Package 'MacroZooBenthosWaterA'

January 20, 2025

Type Package

Title Fresh Water Quality Analysis Based on Macrozoobenthos

Version 0.1.0

Description Includes functions for calculating basic indices of macrozoobenthos for water quality and is designed to provide researchers and environmental professionals with a comprehensive tool for evaluating the ecological health of aquatic ecosystems.The package is based on the following references: Paisley, M. F., Trigg, D. J. and Walley, W. J. (2014)<doi:10.1002/rra.2686>. Arslan, N., Salur, A., Kalyoncu, H. et al.(2016) <doi:10.1515/biolog-2016-0005>. Hilsenhoff W.L. (1987). Hilsenhoff. W.L. (1988) Barbour, M.T., Gerritsen, J., Snyder, B.D., and Stribling, J.B. (1999).

License GPL (>= 3)

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Repository CRAN

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Contents

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calculate_ASPT	*The Average Score Per Taxon (ASPT) represents the average tolerance score of all taxa within the community, and is calculated by dividing the BMWP by the number of families/taxa represented in the sample.*

Description

The Average Score Per Taxon (ASPT) represents the average tolerance score of all taxa within the community, and is calculated by dividing the BMWP by the number of families/taxa represented in the sample.

Usage

```
calculate_ASPT(
  dataset,
  Site = "Site",
  tolerances = list(Siphlonuridae = 10, Heptageniidae = 10, Leptophlebiidae = 10,
   Ephemerellidae = 10, Potamanthidae = 10, Ephemeridae = 10, Taeniopterygidae = 10,
   Leuctridae = 10, Capniidae = 10, Perlodidae = 10, Perlidae = 10, Chloroperlidae = 10,
     Aphelocheridae = 10, Phryganeidae = 10, Molannidae = 10, Beraeidae = 10,
     Odontoceridae = 10, Leptoceridae = 10, Goeridae = 10, Lepidostomatidae = 10,
   Brachycentridae = 10, Sericostomatidae = 10, Astacidae = 8, Lestidae = 8, Agriidae =
     8, Gomphidae = 8, Cordulegasteridae = 8,
       Aeshnidae = 8, Corduliidae = 8,
   Libellulidae = 8, Caenidae = 7, Nemouridae = 7, Rhyacophilidae = 7, Polycentropodidae
   = 7, Limnephilidae = 7, Neritidae = 6, Viviparidae = 6, Ancylidae = 6, Hydroptilidae
     = 6, Unionidae = 6, Platycnemididae = 6, Coenagriidae = 6, Mesoveliidae = 5,
    Hydrometridae = 5, Gerridae = 5, Nepidae = 5, Naucoridae = 5, Notonectidae = 5,
     Pleidae = 5, Corixidae = 5, Haliplidae = 5, Hygrobiidae = 5, Dytiscidae = 5,
      Gyrinidae = 5, Hydrophilidae = 5, Clambidae = 5, Helodidae = 5,
        Dryopidae = 5,
    Elmidae = 5, Chrysomelidae = 5, Curculionidae = 5, Hydropsychidae = 5, Tipulidae = 5,
    Simuliidae = 5, Planariidae = 5, Dendrocoelidae = 5, Baetidae = 4, Sialidae = 4,
    Piscicolidae = 4, Valvatidae = 3, Hydrobiidae = 3, Lymnaeidae = 3, Physidae = 3,
    Planorbidae = 3, Sphaeriidae = 3, Glossiphoniidae = 3, Hirudidae = 3, Erpobdellidae =
       3, Asellidae = 3, Chironomidae = 2, Oligochaeta = 1, Cypermethrin = 0),
    print_results = TRUE
)
```

Arguments

dataset	data must have Family and Site
Site	Site should given as default to your data
tolerances	this parameter is given by default
print_results	A logical value that determines whether or not to print the results. Defaults to TRUE.

Value

will give values of ASPT index from 0-10 and Pollution degree for each site

References

Paisley M.F., Trigg D.J. & Walley W.J. 2013. Revision of the Biological Monitoring Working Party (BMWP) Score System: Derivation of present-only and abundance-related scores from field data. River Res. Appl. 30 (7): 887–904. DOI: 10.1002/rra.2686

Zeybek M., Kalyoncu H., Karakaş B. & Özgül S. 2014. The use of BMWP and ASPT indices for evaluation of water quality according to macroinvertebrates in Değirmendere Stream (Isparta, Turkey). Turk. J. Zool. 38: 603–613. DOI: 10.3906/zoo-1310-9

Arslan, N., Salur, A., Kalyoncu, H. et al. The use of BMWP and ASPT indices for evaluation of water quality according to macroinvertebrates in Küçük Menderes River (Turkey). Biologia 71, 49–57 (2016). https://doi.org/10.1515/biolog-2016-0005

Biological Monitoring Working Party Final Report: Assessment and Presentation of Biological Quality of Rivers in Great Britain. December 1978, Department of the Environment, Water Data Unit (1978), p. 37

L. Li, B. Zheng, L. Liu Biomonitoring and bioindicators used for river ecosystems: definitions, approaches and trends Procedia Environ. Sci., 2 (2010), pp. 1510-1524, 10.1016/j.proenv.2010.10.164

National Water Council River Quality: the 1981 Survey and Future Outlook National Water Council, London, UK (1981), p. 39

J. Alba-Tercedor Macroinvertebrados acuáticos y calidad de las aguas de los ríos. IV Simposio del agua en Andalucía (SIAGA) Almería, 2 (1996), pp. 203-231

S. Guareschi, A. Laini, M.M. Sánchez-Montoya How do low-abundance taxa affect river biomonitoring? Exploring the response of different macroinvertebrate-based indices J. Limnol., 76 (s1) (2017), pp. 9-20, 10.4081/jlimnol.2016.1516

S.E. Mustow Biological monitoring of rivers in Thailand: use and adaptation of the BMWP Score Hydrobiologia, 479 (2002), pp. 199-229

Examples

```
Site <- c("L1", "L2", "L2")
Family <- c("Capniidae", "Aeshnidae", "Chloroperlidae")
test <- data.frame(Family, Site)
calculate_ASPT(test)
```

---

calculate_BMWP	*The Biological Monitoring Working Party score (BMWP) This index provides single values, at the family level (with exception of Oligochaete which is to the order level), representative of the organisms' tolerance to pollution.*

Description

The Biological Monitoring Working Party score (BMWP) This index provides single values, at the family level (with exception of Oligochaete which is to the order level), representative of the organisms' tolerance to pollution.

Usage

```
calculate_BMWP(
  dataset,
  Site = "Site",
  tolerances = list(Siphlonuridae = 10, Heptageniidae = 10, Leptophlebiidae = 10,
   Ephemerellidae = 10, Potamanthidae = 10, Ephemeridae = 10, Taeniopterygidae = 10,
   Leuctridae = 10, Capniidae = 10, Perlodidae = 10, Perlidae = 10, Chloroperlidae = 10,
    Aphelocheridae = 10, Phryganeidae = 10, Molannidae = 10, Beraeidae = 10,
    Odontoceridae = 10, Leptoceridae = 10, Goeridae = 10, Lepidostomatidae = 10,
   Brachycentridae = 10, Sericostomatidae = 10, Astacidae = 8, Lestidae = 8, Agriidae =
    8, Gomphidae = 8, Cordulegasteridae = 8,
     Aeshnidae = 8, Corduliidae = 8,
   Libellulidae = 8, Caenidae = 7, Nemouridae = 7, Rhyacophilidae = 7, Polycentropodidae
   = 7, Limnephilidae = 7, Neritidae = 6, Viviparidae = 6, Ancylidae = 6, Hydroptilidae
    = 6, Unionidae = 6, Platycnemididae = 6, Coenagriidae = 6, Mesoveliidae = 5,
   Hydrometridae = 5, Gerridae = 5, Nepidae = 5, Naucoridae = 5, Notonectidae = 5,
    Pleidae = 5, Corixidae = 5, Haliplidae = 5, Hygrobiidae = 5, Dytiscidae = 5,
    Gyrinidae = 5, Hydrophilidae = 5, Clambidae = 5, Helodidae = 5,
     Dryopidae = 5,
   Elmidae = 5, Chrysomelidae = 5, Curculionidae = 5, Hydropsychidae = 5, Tipulidae = 5,
   Simuliidae = 5, Planariidae = 5, Dendrocoelidae = 5, Baetidae = 4, Sialidae = 4,
   Piscicolidae = 4, Valvatidae = 3, Hydrobiidae = 3, Lymnaeidae = 3, Physidae = 3,
   Planorbidae = 3, Sphaeriidae = 3, Glossiphoniidae = 3, Hirudidae = 3, Erpobdellidae =
    3, Asellidae = 3, Chironomidae = 2, Oligochaeta = 1, Cypermethrin = 0),
  print_results = TRUE
)
```

Arguments

dataset	Data set must have predefined column names: Family and Site
Site	Site should given as default to your data
tolerances	tolerance value are given by default
print_results	A logical value that determines whether or not to print the results. Defaults to TRUE.

Value

will give values from 0-100 of BMWP index, Water Quality and Level of Pollution for each Site

References

Paisley M.F., Trigg D.J. & Walley W.J. 2013. Revision of the Biological Monitoring Working Party (BMWP) Score System: Derivation of present-only and abundance-related scores from field data. River Res. Appl. 30 (7): 887–904. DOI: 10.1002/rra.2686

Zeybek M., Kalyoncu H., Karakaş B. & Özgül S. 2014. The use of BMWP and ASPT indices for evaluation of water quality according to macroinvertebrates in Değirmendere Stream (Isparta, Turkey). Turk. J. Zool. 38: 603–613. DOI: 10.3906/zoo-1310-9

Arslan, N., Salur, A., Kalyoncu, H. et al. The use of BMWP and ASPT indices for evaluation of water quality according to macroinvertebrates in Küçük Menderes River (Turkey). Biologia 71, 49–57 (2016). https://doi.org/10.1515/biolog-2016-0005

Biological Monitoring Working Party Final Report: Assessment and Presentation of Biological Quality of Rivers in Great Britain. December 1978, Department of the Environment, Water Data Unit (1978), p. 37

L. Li, B. Zheng, L. Liu Biomonitoring and bioindicators used for river ecosystems: definitions, approaches and trends Procedia Environ. Sci., 2 (2010), pp. 1510-1524, 10.1016/j.proenv.2010.10.164

National Water Council River Quality: the 1981 Survey and Future Outlook National Water Council, London, UK (1981), p. 39

J. Alba-Tercedor Macroinvertebrados acuáticos y calidad de las aguas de los ríos. IV Simposio del agua en Andalucía (SIAGA) Almería, 2 (1996), pp. 203-231

S. Guareschi, A. Laini, M.M. Sánchez-Montoya How do low-abundance taxa affect river biomonitoring? Exploring the response of different macroinvertebrate-based indices J. Limnol., 76 (s1) (2017), pp. 9-20, 10.4081/jlimnol.2016.1516

S.E. Mustow Biological monitoring of rivers in Thailand: use and adaptation of the BMWP Score Hydrobiologia, 479 (2002), pp. 199-229

Examples

```
Site= c("L1", "L2", "L2")
Family=c("Capniidae",  "Aeshnidae", "Chloroperlidae")
test <- data.frame( Family, Site)
calculate_BMWP(test)
```

---

calculate_EPT	*This index is calculated based on the number of families belonging to three macroinvertebrate orders: Ephemeroptera, Plecoptera and Trichoptera.*

Description

This index is calculated based on the number of families belonging to three macroinvertebrate orders: Ephemeroptera, Plecoptera and Trichoptera.

Usage

```
calculate_EPT(
  dataset,
 EPT_families = c("Ameletidae", "Ametropodidae", "Ameletopsidae", "Arthropleidae",
   "Acanthametropodidae", "Baetidae", "Baetiscidae", "Behningiidae", "Caenidae",
   "Coloburiscidae", "Ephemerellidae", "Ephemeridae", "Heptageniidae", "Isonychiidae",
    "Leptophlebiidae", "Leptohyphidae", "Metretopodidae", "Neoephemeridae",
    "Oligoneuriidae", "Palingeniidae", "Prosopistomatidae", "Polymitarcyidae",
    "Potamanthidae", "Siphlonuridae", "Tricorythidae", "Oniscigastridae",
    "Austroperlidae", "Capniidae", "Chloroperlidae", "Diamphipnoidae",

   "Eustheniidae", "Gripopterygidae", "Leuctridae", "Nemouridae", "Notonemouridae",
   "Peltoperlidae", "Perlidae", "Perlodidae", "Pteronarcyidae", "Taeniopterygidae",
    "Styloperlidae", "Anomalopsychidae", "Antipodoeciidae", "Apataniidae",
    "Arctopsychidae", "Atriplectididae", "Beraeidae", "Brachycentridae",
   "Calamoceratidae", "Chathamiidae", "Dipseudopsidae", "Ecnomidae", "Glossosomatidae",
   "Goeridae", "Helicopsychidae", "Hydrobiosidae", "Hydropsychidae", "Hydroptilidae",
    "Kalophryganeidae", "Kokiriidae",
      "Lepidostomatidae", "Leptoceridae",
   "Limnephilidae", "Molannidae", "Odontoceridae", "Oeconesidae", "Philopotamidae",
    "Philorheithridae", "Phryganeidae", "Polycentropodidae", "Psychomyiidae",
    "Pisuliidae", "Plectrotarsidae", "Rhyacophilidae", "Stenopsychidae",
    "Sericostomatidae", "Tasimiidae", "Uenoidae", "Xiphocentronidae"),
  print_results = TRUE
)
```

Arguments

dataset	Data set must have predefined column names: Family, Abundace and Site
EPT_families	families that belong to EPT are given by default
print_results	A logical value that determines whether or not to print the results. Defaults to TRUE.

Value

values from 0-10,

References

Hilsenhoff, W.L. 1987. An Improved Biotic Index of Organic Stream Pollution. Michigan Ento-mology Society. 20(11):9-13

Lenat, D.R. 1988. Water quality assessment using a qualitative collection method for benthic macroinvertebrates. J.N. Am. Benthological Soc. 7: 222-233.

MacDonald, D.D., Ingersoll, C.G., and Berger, T.A., 2000, Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems: Archives of Environmental Contam-ination and Toxicology, v. 39, p. 20-31.

Weber, C.I., ed., 1973, Biological field and laboratory methods for measuring the quality of surface waters and effluents: Cincinnati, Ohio, U.S. Environmental Protection Agency, EPA-670/4-73-001.

Lenat DR, Penrose DL. History of the EPT taxa richness metric. Bulletin North American Benthological Society. 1996;12:279–290. https://doi.org/10.2307/1467463.

Examples

```
Site= c("L1", "L2", "L2")
Family=c("Capniidae",  "Aeshnidae", "Chloroperlidae")
test <- data.frame( Family, Site)
calculate_EPT(test)
```

---

calculate_FBI	*Assigned tolerancevalues range from 0 to 10 for families and increase as water quality decreases*

Description

Assigned tolerancevalues range from 0 to 10 for families and increase as water quality decreases

Usage

```
calculate_FBI(
  data,
 tolerances = list(Capniidae = 1, Aeshnidae = 3, Chloroperlidae = 1, Calopterygidae = 5,
  Leuctridae = 0, Coenagrionidae = 9, Nemouridae = 2, Cordulegastridae = 3, Perlidae =
  1, Corduliidae = 5, Perlodidae = 2, Gomphidae = 1, Pteronarcyidae = 0, Lestidae = 9,
  Taeniopterygidae = 2, Libellulidae = 9, Macromiidae = 3, Baetidae = 4, Baetiscidae =
   3, Athericidae = 2, Caenidae = 7, Blephariceridae = 0, Ephemerellidae = 1,
  Ceratopogonidae = 6, Ephemeridae = 4, Chironomidae_red = 8, Heptageniidae = 4,
   Chironomidae_other = 6,
    Leptophlebiidae = 2, Dolichopodidae = 4, Metrtopodidae
   = 2, Empididae = 6, Oligoneuriidae = 2, Ephydridae = 6, Polymitarcyidae = 2,
  Psychodidae = 10, Potamanthidae = 4, Simuliidae = 6, Siphlonuridae = 7, Muscidae = 6,
  Tricorythidae = 4, Syrphidae = 10, Tabanidae = 6, Pyralidae = 5, Tipulidae = 3,
  Brachycentridae = 1, Dryopidae = 5, Calamoceratidae = 3, Elmidae = 4, Glossosomatidae
   = 1, Psephenidae = 4, Helicopsychidae = 3, Hydropsychidae = 4, Gammaridae = 4,
   Hidroptilidae = 4, Hyalellidae = 8,
    Lepidostomatidae = 1, Leptoceridae = 4,
  Asellidae = 8, Limnephilidae = 4, Molannidae = 6, Odontoceridae = 0, Astacidae = 6,
  Philopotamidae = 3, Phryganeidae = 4, Lymnaeidae = 6, Polycentropodidae = 6, Physidae
  = 8, Psychomyiidae = 2, Rhyacophilidae = 0, Pisidiidae = 8, Sericostomatidae = 3,
  Oligochaeta = 8, Uenoidae = 3, Hirudinea = 10, Turbellaria = 4, Corydalidae = 0,
  Sialidae = 4, Ameletidae = 0, Baetiscidae = 4, Isonychiidae = 2, Leptohyphidae = 4,
   Metretopodidae = 2, Potomanthidae = 4, Peltoperlidae = 0,
    Corixidae = 5,
   Apataniidae = 3, Dipseudopsidae = 5, Goeridae = 3, Curculionidae = 5, Dytiscidae = 5,
```

```
      Gyrinidae = 4, Haliplidae = 5, Hydrophilidae = 5, Ptilodactylidae = 3, Scirtidae = 5,
      Sisyridae_Climacia_sp = 5, Anthomyiidae = 6, Chaoboridae = 8, Culicidae = 8, Dixidae
      = 1, Ptychopteridae = 1, Scathophagidae = 6, Stratiomyidae = 7, Tanyderidae = 3,
      Arrenuridae = 6, Lebertiidae = 6, Atractideidae = 6, Mideopsidae = 6, Tyrellidae = 6,
       Limnesidae = 6, Limnocharidae = 6, Sperchonidae = 6, Unionicolidae = 6,

      Polydesmida = 6, Anthuridae = 5, Idoteidae = 5, Crangonyctidae = 6, Oedicerotidae =
       5, Talitridae_Hyalellidae = 8, Acariformes = 4, Ostracoda = 8, Planorbidae = 7,
      Ancylidae = 6, Viviparidae = 6, Pleuroceridae = 6, Bithyniidae = 8, Hydrobiidae = 6,
       Valvatidae = 8, Pelecypoda_Bivalvia = 8, Unionidae = 6, Corbiculidae = 6,
      Dreisseniidae = 8, Sphaeriidae = 6, Pisidiidae = 8, Haplotaxidae = 5, Lumbricida = 6,
       Lumbriculidae = 5, Enchytraeidae = 10, Tubificidae = 9, Naididae = 8,
       Glossiphoniidae_Helobdella = 6,
        Glossiphoniidae_other = 8, Aeolosomatidae = 8,
       Branchiobdellidae = 6, Sabellidae = 6, Platyhelminthidae = 4),
    print_results = TRUE
)
```

Arguments

data	For the families that we have given the value for particular genera and you should add data like this : Sisyridae_Climacia_sp Talitridae_Hyalellidae, Pelecypoda_Bivalvia, Glossiphoniidae_Helobdella,Glossiphoniidae_other Chironomidae_red, Chironomidae_other
tolerances	tolerance value are given by default
print_results	A logical value that determines whether or not to print the results. Defaults to TRUE.

Value

will give values from 0-10

References

1. Hilsenhoff, W.L. 1988. Rapid field assessment of organic pollution with a family- level biotic index. J. N. Am. Benthol. Soc. 7(1):65-68. Barbour, M.T., Gerritsen, J., Snyder,

2. Bode, R.W., Novak, M.A., and Abele, L.E. 1996. Quality Assurance Work Plan for Biological Stream Monitoring in New York State. NYS Department of Environmental Conservation, Albany, NY. 89p. 4 appendices.

3. Bode, R.W., Novak, M.A., Abele, L.E., Heitzman, D.L., and Smith, A.J. 2002. Quality Assurance Work Plan for Biological Stream Monitoring in New York State. NYS Department of Environmental Conservation, Albany, NY. 115p

4. Hauer, F.R., Lamberti, G.A. (eds.) 1996. Methods in Stream Ecology. Academic Press. ISBN: 0-12-332906-X. 696pp.

5.B.D., Stribling, J.B. 1999.Rapid BioassessmentProtocols For Use in Streams and Wadeable Rivers:Periphyton, BenthicMacroinvertebrates, and Fish. Second Edition. EPA 841-B-99-002. Washington, D.C. xiv, 11chapters,

6. Plafkin, J.L. , Barbour, M.T., Porter, K.D., Gross, S.K., and Hughes, R.M.. 1989. Rapid Bioassessment Protocols for use in Streams and Rivers: Benthic Macroinvertebrates and Fish. U.S. Environmental Protection Agency. EPA 440/4- 89/001. 8 chapters, Appendices A-D.

Examples

```
Site= c("L1", "L2", "L2")
Family=c("Capniidae",  "Aeshnidae", "Chloroperlidae")
Abundance=c(4,2,15)
test <- data.frame( Family, Abundance, Site)
calculate_FBI(test)
```

---

calculate_SWRC   *SWRC - Biotic index (Stroud Water Research Centre - Biotic index)*

Description

SWRC - Biotic index (Stroud Water Research Centre - Biotic index)

Usage

```
calculate_SWRC(
  data,
 tolerances = list(Trichoptera_Hydropsychidae = 2.8, Trichoptera = 5, Plecoptera = 1,
    Ephemeroptera = 3.6, Diptera_Athericidae = 2, Diptera_Chironomidae_white = 6,
   Diptera_Chironomidae_red = 8, Diptera_Tipulidae = 3, Diptera_other = 6, Amphipoda =
   6, Gastropoda = 7, Oligochaeta = 8, Hirudinea = 8, Coleoptera = 4.6, Mollusca = 7,
   Nematoda = 8, Coleoptera = 4.6, Megaloptera = 3, Odonata_Zygoptera = 7, Isopda = 8,
    Decapoda = 5, Hemiptera = 0),
  print_results = TRUE
)
```

Arguments

data	A data frame with predefined column names: Family, Abundance and Site. The dataset should be at the order level. If the family is not at the order level, it should be linked with an underscore (e.g., Trichoptera_Hydropsychidae).
tolerances	Tolerance values are given by default.
print_results	A logical value that determines whether or not to print the results. Defaults to TRUE.

Value

A data frame with two columns: SWRC Index (0-10) and Water Quality for each site.

References

Schmiedt, K., Jones, R. L., Brill, I. & Pikal, W. (1998). EPT (Epheromeraptera, Plecoptera and Trichoptera) Family Richness Modified Biotic Index. SWRC – Stroud Water Research Centre (2023). Leaf Pack Network: Watersheds. Available from: www.stroudcenter.org/lpn/more/data. SWRC (STROUD WATER RESEARCH CENTER) (2003). Water quality monitoring in the source water areas for New York City: an integrative approach. A report on the first phase of monitoring. Stroud Water Research Center, Avondale, PA, U.S.A.

Examples

```
Site= c("L1", "L2", "L2")
Family=c("Capniidae",  "Aeshnidae", "Chloroperlidae")
Abundance=c(4,2,15)
test <- data.frame( Family, Abundance, Site)
calculate_SWRC(test)
```

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