Tolerant/Intolerant Taxa

Comments by Robert Wisseman, March 2012 on tolerant/intolerant taxa to urbanization in Puget Sound Lowland streams as noted on the spreadsheet Empirical results for Tolerant and Intolerant Taxa.xlsx.
Comments by Leska Fore in red, March 31, 2012.

I've gone over the list carefully and done this:

1. Rejected some taxa as terrestrial, water column taxa, or probable erroneous I.D.s'

LF: Jo Wilhelm is working with James Develle to update the taxonomy as appropriate.

2. Where taxonomic effort has been very inconsistent over the years, I have recommended rolling up some taxa to a higher taxonomic level.

LF: Labs are still identifying to these levels and if so, we want to catch the taxa names and assign correct attribute information to them as data come in. Over time this taxonomic nomenclature will hopefully fade out.

3. Recommended that some species or species groups be analyzed separately when they occur at enough sites and when there are well known habitat differences.

LF: In cases where Bob W. called out specific species that should not be included with a designation made at the genus (or coarser) level, these were changed. In other cases, where Bob W. recommends that we test at a more coarse taxonomic level, if the testing was already done it is reported (below). Alternatively, for most instances we let the genus level testing stand in order to be consistent with our criteria and apply it as uniformly as possible to all taxa. The criteria were genus level testing (or more coarse if data were summarized at the family level or higher) for taxa with >25 sites. The data file we sent to Bob W. had more sites than were available for testing because some of those sites didn't have land use data.

These changes shorten the list dramatically. We have to work with what we have. Hopefully, standard taxonomic effort will improve and in the next iteration of this analysis we can evaluate more taxa at a finer taxonomic level.

See the updated spreadsheet
Column B: There are many notes explaining name combinations or rejections. I go into more detail for some of these below. Names highlighted in red should be rolled up, combined or rejected.

Column C: The original level of analysis.

Column D: Lists the initial taxonomic level I think the analysis should be run at provided they meet the 25 site criteria (Primary).

Column E: Lists additional coarser taxonomic levels that should be analyzed (Secondary).

Column F: Lists a few additional levels of coarser or finer taxonomic levels that should be analyzed (Tertiary).

The initial analysis and designation of tolerant and intolerant taxa to urbanization shows some strong signals, and I think the approach is robust. Reanalysis at the levels I'm suggesting should tighten it up, get rid of some noise, and be more defensible. Additional tolerant/intolerant taxa may become evident.
LF: See specific notes for each taxonomic group below.

The initial analysis is weighted with significantly more tolerant taxa. A reanalysis at the suggested levels may add some more intolerant taxa. What would you think about relaxing the selection criteria for fewer sites, e.g 20 sites, or maybe upping from 15 to 20% for the lowest T95 values (intolerant) and greatest difference (tolerant)?
LF: The >25 cut-off provides a reasonable number of sites to define the distribution of sites with a taxon present. This criterion follows Utz et al. 2009. Our goal with this analysis is not to identify every tolerant and intolerant taxon, this is too hard, particularly for the intolerant taxa that may also be rare. Instead our goal is get a "good enough" list of these taxa that will provide a good signal as a metric when tested against urbanization in the watershed. We will add more taxa as needed to get a good signal in the metric from 0-80% urbanization in the watershed.
As you've mentioned, this analysis targets Puget Sound Lowland streams, and may be suitable for lowland streams in general in western Oregon and Washington. That's the data you had to work with. I think we have to emphasize that so folks don't stretch it too far.
LF: Agreed. This is an important caveat for this list.
Absent is a whole suite of mid-upper elevation montane taxa that could provide useful indicators to human disturbance. We need a similar analysis for PNW montane taxa, correlated with forestry/agriculture/grazing/roading disturbance instead of urbanization.

There are very **tolerant taxa** to low D.O., warm water, and probably urbanization that didn't get picked up by this analysis because they occur primarily in lentic habitats, low gradient streams, and pools (e.g. the midges Chironomus, Procladius, etc.). They did not make the >25 site cut-off. They're hard for me to ignore if present at a site, but maybe they can be registered by some other metric.

The number of **intolerant taxa** is skimpy. I'd like to see more. Hopefully the second run on the analysis will pick up a few more.

1. There's a subset of spring and very small stream associated taxa that are probably very sensitive to urbanization that didn't get evaluated because they occurred at <25 sites (e.g. Pistinicola hemphilli, Rhyacophila grandis, Goeracea, etc.). These would be hard to ignore if they occurred at a sampling site. They need to be acknowledged somehow if they occur at a site.
2. Some of the intolerant taxa that did make the cut are really mid-high elevation cold water biota, that just made the >25 site cut-off (e.g. Oreogeton, Moselia, Yoraperla, Doroneuria, Ecclisomyia). They may occur in lowland streams with dense canopy and cold, spring-fed water sources. They were probably much more common in the lowlands before Euoropean settlement. There are more of these taxa that may appear in the lowlands that would be hard to ignore.
3. There are indigenous lowland taxa that are intolerant of urbanization but weren't analyzed because they occurred at <25 sites. They're rare because of their sensitivity to human development (e.g. mussels like Margaritifera, native crayfish like Pacifasticus, etc.). They need to be acknowledged somehow if they occur at a site.

Leeches (Hirudinea) rows 2-4, 27-33
There is a STE problem here. Identifications have been at the subclass (Hirudinea), family, genus and species level. It looks like only Erpobdellidae and Hirudinea met the criteria >25 sites. I think the Glossiphoniidae (which includes Helobdella) will turn out to be equally or more tolerant than the Erpobdellidae. In older data sets identifications for the ubiquitous and tolerant genus Helobdella are split between Helobdella, Helobdella stagnalis, Glossiphonidae, or just left at Hirudinea. Could you analyze:

A. Relax the >25 site standard and see how Glossiphoniidae (inclusive of Helobdella and Glossiphonia) turns out? That's about 18 sites.

LF: We need to keep a consistent protocol for testing and apply it to all taxa, for this analysis we based the minimum of 25 sites on Utz et al. 2009.

B. Since leech I.D.'s have been all over the map, could you roll them all up to Hirudinea and run that?

We really need all the labs to start identifying the leeches to family, and also consistently identify Helobdella, which is easy. Then we can test all the families and Helobdella on their own.
LF: Taxonomic ID issue.

Oligochaeta rows 6-34

I agree that this is Oligochaeta is too coarse of a taxonomic level to include. Rows 11-26 roll up to Oligochaeta.
LF: Agreed.

Acari (mites) rows 39-59
What a STE mess. I do not trust the genus or family names. I would roll all the mites up to Acari and look at that. First you have to kick out Oribatida (soil mites) and Arachnida (terrestrial spiders).
LF: Agreed.

Dytiscidae (predaceous diving beetles) rows 64-75
Again, level of I.D. is all over the place. I would roll all up to the family level and rerun. It might show a tolerant signal. I'm not confident that most of the Oreodytes identifications are correct.
LF: Taxonomic ID issue.

Elmidae (riffle beetles) rows 76-89

Lots of duplicate names here that need to be combined and reanalyzed.
LF: Taxonomic ID issue.

Was Heterlimnius close to being classed as intolerant? I think it should be.
LF: Yes, close, but did not meet criteria.

I'm OK with genera that I've considered to be tolerant (Cleptelmis, Optioservus, Zaitzevia) not popping out here, since my classification was in a cool, montane stream context. If they're present in a Puget Sound Lowland stream, that's generally a good sign.

Haliplidae (beetles) rows 90-93
Roll up to family level and analyze even if that doesn't quite make the 25 site cut-off. They should turn out to be tolerant.
LF: Need to keep consistent criterion of Genus level roll up.

Hydrophilidae (beetles) rows 100-106
Roll up to family level and analyze, but exclude Ametor (row 100). That will get the >25 site threshold. Most are tolerant. Ametor is atypical and intolerant.
LF: Need to keep consistent criterion of Genus level roll up.

Ceratopogonidae (no-see-um midges) rows 116-128
Roll up genera to subfamily and analyze. Genus names are highly dubious. Reject family level I.D.'s (Ceratopoginidae). They don't mean much at that taxonomic level.

Ceratopogoninae (includes)

LF: This taxonomic level was tested and not significant. Roll up won't change results.

Bezzia
Ceratopogon
Culicoides
Monohelea
Palpomyiini
Probezzia
Serromyia
Sphaeromias
Ceratopogoninae

Forcipomyiinae (includes)

Atrichopogon
Forcipomyia
Forcipomyiinae

Chironomidae rows 131-258

We're dealing with uneven taxonomic effort here. There is a very large set of sites where the midges were identified to family or subfamily only. This really cuts down on the potential suite of genera that would have been found at >25 sites. However, the genera that popped out as tolerant to urbanization make sense. My concern is that quite a few obviously intolerant or tolerant taxa did not make the cut because they were at <25 sites. I've updated the spreadsheet to indicate some more taxa that I now consider to be tolerant or intolerant. Here are some ideas:

A. Relax the site standard from 25 to 20 and see if a few more tolerant taxa pop out.

LF: We need to keep a consistent protocol for testing and apply it to all taxa, for this analysis we based the minimum of 25 sites on Utz et al. 2009.

B. I'm very curious to see what would happen if you roll up the taxonomic level to subfamily. I'm thinking the Chironominae may turn out to be a good signal for tolerant taxa. Also, the Diamesinae and Prodiamesinae may come out as intolerant. Use column E on the spreadsheet to roll up to subfamily.

C. I'd like to see what happens if you look at just the Tanytarsini (tribe of Chironominae). Use column F in the spreadsheet to pick out Tanytarsini.

LF: We may pursue additional testing at the subfamily level for chironomids.

There is lots of cleaning up to do on the list with duplicate names.

Cricotopus: I don't think it will make a big difference, but definitely remove Cricotopus (Nostococladius) (2 sites) from the analysis. This taxa is atypical within the genus, is intolerant and shouldn't be mixed in with the rest of Cricotopus. Looks like Cricotopus was showing a signal but it was clouded by the taxonomic levels being inconsistent. I think some of the individual groups will eventually be shown to be tolerant, but we're going to have to get people to identify these groups consistently.
LF: Taxonomic ID issue.

Diplocladius: I'm surprised at the number of sites it shows up at. I didn't think it was that common. If most of those identifications are coming from one lab or data set, there might be a taxonomic/mis-identification problem.
LF: If there is a taxonomic ID problem, we cannot change data.

Eukiefferiella: Yes, they are ubiquitous. Looks like the signal was strong at the genus level. I would be interested to see how the individual groups pop out.
LF: Only tested at Genus level to be consistent across taxa.

Heterotrissocladius: Have to analyze at genus level now. The more recent STE is to identify to species group. Rows 172-173 and also row 253 need to be combined under Hetrotrissocladius. That will give >25 sites for the genus. Roll up to Heterotrissocladius.

LF: Did not test this taxon. Too much work to go back for one taxon.

Krenosmittia: I'm surprised that it didn't show a stronger intolerant signal. This is a spring and cold groundwater associated taxa.

Microtendipes rows 184-185 and row 251
The current STE is to take to species group, but we're dealing with a long legacy of genus level I.D.s'. Roll up to Microtendipes.
LF: Taxonomic ID issue.

Orthocladius: Orthocladius (Symposiocladius) and Orthocladius lignicola are the same beast. This is a wood associated taxa. I would remove this taxa from the Orthocladius analysis. It is atypical for the genus, and in fact used to be in its own genus, Symposiocladius. Reanalyze just Orthocladius and Orthocladius (Orthocladius Complex) together and see what happens.
LF: These groups were not significantly tolerant or intolerant when tested separately. Did not test together because don't expect results to change.

Orthocladiinae sp. RAI# 0004 & 0011 rows 247-248
These are Rhithron designations for unknown taxa in Orthocladiinae. Include them in Orthocladiinae, but they don't stand for the subfamily Orthocladiinae. Roll up to Orthocladiinae.

Potthastia: When Potthastia taxa are rolled up to just the genus I get 26 sites. Why wasn't this one run? The current STE is to take to group, but we're dealing with a legacy of just genus names. Roll up to Potthastia.
LF: the number of sites are not correct in this file. They are too high because some of these sites didn't have land use data. In the file I used to test there were <25 sites.

Tvetenia: Maybe I'm interpreting this wrong, but it looks like Tvetenia just missed the cut for tolerant taxa? This taxa seems to be present in most urban and suburban streams. STE now is to species group, but there is a legacy of I.D.'s to just the genus level. Roll up to Tvetenia.
LF: These taxa were rolled up to Tvetenia and were not significantly tolerant.

Intolerant midges: It bothers me that no midges made the intolerant list. I think that's because most of the probable ones did not make the >25 site cut. Do look at Diamesinae and Prodiamesinae.
LF: for Diamesinae, Pagastia was tolerant. Not enough occurrences to test other taxa.
LF: Did not originally test at the subfamily level, just tested at genus level to be consistent. But may go back and test at the subfamily level.

Dixidae rows 263-266
Please run Dixella (tolerant I think) and Meringodixa (intolerant I think). They have 20-25 sites.
LF: We need to keep a consistent protocol for testing and apply it to all taxa, for this analysis we based the minimum of 25 sites on Utz et al. 2009.

Empididae rows 268-280
The Empididae sp. RAI #0001 & 0002 taxa in rows 276 and 277 should not be mixed in with Empididae at the family level. These are Rhithron designations for unknown larval forms.
I'm glad Oreogeton came out as intolerant, but it is a cold water taxa, not likely to occur in lowland streams.
I'm surprised that Hemerodromia didn't come out as more strongly tolerant.

Ephydridae row 281
Is very tolerant, but is pool and brackish water related. They show up at 53 sites, but in low numbers, so not a good signal.

Glutops rows 284-285
I really think they are intolerant, but won't be well represented in lowland streams, so may not correlate well with urbanization. They're a cool/cold water taxa found more at mid-high elevations. If they were on the borderline of being classed as intolerant, I would include them as such.
LF: Yes, they were very close to the cut-off for intolerant. If we need more taxa in this metric, they will be included.

Psychodidae rows 287-291
Combine Pericoma under Pericoma/Telmatoscopus.
Who's just identifying to Psychodidae?
LF: Taxonomic ID issue.

Ptychoptera row 292
This is an example of a taxa that is very tolerant of warm water, fine sediment and low D.O., but may not be tolerant of urbanization. It is a pool related taxa that lives burrowed in fine particulate organic matter, a habitat that tends to disappear in urban streams.
LF: Comment noted.

Simuliidae rows 294-296
I agree that Simulium is a good tolerant signal for urbanization. Those identified to just Simuliidae will be 99% Simulium. Prosimulium is entirely different. It is a cold water taxa, found most commonly at higher elevations. It may be in lowland streams, but only during the cool months of the year, and will not get picked up in summer and early fall sampling. If you want to roll up the analysis to Simuliidae, I would include Simuliidae and Simulium, but not Prosimulium.
LF: Prosimulium excluded.

Stratiomyidae rows 297-299
Tolerant, but not a good signal. Even if you roll up to family level, they're only at a few sites.

Tabanidae rows 301-303
Same as Stratiomyidae. Roll up to family level. Genus level I.D.'s are very suspect and problematic.
LF: Too few to test, need to keep to criteria of genus level and >25 sites.

Menetus row 304
There's been a mistake here. Menetus is a snail (Planorbidae). I learned something new here. There is a terrestrial fly also named Menetus (Diptera: Tachinidae), but it is not our guy. This is an example where the International Commission on nomenclature needs to make a ruling so the same name is not applied to two invertebrate taxa. I e-mailed a snail colleague to see if this has been resolved.

Taxonomy has been fixed in the PSSB. However, b/c data were downloaded prior to implementing the fix, all Menetus should be combined and re-run.

Thaumaleidae rows 305-306
Discard the genus name Thaumalea, roll up to family level and run the analysis. That puts it over 25 sites. They may be intolerant.
LF: too few sites to test.

Tipulidae rows 307-329
Some genera that are definitely intolerant did not make the 25 site cut. How about running Molophilus and Pedicia (20 & 18 sites) to see if they are giving an intolerant signal? Limonia is tolerant, but not at enough sites.
Hesperoconopa likes clean, sandy substrates.
I'm surprised that Rhabdomastix did not turn out to be more intoletrant, maybe because it is found mostly at higher elevations.
I'm not surprised that Tipula came out as tolerant.
LF: We need to keep a consistent protocol for testing and apply it to all taxa, for this analysis we based the minimum of 25 sites on Utz et al. 2009.

Ameletus row 332. Strong intolerant signal. Good, what I thought. This is a large genus with a broad longitudinal and elevational range. I don't include them as intolerant, cold water biota, but it looks like they are highly sensitive to urbanization.
LF: Comment noted.

Baetis rows 335-339
Tolerant of urbanization. I agree. Genus level OK for the Puget Sound lowlands. They may skew the % tolerant metric.
LF: Need to test this taxon separately before including as tolerant due to high numbers of individuals. Used different criteria to include, that is, ubiquity.

Attenella rows 350-352
Attenella margarita is more tolerant than A. delantala. 95+% of the specimens identified to just Attenella will probably be A. delantala. You could rerun combining just A. delantala + Attenella, and leaving A. margarita out, but the signal is strong enough even with the A. margarita mixed in.
LF: Very few A. Margarita in Genus. Genus was not tolerant or intolerant. Excluding this species will not change designation.

Caudatella rows 353-354
Should be intolerant of urbanization, but not enough sites to qualify.
LF: Comment noted.

Drunella rows 355-360
Intolerant at the genus level works for me. Note name changes and combinations.
LF: Comment noted.

Ephemerella rows 361 364 & Serratella rows 365-368
Serratella tibialis is now Ephemerella tibialis. Combine.
Between the two genera, Ephemerella excrucians and Ephemerella tibialis are dominant in the region. Just in case, I would run these two taxa separately, at the species level. I don't think they will show a clear signal.

LF: We need to keep a consistent protocol for testing and apply it to all taxa, for this analysis we based the minimum of 25 sites on Utz et al. 2009.

Heptageniidae rows 371-384
Cinygmula, Epeorus, Ironodes, Rhithrogena coming out as intolerant at the genus level works for me. There are species of Rhithrogena that are tolerant, but may not be present in the region.
LF: Comment noted.

Note name changes.

Paraleptophlebia rows 385-389
See comments about species names and combinations on spreadsheet.
Basically there are only two names now:
Paraleptophlebia
Paraleptophlebia-tusked larvae
LF: Taxonomic ID issue.

Odonata rows 407-416
I'm surprised by the low number of sites and total bugs. Not enough to provide a signal, though I do think Octogomphus & Cordulegaster should be sensitive to urbanization. Octogomphus specularis is very common in western Oregon, why not in western Washington? For all the Gomphidae, there are 15 sites. Is that enough to show anything?

Capniidae, Kathroperla, Paraperla rows 417-419
Intolerant. Good, as expected.
LF: Comment noted.

Leuctridae rows 424-429
Moselia is intolerant as expected, but this is more of a cold water, higher elevation taxon. I would also try rolling all up to Leuctridae and see if it comes out as intolerant at the family level.
LF: Tested Leuctridae for ~100 sites, did not meet intolerant cut-off. Did not roll up all genera.

Nemouridae rows 430-439
Malenka appears to be tolerant? I would say it is.
Visoka cataractae is definitely intolerant, but is a higher elevation, cold water taxa, not found at enough sites.
Please run Zapada cinctipes, Zapada columbiana and Zapada Oregonensis Group separately. I feel real strongly about this. Z. Columbiana is definitely a higher elevation, cold water taxon. Z. cinctipes is a ubiguitous taxon that may pop out as tolerant. Z. Oregonensis Group may pop out as intolerant.

Z. columbiana, Z. frigida and Visoka cataractae are the three intolerant, cold water, higher elevation taxa. What if we combined these three and looked at the response?
LF: Need to be consistent with testing. Otherwise gets too hard to track and explain if we combine some species and not others within a genus.

Peltoperlidae rows 440-443
Yoraperla intolerant as aspected. Level of I.D. has been inconsistent. Combine under Yoraperla.
LF: Taxonomic ID issue.

Perlidae rows 444-451
Looks like perlids are intolerant to urbanization in general. I would agree. How about rolling up to the family level and see how the analysis turns out? Doroneuria is the cold water, higher elevation taxon. You classified Claassenia sabulosa as intolerant, even though it was found at only 4 sites. This is a riverine taxa, but is probably intolerant of urbanization, though not to warmer water temperatures.
LF: Claassenia should not have been classified as intolerant with only 4 sites. Corrected this.

Perlodidae rows 452-463
Combine Kogotus, Kogotus nonus, Rickera, Rickera sorpta under Kogotus/Rickera. These two genera are not easily separated and I.D,'s are suspect. That will give >25 sites for the combined names. The two genera are both cool/cold water taxa and may turn out to be intolerant. I think so.
LF: <25 sites in the testing data set which is smaller because not all sites in have land use data.

Isoperla is a huge genus occupying many lotic habitats. I'm not surprised there was no signal at the genus level

Skwala is ubiquitous and common in western North America in cool/warm streams.

Megarcys is a classic cold water taxon, and is widely distributed and common at higher elevations. I would be surprised to see it in Puget Sound Lowland streams <1500' elevation.

Analyze at family level also. Roll everything up to Perlodidae, and see if it gives a signal like Perlidae.
LF: tested for Perlodidae with >150 sites (without genera) and it was not significant.

Pteronarcyidae rows 464-469

Most of the I.D.'s are at the genus level, which is too bad. Pteronarcys californica is the downstream, lower elevation, warmer water species, and Pteronarcys princeps is found in cool/cold headwater streams at mid-high elevations. I'm surprised that Pteronarcys at the genus level did not show a stronger intolerant signal to urbanization. This is a large and long-lived taxa that I always thought was sensitive to human activities.

Pteronarcella is more common in basin/valley streams. Even though it only has 18 site occurrences, I would be interested to see if it is displaying any signal.

It would also be worth running the analysis at the family level. Pteronarcyidae are big time salmonid food items, and of great interest to fisherman.
LF: I also expected this taxon to be more sensitive. Perhaps this is where the large/rare search brings variability if we are looking harder in samples for certain taxa.

Taeniopterygidae rows 470-471
I'm really surprised that they occurred at only 7 sites in the whole data set. Much of that is due to the seasonal timing of sampling. Taeniopterygids aestivate as early instar larvae or eggs in the hyporheos and become surface active mid-late fall as water temperatures cool down. They grow over winter and emerge in the spring or early summer, depending on elevation and water temperature regimes. Most sampling is done in the summer months and won't pick them up. I would predict they are intolerant of urbanization, but they have to be excluded since we're just not censusing them.
LF: comment noted.

Apatania (Trichoptera) row 473
Yes, I think they are sensitive to urbanization. They sure showed a strong intolerant signal, however I'm curious about the distribution of the sites they were found out. Were they all clumped at higher elevations, or did they also occur in lowland streams?
LF: Sites were all <500m. We have data to cross-check exact elevation of these streams, would take some time.

Brachycentridae rows 475-483
No signal one way or another. I'm not surprised. Eobrachycentrus gelidae is a rare, higher elevation, cold water species (1 site). There are spring associated, cold water specie(s) in Micrasema, but we can't consistently separate those larvae out yet.
LF: comment noted.

Heteroplectron californicum row 484
I think this guy is intolerant of urbanization, but western WA is the northern limit of its range and it is not common enough there to pick up a signal.
LF: comment noted.

Glossosomatidae rows 485-489
Agapetus is uncommon in western WA and adults emerge in the spring. The summer is often spent in the egg stage, so summer sampling often doesn't census them.
Anagapetus is a small, cool/cold stream taxa that I consider to be intolerant. I think a lot of labs are missing these guys. Also, like Agapetus larvae may not be surface active in the summer when most sampling takes place.

Glossosoma: This is a big and common genus, with species spread up and down the longitudinal profile of river systems. I would not expect there to be a signal at the genus level.

Protoptila: A riverine taxon, uncommon in western WA.
LF: comment noted.

Goeridae rows 490-492
Goeracea is a spring and spring stream taxon not often sampled.
LF: comment noted.

Hydropsychidae rows 493-501
Arctopsyche: I'm not surprised it is intolerant of urbanization.

Cheumatopsyche: Coming out as Intolerant really surprises me. In the maritime NW it occurs primarily in lowland rivers and is quite tolerant of warmer water and nutrient enrichment. In more xeric regions it can be found in mid-order streams, often associated with heavy cattle grazing. I see it occasionally in western OR/WA in smaller streams with some kind of nutrient enrichment, or in lake outlet streams where plankton density is high. I would check the type of streams these records came from and see if that might have skewed the results.
LF: this taxon was one of the most highly intolerant, not found at any sites with >30% urbanization in the watershed.

Hydropsyche: This is a huge common genus with species spread all along the longitudinal profile of stream systems. Picking up a signal at the genus level is unlikely.

Parapsyche !!!!! Analysis at the genus level is a real problem here. We're dealing with two very common species that are like apples and oranges. P. elsis is a classic cold water taxon, found at mid-higher elevations, though may occur at lower elevations in spring streams. Parapsyche almota is found in small-mid size basin and valley streams and does appear to be quite tolerant of urbanization. I find it to be common in western OR/WA urban/suburban streams. These two species really need to be analyzed separately. You may not get an intolerant

signal with P. elsis (16 sites) because it is not typically found at lower elevations where most of the urbanization is.

There is a taxonomic problem here that I won't get into right now. People have been very inconsistent on I.D.'s. I think most of the I.D.'s for P. elsis and P. almota are OK. There's a large block left at genus (58) that are probably mostly P. almota, but we can't be sure. They should probably be discarded from the analysis.

LF: Changes made. P. elsis not marked at tolerant.

Hydroptilidae rows 502-506
Hydroptilidae sp. RAI #001 is a Rhithron designation for an unknown taxon and should not be combined with Hydrotilidae.
Looks like you classed all Hydroptilidae as tolerant based on the results from Hydroptila and Hydroptilidae. **I would not do this!!!** Hydroptila is by far the most common hydroptilid in the west. This is a huge genus and most species are tolerant. I would bet that most of the unidentified Hydroptilidae are Hydroptila, and that is why Hydroptilidae also came out as Tolerant. I would classify only Hydroptila as Tolerant. That's the only true evidence you have so far at the genus level, and not extend it to all Hydroptilidae. I think genera like Ochrotrichia and Agraylea may turn out to be moderately sensitive to urbanization once we have enough sites to work with.
I.D.'s to the family level, Hydroptilidae, are pretty meaningless for this analysis.

LF: Changes made. Only Hydroptila marked as tolerant.

Lepidostomatidae rows 507-512
Lepidostoma is a large genus. Some of the individual species, like L. hoodi and L. cascadense, are intolerant, but we don't have everyone on board yet to consistently identify those. After the caddis workshop in Feb. we will hopefully get better resolution in the genus (species and groups) and can rerun the analysis when a big enough data set is available with >genus level resolution. I think there will be some signals here.
LF: comment noted.

Leptoceridae rows 513-517
Lots of lentic, low gradient stream and riverine taxa in this family. They are just not common in western WA streams.
LF: comment noted.

Limnephilidae rows 518-538
This is a big family with lots of intolerant genera/species found in cold water and small stream habitats at mid-high elevations. There are also a lot of species found in pools or lentic habitats that are not picked up by targeted riffle sampling.

This all boils down to having only a few genera that are common in riffles in lowland streams.
LF: comment noted.

Dicosmoecus!!! This is another apples and oranges situation. D. atripes is a cold water taxon found at higher elevations. D. gilvipes is a large stream and riverine taxa found at low-mid elevations. I would run just Dicosmoecus gilvipes by itself. D. atripes (7 sites) is not typically found in lowland streams and should be ignored for now. I would reject the sites where there was only genus level identification.
Ecclisomyia: Intolerant as expected. This genus is very common in western WA, particularly at mid-high elevations, and is one of the few genera routinely picked up in riffle samples.
Onocosmoecus and Psychoglypha are also genera that are common and widespread in western WA and frequently picked up in benthic samples.

Also, roll up all into Limnephilidae and see what kind of signal that gives.
LF: Tested Limnephilidae without including genera and it was not significantly tolerant or intolerant for ~70 sites.

Philopotamidae rows 539-541
Dolophilodes is intolerant but is either in very small streams or springs at lower elevation, or in mid-high elevation streams.

Wormaldia: has a number of species spread up and down the longitudinal axis of stream systems. Some are tolerant, some intolerant. At the genus level, I wouldn't expect a strong signal.
LF: comment noted.

Polycentropodidae rows 544-546
I can see where Polycentropus is intolerant of urbanization. Larvae inhabitat open pores between cobble/gravel and are sensitive to embedding of substrates with fine sediment. The Polycentropodidae and Polycntropodinae are probably Polycentropus, but we can't be sure, so I would reject them.
LF: Agreed.

Psychomyia row 547
I'm surprised it was found at only 2 sites. They are common in western Oregon and probably sensitive to urbanization. Psychomyia is rare in general in western WA.
LF: comment noted.

Rhyacophila rows 548-572
This is such a big genus with species partitioned between many habitat types, that an analysis at the genus level will not show a clear signal. Please see the comments on names in the spreadsheet. There's lots of cleaning up and

combining to do. Some of the Rhyacophila taxa are just too rare in this data set to deal with, e.g. higher elevation, or spring/small stream groups like Oreta Group, Vofixa Group, and Rotunda Group.
LF: Reconsidering Rhyacophila at the sub genus level. The genus for this taxon is more like a family level designation.

Please analyze by the following! A few of the taxa are skinny on sites (<25), but I would like to see which way they lean.

Rhyacophila Angelita Group. Combine as follows, they are the same beast.
Rhyacophila angelita (2 sites)
Rhyacophila Angelita Group (15 sites)

Rhyacophila arnaudi (45 sites) analyze at the species level.

Rhyacophila Atrata Complex (new designation 2012). These are all the same beast. Combine as follows.
Rhyacophila pellisa (1 site)
Rhyacophila pellisa/valuma (12 sites)
Rhyacophila valuma (41 sites)

Rhyacophila Betteni Group. Combine as follows, they are the same beast.
Rhyacophila betteni (11 sites)
Rhyacophila Betteni Group (291 sites)

Rhyacophila blarina (133 sites) analyze at the species level.

Rhyacophila Brunnea/Vemna Group. Combine as follows, they are the same beast.
Rhyacophila brunnea (16 sites)
Rhyacophila Brunnea/Vemna Group (322 sites)
Rhyacophila Vemna Group (1 site)

Rhyacophila grandis (this is the only species in the Grandis Group in the region). Combine as follows. They are the same beast.
Rhyacophila grandis (18 sites)
Rhyacophila Grandis Group (7 sites)

Rhyacophila Hyalinata Group. Combine as flows, they are the same beast.
Rhyacophila hyalinata (1 site)
Rhyacophila Hyalinata Group (15 sites)

Rhyacophila malkini (13 sites) Not 25 sites but of interest to see if they lean towards tolerant.

Rhyacophila narvae (203 sites) analyze at species level.

Uenoidae rows 574-581
Farula, Neothremma and Oligophlebodes are mid-higher elevation or small stream taxa that are rare in the lowlands.
LF: comment noted.

Neophylax: I'm glad to see they come out as intolerant at the genus level, and that is all that's necessary, but I would be interested if there is a big difference if you analyzed N. rickeri and N. splendens separately. There are enough sites for both species. This is a sister species pair, where N. splendens is typically found in cooler, forested headwater streams, and N. rickeri in larger, more open, warmer streams.

Also analyze at the family level.
LF: To be consistent, we are setting criteria at genus level.

Amphipoda rows 583-592
It would be better if I.D.'s were consistently to genus, but we have to work with what we have. It looks like a large block were identified only to Amphipoda and that gave a tolerant signal, so you applied that to all Amphipoda. I would not do that. Most of what was called Amphipoda are probably Crangonyx.

The Anisogammaridae (Eogammarus & Ramellogammarus) and Americorophium are marine taxa that do penetrate up coastal streams and rivers. I would not designate them as tolerant without evidence.

Crangonyx is common and clearly tolerant by the analysis. This is more of a stream taxa.

Hyalella is very tolerant of warm water and low D.O. I'm surprised it was only found at 7 sites, but it is primarily a lentic and low gradient stream taxa.

Gammarus same as Hyalella. I would go ahead and analyze, even though there's only 19 sites.
LF: Changes made, these taxa not marked as tolerant.

Analyze all Amphipoda combined.

Crayfish rows 593-596
I think urbanization is hard on the native crayfish (Pacifasticus). If you combine P. leniusculus under Pacifasticus (same beast), that gives you 21 sites. I'd like to see how that turns out.
LF: <25 sites in the testing data set which is smaller because not all sites in have land use data.

Isopoda rows 597-600

Caeidotea, tolerant, definitely.
Gnorimosphaeroma is a marine taxa that may appear at the mouth of streams flowing into Puget Sound. I would ignore.
LF: marine taxon noted.

Copepoda row 601
Most labs reject these from benthic sample analysis, including me. Most of the copepods are water column taxa. The Harpacticoida are more benthic related, but they are so small that most pass through 500 micron sieves. Please reject.
LF: Comment noted.

Hydra rows 603-604
Hydra and Hydrozoa are the same beast, or should be. I call them all Hydra. Strange that Hydozoa turned out as tolerant and Hydra alone did not. I wonder if there is mis-identification going on with Hydrozoa. I consider Hydra to be tolerant. Try combining the two and analyzing.

LF: not tolerant when combined.

Mussels row 605-607
Margaritifera falcata: Historically much more common in lowland streams. I think they are very sensitive to urbanization and that's why they've only been found at 9 sites. This is probably a good illustration of a sensitive taxon being left out of the analysis because it has been extirpated from so many stream systems you can't get enough sites with the criteria you've set.

Sphaeriidae (fingernail or pea clams) rows 608-611
Here's some history. For quite a while all these taxa were included under Sphaeriidae. Then one authority divided them into two families Pisidiidae (with Pisidium) and Sphaeriidae (with Sphaerium and other genera). Not everyone was happy with this division and many converted back to just Sphaeriidae. These transitions happened during the period the PSSB data was/is being collected. If something was identified as Pisidium or Pisidiidae, they're probably all Pisidium. Sphaeriidae with the most sites could be anything, but probably mostly Pisidium. It's interesting that Pisidium came out as tolerant, but I would roll everything up to the family level, Sphaeriidae (including Pisidium and Pisidiidae) and reanalyze. Almost all of these will be Pisidium, since other genera are rare in Puget Sound Lowland streams.

LF: Combine and rerun – they are the same organism.

Ferrissia rows 614-615
This genus has been recently transferred to the family Planorbidae. I'm pretty sure the I.D.'s under Ancylidae are Ferrissia. Combine these with Ferrissia and reanalyze.
LF: Not significantly tolerant or intolerant.

Lymnaeidae rows 616-619
Roll up to family level and reanalyze. That will give you 25 sites (Fossaria, Lymnaea, Stagnicola, Lymnaeidae).
LF: Consistent selection criteria used with genus level testing, not rolling to family.

Physidae rows 620-621
They're all Physa. Combine and reanalyze.
LF: Changed to mark all as tolerant.

Planorbidae rows 622-625 (sensu lato, meaning latter sense, since Ferrissia has recently been included under the Planorbidae)
I don't think identifications in this family have been accurate and consistent. I'm very suspicious of all those Promenetus I.D.'s. I think most are Menetus. Menetus is at row 304 on your list, mistakenly put under Diptera. I would roll up to family level and reanalyze. They're all pretty tolerant taxa. Menetus+Gyraulus+Helisoma+Promenetus+Planorbidae.
LF: When Planorbidae (without genera included) was tested at family level it was not significantly tolerant or intolerant. Menetus and Promenetus were designated as tolerant.

Juga row 630
I'm surprised it hasn't been found at more sites. This snail is very tolerant and very common in western Oregon and into SW WA, but seems to fade out going north into the Puget Sound area.

Comment noted.

Turbellaria rows 636-639
The only safe level of I.D. is Turbellaria. I'm really suspicious of all those Polycelis coronata I.D.'s. Are these all coming from one lab? This is an alpine/subalpine, very cold water associated taxa. Combine all under Turbellaria and reanalyze.
LF: Neither Polycelis or Turbellaria were significantly tolerant or intolerant.