

Predator Feeding Group Attribute List:
Documentation of methods for deriving the list

Robert Wisseman, Aquatic Biology Associates, Inc., June 13, 2012

Karr's Benthic Index of Biotic Integrity (BIBI) for benthic macroinvertebrates uses the percent of the benthic community that are predators as one of 10 metrics to evaluate the biological integrity of streams (<http://www.pugetsoundstreambenthos.org/>). For the second iteration of this index for Puget Sound Lowland streams, the classification of predators is being updated and refined.

Gut content analysis reveals that many aquatic invertebrates are omnivorous (Merritt et al. 2008). Larvae grazing algae from hard surfaces or consuming leaf detritus ingest a mix of algae, small animals, fungi, bacteria, and coarse and fine particulate detritus, a veritable stew. The application of an herbivore, carnivore, detritivore trophic level classification used in marine communities for example (Lindeman 1942) does not readily translate to feeding ecology and energy transfer studies in freshwater ecosystems. Cummins and Klug (1979) proposed the use of a functional feeding group (FFG) approach for freshwater invertebrates that focuses on morphological and behavioral mechanisms by which invertebrates acquire food. Merritt et al. (2008) further refined functional feeding group definitions and compiled designations for North American freshwater insects. Functional feeding categories are:

- Shredders** Chewers of coarse detritus (leaf, needle, or wood) or chewers or miners of aquatic macrophytes.
- Collectors** Filterers of fine particulate organic matter (FPOM) from the water column, or gatherers of FPOM from within or on the surface of stream sediments.
- Scrapers** Graze periphyton by scraping hard mineral or wood surfaces.
- Macrophyte piercers** Utilize specialized mouth parts to pierce the tissue of aquatic macrophytes and filamentous algae to feed on cell contents.
- Parasites** Feed on living animal tissue either as internal or external parasites.
- Predators** Carnivores that attack and engulf animal prey or pierce prey tissue and suck fluids.

In the development of the original Karr BIBI, Fore, Karr et al. examined the relation between human disturbance and functional feeding groups in Puget Sound Lowland streams. A strong negative correlation was found between human disturbance as measured by percent impervious area in the watershed and the percentage dominance of the benthic community by predators. Predator dominance declined with increasing levels of human disturbance. Davis et al. (2010) found that nutrient enrichment in forested streams in the Appalachian Mountains also had a negative impact on predator production.

After a decade or more of benthic biomonitoring studies conducted throughout the Puget Sound Lowland region, we are reviewing here the original Karr BIBI metrics and updating the predator (yes or no) status of the commonly encountered taxa. For aquatic insects, tables compiled for each order in Merritt et al. (2008) is our major source of information. Feeding ecology information summarized in Pennak (1989) and Thorp and Covich (2001) was consulted for non-insect groups. Most stream invertebrate predators are obligate in their predation habits, consuming little else besides animal tissue. Some taxa are facultative predators. For these we relied on any published literature on their feeding ecology and best professional judgment to designate as a predator or not.

Major differences between the predator classification used in the original Karr BIBI and this updated version are:

Turbellaria (flatworms): Predator (yes). Pennak (1989) states that the vast majority of flatworms feed primarily on small, living invertebrates. We classify them as predators.

Brachycera (Diptera: higher fly larvae): Predator (yes). Miscellaneous specimens identified at this higher level are now classed as predators, since aquatic larvae of most of the families that may be involved are obligate predators.

Ceratopogoninae (no-see-um midges): Predator (yes). Aquatic larvae in this subfamily are primarily obligate predators (Merritt et al 2008).

Forcipomyiinae (no-see-um midges): Predator (no). Aquatic larvae of this subfamily are primarily collector-gatherers (Merritt et al. 2008).

Tanypodinae (midges): Predator (yes, all genera). Aquatic larvae of this subfamily are primarily predators (Merritt et al 2008). Some genera of Tanypodinae were designated as predator (no) in the original Karr BIBI.

Chelifera/Metachela (Diptera: Empididae), **Limnophila & Palaria** (Diptera: Tipulidae), **Drunella grandis/spinifera** (Ephemeroptera: Ephemerellidae), **Kogotus/Rickera** (Plecoptera: Perlodidae), and **Oecetis** (Trichoptera: Leptoceridae) were not designated as predators in the original Karr BIBI, but are so here.

The revised list of predators for Puget Sound Lowland streams subtracts only a few taxa originally classified as predators, and adds some groups that can be common to abundant in samples (e.g. Turbellaria).

References

- Cummins, K.W. and M.J. Klug 1979.** Feeding ecology of stream invertebrates. *Annual Review of Ecology and Systematics* 10: 147-172.
- Cummins, K.W., R.W. Merritt and P.C.N. Andrade 2005.** The use of invertebrate functional feeding groups to characterize ecosystem attributes in selected streams and rivers in south Brazil. *Studies on Neotropical Fauna and Environment* 40: 69-89.
- Davis, J.M., A.D. Rosemond, S.L. Eggert, W.F. Cross and J.B. Wallace 2010.** Long-term nutrient enrichment decouples predator and prey production. *Proceedings of the National Academy of Sciences*
www.pnas.org/cgi/doi/10.1073/pnas.0908497107.
- Lindeman, R.L. 1942.** The trophic-dynamic aspect of ecology. *Ecology* 23: 399-418.
- Merritt, Richard W., Kenneth W. Cummins & Martin B. Berg (editors) 2008.** An Introduction to the Aquatic Insects of North America. Kendall/Hunt Publishing Company, Dubuque, Iowa, 1158 pages.
- Pennak, Robert W. 1989.** Fresh-Water Invertebrates of the United States: Protozoa to Mollusca. Third Edition. John Wiley & Sons, Inc., New York. 628 pages.
- Thorp, James H. and Alan P. Covich (editors) 2001.** Ecology and Classification of North American Freshwater Invertebrates. Second Edition. Academic Press, New York, 1056 pages.