**Summary**

Headwater streams are critical habitat for rare and endangered species and guardians of many downstream resources and ecosystem services which humans rely. High levels of habitat diversity among and within these small streams create niches for diverse organisms, including headwater-specialist species of aquatic invertebrates, amphibians and fish. Because of their close terrestrial–aquatic linkage the ecosystem services provided by headwaters and the species they support tend to be very sensitive to natural and anthropogenic disturbance of surrounding lands. New species occurrences and rare species are often found in headwater streams because such streams are relatively unexplored. Also, the roles of headwater systems are typically underestimated and inadequately managed compared with larger downstream systems (Gomi et al., 2002). Upland streams were selected during this study because of the reasons mentioned above and the study was focused on the fish communities and the habitat conditions in upland stream that are pristine and less exposed to anthropogenic influence; some have not been surveyed at least during the past two decades. Fish diversity, habitat conditions and their relation to communities have been elucidated. Assessment of stream health using fish based metrics and instream variables has been attempted on test basis. Conservation status of fish fauna irrespective of its occurrence in protected region would show the true picture of the extent they remain safe and highlight the threats and aid in management measures.
The uplands proved to be under surveyed or remain unexplored for a long time; which is evident from the discovery of two new species *Psilorhynchus tenura* and *Nemacheilus stigmofasciatus* and from the records of two species showing range extensions in their distribution. *Barilius bakeri* and *Batasio sharavatiensis* were the new records, the former has shown extended distribution from streams of Kerala and the latter has shown its distribution range to river basin other than its type locality towards south in Karnataka state. Fish assemblages in 36 streams from 4 river basins comprised of 60 species representing 6 orders, 14 families, 11 subfamilies and 33 genera. Nethravathi at Nidugal showed higher abundance of 192 and Honekarahalla had only 6 specimens collected. Korkanhalla of Thunga river was higher in species richness (17) Kanjalkathae and Suthanabi falls showed less species diversity with only 2 species each. Species clustering was based on species diversity and also based on the similarities and dissimilarities of species distribution. Endemic species distribution restricted to stretches of a single river basin, the species typical to rivers close to estuaries distinguished between the river basins. Differences in flow between main stream and tributaries showed temporal differences in species richness. Relationship of fish assemblage to environmental variables was studied using fish metrics in 23 sites selected for detailed inventory. Two fish assemblage metrics, Number of species and Percent insectivores were highly significant. Sites adjacent to farms and agricultural areas showed reduction in insectivores due to alteration of forest habitat and due to increased nutrient content primarily nitrate from agricultural discharge. Eight of 18 environment variables were significant factors. Depth, water temperature and nitrate were the highly influencing factors. Distributional differences in the fish assemblages were due to natural barrier,
land use and elevation. Streams situated at high altitude were distinguished from sites located at lower elevation by the difference in temperature and streams closer to agricultural land were differentiated by the presence of higher nitrate content compared to pristine streams away from cultivated lands. In addition, the west flowing rivers showed variation in the assemblages by presence of secondary freshwaters species *Sicypoterus griseus*, *Glossogobius giuris* and *Etroplus canarensis*.

The utility of fish assemblage in biological monitoring of stream health is proverbial, in this context, the conditions of the fish community structure and the related stream health were determined by calculating IBI (Index of Biotic Integrity) and HHEI (Headwater Habitat Evaluation Index). Sixteen of 36 study sites surveyed were chosen for biological and physical habitat evaluation. Twelve metrics categorized from the available fish assemblages were employed for testing the IBI. Seven metrics among them namely, number of native species, number of benthic species, number of column species, number of primitive/ancient species, number and identity of intolerant species, proportion of individuals as tolerant species and proportion of individuals as omnivorous were considered as predictor metrics as evident by their contribution to IBI scores. The index, obtained from the total IBI scores, graded the streams that scored above 3.75 as good. According to the index as calculated during this study 9 streams were graded as good and 7 streams as fair. Streams of Thunga and Bhadra showed higher scores than Seethanathi and Nethravathi river basins. Instream factors that significantly influenced the HHEI scores were riparian vegetation, channel alteration, channel flow and frequency of riffles. Korkanhalla and Vimalanathi of Thunga river scored high with the presence of high
frequency of riffles and absence of channelization also complemented by the presence of
good riparian vegetation. Summative scores of all criteria utilized during this study of
each site were graded either as good or fair based on percentile ranks. Nine sites were
found as good in ecological integrity. Scores have been carefully validated for both the
indices, though no site was degraded; it was intentional that sites that have been graded as
fair was to improve the management plans.

Habitat preferences of 32 species, of 1901 individuals of the order Cypriniformes
were studied. Habitats were classified as Shallow pool, Slow riffle, Fast riffle, Raceway,
Medium pool and Deep pool. Availability of each of the six habitats in streams
dominated by the Cypriniform species was noted. Habitat heterogeneity was higher in
Thunga and Nethravathi river basins each with 5 types. Seethanathi was found to show
the lowest (3) habitat diversity and correspondingly the number of species represented
were also less. Shallow pools and slow riffles were the most preferred and deep pools
were least preferred habitats according to the present study. Substrate and fish cover
preferences varied depending upon the stream environment, except some substrates
specific species. *Mesonemacheilus petrubanarescui*, *Botia striata* and *Nemachilichthys
ruppelli* occurred only in sites with the substrates they preferred. Habitats with higher
complexity were rich in species diversity. Depth and flow influenced more than substrate
and fish cover as the sampling was done during summer season. More the complexity in
sites greater was the variation in the morphological distance among the species available
which meant it accommodates species of varied morphological structures ranging from
stream lined to deep bodied, species with dorsally compressed wide head to species with narrow head width.

Conservation status of fish fauna were assessed employing 10 criteria based on IUCN methodology. The conservation status has been categorized as critical, species at higher risk, moderate risk and lower risk. The weighted scores of 55 species were in the score range of 20 to 73. The highest score was for *Tor mussullah* which is a critically endangered species *Puntius amphibius* scored low with 20 and was considered as species at lower risk. Of the total species assessed about 75% were in the lower risk and moderate risk categories. *Tor mussullah, Puntius narayani, Hypselobarbus kolus, Mesonemacheilus petruhanarescui* and *Longischistura bhimachari* were critical and hence need more conservation priorities. Ranking of each criterion has been effective for the scoring of conservation status of each species in the present study. The species that require special conservation, as described by the scores were summative response of all the requisite criteria. The influence of additional points provided in some categories for deserving species as mentioned in the methodology of criteria selection has significantly contributed to the categorization of species for conservation priorities.