Aquatic Insects for Biomonitoring Freshwater Ecosystems- A Methodology Manual

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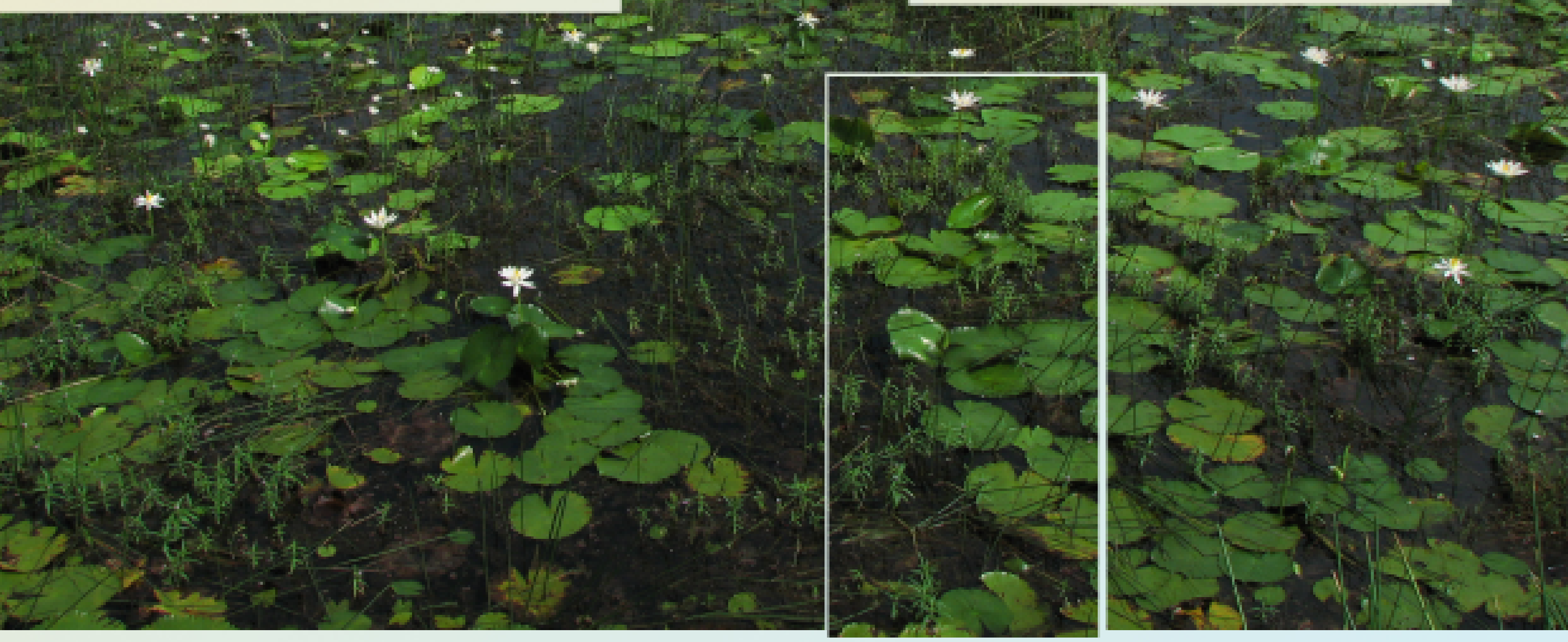

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Table of Contents

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1. Introduction

Around the world, freshwater habitats are being subjected to increased levels of human disturbance (Saunders *et al.,* 2002). A recent assessment of the status of inland water ecosystems shows that globally most threatened river catchments are to be found in the Indian subcontinent (WCMC, 2000). A study based on 195 animal species of inland water ecosystems indicates that on average monitored populations have declined by 54% during 1970-2000. This compares with a decline over the same period of some 35% in 217 marine and coastal species, 15% in 282 terrestrial species. Though, not conclusive, these provide strong indications that inland water ecosystems are suffering the greatest negative impact from human activities at present (WWF 2002 & WCMC, 2000). In this juncture, it is imperative to identify, monitor and conserve important areas biodiversity especially of the riverine ecosystems (Dudgeon, 1994).

Dudgeon *et al.,* (1994, 2000) stresses the importance of biomonitoring and identifying areas of riverine biodiversity for long term conservation. Biological assessment of the freshwater habitats aims at characterizing and monitoring the conditions of the aquatic resources (Sivaramakrishnan, *et al.,* 1996a). The assessments are commonly associated with human impact (Resh, *et al.,* 1995). The use of living organism for monitoring water quality originated in Europe early in this century and it is widely used (Cairns and Pratt, 1993; Metcalfe-Smith, 1994). A spectrum of biological communities including plankton, periphyton, microphytobenthos, macrozoobenthos, aquatic macrophytes and fish has been used in the assessment of the water quality (De Pauw *et al.,* 1992). However, experiences from USA and European programmes have demonstrated that benthic macroinvertebrates are most useful in monitoring freshwater ecosystems (De Pauw *et al.,* 1992; Hellawell, 1986; Rosenberg and Resh, 1993).

1.1. Assumptions: Biological assessment methods using macroinvertebrates are based on the assumptions that with increasing pollution, change will occur in

(1) the species present (e.g., appearance of tolerant species)

(2) the number of species and

(3) change in abundance of species.

Anisocentropus and *Chironomus* are indicators of unpolluted and polluted waters respectively.

1. 2.Advantages: Current monitoring techniques detect one or more of these changes to identify water quality problems at a site (Sivaramakrishnan *et al.,* 1996a). Traditionally, qualitative and quantitative approaches are employed for biomonitoring of freshwater ecosystems. The analytical methods used for quantitative biomonitoring methods require replicate sampling. The problem with this approach is only few sites can be sampled and most of the time will be expended on identification of the whole sample (Sivaramakrishnan *et al.,* 1996). In contrast, the qualitative sampling requires only few samples from a site and various measures (or metrics) are easily calculated (Resh and Jackson, 1993; Metcalfe-Smith, 1994). The level of impairment is estimated by comparing the deviation of the test site values from the reference site (Sivaramakrishnan *et al.,* 1996).

Biomonitoring can not entirely replace standard physic-chemical water quality methods. Standard physico-chemical water quality measures provide information on water quality at a particular spatial unit during the time of sampling. It cannot provide historical information on water quality. On the other hand, by knowing the ecology of aquatic insect community, biomonitoring tools provide some historic insights into the water quality. Standard physico-chemical water quality methods need to be carried out in conjunction with biomonitoring tools to comprehensively evaluate the health of freshwater ecosystems. This is particularly important when heavy metal or pesticide contamination is suspected.

1. 3. Historic background: The biotic index approach adopted by many European programmes integrates the indicator species concept with elements of diversity. A biotic index is a “scoring system” and assigns scores to taxonomic groups based on assumed tolerance of the taxa to pollution and habitat disturbance (Cairns and Pratt, 1993). The basis for modern day biotic indices is the Trent Biotic Index (TBI), which was originally developed in 1964 for the Trent River in England (Metcalfe-Smith, 1994). Currently, for biomonitroing the Biological Monitoring Working Party (BMWP) score (Armitage *et al.,* 1983) and the "Average Score per Taxon" (ASPT) modification of this index is frequently used (Sivaramakrishnan *et al.,* 1996). In India various studies have presented spatial and temporal trends in diversity or biotic index of streams, rivers and lakes (Chattopadhyay *et al.,* 1987; Jhingran *et al.,* 1989; Khanna, 1993; Verma *et al.,* 1978, Bhat, 2002). The biomonitoring system developed for the temperate streams was tested and found to be useful for the river Cauvery (Sivaramakrishnan, 1992; Sivramakrishnan *et al.,* 1996). The biomonitoring scores for the river Cauvery was developed by using, the modified form of standard table of Armitage *et al.,* (1983) developed for the Yamuna River (Trivedi, 1991; Sivaramakrishnan, 1992; Sivramakrishnan *et al.,* 1996).

2. Methods

2. 1.Tools for Sampling

A checklist of tools for sampling aquatic insects is provided in the **Appendix-1** and figure-1. Most of the materials for sampling can be locally fabricated or procured.

2. 2.Selecting Study sites

A reconnaissance visit to the proposed study site is necessary to select sampling locations, design sampling protocol and work out the logistics. It is better to take one or two local persons who are familiar with the area during the reconnaissance tour. You can particularly request them to show most polluted and least disturbed areas of your study site. You may even hold a small meeting of local residents and explain them the purpose of your study and inform about your proposed study locations. Try to involve local schools/ colleges in your study. If your study site falls under any forest/defence/private/panchayat/ municipality/ corporation area take written permissions from concerned authority.

Topographic maps (Survey of India Topo sheets 1:2, 50,000 and 1:50,000) is necessary to understand the ecological setting of the study locations. SOI topo sheets of 1:2, 50,000 scales are easily available for general public and would serve most of the practical purpose. It is advisable to carry the topo sheets during reconnaissance tour and mark changes in the water bodies after the publication of the map. Note down the local names of water bodies from local residents. This will help in communicating the results of your findings to locals.

It is very important to select reference site(s) within the study site. Reference site(s) are locations which are assessed to be least disturbed or represent natural or near natural condition of the freshwater ecosystem under study. It is advisable to select the reference site(s) within the same catchment (Fig.2). However, if the suitable reference site(s) are not available within the catchment, sites from neighbouring catchment can be selected.

3.Sampling Protocol

3. 1.Identifying Freshwater Habitat: The inland freshwaters encompass a diverse array of ecosystems as varied as lakes and rivers, ponds and streams, temporary puddles, thermal springs and even pools of water that collect in the leaf axils of certain plants. This is a small fraction of world's water resource. Despite this, inland aquatic habitats show far more variety in their physical and chemical characteristics than marine habitats and contain a disproportionately high fraction of the world's biodiversity.

Inland water habitats can be classified into stagnant (*lentic)* and flowing (*lotic*)*.* They may also be classified into perennial or transient. Each of these has its own set of distinctive ecology and biological community. Lentic systems comprise lakes and ponds. Manmade lentic habitats such as irrigation tanks, ponds and reservoirs are predominant landscape features in many parts of Asia.

Lotic system encompasses rivers and streams. A river system is essentially a linear body of water draining under the influence of gravity. Most of the river systems discharge intose the sea and some into lakes. A few watercourses in arid regions enter inland basins where no permanent lakes exist and disappear into the dry plains. Large rivers such as Ganges and Brahmaputra cross over many degrees of latitude and traverse a wide range of climatic conditions. Variations in water flow and underlying geology also create a wide range of habitats, often within a short distance. Because of this change in habitats, different organisms are typically present in different parts of any given river system. Even though rivers are physically very dynamic, large rivers rarely disappear, and there are indications that some of the large rivers are in existence for tens of millions of years. This is reflected in the fact that, all the taxonomic groups are found in running waters, and some invertebrate taxa are exclusive or attain greatest diversity there.

Widely accepted classification scheme for inland aquatic habitats is given in **Appendix-2.**

3. 2. How many samples? This is a recurring question in biomonitoring studies. As a guideline, widely accepted taxa/family accumulation curve (across samples) can be used to determine the efficacy of the sampling. Figure-2 shows family accumulation curve across samples. It shows that most of the families have been encountered by 39 sampling sessions. This graph can be easily prepared in MS Office Excel and it is better to plot this graph after few sampling (about 10) to know the taxa accumulation trend and to decide on future sampling.

3.3.When to sample? This is a very important sampling issue. Many aquatic insects show clear seasonality and community composition changes across seasons. So it is better to sample the study sites across seasons. Studies in peninsular India have shown that sampling during post monsoon (August-December) gives a reasonable picture of community composition. However, this may not be applicable to other parts of India and more data is required to design appropriate sampling schedule for those parts.

3.4.Where to sample? It is better to stratify the study area before sampling. The study area can be stratified based on broad ecological variables (altitude, rainfall gradient, vegetation type, riparian landuse etc.), or disturbance regime (polluted, unpolluted, dams, canalized etc.). Topographic and thematic maps are essential at this stage to decide on sampling spot.

3.5.Are water quality parameters necessary? Basic water quality parameters (water temperature, pH, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Turbidity, Total Suspended Solids (TSS) and Total Dissolved Solids (TDS) provides useful information and helps in analyzing biological data. Protocols for these methods are standardized. The methods standardized by American Public Health Association (APHA) (Clescerl et al., 1999) are universally accepted and followed.

3.6. What other data to collect? Data on aquatic plants and observations on disturbances are quite useful. Interviewing local residents, fisher folks, and other indigenous communities who are depending on the water body will provide interesting insights on the history of the ecosystem. This is very important to understand the stake holder perception on the ecosystem and design future conservation strategies.

3.7. Sampling Data Sheet:

A sample data sheet is provided in **Appendix-3.**

4 .Collection and Preservation of Samples:

Different methods are employed to sample aquatic insects from the target habitats. The methods employed for collecting aquatic insects from different habitats are outlined below. In all the methods, collected samples are stored in 70% ethanol and labeled separately in the field for each sampling session.

4.1. Lotic habitats (Streams and Rivers):

In streams where the water flows through boulders and cobbles with high turbulence using nets is extremely difficult owing to its physical nature. An “all out search” method can used to collect the aquatic insects. The effort in sampling is standardized by restricting the collection of aquatic insects from 10 sq.m area for one hour. Within the sampling area, aquatic insects are searched in all the possible substrata collected from substrata such as bedrocks, boulders, cobbles, leaf litter and dead wood. A sable hairbrush or forceps is used to collect all samples.

In stretches of streams and rivers where the water flows with little turbulence over gravel and sand, physical nature permits to use nets. Aquatic insects were sampled by taking three, 1-minute kick-net samples (mesh opening: 180µm; area 1m^2). The kick-net is held against water current and an area of 1m^2 in front of the net is disturbed for one minute. Contents of the net is pooled and preserved in 70% ethanol.

Pools are stretches of streams and rivers where the water flow is minimum with least turbulence. Aquatic insects on water surface are collected using a nylon pond net (mesh opening: 500µm; diameter: 30cm; depth: 15cm). All out search method mentioned earlier is also employed to collect aquatic insects from the substratum in the shallow pools.

4.2. Lentic habitats (Ponds and lakes):

In ponds and lakes aquatic insects can be sampled using a pond net mentioned earlier. A bigger pond net (mesh opening: 500μm; diameter: 60cm; depth: 50cm) with adjustable handle is quite useful in large lakes and ponds. Many aquatic beetles and bugs use aquatic vegetation as a shelter. Aquatic vegetation can be taken out to the shore with the pond net and vigorously searched for aquatic insects using a forceps. Make a special effort to sample shores of the water body to collect semi aquatic insects.

5.Analyzing samples

5.1. Identification of Samples:

Collected samples should be examined under a dissection or stereozoom microscope (10X and above) and identified using standard taxonomic literature. Samples can be assigned to a family or genus using taxonomic keys for that particular group. Following keys are useful for identification: *Ephemeroptera* (Dudgeon, 1999); *Odonata, Plecoptera, Hemiptera, Megaloptera, Coleoptera, Diptera* and *Lepidoptera* (Fraser, 1933-36; Morse *et al.,* 1994; Dudgeon, 1999); *Hemiptera* (Thirumalai 1989, 1999; Morse *et al.,* 1994), *Trichoptera* (Wiggins, 1975, 1996).

5.2. Data organization:

Data collected can be organized for future analysis using spread sheets such as MS Office Excel 2003-2007. It is better to make to master list of taxa with corrected spelling for before entering the data. This will eliminate problem of “pseudo taxa” while creating the data matrix using the software. Data in matrix is used to calculate biodiversity indices and biomonitoring scores. Pivot table function of MS Office Excel is useful in creating data matrix.

5.3. Basic data analysis:

There are many free softwares in Windows platform to estimate basic biodiversity parameters. Programs such as **Past**, **EstimateS** and **BiodiversityPro** will meet most of the basic analytical requirement.

6.Calculating Biomonitoring Scores

6.1. Assigning BMWP Scores:

The determination of Biomonitoring Working Party (BMWP) scores was based on the standard table of Armitage *et al.,* (1983). Trivedi (1991) adopted this in a modified form for the biomonitoring studies of Yamuna River. For calculation of BMWP score, identification to family is sufficient. The biomonitoring scores can be obtained by summing the individual scores of all families present (**Appendix-4**). Score values for individual families reflect their pollution tolerance based on the current knowledge of distribution and abundance. Pollution intolerant families have high BMWP scores, while pollution tolerant families have low scores (Sivaramakrishnan, 1992).

6.2. BMWP-ASPT: The Average Score per Taxon (ASPT) is calculated by dividing the score by the total number of scoring taxa. A high ASPT usually characterizes clean sites with relatively large numbers of high scoring taxa. Disturbed sites generally have low ASPT values and do not support many high scoring taxa (Sivaramakrishnan, 1992).

6.3. Percent Ephemeroptera, Plecoptera and Trichoptera (%EPT):

Propotion of Ephemeroptera, Plecoptera and Trichoptera in total number of individuals collected gives a fairly descent picture of water quality in rivers and streams. These groups prefer clear, unpolluted fast flowing streams and are sensitive to pollution.

7. Interpreting and Presenting Results

Results of impacted site should be compared with reference site to know how the aquatic insect community has responded to habitat change. The results thus obtained can be presented as simple tables and charts. It is advisable to prepare charts in black and white for easy reproduction. Key results should be highlighted and presented in simple language. Graphical representation of results through maps and charts are powerful tools for communicating the results to general public.

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Softwares

1. **EstimateS 8.0**: http://viceroy.eeb.uconn.edu/estimates
2. **PAST:** http://folk.uio.no/ohammu/past/
3. **BiodiversityPro:** www.sams.ac.uk/research/software

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Appendix-1. Tools for Sampling Aquatic Insects

1. Pencil
2. Alcohol proof pen
3. Field note book
4. Fine forceps
5. Blunt forceps
6. Hand lens
7. Watch glass
8. Plastic tray
9. Plastic jars (various sizes)
10. Leak proof vials (vaious sizes)
11. Measuring tape
12. Rope
13. Twine
14. Blade
15. Scissors
16. Knife
17. Box for keeping samples
18. Map of the study area
19. Magnetic compass
20. Geographic Position System (GPS) if available
21. Altimeter
23. Thermometer
24. Kicknet
25. Pond net
26. Small sieve
27. Brushes-various sizes
28. Torch
29. Polythene covers
30. Camera
31. Data sheets
32. Permission letters
33. Contact addresses
34. First aid kit

Essential Equipments for Sampling Aquatic Insects

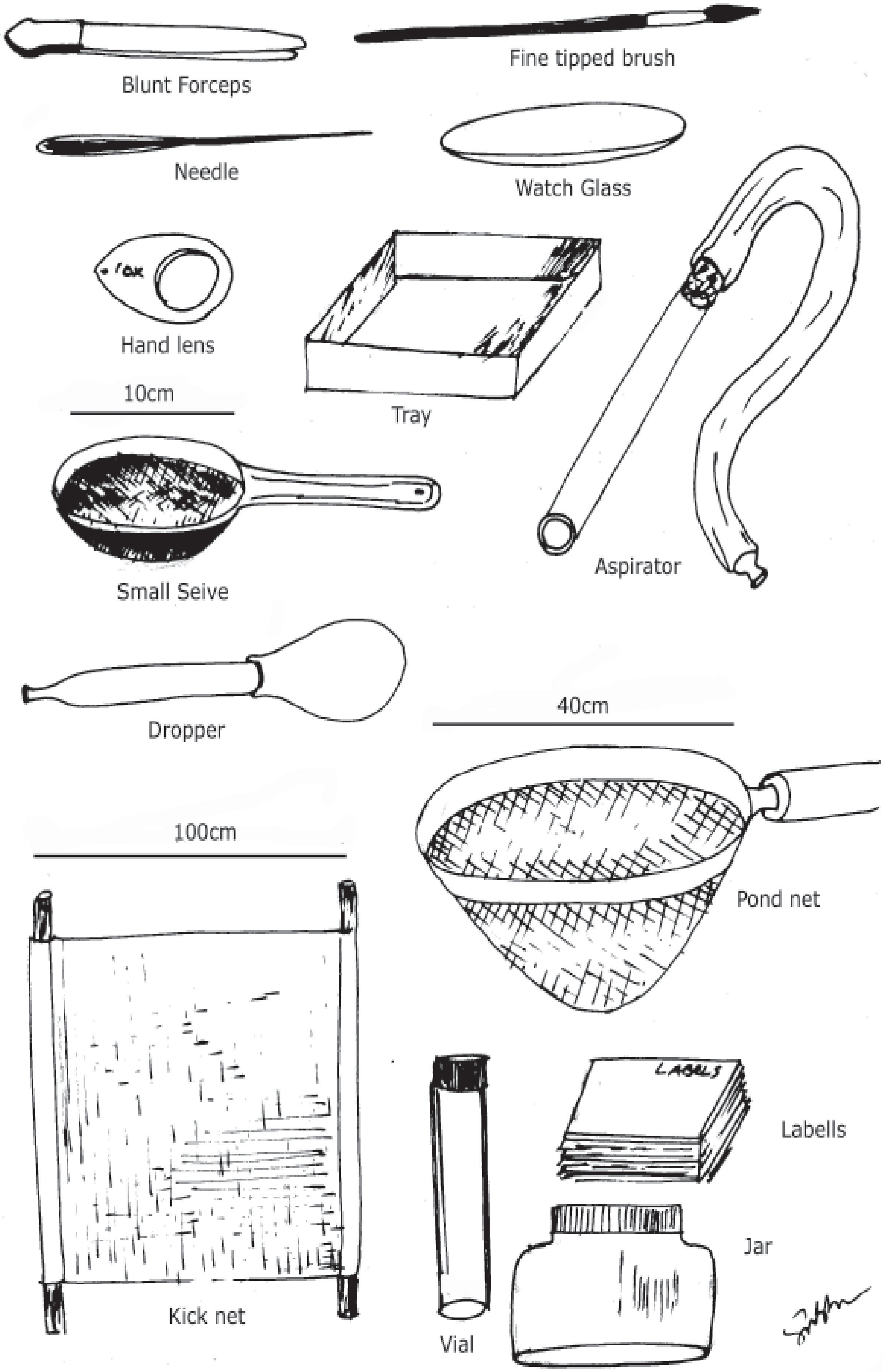
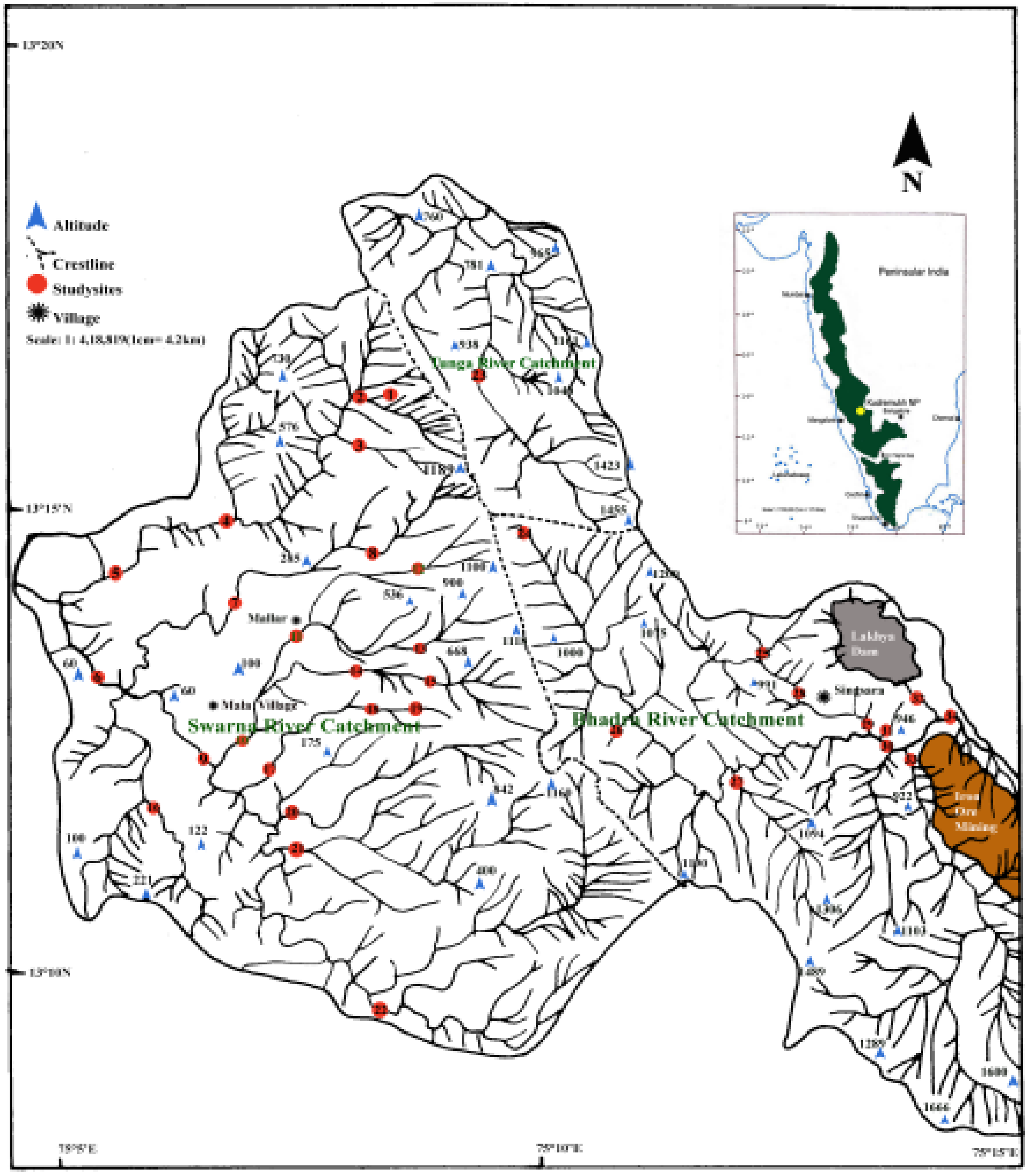


Figure-2. An example for distributing study sites within a landscape



(Ref: K.A.Subramanian et.al., (2005). ***Journal of Insect Science*** **5:49)**

Appendix-2 Classification of Freshwater Habitats (Dugan, 1993)

1.0. Freshwater

1.1 Riverine

1.Perennial

i) Permanent rivers and streams, including waterfalls.
ii) Inland deltas.

2.Temporary

i) Seasonal and irregular rivers and streams
ii) Riverine floodplains, including river flats, flooded river basins, seasonally flooded grassland.

1.2 Lacustrinel

1.Permanent

i) Permanent freshwater lakes (> 8ha), including shores subject to seasonal of irregular inundataion
ii) Permanent freshwater ponds (< 8ha).

2.Seasonal

i) Seasonal freshwater lakes (> 8ha), including floodplain lakes.

1.3 Palustrinel

1.Emergent

i) Permanent freshwater marshes and swamps on inorganic soils, with emergent vegetation whose bases ie. below the water table for at least most of the growing season.
ii) Permanent peat-forming freshwater swamps,including tropical upland valley swamps dominated by Papyrus or Typha.
iii) Seasonal freshwater marshes on inorganic soil, including sloughs, potholes, seasonally flooded meadows, sedge marshes, and dambos.
iv) Peatlands, including acidophilous, ombrogenous, or soligenous mires covered by moss, herbs or dwarf shrub vegetation, and fens of all types.
v) Alpine and polar wetlands, including seasonally flooded meadows moistened by temporary waters from snowmelt.
vi) Freshwater springs and oases with surrounding vegetation.
vii) Volcanic fumaroles continually moistened by emerging and condensing water vapour.

2.Forested

i) Shrub swamps, including shrub-dominated freshwater marsh, shrub and thickets, on inorganic soils.

ii) Freshwater swamp forest, including seasonally flooded forest, wooded swamps on inorganic soils.

iii) Forested peatlands, including peat swamp forest.3. Man-Made Wetlands

3.Manmade wetlands

3.1Aquaculture/ Mariculture

i)Aquaculture ponds, including fish ponds and shrimp ponds.

3.2 Agriculture

i) Ponds, including farm ponds, stock ponds, small tanks.

ii) Irrigated land and irrigated channels, including rice fields, canals and ditches.

iii) Seasonally flooded arable lands.

3.3 Urban/ Industrial

i) Excavations, including gravel pits, borrow pits and mining pools.

ii) Wastewater treatment areas, including sewage farms, settling ponds and oxidation basins.

3.4 Water-storage areas

i) Reservoirs holding water for irrigation and/ or human consumption with a pattern of gradual, seasonal, draw down of water level.

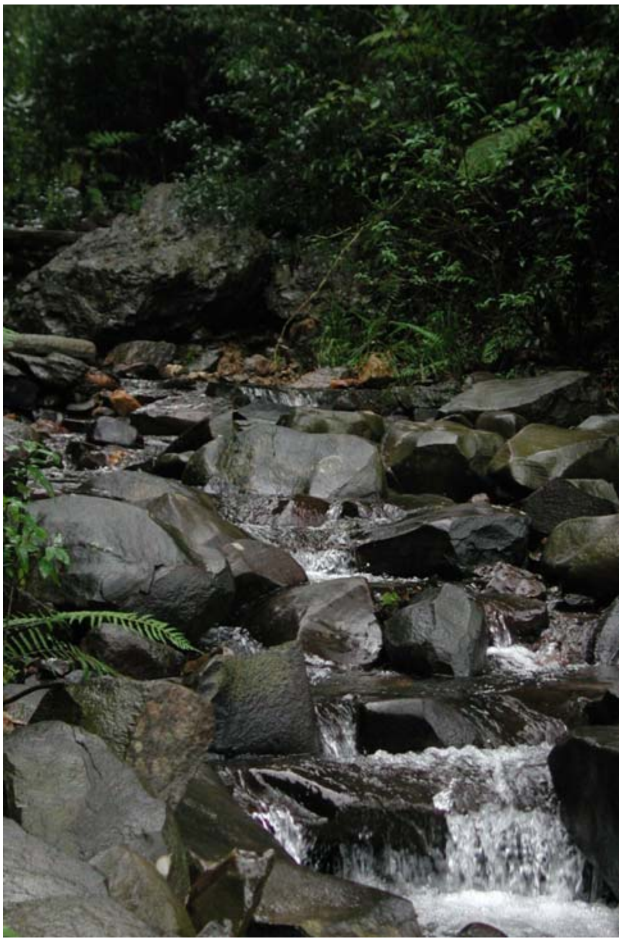
ii) Hydro-dams with regular fluctuations in water level on a weekly or monthly basis.

Plate-1. Some Freshwater Ecosystems

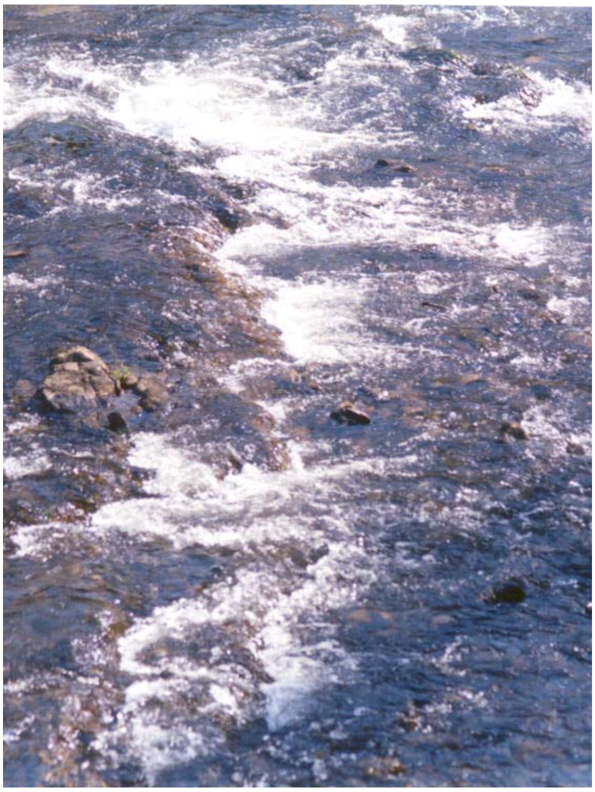
Ecosystem	Suggested Methodology
(1) Pond..	Pond net and sweep net
(2) Lake..	Pond net and sweep net
(3) Reservoir..................................	Pond net and sweep net
(4) Stream.....................................	Kicknet, Pond net and all out search
(5) River...	Kicknet, Pond net and all out search
(6) Myristica Swamp....................	All out search

Plate-2. Major Lotic Habitats

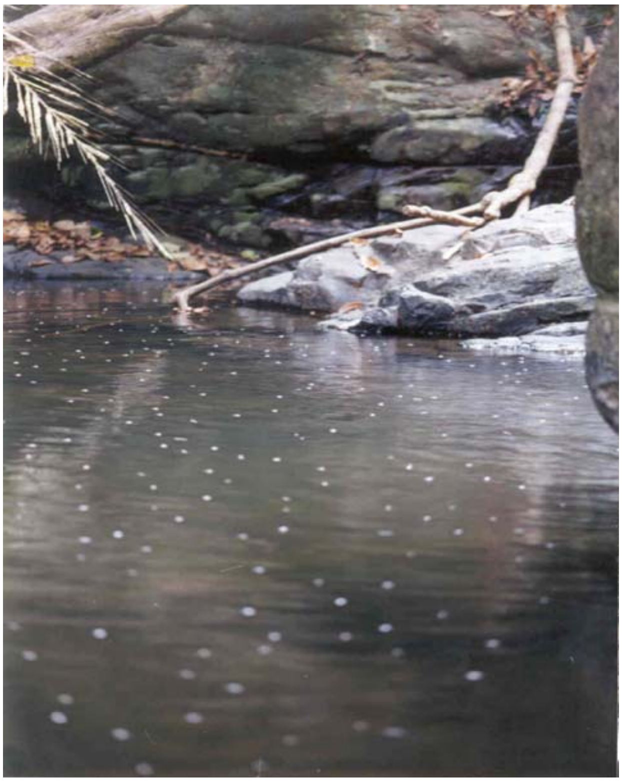
Waterfalls



Cascades



Riffles



Pools

Plate-3. Use of Kicknet and unsorted beetle samples

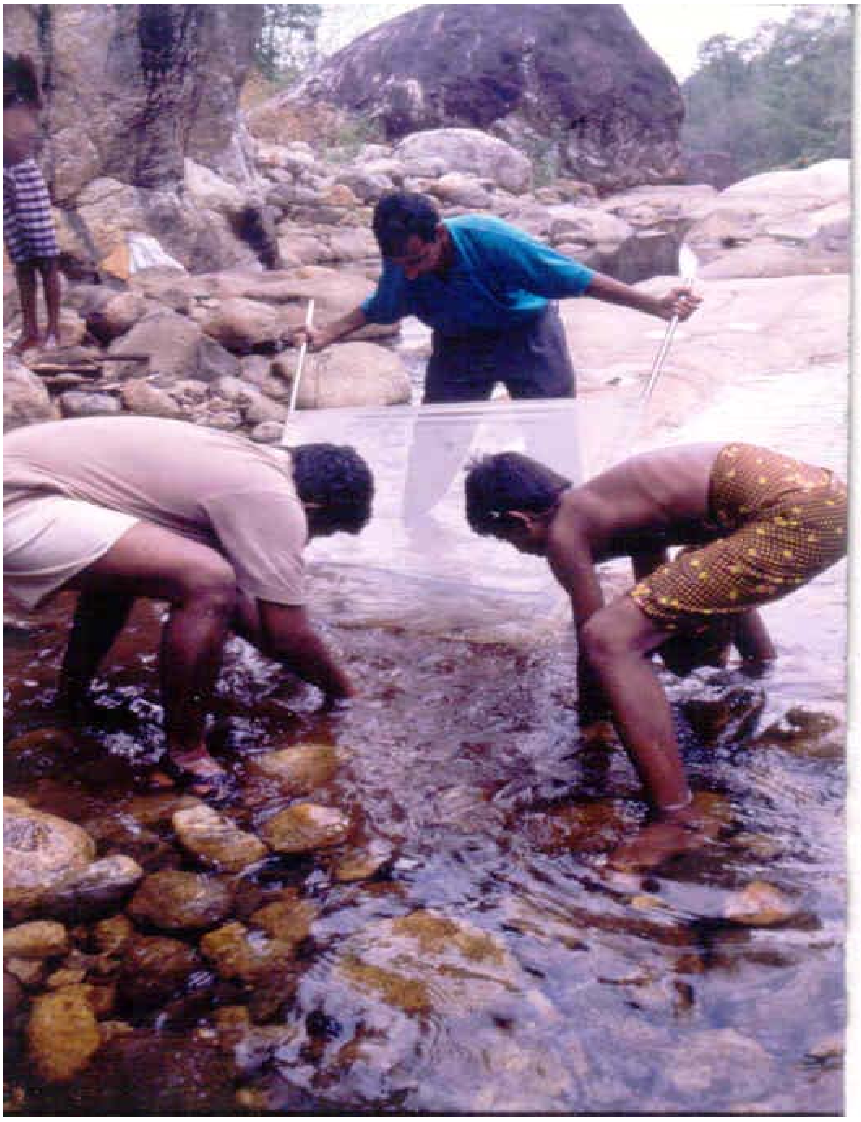


Plate-4.Some Common Aquatic Insects

Thalerosphyrus (Heptageniidae)

Euphaea (Euphaeidae)

Cybister (Dytiscidae)

Leptonea (Hydropsychidae)

Anisocentropus (Calamoceratidae)

Glossosoma (Glossosomatidae)

Aulocodes (Pyralidae)

Philorus (Blephariceridae)

Photos: K.A.Subramanian

Plate-5.Some Common Aquatic Insects

Isonychia (Oligoneuridae)

Caenis (Caenidae)

Neoperla (Perlidae)

Eubrianax (Psephenidae)

Macronema (Hydropsychidae)

Hydropsyche (Hydropsychidae)

Simulium (Simulidae)

Ephydridae

Photos: K.A.Subramanian

Plate-6.Some Common Aquatic Insects

Baetis (Baetidae)

Tenagogonus (Gerridae)

Metrocoris (Gerridae)

Rhagovelia (Velidae)

Dineutus (Gyrinidae)

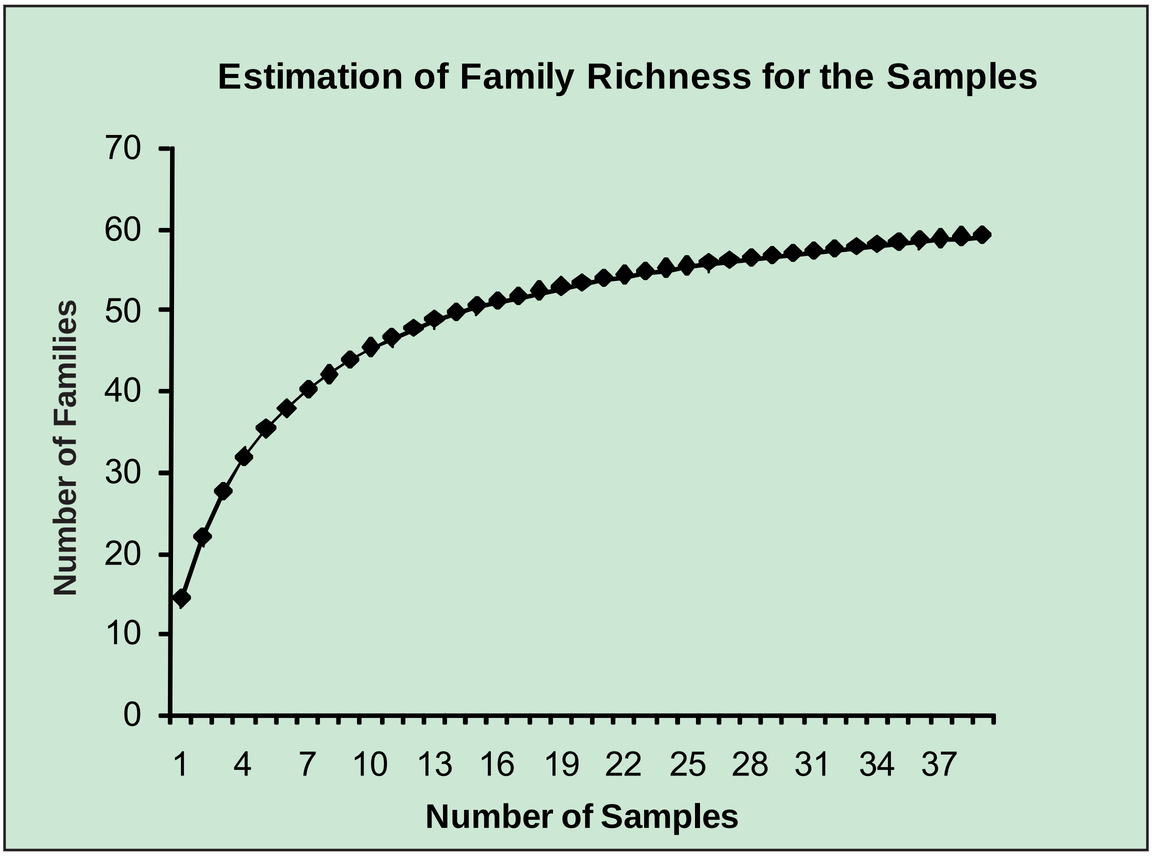
Sandracottus (Dytiscidae)

Goerodes (Lepidostomatidae)

Helicopsyche (Helicopsychidae)

Photos: K.A.Subramanian

Figure-3. Family accumulation curve across samples in Kudremukh Streams, Karnataka



The graph indicates that by 37 sampling sessions, most of the families are encountered in the study site.

Appendix-3. Basic Details of Sampling Localities and sample data

State: Karnataka
River Basin: Sharavathi

Sl.No	Site Name	District	Altitude(m)	Latitude(°N)	Longitude(°E)	AARF(mm)	NDM
1	Hosanagara	Shimoga	513	13.8833	75.05	2500	6
2	Nagodi	Shimoga	550	13.91299	74.85861	2500	6
3	Nittur	Shimoga	550	13.9333	75.9	2500	6
4	Nellibedu	Shimoga	550	13.93822	74.8497	2500	6
5	Mavinahole	Uttara Kannada	550	13.9666	75.1	3500	6
6	Nandihole	Shimoga	530	14	75.1333	981	6
7	Haridravathi	Shimoga	525	14.1	75.1333	981	6
8	Malemanne	Uttara Kannada	500	14.2833	74.7333	4000	6
9	Kathlekan	Uttara Kannada	525	14.2833	74.75	4000	6

AARF: Average Annual Rainfall; NDM: Number of Dry Months

Sample Data from Kudremukh National Park, Karnataka

SNo	Sample Number	Site code	Order	Family	Genus	Number of individuals
24	40	7	Ephemeroptera	Baetidae	Baetis	3
537	40	7	Coleoptera	Elmididae	Leptelmis	6
532	40	7	Odonata	Euphaeidae	Euphaea	3
531	40	7	Odonata	Gomphidae	Lamelligomphus	1
147	40	7	Trichoptera	Hydropsychidae	Hydropsyche	10
148	40	7	Trichoptera	Hydropsychidae	Leptonema	2
142	40	7	Trichoptera	Lepidostomatidae	Goerodes	1
143	40	7	Trichoptera	Limnephilidae	Moselyana	1
535	40	7	Plecoptera	Perlidae	Neoperala	3
144	40	7	Trichoptera	Polycentropodidae	Polycentropus	2
536	40	7	Coleoptera	Psephenidae	Eubrianax	5
132	41	7	Ephemeroptera	Baetidae	Baetis	5
131	41	7	Ephemeroptera	Heptagaeniidae	Epeorus	8
132	41	7	Trichoptera	Hydropsychidae	Hydropsyche	12
152	41	7	Trichoptera	Hydropsychidae	Hydropsyche	25

Appendix-4 BMWP Scores of families

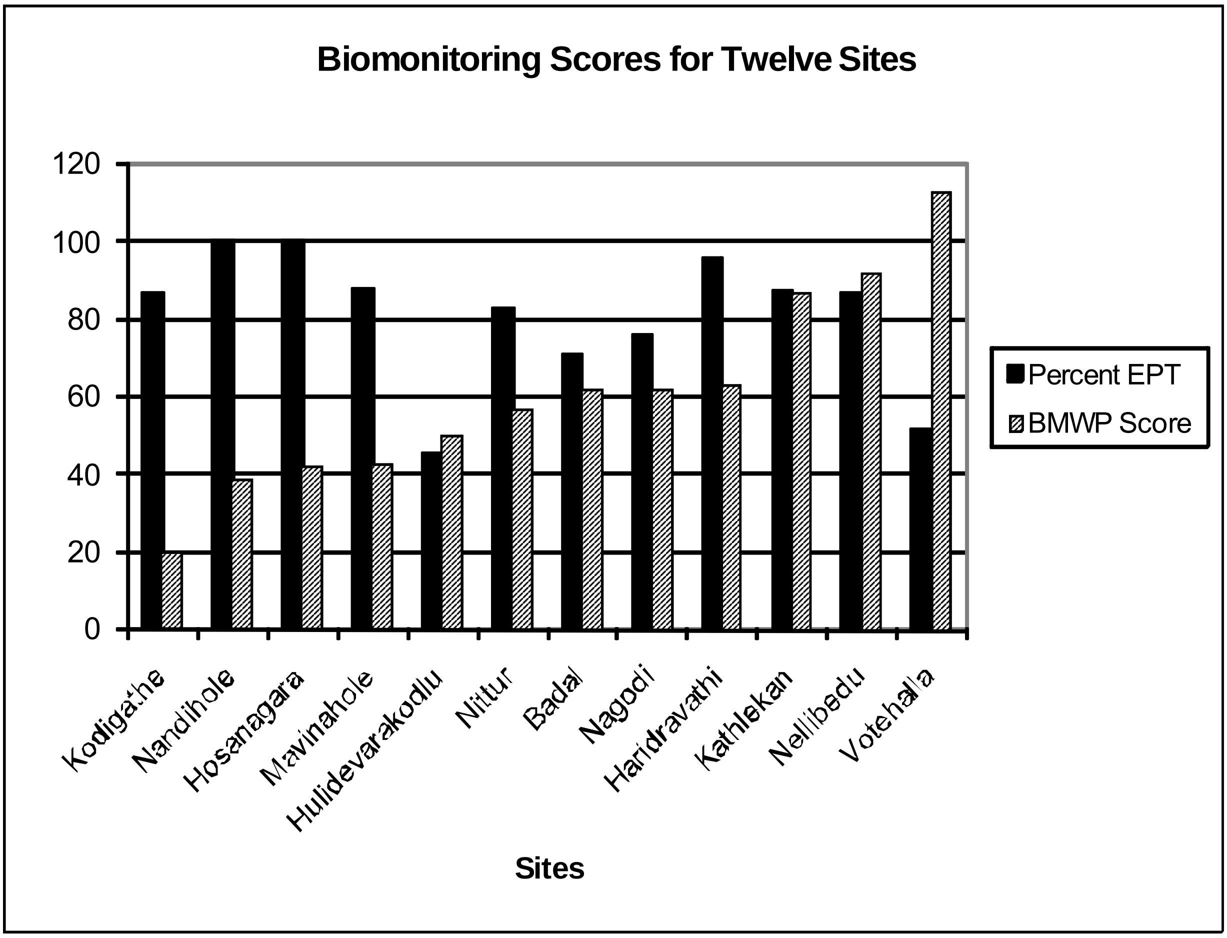
SlNo	Order	Family	BMWPScore
I	**Ephemeroptera (Mayflies)**		
1		Baetidae	04
2		Caenidae	07
3		Ephemerellidae	10
4		Heptageniidae	10
5		Oligoneuridae	10
6		Leptophlebiidae	10
7		Potamanthidae	10
8		Trichorythidae	10
II	**Odonata (Dragonflies and Damselflies)**		
9		Chlorocyphidae	10
10		Euphaeidae	09
11		Gomphidae	08
12		Libellulidae	08
13		Protoneuridae	08
III	**Plecoptera (Stoneflies)**		
14		Perlidae	10
IV	**Orthoptera (Grasshoppers and Crickets)**		
15		Tetrigidae	10
V	**Blattodea (Semiaquatic Cockroach)**		
16		Blaberidae	07
VI	**Hemiptera (Aquatic Bugs)**		
17		Corixidae	05
18		Gerridae	05
19		Hebridae	05
20		Naucoridae	05
21		Notonectidae	05
22		Pleidae	05
23		Veliidae	10
VII	**Megaloptera (Alderflies)**		
24		Corydalidae	10
VIII	**Coleoptera (Aquatic Beetles)**		
25		Curculionidae	05
26		Dytiscidae	05
27		Elmidae	05
28		Gyrinidae	05
29		Haliplidae	05
30		Hydrophilidae	05
31		Noteridae	07
32		Psephenidae	08

33		Staphylinidae	05
IX	**Trichoptera (Caddiesflies)**		
34		Calamoceratidae	10
35		Glossosomatidae	10
36		Helicopsychidae	10
37		Hydropsychidae	05
38		Lepidostomatidae	10
39		Limnephilidae	07
40		Philopotamidae	08
41		Polycentropodidae	07
42		Rhyacophilidae	07
43		Stenopsychidae	10
X	**Lepidoptera (Aquatic Moths)**		
44		Pyralidae	08
XI	**Diptera (Flies)**		
45		Blephariceridae	10
46		Chironomidae	02
47		Ephydridae	07
48		Simuliidae	05
49		Tabanidae	06
50		Tipulidae	06

Appendix-5: Biomonitoring Scores for study sites in Sharavathy River, Karnataka

Site	Gen.Richness	%EPT	BMWP	ASPT
Kodigathe	2	86	20	10
Nandihole	5	100	39	8
Sharavathy	6	100	42	7
Huledevarakudulu	8	88	43	5
Markatehole	9	45	50	6
Badal	10	83	57	6
Mavinahole	10	71	62	6
Kathlekan	11	76	62	6
Haridravathi	11	96	63	6
Nagodihole	11	87	87	8
Nellibedu	12	86	92	8
Votehalla	18	51	113	6

Legends: (1) **%EPT**: Percent of Ephemeroptera, Plecoptera and Trichoptera (2) **BMWP**: Biomonitoring Working Party Score (3) **ASPT**: Average Score Per Taxon



Space for Notes

Photo:K.A.Subramanian

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