Indicator type: Stressor

Category: Physical Habitat

Risk level: Moderate

INSTREAM COVER

This indicator reports on the risk posed to aquatic life in Dry Creek due to the lack of instream cover. Instream cover consists of the variety of natural features in and around the waterway that can be used by fish and benthic macroinvertebrates (BMI) to hide, rest, or hunt for prey. Results of the stressor analysis suggested that insufficient instream cover is a secondary factor affecting the viability of aquatic life in the watershed, posing a moderate risk.

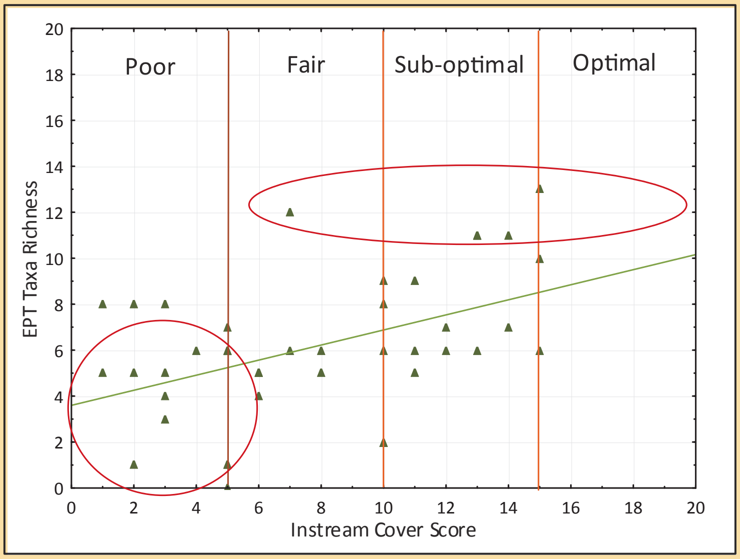

Figure 1. The relationship between the instream cover score and EPT taxa richness. Each data point represents a single sampling event that occurred yearly for 5 years at 10 sites. Correlation coefficient = 0.46; level of significance: $p < 0.01$. Sample size = 42. The red circle in the lower left corner of the graph identifies data collected from Sites 3 and 9 (impaired sites) while the upper right oval identifies data from Site 5 (the internal reference or comparator site). As instream cover score increased, EPT taxa richness also increased.

What is the graph showing?

Figure 1 shows the relationship between the instream cover score and EPT taxa. The score is a qualitative assessment of the variety and abundance of logs, rocks, aquatic and bank vegetation; the higher the score, the better the habitat. EPT are sensitive aquatic insects such as mayflies, stoneflies, and caddisflies (Ephemeroptera, Plecoptera, and Trichoptera) that are frequently used as indicators of the health of aquatic life. The graph shows that as instream cover increases, so do the number of different types of sensitive aquatic insects. These three groups tend to be more sensitive to pollution and habitat degradation than most other benthic insects; thus their ability to thrive relates to the overall stream quality. Examples of good and poor instream cover are shown in Figure 2. In the Dry Creek watershed, instream cover scores predominantly fell in the poor to sub-optimal range.

Why is this indicator important?

Instream cover provides places for aquatic organisms to live, feed, rest, hide, and reproduce (Harrington, 2000). Features that function as instream cover include boulders and cobbles (fist-sized rocks), fallen trees, logs and branches, exposed roots, undercut banks, and aquatic and overhanging bank vegetation (Harrington & Born, 2000; Kaufmann et al., 1999). Cobbles in fast shallow water (riffles), submerged plants, and exposed tree roots are especially important as nurseries for the eggs of

Poor Instream Cover

Good Instream Cover

Figure 2 (above) Examples of instream cover in two creeks in the Dry Creek Watershed. The picture on top is an example of poor instream cover due to the dominance of sand and small gravel and the lack of habitat structures in the stream. In contrast, the picture below illustrates good instream cover due to the presence of boulders, cobbles, large woody debris and overhanging bank vegetation.

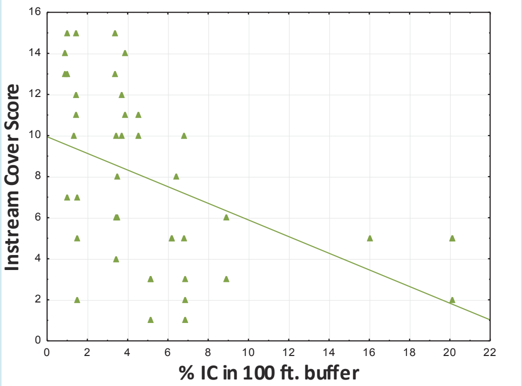

Figure 3: Relationship between percent impervious cover within the 100 foot wide creek corridor (from each side of the bank) and instream cover. Each data point represents a single sampling event that occurred yearly for 5 years at 10 sites; not all sites sampled each year. Correlation coefficient = 0.63; level of significance: $p < 0.001$. With increasing amounts of impervious cover within 100 feet of the streams, there is a decrease in instream cover. This suggests that the disturbances associated with imperviousness adversely affect instream habitat diversity.

BMI and juvenile fish. Instream cover also serves as shelter and as a place to find food that gets trapped or that grows on rocks, such as complex mixtures of algae (Li and Fields, 1999; Beisel et al., 1998). In streams with sand, silt, and/or clay as the dominant bed material, structures such as woody debris and exposed tree roots provide the only stable hard surfaces on which macroinvertebrates can colonize (Crook and Robertson, 1999). Woody material is important habitat for fish because it provides overhead cover from aerial predators, visual isolation from aquatic predators, and refuge from swift currents. Hiding behind boulders, in root wads, and in the spaces between small rocks and cobbles conserves the energy of growing fish as well (Li and Fields, 1999; Crook and Robertson, 1999). This is important to young salmon in particular because it improves their chances of successfully migrating to the ocean. Instream cover provides places away from the stream current, where young fish can save energy. It also offers habitat where young salmon can hide to avoid predators as well as increase their chances for catching prey. These factors contribute to young fish becoming larger and stronger fish, which increases their odds of surviving the trip through the Delta. Additionally, if there is little instream cover, then there is literally less available space for many benthic macroinvertebrates and fish to live (Harrington, 2000). In addition to providing aquatic habitat, overhanging vegetation and downed logs are important to the natural cycling of nitrogen, carbon, and other essential building blocks of life (Rhodes & Hubert, 1991). These elements provide the basis for the entire aquatic food chain.

What factors in Dry Creek watershed influence instream cover?

1. Anthropogenic Factors

It appears that instream cover is insufficient in the Dry Creek watershed primarily due to human activity. Alterations in the hydrologic cycle, or hydromodification, cause larger volumes of water to flow through the stream at increased velocities (Allan, 2004; Paul &

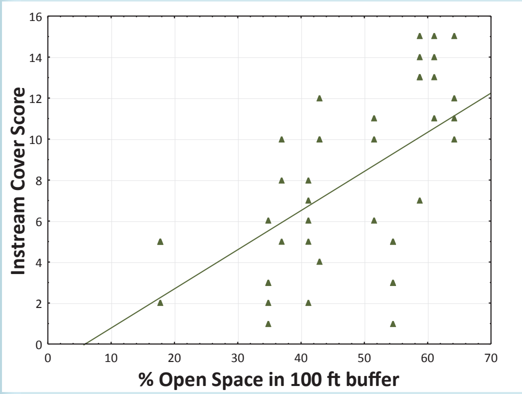

Figure 4: Relationship between land dedicated to open space within the 100 foot wide buffer and instream cover. Each point represents a single sampling event at one of 10 sites collected each year for 5 years. Correlation coefficient = 0.66; level of significance: $p < 0.001$. There is a positive relationship between increased open space and the instream cover score, just the opposite of the relationship of % IC (Figure 3). This relationship highlights the importance of protecting undisturbed areas close to the waterways.

Meyer, 2001; Walsh et al., 2005). These flows can cause scouring of the channel bed and bank, transport eroded sediment downstream, and cause cobbles to become covered with fine sediment. Fallen tree branches, snags, and aquatic and bank vegetation can be washed out by these high flows. Another factor that contributes to poor instream cover is disturbance in the stream corridor. Buildings and roads in close proximity to streams increase impervious cover. This can result in a decrease of woody material and leaf litter input to the stream and an increase in bank and channel erosion through the removal of riparian vegetation (Allan, 2004; Paul & Meyer, 2001; Walsh et al., 2005). Data from the watershed showed a highly significant relationship between the increase in impervious cover and decreased instream cover (Figure 3). Additionally, greater amounts of fine sediment were strongly correlated with lower instream cover scores (data not shown; see % Fines indicator). Another way humans influence instream cover is through stream corridor management policies that require the removal of branches and downed trees from creeks. Frequently, public works departments of local municipalities remove downed woody material to reduce perceived liabilities, thereby reducing the abundance of instream cover (Crook and Robertson 1999).

Instream cover correlates with the amount of open space in the riparian or stream corridor (Figure 4). Similarly, greater levels of vegetative cover and bank stability were also strongly related to higher instream cover scores. The data suggests that open space throughout the entire stream corridor (from the sampling site to the headwaters of each tributary) contributes materials such as rocks and wood that provide cover and supports a higher diversity of aquatic life.

2. Natural Factors

Natural conditions and processes can alter the variety and amount of instream cover. Large storms, the type that occur every 10, 20, or 50 years, can cause very high stream velocities, which wash out existing instream cover. These flood flows also cause erosion of the banks that can uproot overhanging vegetation that provides cover. At the same time, flood flows cause dead branches to break off of trees, providing instream habitat diversity in the future. Flood flows are part of the natural remodeling processes that influence the shape of streams (Allan, 2004).

TECHNICAL CONSIDERATIONS

1. Data Collection

Data used to characterize instream cover was collected by the Dry Creek Conservancy as part of their yearly survey of physical habitat and benthic macroinvertebrates. Instream cover, referred to as epifaunal substrate in the SWAMP (Surface Water Ambient Monitoring Program) protocol, is one of the metrics collected as part of this survey. This metric qualitatively assesses instream cover based on a visual estimate of the availability and stability of features such as large rocks, fallen branches, undercut banks, and overhanging bank vegetation. All sites except 3, 4, 8, and 10 were sampled every year. At each of 10 transects, scores from 1 - 20 were assigned based on the amount/variety of instream cover: poor (<20% stable and suitable habitat for BMI colonization and use as cover for fish), marginal (20 – 40% cover), sub-optimal (40-70% cover), and optimal (> 70% cover). These scores were then averaged to characterize the entire sampling site.

2. Summary of Stressor Identification Evaluation

The overall ranking of instream cover, based on the stressor identification analysis, was 55 percent, which placed this stressor in the “moderate risk” category. While the amount of instream cover is an important habitat feature, it is unlikely that it is the sole or primary contributor to the impairment of aquatic life in the Dry Creek watershed. More likely, it is one of many factors that cumulatively adversely impact aquatic life.

i. Data from the Case

Spatial Co-occurence

The differences in instream cover between the most impaired sites (Sites 3 and 9), and the watershed reference or comparator site that was least impaired (Site 5), were evident (Fig. 5). For example, Lower Cirby Creek (Site 9) had among the smallest amounts of instream cover (average score = 3.25 out of a possible 20) and was the site with the least diversity of BMI in the watershed. In contrast, Secret Ravine (Site 5) had the greatest diversity and abundance of BMIs, an average instream cover score of 12.25, and in one year, a score of 15 out of 20, the highest score recorded anywhere in the watershed. Sites 1 and 10 had similar scores to the impaired sites and 6 and 7 had similar scores to the comparator site. In other words, the scores of most impaired and comparator sites were not unique. Additionally, confidence in the scores for this and all other stressor identification criteria was not great due to the qualitative nature of the scoring process. Taken together, these and other data lend modest support to the case that instream cover played an important role in affecting the health of aquatic life in Dry Creek.

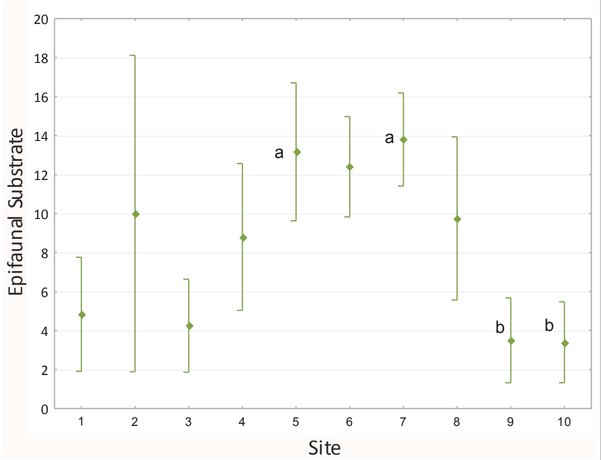

Figure 5: Spatial differences in instream cover score. Box and whiskers represent the mean +/- 95% confidence interval. Letters (a or b) indicate statistically significant differences between sites. BMI metrics were highest at Site 5, 6, and 7 while lowest at Sites 1, 3, 9, and 10.

Stressor Response Relationships

There was a statistically significant stressor-response relationship between instream cover and just under half of the 24 of BMI metrics collected (one of which is shown in Fig. 1). Correlations (Spearman’s test) ranged from 0.34 to 0.50 and most p-values were below 0.01, ranging from 0.0007 to 0.03. The diversity of BMI communities and the number of sensitive species increased with increasing abundance and diversity of instream cover. For example, as instream cover increased, EPT taxa increased and the proportion of tolerant species, associated with degraded habitat, decreased (Fig. 1). The data evaluated lends support to a role for a lack of instream cover contributing to the impairment of aquatic life.

Causal pathway

Data was available for impervious cover, bank stability, vegetative cover, instream cover, and BMI community structure (Figure 6). A greater amount of impervious cover within the 100 foot stream buffer was linked with decreased riparian and bank vegetation. With less vegetation, there was less large woody debris and overhanging bank vegetation, which reduced habitat quality and negatively impacted aquatic life. The links between these factors support the case that reduced instream cover has a negative effect on the abundance and diversity of benthic insects.

ii. Data from Elsewhere

A survey of Secret Ravine was performed by S.K. Li, PhD and W.C. Fields (1999) for the Dry Creek Conservancy. They evaluated 873 reaches for the percent of the area covered by woody debris, boulders, and vegetative cover. The median value was 37.1% which they classified as in the “poor” range and identified poor cover as one of the major constraints on salmon habitat.

There was little evidence in the peer-reviewed literature to support a stressor-response relationship between instream cover and benthic macroinvertebrate metrics. Hall et al. (2009) identified a weak relationship between an increase in instream cover and the proportion of collector/gatherers in a stream in a residential neighborhood. In a study evaluating macroinvertebrate-habitat relationships in Wales, Jenkins et al. (1984) found little difference in the diversity (number of different taxa) of BMIs collected from a variety of habitat types including riffles, along banks, and among tree or plant roots. Greater diversity and abundances of BMIs, however, were reported when submerged tree roots and vegetation, dense woody debris patches, and undercut bank habitat was abundant (Beisel et al. 1998; Schneider and Winemiller, 2008; Rhodes and Hubert, 1991).

iii. Strengths and Limitations of the Data

Five years of instream cover data collected from 2002-06 were used in this analysis. Most of the 10 sampling sites had data available for all five years, the exceptions being Sites 3, 4, and 10 which were missing data for a single year. The qualitative nature of this metric introduces some variability because it is based on visual estimations. However, an experienced field team collected the data for all sampling events, reducing the variability in the estimate of cover.

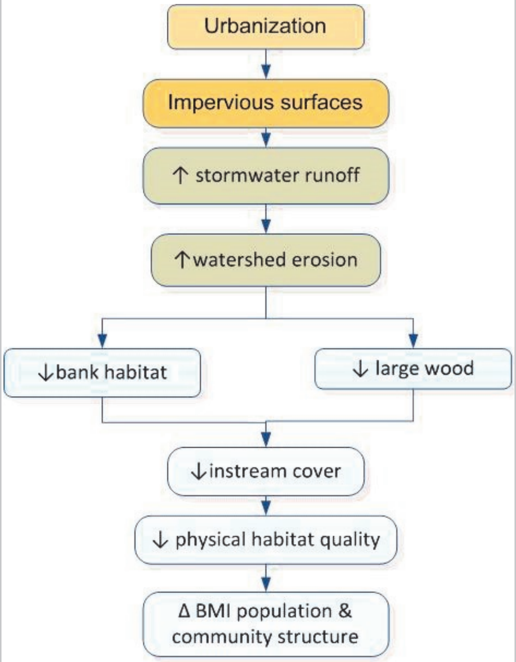

Figure 6: Casual pathway that links urbanization to increased runoff, a decrease in instream cover and alterations in BMI communities.

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