2017 BMI Report: Cordonices, San Leandro, and Sin-bad Creeks

Alameda Creek Alliance
Friends of Five Creeks
Friends of San Leandro Creek

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Benthic Macroinvertebrates and the Health of our Creeks

All of life depends on water, and all of us are citizens of a watershed. A watershed is an area of land where all the water drains to one place. Healthy watersheds absorb rain, store and release water, filter pollutants, anchor soil, and support a diverse community of wildlife and people.

Water that falls as precipitation generally collects and drains through our creeks and rivers. When there are problems in a watershed, their symptoms often first appear in these streams in the form of degraded water quality.

By monitoring our local creek or river we can learn about its health and the community of plants and animals it supports. We can help provide the background information needed to develop pollution prevention measures or restoration projects. We may be able to pinpoint pollution sources or identify widespread problems. The information can be instrumental in protecting or improving the waters in our communities.

Biological Assessment (Bioassessment) uses information on what lives in an area, along with measures of the physical habitat, to measure whether the area can support a diverse and balanced community of organisms. In this monitoring effort, we used **benthic macroinvertebrates (BMI)** as our main Bioassessment tool.

Photos Left: Collecting insects along Sinbad Creek; **Right:** Walking a transect along Cordonices Creek.

What are Benthic Macroinvertebrates (BMI)?

Benthic Macroinvertevrates (BMI) are animals that live at the bottom (benthos) of water bodies, visible to the naked eye (macro), and lacking backbones (invertebrates).   Many are insects familiar to fly-fishing enthusiasts or anyone who turns over rocks in streams. Examples include mayflies, stoneflies, caddisflies, dragonflies, and black flies. Many of these spent part of their lives out of water. Non-insect invertebrates include snails, leeches, worms, crustaceans, and scuds.

1. Dragonfly (Odonata)

These tiny animals are central to the proper function of streams. They keep streams clean by consuming algae and decomposing organic matter (wood and leaf debris), and provide food to other wildlife such as fish and birds.

Mayfly (Ephemeroptera)

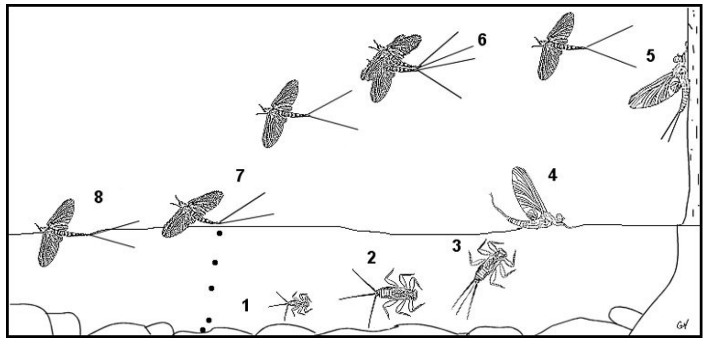
BMI provide a tool to measure the response of stream life to habitat changes resulting from land use or pollution. When pollution does not originate from a single point ("non-point"), it can be difficult to measure using chemical methods as this type of pollution can easily be missed in a single water sample. An advantage of using BMI is that they live in the stream and experience everything that flows over and around them, and so incorporate the effects of pollution that occur over time. A disadvantage of this method is that it won't determine specific pollutants.

Caddisfly with case (Tricoptera)

Biological condition is the most comprehensive single indicator of the health of creeks or rivers. When the biology of a water body is healthy, the chemical and physical components of the water body are also typically in good condition. Generally, healthy creeks support a wide variety and high number of macroinvertebrates, including many that are intolerant of pollution. Samples yielding only pollution–tolerant species or very little diversity or abundance indicate a less healthy creek.

Stonefly (Plecoptera)

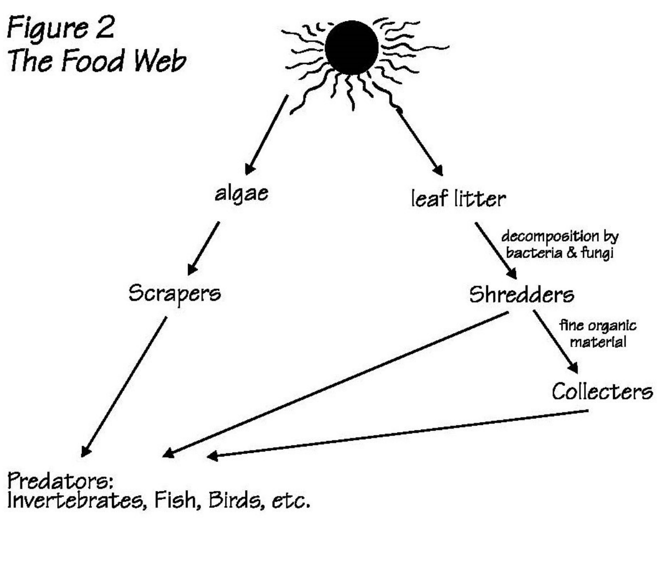
BMI and the Creek Food Web



Above figure: Example of the life cycle of an aquatic insect (mayfly)

Streams offer a variety of food resources for BMI: large organic particles like leaf litter and wiid; smaller organic matter in sediment or water; algae and diatoms; other animals; and biofilm — a complex of algae, fungi, bacteria, and protozoa adhering to rocks and wood in the creek. Macroinvertebrates consume these foods in different ways. Macroinvertebrate can be roughly grouped into feeding types such as shredders, collector-gathers, scrapers, filterers, or predators.

Shredders feed on larger pieces of organic matter such as leaves and twigs. They churn these into smaller pieces of organic matter that can be fed upon by collector-gatherers.
Collector-gatherers wander the bottom of creeks, feeding on small particles of organic matter that lodge between rocks or settle in pools.
Scrapers feed on diatoms, algae, and biofilm attached to underwater surfaces.
Filterers strain small organic materials out of the water. They swim through water or attach to a surface and filter out particles that float by, like pieces of leaves or biofilm.
Predators feed on other macroinvertebrates, tadpoles, and even small fish.
In healthy streams, all feeding groups should be present.



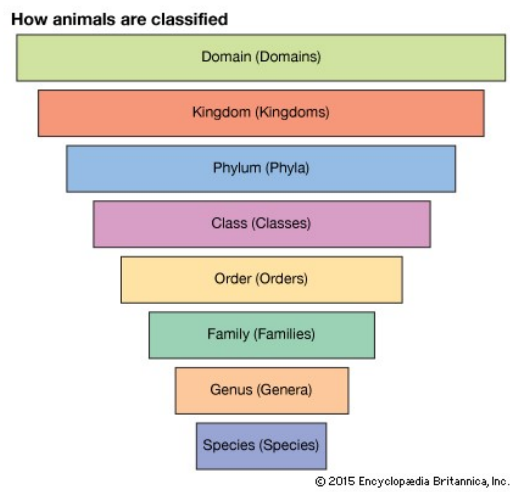
Survey Methods

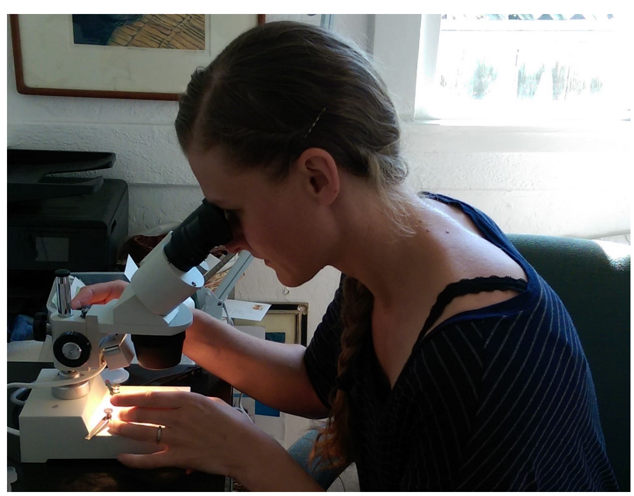
This project examined and assessed the BMI community in three Bay Area Creeks: Cordonices Creek (Berkeley), San Leandro Creek (San Leandro), and Sinbad Creek (Sunol).

A 150-meter reach of creek was sampled for BMI in each of the three creeks, using protocols developed by the California Surface Water Ambient Monitoring Program (SWAMP)[1]. Using a D-net, 11 BMI samples were collected at 15-meter intervals within the reach. The 11 samples were combined and placed in a jar with 95% alcohol.

At each sampling point, wetted width, bank stability, algal cover, and flow habitat were assessed. This data was used to characterize the habitat in the stream reach.

The collected BMI were sorted and identified to family. Recent work by James Harrington from the California Department of Fish and Wildlife show that ID'ing to the family level is as informative as species-level IDs, and is much easier.





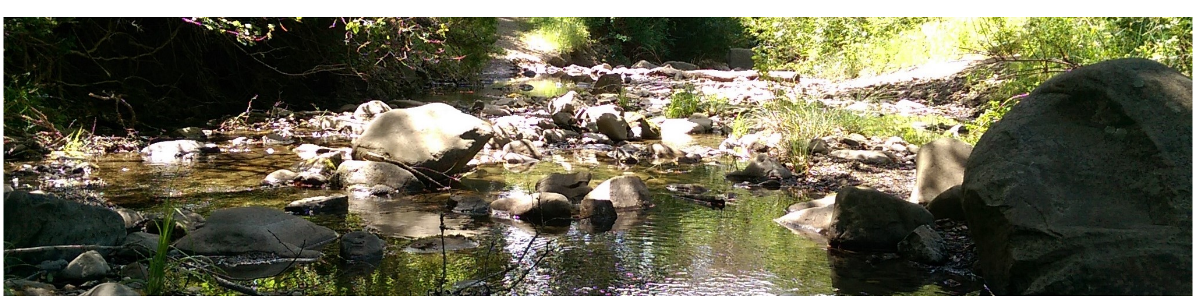
Biological Metrics

Biological metrics are used to assess the biological condition of the stream reach where the samples were taken, based on principles of ecology and observations of the benthic macroinvertebrates themselves. The ecological principles include, for example, the ideas that diversity and a balanced food web are indicators of a healthy ecosystem, and that human or natural disturbance will cause a shift in the type of food available and thus the composition and diversity of BMI.

We used the following metrics:

- **Richness:** These metrics reflect the total number of taxa present, or the diversity of the aquatic community.
- **Composition:** These metrics reflect the relative contribution of the population of individual taxa, or groups of taxa, to the overall community.
- **Tolerance/Intolerance:** These metrics reflect the relative sensitivity of the community to aquatic disturbances. The taxa used are usually pollution tolerant (higher tolerance values) or pollution intolerant (lower tolerance values), but are generally nonspecific to the type of stressor. **% Intolerant Organisms** refers specifically to organisms with tolerance values of 0, 1, or 2 (on a 10-point scale– those least tolerant of pollution). **% Tolerant Organisms** are those with tolerance values of 8, 9, or 10 (the organisms most tolerant of pollution)
- **EPT Index:** This Index is named for three orders of aquatic insects that are common in the BMI community and have low tolerance for pollution: ***Ephemeroptera (mayflies)***, ***Plecoptera (stoneflies***), and ***Trichoptera (caddisflies)***. A large percentage of EPT taxa generally indicates high water quality.
- **Functional Feeding Group (FFG):** These metrics provide information on the balance of feeding strategies — shredders, scrapers, filterers, collectors, and predators — in the aquatic community. An imbalance of feeding groups generally reflects unstable food dynamics and indicates a stressed condition.

  Broadly, stoneflies are predators, mayflies are scrapers or collectors, and caddisflies are scrappers, collectors, or shredders. The ratio and number of these macroinvertebrates change with the stream food resources and human impacts and therefore can be used as a tool for assessing the ecological status of the biotic community and water quality.

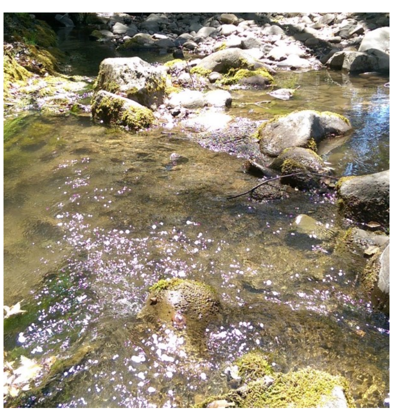
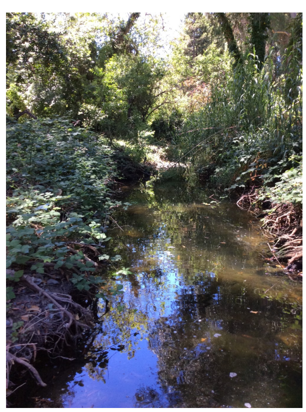
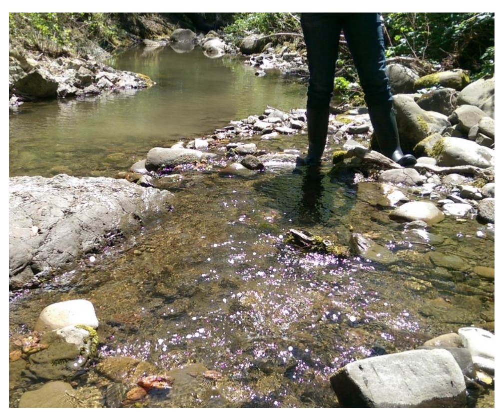


Physical Habitat: Flow

At each sampling point, field crews measured wetted width and assessed flow type. Stream flow is directly related to the amount of water moving into the stream channel, as well as the channel's slope. It is affected by weather, and changes over the seasons of the year. Flow is has impacts on water quality, the living organisms, and the habitats in the stream.

Diversity of organisms in a stream is limited by the diversity of flow habitats present. While some streams are naturally slow-moving and others fast-moving, a healthy stream generally has an assortment of flow habitats. Fast-moving streams are generally better aerated and have higher levels of oxygen.

Flow Habitat	Description
Cascades	Short, high graded drop in stream bed elevation often accompanied by boulders and considerable turbulence
Falls	High gradient drop in elevation bed associated with an abrupt change in the bed-rock
Rapids	Stream reaches with swiftly flowing water and considerable surface turbulence. Rapids tend to have larger substrate sizes than riffles.
Riffles	Shallow reaches where the water flows over coarse stream bed particles that create mild to moderate surface turbulence; (<0.5 m deep, > 0.3 m/s)
Runs	Long, relatively straight, low-gradient reaches without flow obstructions. The stream bed is typically even the the water flows faster than it does in a pool; (> 0.5 m deep, > 0.3 m/s). A step-run is a series of runs separated by short riffles or flow obstructions that cause discontinuous breaks in slope.
Glides	A reach with little or no turbulence, but faster velocity than pools; (>0.5 m deep, < 0.3 m/s)
Pools	A reach of stream that is characterized by deep, low-velocity water and smooth surface; (> 0.5 m deep, < 0.3 m/s)

Photos (left to right): (1) Riffle, Sinbad Creek; (2) Glide, San Leandro Creek; (3) Riffle running into a pool, Sinbad Creek.

Physical Habitat: Bank Stability and Habitat Complexity

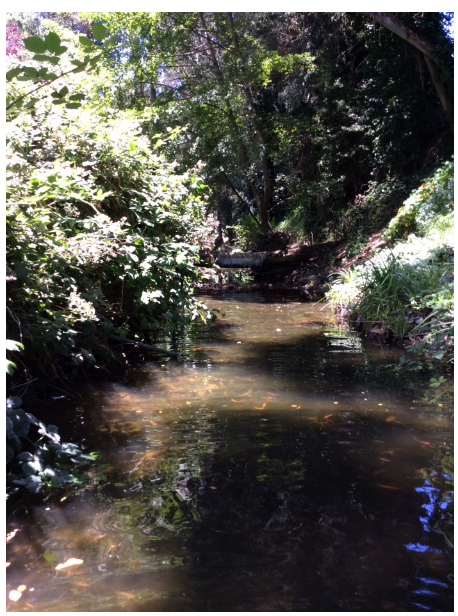
Bank stability and in-stream habitat complexity were two other components of physical habitat assessed in addition to flow habitats.

Bank stability was visually examined on each bank at the sample points. Banks were rated as eroded, vulnerable, or stable. Erosion and deposition are natural processes that are in balance in healthy steams.

Habitat complexity refers to the variety of habitat types present in the stream. It was rated on a scale of 0 to 4 {0=absent, 1=sparse, 2=moderate, 3=heavy, 4=very heavy} at each sampling point.

Bank Stability	
Eroded	Banks show obvious signs of erosion from the current or previous water year; banks are usually bare or nearly bare
Vulnerable	Banks have some vegetative protection (usually annual growth), but not enough to prevent erosion during flooding
Stable	Bank vegetation has well-developed roots that protect banks from erosion, or bedrock or artificial structures (e.g. concrete/rip-rap) prevent bank erosion.

Left picture: Woody vegetation rooted into the banks provide stability against erosion. Banks without vegetation cover or limited to annuals are more vulnerable to erosion (**right picture)**



Results: Cordonices Creek (Berkeley)

Physical Habitat

Cordonices Creek flows from the Berkeley Hills west to San Francisco Bay along its 2-mile length. Cordonices probably had no direct, permanent connection to the Bay prior to European settlement. It is now a perennial stream that supports populations of native fish, including steelhead trout.

Cordonices Creek is largely urbanized through much of its reach. The stream reach sampled is a lower elevation (about 25 ft above sea level), urbanized and highly impacted reach.

Flow habitat along the sampled reach consisted of riffles, runs, glides and pools. Streambanks along the reach were largely stable (64%) or vulnerable (36%). Overhanging vegetation was heavy, and undercut banks were sparse. There was little in-stream complexity in the form of boulders or woody vegetation. No artificial structures were present in the sampled reach, though concrete pieces made up part of the substrate.

Metric	Codornices Creek
Sample Abundance	763
Taxa Richess	9
EPT Taxa	2
EPT Index	4.2
Sensitive EPT Index	2.0
Tolerance Value	5.53
% Intolerant Organisms	2.0
% Tolerant Organisms	9.4
% Dominant Taxa	33.7

Functional feeding groups in Cordonices Creek were somewhat imbalanced, with a large percentage of collectors, a moderate number of filterers, a low numbers of predators and shredders, and no scrapers. The dominant taxa was a non-biting midge, a collector with a tolerance value of 6 (moderately tolerant).

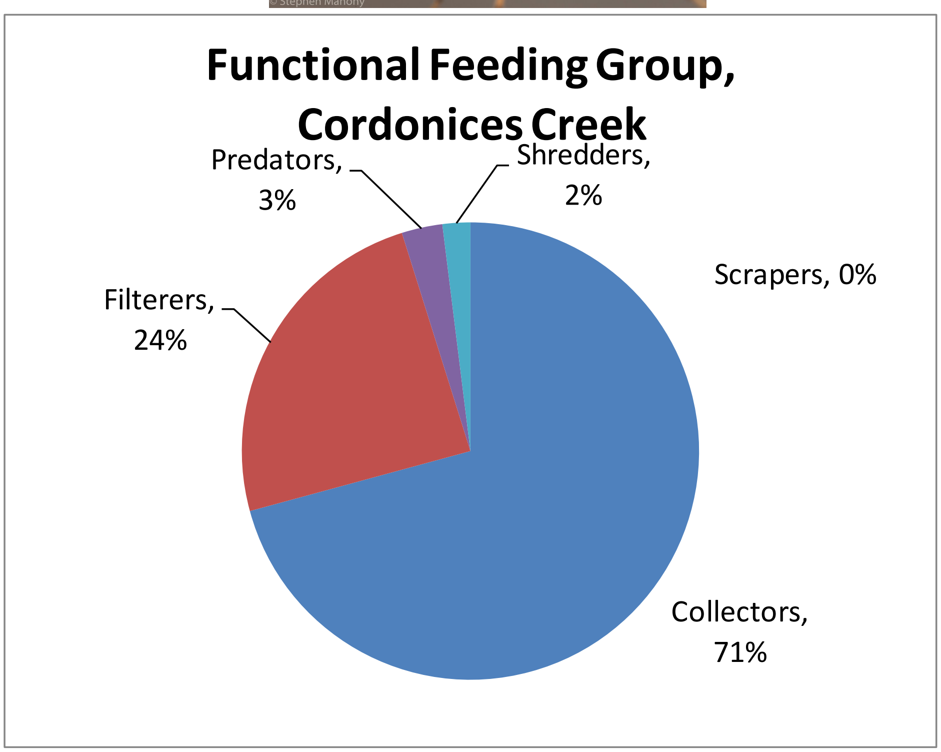
Results: Cordonices Creek (Berkeley)

Dominant Taxon: Non-biting midge (36% of sample)
Order: *Diptera*
Family: *Chironomidae*

Filamentous Algae	Absent
Aquatic Macrophytes	Nearly absent
Boulders	Nearly absent
Woody Debris <0.3m	Nearly absent
Woody Debris >0.3m	Sparse
Undercut Banks	Sparse
Overhanging Vegetation	Heavy
Live Tree Roots	Moderate
Artificial Structures	Sparse

Flow Habitat

Cascade-Falls	0%
Rapid	0%
Riffle	50%
Run	14%
Glide	20%
Pool	17%
Dry	0%



Results: San Leandro Creek (San Leandro)

Physical Setting

San Leandro Creek is a 21.7-mile long year-round stream. It runs along the east face of the Oakland and San Leandro Hills, passing through Upper San Leandro Reservoir and Lake Chabot, and through the city of San Leandro before emptying into San Francisco Bay north of the Oakland Airport. Chinook salmon and steelhead trout have historically been present in the watershed.

Flow habitat during sampling was mostly glide, with the remaining habitat a mix of riffles, runs, and pools . The average wetted width along the sampled reach was 3.8 meters. Streambanks along the reach were largely vulnerable (82%) or eroded (14%), with few stable streambanks (4%). Overhanging vegetation was heavy, with moderate to heavy undercut banks. In-stream complexity was low in terms of boulders or woody debris. There were no few artificial structures present in the sampled reach.

Functional feeding groups in San Leandro Creek were somewhat imbalanced, with an overweighting of collectors, a healthy number of filterers, but low numbers of shredders and predators, and no scrapers. The dominant taxa was the small minnow mayfly, a collector with a tolerance-value of 4 (moderately intolerant of pollution or other impacts).

Metric	San Leandro Creek
Sample Abundance	1444
Taxa Richess	10
EPT Taxa	5
EPT Index	36.3
Sensitive EPT Index	1.0
Tolerance Value	5.20
% Intolerant Organisms	1.0
% Tolerant Organisms	0.6
% Dominant Taxa	35.9

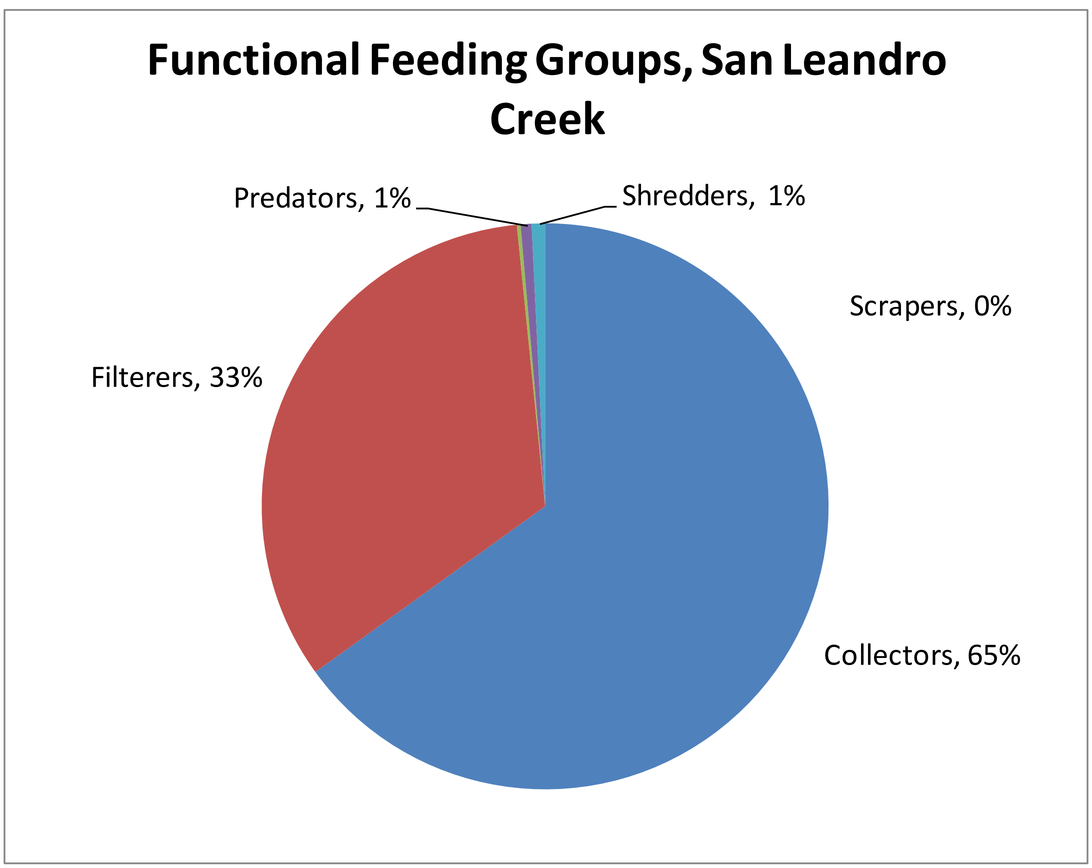
Results: San Leandro Creek (San Leandro)

Dominant Taxon: Small minnow mayfly (36% of sample)
Order: *Ephemeroptera*
Family: *Baetidae*

Flow Habitat

Cascade-Falls	0%
Rapid	0%
Riffle	16%
Run	3%
Glide	66%
Pool	14%
Dry	1%

Filamentous Algae	Moderate - Heavy
Aquatic Macro-phytes	Nearly Absent
Boulders	Sparse
Woody Debris <0.3m	Sparse
Woody Debris >0.3m	Sparse
Undercut Banks	Moderate - Heavy
Overhanging Vegetation	Heavy
Live Tree Roots	Moderate
Artificial Struc-tures	Absent



Results: Sinbad Creek (Sunol)

Physical Setting

Sinbad Creek is 7.5 miles long and drains 6.44 square miles. It flows south from its headwaters through Pleasanton Ridge Park, along a wooded residential road, and through the small town of Sunol. Historical evidence shows that steelhead trout once inhabited Sinbad Creek.

Sinbad Creek is a semi-rural creek that is ephemeral, or goes dry in places, in all but the wettest years. Our sampling location was near the northern end of Kilkare Rd., at the bounds of Pleasanton Ridge Regional Park. Our sampled reach is relatively high in the watershed, near 900 ft elevation. There is a history of grazing and agriculture upstream of our sampling location, but it is lightly impacted compared to many Bay Area creeks.

Flow habitat during sampling was largely riffle, with some rapids, runs, glides, and pools. The average wetted width over the sampled reach was 2.6 meters. Streambanks along the reach were largely stable (91%) or vulnerable (9%). Overhanging vegetation was heavy, but there were low amounts of undercut banks. In-stream complexity was largely in the form of boulders, with little woody debris. There were only a few artificial structures present in the sampled reach.

Metric	Sinbad Creek
Sample Abundance	734
Taxa Richess	14
EPT Taxa	5
EPT Index	83.9
Sensitive EPT Index	56.5
Tolerance Value	3.18
% Intolerant Organisms	56.8
% Tolerant Organisms	0.5
% Dominant Taxa	41.3

Functional feeding groups in Sinbad Creek were balanced between collectors and scrapers, with a healthy number of predators. The dominant taxa was the prong-gill mayfly, an scraper with a tolerance-value of 2 (intolerant of pollution or other impacts).

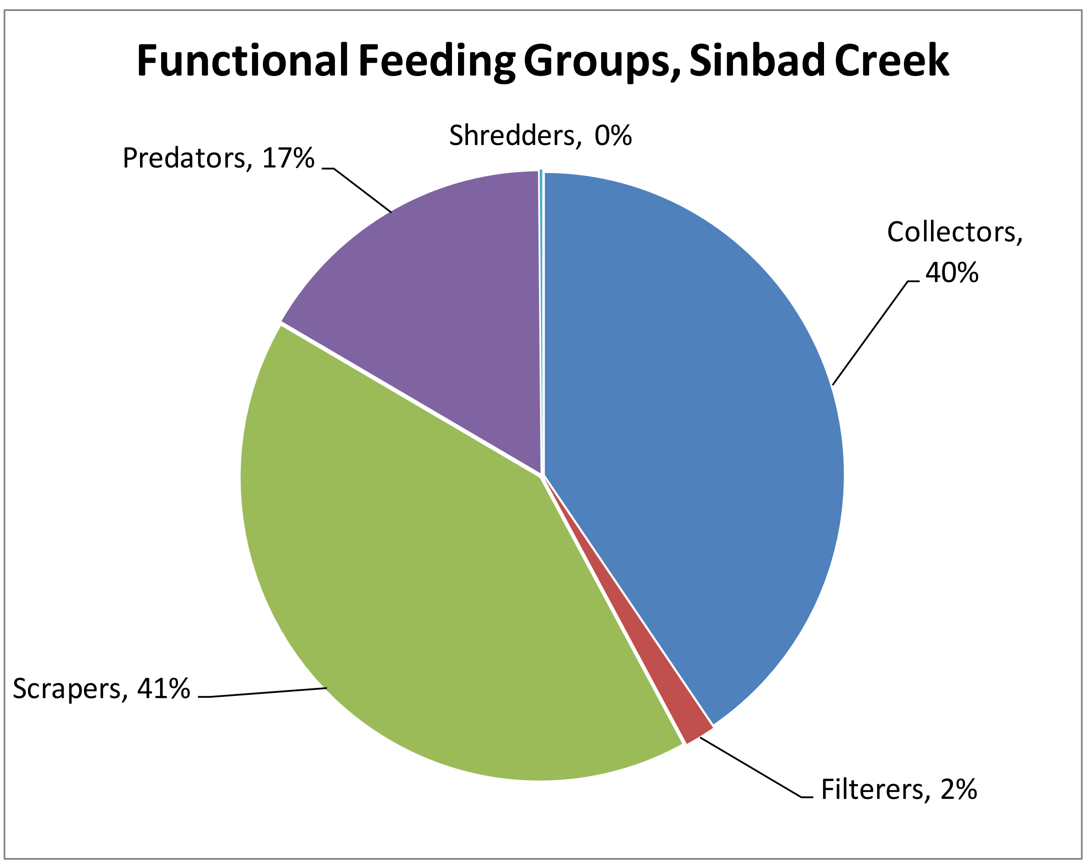
Results: Sinbad Creek (Sunol)

Dominant Taxon: Prong-gill mayfly (41% of sample)
Order: *Ephemeroptera*
Family: *Leptophlebiidae*

Flow Habitat

Cascade-Falls	0%
Rapid	5%
Riffle	54%
Run	16%
Glide	19%
Pool	6%
Dry	0%

Filamentous Algae	Sparse-Moderate
Aquatic Macrophytes	Sparse-Moderate
Boulders	Moderate
Woody Debris <0.3m	Sparse
Woody Debris >0.3m	Sparse
Undercut Banks	Sparse
Overhanging Vegetation	Heavy
Live Tree Roots	Sparse
Artificial Structures	Nearly Absent



Discussion: Comparison of Cordonices, San Leandro, and Sinbad

Sinbad Creek had the highest diversity among the three creeks, with at least 40% more taxa than the others. It also had the best water quality among the three, as indicated by the BMI assemblage. This was true across all of the indices. This is as expected given the protected status of the watershed lands above our sampling point.

Cordonices Creek, in contrast, had the lowest diversity, with the fewest number of taxa, and few predators. San Leandro Creek showed moderate diversity, with slightly higher taxa richness and more EPT taxa than either Sinbad or Cordonices. However, while the number of EPT taxa was high in San Leandro Creek, like Cordonices it had very low sensitive EPT index, and the two creeks had similar overall tolerance values.

Sinbad Creek had the highest sensitive EPT index, the highest percentage of intolerant organisms and the lowest tolerance value of the three creeks, indicating the best water quality. In many ways, Sinbad Creek can be thought of as a “reference” reach, or one which is used as an example to set restoration goals for other reaches.

	Sinbad Creek	**San Leandro Creek**	**Codornices Creek**
Sample Abundance	734	1444	763
Taxa Richess	14	10	9
EPT Taxa	5	7	2
EPT Index	83.9	36.3	4.2
Sensitive EPT Index	56.5	1.0	2.0
Tolerance Value	3.18	5.20	5.53
% Intolerant Organisms	56.8	1.0	2.0
% Tolerant Organisms	0.5	0.6	9.4
% Dominant Taxa	41.3	35.9	33.7

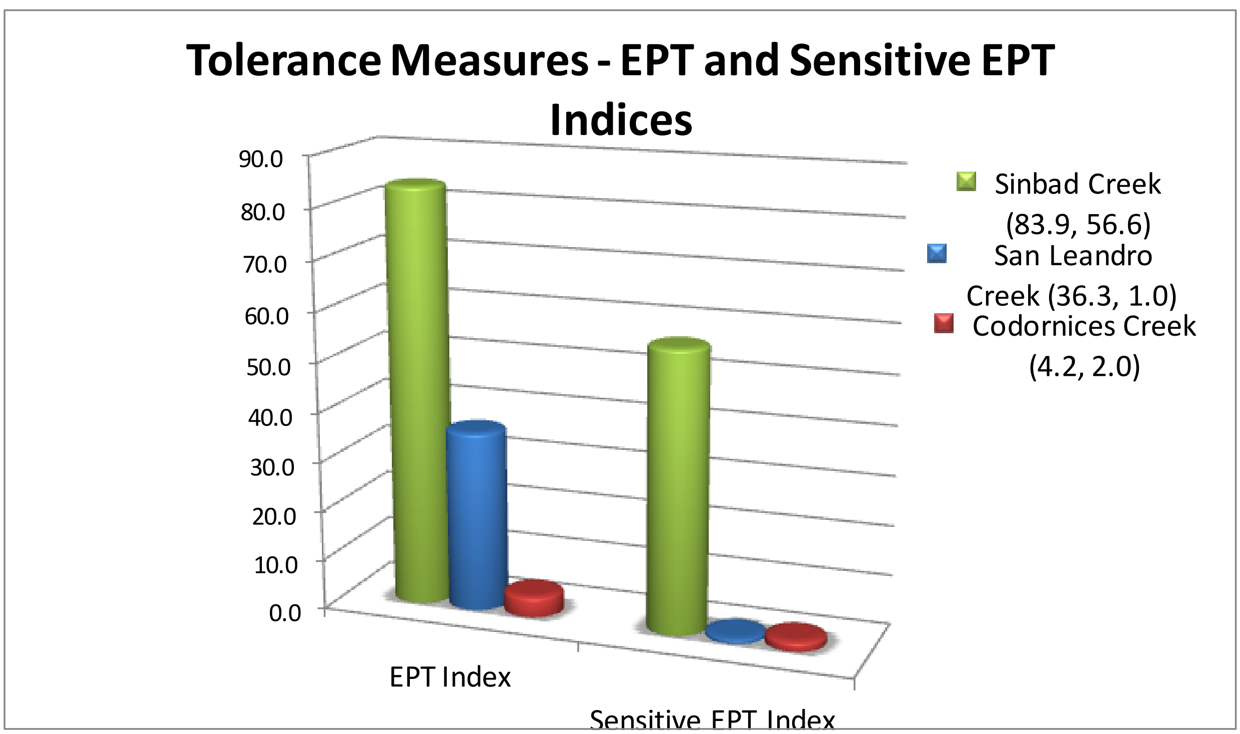
Results: Comparison of Cordonices, San Leandro, and Sinbad Creeks

While all three creeks had good cover of woody vegetation and riparian trees, the banks of Sinbad Creek were much more stable that those of San Leandro or Cordonices Creeks. Efforts to improve the BMI community in these streams might focus on adding native riparian vegetation to the immediate banks, which might require the removal of some invasive plants.

A better understanding of the water chemistry in Codornices and San Leandro Creeks might give us an indication as to why so few low-tolerance BMI were found in these creeks. Codornices Creek also lacks in-stream habitat complexity, which can be improved by the addition of roots and boulders.

BMI monitoring on these three creeks should be continued on a regular bases to assess trends within the benthic communities. Future monitoring efforts should also seek to investigate other reaches of these creeks. Impacts to BMI, though integrative in time, may vary spatially along the length of each creek as it runs from the headwaters to the bay.

It would also be worthwhile to compare these results with data from other East Bay creeks. While we often can't protect land that is already heavily populated, finding urban creeks that are doing well despite the odds will help us understand how to improve the health of the others.



Appendix: 2017 IBI Data Cordonices, San Leandro, and Sinbad Creeks, Alameda County, CA

Insect Order	Insect Family	Common name	Toler-ance value	Func-tional Feeding Group	Sinbad Creek	San Leandro Creek	Codor-nices Creek
Ephemeroptera	Baetidae	small minnow mayfly	4	CG	201	518	17
(may fly)	Leptophlebiidae	prong-gill mayfly	2	SC	303	3	
Plecoptera	Nemouridae	nemouridae stonefly	2	P	1	3	15
(stone fly)	Perlodidae	Perlodid stonefly	2	P	110		
Trichoptera	Rhyacophilidae	rock worm	0	P	1		
(caddis fly)	Hydropsychidae	net-spinner caddisfly	4	FC		25	
	Brachycentridae	humpless casemaker	3	CG		7	
	Lepidosto-matidae		1	SH		8	
	Hydroptilidae	micro caddisfly	4	-		2	
Diptera	Simuliidae	black fly	6	FC	12	456	186
(true fly)	Chironomidae	non-biting midge	6	CG	93	413	257
	Ceratopogo-nidae	biting midge	6	P	1		1
	Dixidae	dixid midge	2	CG	1		
	Empididae	dance fly	6	P	1		
Coleoptera (water beetle)	Dytisicidae	predatory diving beetle	5	P	5		
Odonata	Coenagrionidae	damselfly	9	P		9	20
(dragon/ damselfly)	Aeshnidae	dragonfly	3	P			1
Megaloptera	Corydalidae		0	P	1		
Oligochaeta *	worm		8	CG	2		52
Hirudinea *	leech		10	P	2		
Amphipoda *	fresh water shrimp		4	CG			214

* Oligochaeta, Hirundinae, and Amphipoda are non-insect benthic macroinvertebrates.

Acknowledgements

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BMI and Physical Habitat Volunteers:

Codornices Creek - Brenda Delgadillo, Tessa Diem, Melissa Orozco

San Leandro Creek- Kathleen Harris, Susan Levenson, Stephanie Antalocy, David Roche

Sinbad Creek - Francine Huang, Tessa Diem, Ying-Tsu Loh, Josiah Chacon-Lontin

BMI ID and Sorting Volunteers:

Kathleen Harris, Susan Schwartz, Bob Zucker, Francine Huang, Brenda Delgadillo, Tessa Diem, Susan Levenson, Ying-Tsu Loh

Thanks to the volunteers who made this effort possible!

Friends of Five Creeks