had a medium average substrate size (44.1 cm). The flow habitats were all present, but dominated by fast/shallow riffles (60%) and slow/shallow glides (35%). The stream banks were stable, the channel was well shaded (76%) and there was a moderate accumulation of leaf litter (34% CPOM).

Physical Habitat Stressors: The SC14 site had low percent fines/sands (18%), low instream habitat complexity (6), low human disturbance (0.6) and high riparian vegetation (92) compared to the values determined for all streams in southern California (Table 3). This would indicate that low instream habitat complexity would be a contributor to the observed biotic condition at SC14, but the other three important

physical habitat stressors contributing to poor IBI scores in southern California streams were not a factor.

Recommendations for Future Monitoring: The SC14 site is of special concern because it is located on a reference stream and has been on a trend to lower biotic condition scores since 2002. NZMS have not infested this site but they have been identified in most of the watershed downstream of this site. Water chemistry and lack of instream habitat complexity are probably the primary stressors at this site since the other physical habitat stressors do not seem to be an issue. The SC14 site should be monitored regularly to assess its biotic condition and to check for the presence of NZMS since they are already established in the watershed.

Solstice Creek downstream of Corral Bridge near Pacific Coast Hwy (SC22)

Biotic Condition Summary: The SC22 site was established in 2006 because it was downstream of a concrete removal project and used as a test site to measure the effects of the restoration project on the site's biotic condition. At the first sampling event in 2006, the site had a similar BMI community and IBI score as SC14, but in 2008 NZMS invaded the site and its IBI value decreased. However, it is unclear if the decreased IBI score resulted from the restoration work, from NZMS infestation or some other stressor.

Stream Characteristics: The SC22 site had a very small wetted channel (width of 2.6 m and depth of 3.5 cm) that flowed through a low gradient bankfull channel with a width of 5.8 m and a bank height of 0.3 m. The substrate was moderately embedded (42%), dominated by gravels (50%) with equal amounts of fines/sands (20%), cobble (14%) and boulders (15%) and had a medium average substrate size (32.2 cm). The flow habitats were all present, but dominated by fast/shallow riffles (68%) and slow/shallow glides (26%). The stream banks were stable, the channel was heavily shaded (92%) and there was a moderate accumulation of leaf litter (49% CPOM).

Physical Habitat Stressors: The SC22 site had low percent fines/sands (20%), low instream habitat complexity (5), high human disturbance (4.8) and high riparian vegetation (84) compared to the values determined for all streams in southern California (Table 3). This would indicate that low instream habitat complexity and high human disturbance would be contributors to the observed biotic condition at SC22, but the other two important physical habitat stressors contributing to poor IBI scores in southern California streams were not a factor.

Recommendations for Future Monitoring: The SC22 site is of special concern because it is located on a reference stream and has been on a trend to lower biotic condition scores since 2006 because of the NZMS infestation at the site. Water chemistry, lack of instream habitat complexity and the high level of human disturbance are probably the primary stressors at this site since the other physical habitat stressors do not seem to be an issue. The SC22 site should be monitored regularly to assess its biotic condition and to check for the presence of NZMS since they are already established in the

watershed. Investigation of all upstream stressors, including the restoration project should be determined for this site.

Arroyo Sequit Creek at Mulholland Highway Road (AS19)

Biotic Condition Summary: The AS19 site was established as a reference site in 2001 and is currently in good biotic condition. The IBI value for this site dipped below the good condition in 2006 and 2008, but all other years have been in good condition.

Stream Characteristics: The AS19 site had a small wetted channel (width of 3.5 m and depth of 12.0 cm) that flowed through a moderate gradient (2.37%) bankfull channel with a width of 8.2 m and a bank height of 0.6 m. The substrate was moderately embedded, dominated by boulders (39%) with slightly higher amounts of fines/sands (27%) and equal amounts of gravel (16%) and cobble (14%) and had a medium average substrate size (36.9 cm). The flow habitats were all present, but dominated by slow/shallow glides (55%) and fast/shallow riffles (26%). The stream banks were stable, the channel was well shaded (80%) and there was a moderate accumulation of leaf litter (48% CPOM).

Physical Habitat Stressors: The AS19 site had low percent fines/sands (27%), high instream habitat complexity (12), low human disturbance (1.0) and high riparian vegetation (76) compared to the values determined for all streams in southern California (Table 3). This would indicate that the most important physical habitat stressors contributing to poor IBI scores in southern California streams were not a factor on the observed biotic condition at AS19.

Recommendations for Future Monitoring: The AS19 site has good IBI scores, is not influenced by any of the important physical habitat stressors and the water chemistry is better than most sites in the Malibu Creek watershed As of 2009, NZMS has not infested this watershed which makes it of special concern for protection and further monitoring. The AS19 site should be monitored regularly as a reference site to assure that it maintains its good biotic condition and to check for the presence of NZMS.

Cheeseboro Creek at Chesebro Road (CH6)

Biotic Condition Summary: The CH6 was established as a reference site in 2001 and then discontinued because it is directly below the city of Calabasas landfill. The site was never above a fair condition for biotic integrity except for spring 2002 when it was barely into the good category. The site maintained its fair rating through 2006, but was not sampled until 2010 when its biotic condition score was in the poor category and below the impairment threshold value for southern California streams. Although this site has been on the decline since 2002, the lowest IBI score in 2010 was related to the dramatic decrease in the sensitive EPT and other intolerant taxa.

Stream Characteristics: The CH6 site had a very small wetted channel (width of 2.3 m and depth of 3.3 cm) that flowed through a low gradient bankfull channel with a width of 6.9 m and a bank height of 0.7 m. The substrate was dominated by fines/sands (90%) and

the remainder of the substrate in boulders (10%) and had a very small average substrate size (1.03 cm). The flow habitats were dominated by slow/shallow glides (98%). The stream bank stability was 64%, the channel was heavily shaded (99%) and there was a heavy accumulation of leaf litter (100% CPOM).

Physical Habitat Stressors: The CH6 site had high percent fines/sands (90%), average instream habitat complexity (10), average human disturbance (1.3) and high riparian vegetation (96) compared to the values determined for all streams in southern California (Table 3). This would indicate that sandy substrate would contribute to the observed biotic condition at CH6, but the other three important physical habitat stressors contributing to poor IBI scores in southern California streams were not a factor.

Recommendations for Future Monitoring: The CH6 site has poor IBI scores and for the first time in 2010 is below the impairment threshold value for southern California streams. Water chemistry and sandy substrate are probably the primary stressors at this site since the other physical habitat stressors do not seem to be an issue. As of 2009, NZMS has not infested this watershed which makes it of special concern for protection and further monitoring. The upstream stressors need to be identified and managed, and the CH6 site should be monitored regularly to determine if it degrades further and to check for the presence of NZMS.

Lachusa Creek at bottom of watershed near PCH (LCH18)

Biotic Condition Summary: The LCH18 site was established as a reference site in 2001 and had consistent IBI scores in the good category of biotic condition for the first two years and then dropped in 2003 to the fair category with an average value of 47 which is its current condition score. There was one notable anomaly with the biotic condition when in 2006 the IBI score was 11. The score was lower because the sample was dominated by the *Baetis* mayflies (40%) and Hydropsychid caddisflies (25%) and there were few other EPTs or beetle taxa. By 2009 and in 2010, the *Baetis* and Hydrophychid organisms were present but did not dominate and the other taxa were again present resulting in higher IBI scores.

Stream Characteristics: The LCH18 site had a very small wetted channel (width of 2.0 m and depth of 6.2 cm) that flowed through a high gradient (5.80%) bankfull channel with a width of 5.2 m and a bank height of 0.5 m. The substrate was moderately embedded (40%), dominated by fines/sands (30%) and boulders (37%) with equal amounts of gravel (14%) and cobble (12%) and had a medium average substrate size (42.2 cm). The flow habitats were all present, but dominated by fast/shallow riffles (46%) and slow/shallow glides (37%). The stream banks were stable, the channel was well shaded (89%) and there was a heavy accumulation of leaf litter (70% CPOM).

Physical Habitat Stressors: The LCH18 site had average percent fines/sands (30%), high instream habitat complexity (14), low human disturbance (0.8) and high riparian vegetation (100) compared to the values determined for all streams in southern California (Table 3). This would indicate that the most important physical habitat stressors

contributing to poor IBI scores in southern California streams were not a factor on the observed biotic condition at LCH18.

Recommendations for Future Monitoring: The LCH18 site is of special concern because it is located on a reference stream and has been on a trend to lower biotic condition scores since 2003. Water chemistry is probably the primary stressor at this site since the other physical habitat stressors do not seem to be an issue. As of 2009, NZMS has not infested this watershed which makes it of special concern for protection and further monitoring. The LCH18 site should be monitored regularly to assess its biotic condition and to check for the presence of NZMS since they are already established in the watershed.

Triunfo Creek at Triunfo/Lobo Cyn Community Center (TR17)

Biotic Condition Summary: The TR17 site has never had an IBI score above the very poor biotic condition category throughout the 10-year period. However, the first three sampling events and again in 2006 and 2009, the biotic score was at or near 20. In 2003, 2005 and 2010, the IBI score was extremely low because the samples on those events were dominated by pollution tolerant BMIs; 80% to 90% of these samples consisted of a combination of Chrionomid midges, aquatic worms, black flies (*Simulium sp*.) and the scud (*Hyalella sp*.).

Stream Characteristics: The TR17 site had a moderate sized wetted channel (width of 5.0 m and depth of 23.6 cm) that flowed through a low gradient (0.39%) bankfull channel with a width of 10.5 m and a bank height of 1.0 m. The substrate had low cobble embeddedness, was dominated by sands/fines (44%) with an even distribution of gravels (20%), cobbles (20%) and boulders (14%) and had a medium average substrate size (45.8 cm). The flow habitats were dominated by slow/shallow glides (62%) with 18% of both fast/shallow riffles and slow/deep pools. The stream banks were 46% stable, the channel was well shaded (83%) and there was a moderate accumulation of leaf litter (36% CPOM).

Physical Habitat Stressors: The TR17 site had high percent fines/sands (44%), high instream habitat complexity (14), average human disturbance (1.5) and high riparian vegetation (69) compared to the values determined for all streams in southern California (Table 3). This would indicate that sandy substrate would contribute to the observed biotic condition at TR17, but the other three important physical habitat stressors contributing to poor IBI scores in southern California streams were not a factor.

Recommendations for Future Monitoring: With an average IBI score of 10, the TR17 site is well below the impairment threshold value for southern California streams. Water chemistry and sandy substrate are probably the primary stressors at this site since the other physical habitat stressors do not seem to be an issue. This site will probably not improve until upstream stressors are managed so monitoring could be reduced to every five year or until major watershed improvements are enacted. However, the presence of NZMS should be monitored to determine the status of the infestation.

Discussion and Conclusions

The HTB Bioassessment Program that started in 2000 and continues today provides valuable baseline information on the biotic condition of streams within the Santa Monica Mountains and in particular within the Malibu Creek watershed. Although HTB is considered a citizen monitoring program and utilizes volunteers, it maintained a professional bioassessment effort throughout the decade of monitoring. This effort to produce high quality data is reflected in the results of the quality assurance procedures used throughout the program. Throughout the 11 years of bioassessment sampling, HTB staff were regularly field audited by DFG or SLSII to help guarantee that data was collected according to the standardized protocols current at the time.

Between 2005 and 2010, duplicate BMI samples were collected seven times at five different sites to test the in-site variability of the invertebrate community. Additionally, when invertebrate sampling methods were being tested by DFG, HTB complied with the change in 2005 before it was mandated by the SWRCB in 2007 and conducted a comparison study to determine possible differences with the method change. The results of this quality assurance procedure indicated that the variability of the invertebrate community was low and there was no notable difference with the change in sampling procedures.

Most of the sites that were predetermined to be impacted in 2000 when the monitoring program was initiated either maintained a poor biotic condition or degraded further over the years. Two of the reference sites (CC3 and AS19) were consistently in good condition throughout the years of monitoring while three (LV9, SC14 and LCH18) degraded over time. The Malibu Watershed Report prepared by HTB staff gives more detail on the biotic condition of the watershed based on these 16 permanent monitoring sites. With the degraded sites, it is not necessary to continue monitoring until there is some progress on addressing upstream stressors. It is more important to continue monitoring reference sites to determine whether they remain in good biotic condition or begin to degrade. Recommendation on future monitoring is addressed for each site in the Individual Site Assessment section of this report.

The monitoring sites were selected to have homogenous and relatively good physical habitat condition compared to other reaches of stream in the area. This was done to help detect the effect on biotic condition from water chemistry which was a major concern in the watershed. As a result, the physical habitat measure at most sties were in exceptionally good condition given their lower biotic condition scores. Although, this helps determine the impacts of poor water quality, it provides little clue on overall physical habitat condition of the watershed. Since HTB staff collected extensive data on land use activity and habitat alterations throughout the watershed, they were able to address the issue of habitat degradation in the Malibu Watershed Report.

Some physical habitat elements measured using the SWAMP bioassessment procedure were sited in Mazor et al. (2011) as important stressors because they were correlated with poor biotic condition. When applicable, these physical habitat measures were stated

as potential stressors at a particular site. It is important to understand that these physical habitat stressors are only correlated with biotic condition and may not be a direct cause of poor condition. On the other hand, knowing that a site has multiple stressors will help in the interpretation of biotic response when land use improvements are implemented in the watershed.

There was an interesting response on IBI scores at sites that had infestations of NZMS. At most sites, there was a negative response and the IBI scores decreased after the snail was detected in large numbers. At two mainstream Malibu Creek sites where the snail was extremely abundant, there was a decrease in the IBI number when the snail had dramatic decreases in number probably due to high flows in the spring of 2010. This was simply an artifact of the way the IBI scores are calculated and was explained earlier in this report. It is important to remember that this happened at sites that were exceptionally degraded and continued to have very poor IBI scores. The SoCal IBI was developed to detect the influence of human disturbance and is an extremely valuable tool for water quality assessments. NZMS infestations are a unique and additional stressor at a site and probably should be assessed separately from determining biotic condition using the IBI.

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Table 1. Site description, code, GPS location and the number of sampling events at each site indicating the time of year of the sample collection; Spring (S) occurring during April-May, Fall (F) occurring during September-October and winter (W) occurring in December, followed by the year (2000 through 2010) for the 16 permanent and 13 special study sites in the Santa Monica Mountains, HTB Bioassessment Program.

Site Description	Site Code	Sample Location	Years Sampled
Malibu Creek			
Malibu Creek bottom of watershed	MC1	34.04289 -118.68422	S 00, F 00, S 01, F 01, S 02, F 02, F 03, S 03, W 05, S 06, S 08, S 09, S 10
Malibu Creek in State Park upstream of Bridge Rock Pool	MC12	34.09655 -118.72969	F 00, S 01, F 01, S 02, F 02, F 03, S 03, W 05, S 06, S 08, S 09, S 10
Malibu Creek downstream of Tapia WWTP discharges	MC-15	34.0776 -118.70183	S 00, F 00, S 01, F 01, S 02, F 02, S 03, F 03, S 06, S 09, S10
Cold Creek			
Cold Creek at the Backbone Trail	CC2	34.07916 -118.70054	S 00, F 00, S 01, F 01, S 02, S 03, W 05, S 06, S 09, S 10
Cold Creek in Cold Creek Preserve	CC3	34.09201 -118.64756	S 00, F 00, S 01, F 01, S 02, F 02, F 03, S 03, W 05, S 06, S 08, S 09, S 10
Cold Creek in Middle Watershed	CC11	34.0890122 -118.6804712	S 00, F 00, S 01, F 01, S 02, S 03, S 06, S 09, S 10
Las Virgenes Creek			
Las Virgenes Creek at Malibu Creek State Park	LV5	34.09724 -118.72088	S 00, F 00, S 01, F 01, S 02, F 02, F 03, S 03, W 05, S 06, S 09, S 10
Las Virgenes Creek on Ahmanson Ranch	LV9	34.1807682 -118.7073835	S 02, F 02, F 03, S 03, W 05, S 06, S 09, S 10
Las Virgenes Creek at Lost Hills Rd	LV13	34.13644 -118.70531	S 01, F 01,S 02, F 02, F 03, S 03, W 05, S 06, S 09, S 10
Medea Creek			
Medea Creek downstream of Pacific Coast Highway	MD7	34.13931 -118.75939	S 00, F 00, S 01, F 01, S 02, F 03, S 03, W 05, S 06, S 09, S 10
Solstice Creek			
Solstice Creek. at National Park Service Area	SC14	34.0384702	F 01, S 02, F 02, F 03, S 03, W 05, S 06,

		-118.7513264	S 08, S 09, S 10
Solstice Creek downstream of Corral Bridge near PCH	SC22	34.033386 -118.74293	S 06, S 09, S10
Arroyo Sequit			
Arroyo Sequit at Mulholland Highway Road	AS19	34.0655091 -118.9317543	F 01, S 02, F 02, F 03, S 03, W 05, S 06, S 08, S 09, S 10
Cheeseboro Creek			
Cheeseboro Creek at trail crossing in National Park	CH6	34.1548307 -118.7260052	S 01, F 01, S 02, F 03, W 05, S 06, S 10
Lachusa Creek			
Lachusa Creek at bottom of watershed near PCH	LCH18	34.041621 -118.8932475	F 01, S 02, F 02, F 03, S 03, W 05, S 06, S 09, S 10
Triunfo Creek			
Triunfo Creek at Triunfo/Lobo Cyn Community Center	TR10	34.12073 -118.78882	S 00, S 01, S 02, F 03, W 05, S 06, S 09, S 10

Table 4. SoCal IBI scores for the 16 permanent monitoring sites sampled between 2000 and 2010 in the Santa Monica Mountains, HTB Bioassessment Program. The two IBI scores listed for some sampling events are duplicates collected as a quality assurance and control practice.

Site	**Spr. 2000**	**Fall 2000**	**Spr. 2001**	**Fall 2001**	**Spr. 2002**	**Fall 2002**	**Spr. 2003**	**Fall 2003**	**Win. 2005**	**Spr. 2006**	**Spr. 2008**	**Spr. 2009**	**Spr. 2010**
Malibu Creek													
MC1	16	24	26	39	19		26	23	26	26	20	27	6
MC12		23	20	37	33	27	21	31	20	17	29	17	3
MC15	33	17	24	43	40	24	34	23		17		18	6
Cold Creek													
CC2	36		46	73	53		44		27/36	31/42		27	20
CC3	80	76	92	76	83	80	84	64	61	73	67	79/80	82
CC11	54	46	56	54	49		40			47		57	37/43
Las Virgenes Creek													
LV5	29	34	33	33	39	26	20	29	17/19	14/17		26	10
LV9					59	26	46		34	34		42	39
LV13					26	24	21	27	11	18		8	13
Medea Creek													
MD7	23	26	19	34	23		9	9	10	20		19	14
Solstice Creek													
SC14				87	76	76	67	70	63	60	56	69	49
SC22										64		53	44/46
Arroyo Sequit Creek													
AS19				70	72	66	72	70	64	57	50	70	70
Cheeseboro Creek													
CH6			59	57	64		49		54	43			34
Lachusa Creek													
LCH18				73	72	76	54	61	54	11		57	47
Triunfo Creek													
TR17	20		19		19		4		0	20		18	3

Table 5. Values for the 7 biological metric used in the SoCal IBI for the duplicate samples collected at the permanent study sites in the Santa Monica Mountains, HTB Bioassessment Program. RWB=reach-wide benthos and TRC= targeted riffle composite.

Year	2010				2009		2008		2006				2005	
Site	CC11		SC22		CC3		LV26		CC2		LV5		LV5	
Method	RWB	RWB	RWB	RWB	RWB	RWB	RWB	TRC	TRC	TRC	TRC	TRC	TRC	TRC
#Coleop Taxa	4	5	5	4	4	5	2	3	1	1	0	1	0	0
#EPT Taxa	6	6	5	5	11	14	0	0	11	9	3	3	5	5
#Predator Taxa	7	10	9	7	8	15	4	2	9	7	4	5	5	4
% Collectors	89	82	80	71	25	22	12	6	74	70	71	90	96	92
% Intolerant	1	2	0	0	51	24	0	0	4	2	1	0	0	0
% NonInsects	19	26	23	19	14	19	43	36	22	38	61	35	31	33
% Tolerant	33	30	29	24	7	20	88	93	22	38	47	31	31	27

Table 6. Total scores, SoCal IBI score after converting to 0-100 scale, IBI category and point difference for the 7 biological metric used in the SoCal IBI for the duplicate samples collected at the permanent study sites in the Santa Monica Mountains, HTB Bioassessment Program. RWB=reach-wide benthos and TRC= targeted riffle composite.

Year	2010				2009		2008		2006				2005	
Site	CC11		SC22		CC3		LV26		CC2		LV5		LV5	
Method	RWB	RWB	RWB	RWB	RWB	RWB	RWB	TRC	TRC	TRC	TRC	TRC	TRC	TRC
#Coleop Taxa	7	8	8	7	7	8	4	5	2	4	0	2	0	0
#EPT Taxa	3	3	3	3	6	7	0	0	5	5	1	1	3	3
#Predator Taxa	4	7	6	4	5	10	1	0	4	4	1	2	2	1
% Collectors	2	4	5	7	10	10	10	10	7	8	7	2	1	2
% Intolerant	0	1	0	0	10	9	0	0	1	3	1	0	0	0
% NonInsects	7	5	6	7	8	7	1	3	3	4	0	3	4	4
% Tolerant	2	2	3	4	9	5	0	0	0	1	0	2	2	3
Total Score	25	30	31	32	55	56	16	18	22	29	10	12	12	13
SoCal IBI	**36**	**43**	**44**	**46**	**79**	**80**	**23**	**26**	**31**	**42**	**14**	**17**	**17**	**19**
Score Change	**7**		**2**		**1**		**3**		**9**		**3**		**2**	
IBI Category	**Poor**	**Fair**	**Fair**	**Fair**	**Good**	**Exel**	**Poor**	**Poor**	**Poor**	**Fair**	**VP**	**VP**	**VP**	**VP**

Table 7. SoCal Index of Biological Integrity scores and percent New Zealand Mud Snail (*Potamopyrgus antipodarum*) in the sample when present (highlighted in red) for the 16 permanent samples between 2000 and 2010 in the Santa Monica Mountains, HTB Bioassessment Program. IBI values for sites with duplicate samples were averaged.

Site	**Spr. 2000**	**Fall 2000**	**Spr. 2001**	**Fall 2001**	**Spr. 2002**	**Fall 2002**	**Spr. 2003**	**Fall 2003**	**Win. 2005**	**Spr. 2006**	**Spr. 2008**	**Spr. 2009**	**Spr. 2010**
Malibu Creek													
MC1	16	24	26	39	19		26	23	26	26/3	20/78	27/81	6/<1
MC12		23	20	37	33	27	21	31	20	17	29/9	17/65	3/1
MC15	33	17	24	43	40	24	34	23		17/4		18/29	6/13
Cold Creek													
CC2	36		46	73	53		44		32	36		27	20
CC3	80	76	92	76	83	80	84	64	61	73	67	80	82
CC11	54	46	56	54	49		40			47		57	40
Las Virgenes Creek													
LV5	29	34	33	33	39	26	20	29	18	16/24		26/50	10/16
LV9					59	26	46		34	34		42	39
LV13					26	24	21	27	11	18		8/15	13/12
Medea Creek													
MD7	23	26	19	34	23		9	9	10/59	20/45		19/95	14/57
Solstice Creek													
SC14				87	76	76	67	70	63	60	56	69	49
SC22										64		53/33	45/23
Arroyo Sequit Creek													
AS19				70	72	66	72	70	64	57	50	70	70
Cheeseboro Creek													
CH6			59	57	64		49		54	43			34
Lachusa Creek													
LCH18				73	72	76	54	61	54	11		57	47
Triunfo Creek													
TR17	20		19		19		4		0	20		18	3