McKenzie Watershed Council

Macroinvertebrate Monitoring Program 4-Year Comprehensive Report

September 30, 2002

Prepared by:
Jeff Adams, jadams@xerces.org
Director of Aquatic Programs
The Xerces Society www.xerces.org

Contact:
Kate Ferschweiler or Jim Thrailkill
kfersch@callatg.com or jthrail@callatg.com
McKenzie Watershed Council
P.O. Box 53
Springfield, OR 97477
541/687-9076

ACKNOWLEDGEMENTS

Oregon Watershed Enhancement Board (OWEB),
Bonneville Power Administration (BPA),
Willamette National Forest,
Bureau of Land Management - Eugene,
Department of Environmental Quality,
The Xerces Society,
McKenzie Watershed Council,
and the many volunteers!

ABSTRACT

The benthic macroinvertebrate community of a stream or river is a powerful indicator and integrator of periodic or chronic human disturbance (Karr and Chu, 1999). The staff and volunteers of the McKenzie Watershed Council coordinated a 4-year monitoring effort designed to generate a baseline macroinvertebrate assessment of stream health, track long-term trends in the biological condition of streams, and provide experiential learning opportunities for watershed stewards in the McKenzie Watershed. Thanks to contributions from the Oregon Watershed Enhancement Board (OWEB) and watershed partners, the Council has been able to collect 44 macroinvertebrate samples from different locations in the McKenzie watershed, and have those samples processed and analyzed by a qualified taxonomic laboratory. This report provides an overview and interpretation of the laboratory's analysis.

Additional evaluation of the biological condition of the streams monitored will be generated by the Western Oregon and Washington Stream Analysis model (WOWSA). WOWSA is a computer model that was recently developed by Utah State University for the Oregon Department of Environmental Quality (DEQ) and Washington Department of Ecology to help interpret their stream macroinvertebrate data.

The Council's macroinvertebrate samples represent the baseline for an effective monitoring program, fill a niche desired by the DEQ's biomonitoring division, and will assist the Council in prioritizing future monitoring and restoration efforts within the McKenzie River watershed. Based on the success of the McKenzie Watershed Council in addressing their monitoring goals, the following courses of action for the Council's macroinvertebrate monitoring program are recommended:

- continue to support the Macroinvertebrate Monitoring Program as a long-term data resource
- use the macroinvertebrate monitoring data to help guide and focus restoration and conservation efforts
- gather additional baseline data from the eastern portion of the watershed
- return to at least 2 reference sites each year
- return to sites depending on the land use in the watersheds (for example: intense land use - visit annually, or once every other year; low intensity land use - visit every 5 years)
- monitor streams where management changes are expected
- monitor restoration efforts before and after project initiation and upstream and downstream of the site
- monitor consistently between late August and September
- continue successful volunteer recruitment, training, and quality assurance strategies

INTRODUCTION

Macroinvertebrate monitoring

The biological community in a stream reflects the combination of chemical, physical, and biological conditions in which that community evolved. Five classes of environmental factors affecting aquatic ecosystems have been defined: energy source, water quality, habitat quality, flow regime, and biotic interactions (Karr et al.1986). These classes are interrelated and the biological community may be altered by changes in any one or combinations of these factors. Biological communities and their evaluation change as a result of changes in environmental conditions and anthropogenic impacts (Rosenberg and Resh 1992). Therefore, the components and structure of the biological community reflect many environmental factors, and by interpreting and understanding those relationships, biological monitoring becomes a powerful tool in resource protection.

Macroinvertebrates have been used for water quality monitoring since the mid-1800's and surveillance of aquatic habitat quality using macroinvertebrate communities as indicators of biotic integrity has become common practice (Cairns and Pratt 1992). Macroinvertebrates are especially useful for this purpose because they are (a) common in most streams, (b) readily collected, (c) relatively easily identified, (d) not highly mobile, and (e) have life cycles ranging from a few weeks to a few years. Benthic macroinvertebrates have been used to assess water quality in a number of ways, including toxicological assays, bioaccumulation, indicator species, and community measures (including biotic indices, diversity indices, similarity indices, and description of community structure and function).

Chemical and some physical measures may consist of only point measurements that could, for example, be recorded just prior to or immediately after a disturbance, giving a skewed impression of the stream's ability to support a healthy and diverse aquatic community. Macroinvertebrate monitoring is a powerful, stand-alone tool for assessing human activities that occur in a watershed periodically and chronically and augments or is augmented by information about physical and chemical parameters. In a regulatory sense, measuring a stream's biota directly is most powerful when used in combination with physical and chemical measures monitored either after a site has been determined degraded through biological monitoring, or in conjunction with the biological monitoring.

McKenzie Watershed Council monitoring programs

During the later half of the 1990's, the McKenzie Watershed Council collected physical and chemical water quality data from their streams and rivers. The Council also incorporated a biological component in its monitoring efforts by using *Escherichia coli* as an one of its water quality parameters in its Tier I monitoring. To complement these components of the monitoring program and to incorporate a more holistic assessment of stream health, the Council developed a program to monitor the biological components of streams directly. In 1998, the McKenzie Watershed Council and their partners incorporated a pilot macroinvertebrate monitoring program into their Tier III, tributary specific, monitoring. The program had three objectives:

1. Provide baseline information about biological water quality by identifying macroinvertebrate assemblages.
2. Track long-term trends in water quality.
3. Provide local volunteers with experiential learning opportunities related to watershed health concepts.

Macroinvertebrate monitoring was chosen as a tool to gather baseline information and long-term trends that can identify areas of concern in the watershed. This allows the Council to prioritize habitat rehabilitation projects and ensure that those projects have the desired affect on the biological community.

<u>Coordinating efforts of stakeholders</u>
Another valuable contribution to watershed protection that can be credited to the McKenzie Watershed Council and the watershed council concept, is the cohesiveness brought to monitoring efforts throughout the watershed. In the past, various local, state, and federal agencies, and private industries in the McKenzie watershed carried out limited macroinvertebrate monitoring.

For example, in 1991, 1996, and 1997, Weyerhaeuser Company conducted surveys in the mainstem of the McKenzie River immediately upstream and downstream of its operations in Springfield, Oregon. Also, the Bureau of Land Management (BLM) monitored macroinvertebrates in five McKenzie watershed streams in 1991. Also, the DEQ collected macroinvertebrates at six sites (Appendix 1) within the watershed as part of their statewide assessment program. While these studies provided data that contribute to assessing the overall status of habitat throughout the basin, a variety of protocols were used, and the results cannot be directly compared with data collected using protocols from the Oregon Plan for Salmon and Watersheds' Water Quality Technical Guidebook (Oregon Plan 1999). Also, these studies had discrete monitoring periods and objectives, without plans for repeated monitoring at the same sites.

Such difficulties in data comparability reinforce the need for coordination and standardization among all the monitoring programs in the basin. The McKenzie Watershed Council serves this purpose by communicating with biologists from agencies and industries in the Watershed Council, which has ensured that there is less duplication of monitoring efforts. The cohesiveness of data collection and analysis means the data can be shared much more easily among stakeholders in the watershed and can be used in conjunction with DEQ monitoring sites and analysis tools.

To reinforce the collaborative efforts of the Council, Council staff have given numerous talks and presentations about the monitoring program to other volunteer monitoring organizations, and will continue sharing their knowledge. Such efforts expand the conformity of macroinvertebrate data beyond the McKenzie watershed boundaries and increase the usefulness of macroinvertebrate data across the state

Role of watershed council data in management

An important recent development that highlights the value of the macroinvertebrate monitoring efforts of watershed councils in western Oregon streams is the completion of the Western Oregon and Washington Stream Analysis (WOWSA) model. The DEQ intends to use WOWSA to develop numeric standards for the biological condition of wadeable streams in western Oregon, giving macroinvertebrate data more weight in watershed management.

The WOWSA model will provide a comparison of the macroinvertebrate taxa collected at a monitoring site to the taxa the model expects to see based on an extensive database of reference streams. The model will also provide a list of organisms that were expected at the site but not collected and can even be used to determine the level of tolerance of macroinvertebrate taxa to specific stressors. These pieces of information will allow stakeholders to determine how similar or dissimilar their stream is from the best expected conditions of a similar stream. The WOWSA output will complement other analysis techniques, and can be used by watershed stakeholders to determine the success of land use improvements or the effects of increases in the intensity of land use.

The DEQ views Watershed Council efforts in macroinvertebrate monitoring as an important component of statewide monitoring efforts because watershed councils can work at a smaller, more focused spatial scale than the DEQ. The DEQ's biomonitoring division is funded primarily for broad, statewide assessments and rarely has the opportunity to focus macroinvertebrate monitoring efforts on land use level effects on a particular watershed.

REVIEW OF TIER III MACROINVERTEBRATE PROGRAM OBJECTIVES

Objective 1, *Provide baseline information about biological water quality by identifying macroinvertebrate assemblages*

In only 4 years, the McKenzie Watershed Council has been able to collect macroinvertebrate samples from 44 streams throughout the watershed (Figure 1, Table 1). The sites sampled by the Council were chosen largely to obtain a detailed baseline of the biological condition of streams throughout the watershed.

Sites monitoring 1998 to 2001

To provide a true baseline, the monitoring program must obtain broad geographic coverage in the watershed. The 1998 sites were selected across stream types, elevations, and land uses to answer basic questions about the condition of streams within the McKenzie Watershed. Site selection for 1999 focused on watersheds with minimal disturbance, while 2000 and 2001 samples were selected primarily to fill gaps and add to the diversity of stream sizes, ecoregions, gradients sampled in the watershed. The end result was a relatively complete coverage of the watershed (Figure 1). The only noticeable absence in data availability is in the far eastern portion of the watershed

Table 1. McKenzie Watershed Council macroinvertebrate monitoring sites 1998-2002 broken into subwatersheds (numbers correspond to numbered sites in Figure 1).

Mohawk River	**Other tributaries along the mainstem McKenzie**	
1. Lower Mohawk '98 2. McGowan Creek '99 3. Parsons Creek '00 4. Cash Creek '01 5. Shotgun Creek '99 6. Drury Creek '01 7. Log Creek '00 8. Upper Mohawk '98	9. Lower Cedar Creek '98 10. Upper Cedar Creek '99 11. Camp Creek '98 12. Cogswell Creek '99 13. Finn Creek '99 14. Indian Creek '01 15. Lower Gate Creek '99 16. Upper Gate Creek '99	17. N. Fork Gate Creek '98 18. Gale Creek '01 19. Deer Creek (BLM) '00 20. South Fork Deer Ck. '99 21. Ennis Creek '00 22. Quartz Creek '98 23. Cone Creek '99 24. Blue River '98
South Fork McKenzie	**Horse Creek**	**Other tributaries along the mainstem McKenzie**
25. South Fork McKenzie (below Cougar Dam) '01 26. Lower Strube Flat '01 27. Upper Strube Flat '01 28. South Fork McKenzie (above Cougar Res.) '01 29. East Fk. of the South Fork McKenzie '00 30. Walker Creek '00	31. Horse Creek (above campground) '98 32. Horse Ck. (side channel @ campground) '99 33. Horse Creek (@ wilderness bridge) '99 34. Separation Creek '01 35. Castle Creek '01 36. Roney Creek '01 37. Pothole Creek [A '99 & B '01]	38. Deer Creek (FS) [A '98 & B '99] 39. Scott Creek '99 40. Buck Side Channel '99 41. Fritz Creek '99 42. Smith River (below dam) '99 43. Smith River (above reservoir) '99 44. Olallie Creek '98
Mainstem sites not listed on map Lower McKenzie at Camp Harlow '99 Lower McKenzie at Armitage Park ’01, ‘02 Deerhorn ‘02 McKenzie River Below Leaburg Hatchery ‘02 Goodpasture Bridge ‘02		

(primarily wilderness area), where 3 or 4 additional samples from that region would help fill out the baseline.

The sites listed in Table 1 include mainstem McKenzie River sites that are not incorporated into this report. The Council has recently initiated data collection on maintem sites and should be able to evaluate the data collected by 2004.

Reference sites

One of the most important components of any monitoring program is understanding what conditions can be expected in the sample site. For specific projects, this can be accomplished with samples upstream of or in previous years to a disturbance or restoration. In watershed assessment level macroinvertebrate monitoring, this is accomplished with reference sites. Reference streams have no or minimal human disturbance and represent the habitat, water quality, and biological community conditions attainable for that stream type. Since undisturbed drainages are a thing of the past, the streams of "best available" drainages are sometimes chosen as reference sites. Oregon DEQ divides reference sites into three categories:

A. Ideal watershed and stream condition, a watershed with virtually no human disturbance.
B. Good watershed and stream condition, some limited human disturbance is present and/or Best Management Practices are well implemented.
C. Marginal watershed and stream condition. Human disturbance present. Best available. Replace if better quality reference sites are located.

Watershed Council staff worked with the DEQ in 1999 to select several sites that would represent reference watersheds. Similarly, after discussing watershed conditions with Council staff, a few sites from 2000 and 2001 were chosen as reference watersheds (see streams in bold, Table 2).

Because reference sites represent a background of natural conditions, they should be visited at regular intervals to track natural changes in macroinvertebrate communities. If a year is particularly dry or wet, or otherwise might affect the natural community, it is desirable to have data from reference streams to see if natural climatic changes have affected the biota. Changes should then be taken into account in data interpretation.

Use of baseline in identifying and addressing management concerns

The baseline information not only provides reference conditions, but also gives the necessary background for long-term monitoring and characterization of stream conditions and project effectiveness. The baseline is now available as historical evidence of changes in stream condition as land uses changes within the watershed. In an extreme example, the Washington Department of Ecology had collected macroinvertebrate data, as part of their regular monitoring efforts, on a stream that was completely evaporated in a fuel line accident. The biological stream data held the responsible parties accountable for not only the human loss, but also the impacts on the environment.

Current conditions

A wide range of stream conditions (as evaluated by the Aquatic Biology Associates assessment model) were monitored in streams of the McKenzie watershed from 1998 to 2001 (Table 2). The sites are sorted first by the ecoregion in which they were collected (Omernik 1986), and second by their overall score in the ABA assessment tool (out of a possible 100%).

The ABA assessment tool was designed for mountain streams of western Oregon and Washington, so the scores may not reflect similarity to reference conditions for the valley and foothill streams. It does, however, show the trends in stream health within each ecoregion. Reference streams are highlighted in bold for ease of comparison. The reference streams for the valley and foothills ecoregions fall into the DEQ category C of reference condition mentioned above, while those in the Western Cascades fall into the A an B categories.

Five additional measures are included in the table. Generally, characteristics such as the total number of taxa and the number of mayfly, stonefly, and caddisfly taxa respond predictably to changes in human influence and reflect the changes in the assessment scores. Abundance, however, is a measure that does not respond predictably to human influence and does not follow the pattern of the assessment values. Even with the taxa richness metrics, however, the response is not always exactly the same as the over all model score. Thus, several of these characters are combined in this type of assessment (43 different community characteristics in this case) to accurately reflect the biological condition of the stream.

Patterns in baseline data

Several patterns can be observed in Table 2. First, sites in the Gallery Forest ecoregion received markedly lower scores than those in other ecoregions. As mentioned earlier, there is likely some natural difference accounted for in these samples because they don't exactly fit the model, but even the "reference" stream in this set is highly impacted by agriculture and residential development. The link between such land uses and degraded biological communities has been well-documented (Fore et. al, 1996)

Gate Creek. In the ecoregions where a larger sample size is available, biological degradation can be detected by either comparing sites to reference conditions or comparing sites in close proximity. For instance, all three sites in Gate Creek (ABA scores = 49.2%, 51.6%, and 54.0%) scored well below either the references or nearby streams (71.8%, 70.2%, and 68.5%). Such a discrepancy should flag Gate Creek as a biologically limited watershed for further analysis of land uses and potential restoration.

Deer Creek (BLM). Similarly, the Deer Creek that passes through BLM land (site #19) reflected a relatively poor biological condition (50%) as compared to a tributary, South Fork of Deer Creek, just upstream that showed good biological condition (71.8%). This example can also be used to interpret where the cause of the biological limitation is originating. Because the South Fork was in better condition upstream of the mainstem collection site, activities in its drainage are not a likely cause of the degradation.

Table 2: McKenzie River macroinvertebrate collection sites and selected metric values (further defined in Appendix II) sorted by ecoregion and assessment score. (ecoregions are in the left column; potential reference sites are in bold; duplicate and large river sites not included)

	Sample Sites	**ABA % Assessment**	**total abundance (m2)**	**total taxa**	**Mayfly taxa**	**Stonefly taxa**	**Caddisfly taxa**
Gallery Forest of the Willamette Valley Tributaries							
	1 Lower Mohawk 9-12-98	43.5	748	41	5	6	8
	3 Parsons Ck 10-7-00	**42.7**	**2984**	**37**	**8**	**4**	**8**
	9 Cedar Ck 9-12-98	33.1	968	55	9	4	11
Willamette Valley Foothills							
	10 Cedar upper 9-25-99	**65.3**	**2228**	**70**	**8**	**9**	**14**
	2 McGowan Ck. 9-25-99	62.9	6532	49	8	7	10
	11 Camp Ck 9-12-98	57.3	3366	48	10	7	9
Western Cascades Lowlands and Valleys							
	4 Cash Ck 10-6-01	71.8	1142	53	10	8	12
	14 Indian Ck 10-6-01	71.8	1492	67	12	9	10
	20 S Fk Deer 9-25-99	**71.8**	**1999**	**74**	**12**	**8**	**16**
	13 Finn Ck 9-25-99	**70.2**	**2616**	**63**	**10**	**11**	**12**
	6 Drury Ck 10-6-01	68.5	5923	60	10	10	10
	12 Cogswell 9-25-99	**68.5**	**2723**	**66**	**10**	**11**	**13**
	18 Gale Ck 10-6-01	65.3	3298	58	10	10	13
	5 Shotgun Ck 9-25-99	63.7	6069	57	11	7	11
	7 Log Ck 10-7-00	60.5	8487	58	8	9	10
	8 Upper Mohawk 9-12-98	56.5	1566	61	10	10	10
	17 Gate Ck 9-25-99	54	7424	53	10	4	9
	16 Gate Ck 9-12-98	51.6	2868	62	9	10	11
	19 Deer Ck (BLM) 8-30-99	50	2582	60	9	8	11
	15 Gate Ck Bennit 10-5-99	49.2	8700	47	8	7	9
(Western Cascades Lowlands and Valleys with Western Cascades Montane Highland headwaters)							
	32 Horse Ck side channel 9-24-99	83.9	2772	60	16	10	11
	23 Cone Ck 10-13-99	**81.5**	**5832**	**70**	**13**	**12**	**13**
	28 South Fk McKenzie above Cougar 10-6-01	**79**	**6714**	**66**	**11**	**10**	**15**
	31 Horse Ck above campground 9-12-98	78.2	523	55	8	7	19
	25 South Fk McKenzie below Cougar 10-6-01	66.9	3782	45	5	5	12
	22 Quartz Ck 9-12-98	62.1	5409	56	9	9	11
	27 Upper Strube Ck 10-6-01	56.5	3544	52	6	4	10
	24 Blue River above reservoir 9-12-98	47.6	1523	58	12	7	7
	30 Walker Ck 10-7-00	44.4	1053	62	10	12	11
	26 Lower Strube Ck 10-6-01	40.3	1706	56	3	3	10
Western Cascades Montane Highlands							
	37a Pothole Ck 9-24-99	**92.7**	**1380**	**65**	**11**	**16**	**14**
	36 Roney Ck 10-17-01	91.9	2222	69	11	16	16
	35 Castle Ck 11-1-01	87.9	774	56	12	9	16
	33 Horse Ck wilderness bridge 9-24-99	**85.5**	**3053**	**58**	**14**	**9**	**16**
	41 Fritz Ck 9-30-99	83.9	659	63	12	11	14
	40 Buck sid channel 9-13-99	79	3802	47	12	9	10
	38a Deer Ck 9-12-98	78.2	5771	60	12	8	14
	29 East Fork 10-7-00	**77.4**	**2169**	**52**	**10**	**10**	**11**
	43 Smith above dam 9-29-99	71	1555	48	12	10	10
	42 Smith below dam 9-29-99	60.5	1060	48	7	7	14
(Western Cascades Montane Highlands with Cascade Crest Montane Forest headwaters)							
	34 Separation Ck 10-17-01	87.1	1418	55	11	10	13
	39 Scott Ck 10-12-99	87.1	3119	64	10	14	16

Something else to consider is the proximity of the mainstem sample site to the McKenzie River. Influences of the McKenzie could be detected for short distances up such tributaries.

Cougar and Smith Dams. Samples were collected above and below the reservoirs of Cougar and Smith Dams. In both instances the ABA assessment score was about 10 points lower below the dams (Cougar - 79% above, 66.9% below; Smith - 71% above, 60.5% below). Because the Corps of Engineers is in the process of modifying the Cougar Dam to more closely mimic natural temperature and flow levels, this baseline information will be very valuable in follow-up effectiveness monitoring 2, 5, or 10 years after the project.

Drury and Gale Creeks. These streams have been monitored as part of a culvert replacement and a road removal project respectively. Only the pre-modification monitoring has been completed, but evaluating the effectiveness of these projects in the next few years will be made possible by the foresight in collecting the pre-project samples.

Objective 2, *Track long-term trends in water quality*

Long-term trends are only detectable with multiple years of data. To date in the McKenzie, there are two examples of sites that were monitored over more than one year, Deer Creek (FS, Figure 2) and the reference site Pothole Creek (Figure 3). The expectation of a reference site is that it would change little from one year to the next because only natural influences are affecting stream conditions. At monitoring sites, changes in excess of the natural variability observed in the reference sites may be attributed to changes in management. The overall scores and the individual metrics are very similar in Pothole Creek, suggesting little change in the biological condition of the streams, but show a modest downward trend in Deer Creek, possibly flagging it for continued monitoring.

<u>Revisiting sites</u>

A key component to monitoring long-term trends is revisiting sites on a regular or semi-regular basis. Now that the initial baseline has been completed, it is the recommended that the Council begin to revisit sites at regular intervals. If there is little change in land use activity, then the stream may only need a periodic check-up, every 5 years for example, but if intense land use is occurring, land uses are changing, or a restoration project is being implemented, more frequent, even annual, collections are advisable. For example, if the goal is to monitor the effectiveness of a restoration effort, then the Council may want to adopt a strategy of monitoring the year before a project, the two years after, then at 5 years, and again at 10 years after project initiation. This discussion reinforces the need for stable long-term monitoring even if only for a few sites each year.

Factors contributing to variability

The large number of factors that contribute to the variability in macroinvertebrate monitoring results can sometimes make accurately assessing trends in water quality very difficult, for example, using a model designed for Cascade streams to evaluate streams in the Valley Foothills. Fortunately, well trained volunteers, and comprehensive analysis tools eliminate or take into account much of this variability. The new WOWSA model will complement current evaluation methods by incorporating a number of these natural variables - including location, gradient, sediment size, elevation, latitude, ecoregion, and stream width - into the analysis to determine which of the database's reference sites a monitored site will most accurately be compared to.

Factors affecting the macroinvertebrate community structure may include changes in the watershed due to natural disturbances such as floods or drought and variability in the collection or identification of the samples. Thus, one or two reference streams should be monitored each year to track natural changes in environmental conditions. Inherent in a "reference stream" is the understanding that the sub-watershed receives little change in land use. If that holds true, then any changes you might see in reference conditions should be attributable to changes in natural conditions. Obviously, this will not track a fire, a natural debris flow, or other sub-watershed scale natural disturbances that occur in a different sub-watershed, but it will reflect the influences of floods and droughts that generally affect the greater watershed uniformly.

To deal with the potential of sample variability, the Council makes sure the volunteer monitors are well trained, with an evening session, followed by a Saturday morning refresher before going out into the field. Furthermore, the volunteer monitors are accompanied by biologists or others with experience in macroinvertebrate monitoring.

To make sure the samples are being effectively collected, a second set of samples is collected from 10% of the sites, or at least one site each year (Oregon Plan 1999). The overall assessment scores and a number of taxa richness metrics from the 1998, 1999, and 2001 duplicated samples show that there is little difference between these samples and the duplicate samples taken just upstream (Figures 4, 5, 6). The duplicates scored very consistently with the sample sites, reinforcing the fact that the volunteers are effectively collecting useful and sensitive macroinvertebrate data.

By training field crews, collecting quality assurance samples, monitoring study and reference sites on a regular basis, and monitoring during a consistent time of year (late August through September is recommended), the Council will be able to effectively track long-term trends in stream condition in the future.

Objective 3, *to offer local volunteers experiential learning opportunities related to watershed health concepts*

Macroinvertebrate monitoring is an outstanding opportunity for engaging volunteers. The program has provided a forum for individuals to learn about macroinvertebrates and to explore streams in their watershed. After this hands-on experience they start to understand the concepts of a healthy watershed.

Over the four-year program, volunteer recruitment grew from a handful of adult watershed residents to dozens of residents, teachers, and high school students learning through experiential science. In the second year of the program, the Council staff targeted recruitment of volunteers to local teachers, and found that teachers took their experience back into the classrooms to share with their students. In the third year of the program, over half of the volunteers where teachers and after learning how to collect macroinvertebrate samples for themselves, they where more confident in leading their students in a macroinvertebrate study unit. In the fourth year of the program, one of the trained teacher volunteers brought her high school students into the program, and developed a macroinvertebrate monitoring team. The Council then continued to use this "bug" team throughout the year on different streams and macroinvertebrate projects. Over the four year program, the total number of volunteers (over the four-year program) was 65, contributing approximately 550 hours to the McKenzie Watershed Council.

Because public awarness is an integral componet to this program, the Council not only trains volunteers to collect macroinvertebrate samples, but also shares information about the Council's activities in the McKenzie Meanderings Newsletter. The newsletter is distributed to about 5,000 watershed residents three times each year, and includes articles about the monitoring program. This helps educate watershed residents about healthy watersheds.

LESSONS

Lessons learned from the McKenzie Watershed Council macroinvertebrate monitoring experiences for use by others in starting a macroinvertebrate monitoring programs.

- Consult with DEQ's biomonitoring program and the Xerces Society regarding planning, training, and sampling procedure recommendations
- Put the sampling/monitoring program in writing and follow it - document any deviations
- Develop apriori characterization of all subwatersheds - evaluate potential reference sites Provide excellent learning opportunities for schools/teachers/students
- Provide data collection opportunities for watershed stakeholders
- Include water quality monitoring at macroinvertebrate monitoring sites whenever possible

CONCLUSIONS AND RECOMMENDATIONS

The efforts of the McKenzie Watershed Council staff and volunteers have been exceptionally effective in acquiring a thorough baseline of macroinvertebrate monitoring sites in the McKenzie watershed. The Council is encouraged to continue to share their information and lessons with other watershed councils, volunteer groups, and agencies. From reviewing the strategies adopted by the Watershed Council and the data already collected, the continued effectiveness of the program will be supported by:

Objective	**Time frame**	**Frequency**
Objective 1, *Provide baseline information about biological water quality by identifying macroinvertebrate assemblages*		
gather additional baseline data from the eastern portion of the watershed	Late August through September	2003 and/or 2004
incorporate consecutive year monitoring of at least two reference sites where land use in the watershed has remained unchanged	Late August through September	annual
Objective 2, *Track long-term trends in water quality*		
continue support of the macroinvertebrate monitoring program as a long-term data resource and continued effective coordination of stakeholders in watershed	Year round	Annual or as needed for projects
use the macroinvertebrate monitoring data to help guide and focus restoration and conservation efforts	Year round	
return to monitoring sites depending on the land use in the watersheds. Set up a schedule with which the existing sites can be revisited at intervals assigned to them based on the intensity of their land use	Late August through September	intense land use - visit annually; low intensity land use - visit every 5 years
monitor streams where management changes are expected	Late August through September	Pre- and post-changes
monitor restoration efforts before and after project initiation and upstream and downstream of the project	Late August through September	Pre- and 1, 2, 5, and 10 years post- project
consistently monitor from late August through September	Late August through September	Annual
Objective 3, *to offer local volunteers experiential learning opportunities related to watershed health concepts*		
continue successful volunteer recruitment, training, and quality assurance strategies	Late August through September	Annual

REFERENCES

Cairns J. & Pratt J.R. (1992) A history of biological monitoring using benthic macroinvertebrates. *Freshwater biomonitoring and benthic macroinvertebrates*. (eds D.M. Rosenberg & V.H. Resh), pp. 10-27. Chapman & Hall, New York NY

Fore L.S., Karr J.R. & Wisseman R.W. (1996) Assessing invertebrate responses to human activities: Evaluating alternative approaches. *Journal of the North American Benthological Society*, **15**, 212-231.

Karr J.R., Fausch K.D., Angermeier P.L., Yant P.R., & Schlosser I.J. (1986). Assessment of biological integrity in running waters: A method and its rationale. *Illinois Natural History Survey Special Publication*, **5.**

Karr J.R. & Chu E.W. (1999) *Restoring Life in Running Waters: Better Biological Monitoring*. Island Press, Washington, DC.

Omernik J.M. (1987) Ecoregions of the conterminous United States. *Annals of the Association of American Geographers. Text and map supplement*, **77**, 118-125.

Oregon Plan for Salmon and Watersheds. (1999) *Water Quality Monitoring Technical Guide Book*

Rosenberg D.M. & V.H. Resh. (eds.) (1992) *Freshwater biomonitoring and benthic macroinvertebrates*. 488 pp. Chapman & Hall, New York NY

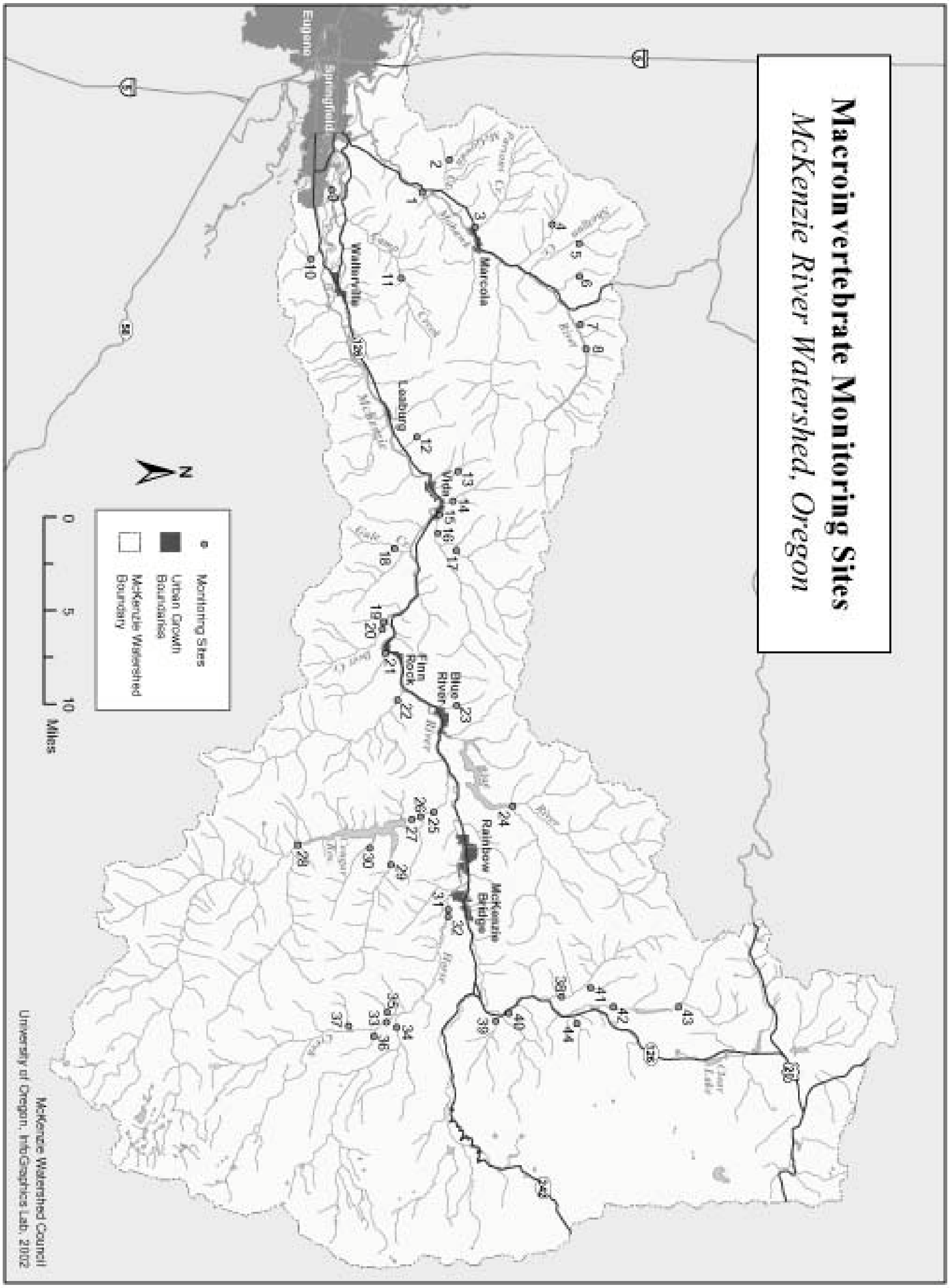


Figure 1. Map of sample macroinvertebrate sample sites in McKenzie River Basin.

Figure 2: Deer Creek Comparison Between Years (further defined in Appendix II)

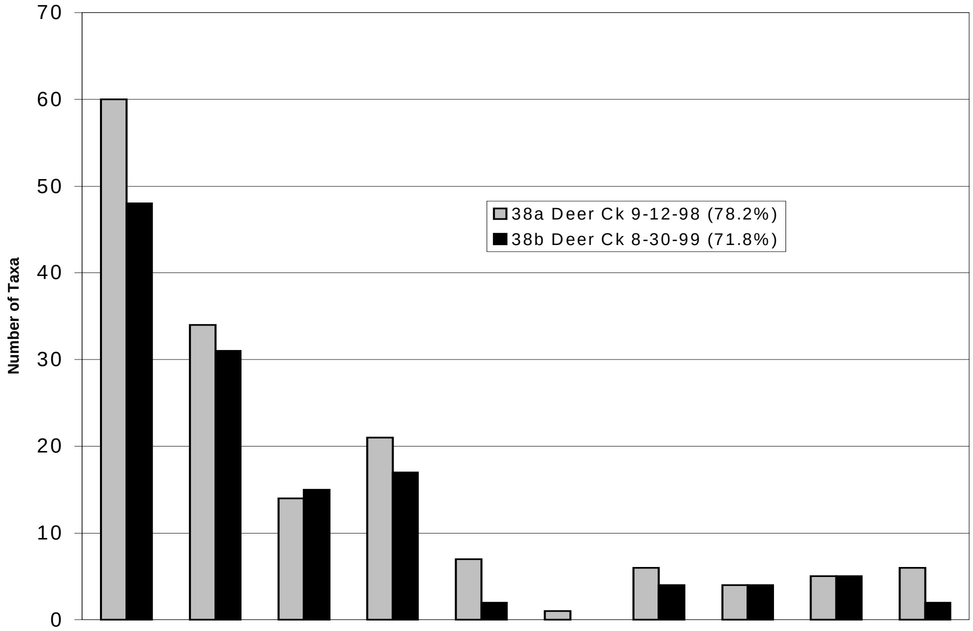


Figure 3: Pothole Creek Comparison Between Years

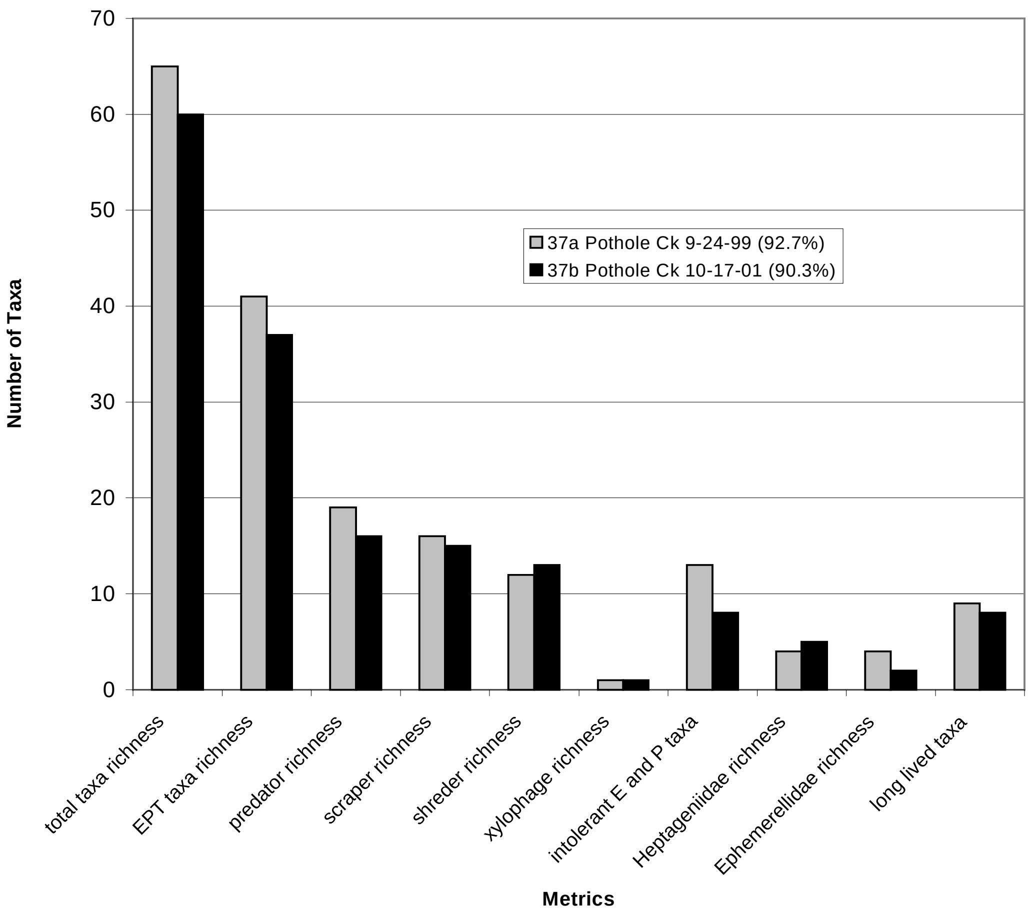


Figure 4: Site 9, Cedar Creek (33.1%; gray) and QA (39.5%; black) 9-12-98 (further defined in Appendix II)

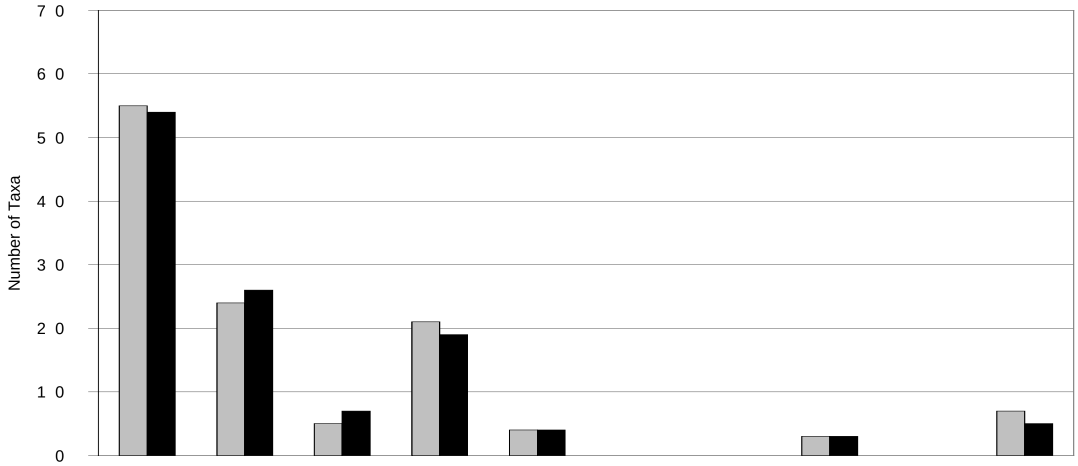


Figure 5: Site 5, Shotgun Creek (63.7%; gray) and QA (63.7%; black) 9-25-99

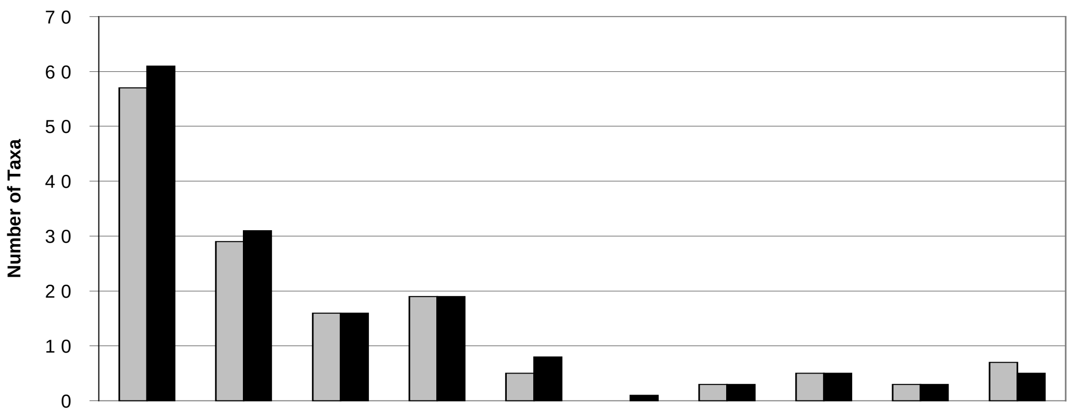
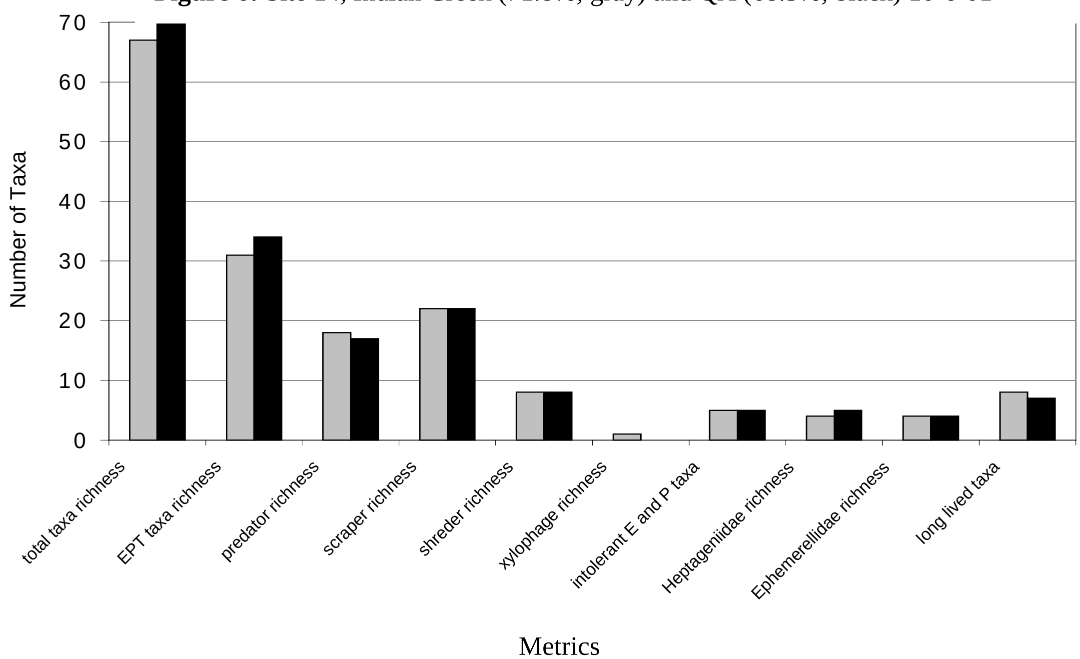


Figure 6: Site 14, Indian Creek (71.8%; gray) and QA (68.5%; black) 10-6-01



APPENDICES

Appendix 1. DEQ macroinvertebrate assessment sites in the McKenzie River Watershed (for additional information on the sites and data availability contact DEQ's biomonitoring program)

Site names
Marten Creek U/S 2 MI FROM GALES CR (McKenzie)
COUNTY Creek at USFS RD 705/706 JCT AND ROCK PILE (McKenzie)
Rebel Creek 1.75 mi from Rebel trailhead U/S from 2nd footbridge (SF McKenzie, McKenzie)
Rush Creek 1.3 mi on USFS RD 415 and hike D/S 1/4 mi (SF Mckenzie, McKenzie, Willamette)
French Pete Creek 0.8 mi U/S from USFS RD 1931 crossing (SF McKenzie, McKenzie, Willamette)
Trib to Rebel Cr at RM 0.40 (McKenzie, Willamette)
Budworm Creek (McKenzie)

Appendix 2. Descriptions of assessment tool and metrics used in graphs and tables.

From Table 2

ABA % Assessment - macroinvertebrate assessment tool based on the combination of 43 community characteristics
Total abundance (m^2) - number of individual macroinvertebrates in a square meter of sample, adjusted from 500 organism subsample
Total taxa - total number of taxa found in a standard 500 organism subsample
Mayfly taxa - number of Ephemeroptera taxa found in a standard 500 organism subsample
Stonefly taxa - number of Plecoptera taxa found in a standard 500 organism subsample
Caddisfly taxa - number of Trichoptera taxa found in a standard 500 organism subsample

From figures

Total taxa richness - total number of taxa found in a standard 500 organism subsample
EPT taxa richness - number of Mayfly (Ephemeroptera), Stonefly (Plecoptera), and Caddisfly (Trichoptera) taxa in standard sample
Predator richness - number of taxa that feed on live animals
Scraper richness - number of taxa that feed by scraping algae off substrate
Shredder richness - number of taxa that feed by shredding vegetation in pursuit of bacteria and fungus
Xylophage richness - number of taxa that feed on instream wood
Intolerant E and P taxa - number of Mayfly (E = Ephemeroptera) and Stonefly (P = Plecoptera) in sample that are classified as generally intolerant to human disturbance
Heptageniidae richness - number of taxa from the generally sensitive family of flat-headed mayflyies (Heptageniidae)
Ephemerellidae richness - number of taxa from the generally sensitive family of spiny crawler mayflyies (Ephemerellidae)
Long lived taxa - number of taxa that live in the aquatic environment longer than a single year