Final Report

HEALTH ASSESSMENT OF GANGA RIVER AT HARIDWAR DURING KUMBH 2013

-A Study Conducted By PSI-

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Background:

River health is a term used to illustrate the ecological condition of a river. “River health” is a concept that incorporates both ecological and human values. The health of a river depends on its ability to maintain its structure and function, to recover after disturbance, to support local biota (including human communities), and to maintain key processes, such as sediment transport, nutrient cycling, assimilation of waste products, and energy exchange. In broad terms, a healthy river is one that has the ability to sustain its ecological integrity.

Rivers possess a delicate ecology that depends on a regular cycle of disturbance within certain tolerances. Maintaining and improving river health requires an accurate assessment of the currentecological state of river ecosystems. This process involves monitoring of all elements of a river ecosystem which basically include status of water quality and biodiversity assessment to know ecological condition.

River health monitoring programs have the potential to provide valuable information on river and its catchment conditions. This information can identify threats and the causes of poor health, help prioritize and guide management responses, and assess the effectiveness of those responses.

With a view to undertake the exercise of

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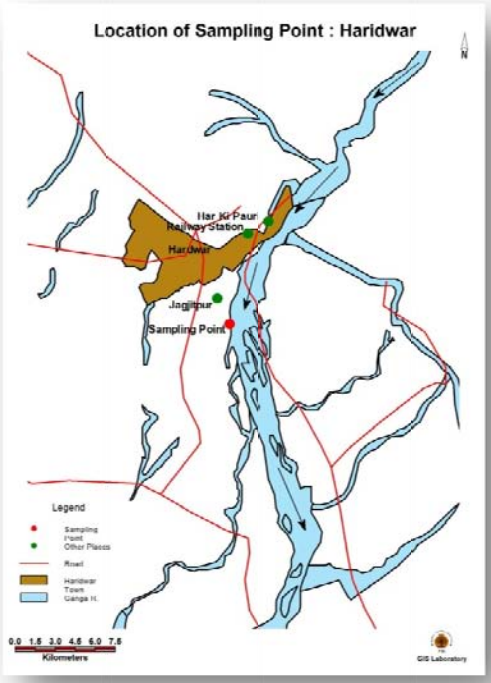
health assessment of Ganga River during Kumbh 2013, a multidisciplinary working group was formed and PSI was a part of this working group. It was assigned the responsibility of conducting water quality monitoring at Jagjitpur (Haridwar) during Kumbh 2013.The present report is based on the socio-cultural perceptions of the people, water quality and river benthos test results from January 10, 2013 to May 20, 2013.

Location of the Study Area: Jagjitpur (Haridwar)

Rationale for Selection of the Site: To study the impact of release of flows on Ganga River during Kumbh 2013 at different locations.



Key objectives:

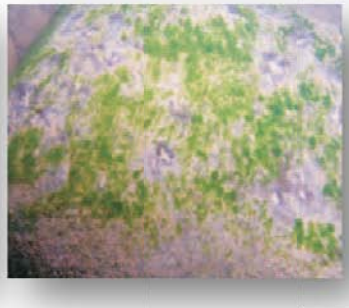
- To monitor the health of river Ganga pre, duringand post *Kumbh 2013* at Jagjitpur in Haridwar on certain dates specified by WWF as mentioned in the table below.
- To employ the use of field based water testing kit (supplied by WWF-India) to test water samples at the monitoring site.
- To conduct water quality tests in the laboratory for the water samples collected from the monitoring site at Haridwar.

Monitoring Schedule:

January	February	March	April	May
10^{th}, 14^{th}, 27^{th}, 2013	10^{th}, 15^{th}, 25^{th}, 2013	10^{th}, 20^{th}, 2013	20^{th}, 2013	20^{th}, 2013

The above dates have been provided by WWF (decided in working group)

GENERAL OBSERVATIONS AT THE SITE	
Sampling Location	Jagjitpur, Haridwar
GPS Location	29°53.162N 78°08.386E
Channel Description	Uniform bank profile
Season	Winter
Weather	Clear & sunny on sampling dates
Land Use	Residential/farm land
Substrate	Mostly boulders, sand & pebbles on the bank
Activities Observed	Sand mining, cattle wading, STP plant present at Kankhal (roughly one and a half kilometers u/s of the sampling location)

BIOTA HEALTH		
Vegetation Structure	Complex (having more than four vegetation types)	
Riparian vegetation	Poplar, eucalyptus, shisham, ber, few patches of grass, sugarcane and vegetable farms.	
Key Indicator Species Present	Migratory birds (brahminy ducks, cormorants, painted stork and pintails)	 
Livestock	Cattle, goat, nilgai	 
Algae	Chlorophyta (Family Chaetophoraceae)	 

Thefish varieties found weremahseer, rohu, mrigal, calbasu, kiran, bata	Fish varieties like Mahseer and Rohu are decreasing in the sampling area probably because they are sensitive to pollution. The other fish varieties like *Kiran* and *Bata* found here are pollution tolerant.	

I. Socio-Cultural Perceptions:

The highest level of ecosystem health is associated with minimal human disturbance. But through socio-cultural perceptions of the community residing nearby, a locally acceptable state of river health can be assessed to support the needs of the people and the aquatic ecosystem. PSI conducted surveys to find out the socio-cultural perceptions of the people regarding the health of the river.

Sample size: Overall the sample size was 10 which included respondents residing near the sampling site at Jagjitpur, Haridwar.

Data Collection Methodology: Interviews are extensively used for data collection across all the disciplines of the social sciences & in educational research. Hence, interviews were conducted for collecting information on socio-cultural perceptions of the people on river health. The informants were asked open-ended questions. Probing was used wherever necessary to obtain relevant information.The questionnaire for the survey was provided by WWF.

Table 1: Views of the local people about Ganga at Jagjitpur (Analysis of Socio-Cultural Perceptions) Total Number of Respondents = 10

S.No.	Question	Response
1	How is the river water supporting the local public?	According to the respondents, the river water is very dirty and is not supporting the needs of the local communities as it used to earlier. These days'people are using the river water for washing their clothes and vehicles, bathing their livestock and for sand.
2	What is the view point of local communities about the river health condition?	It has turned into a drain. River water is very dirty. It has got polluted and the water is not fit for drinking use. Water smells bad.
3	What do they feel about river pollution? What are the indicators according to them?	There is change in the water quality.There is change in the appearance of water. It is grey in colour. A lot of floating material is seen in the river. It is not fit for domestic or even agricultural purposes. People do not like to take bath in the river.
4	Is there any change in the services offered by the river over the years?	Fish catch has reduced. Water is not fit for any direct services. But still because of faith people use the same water for religious customs. Level of water in some of the wells has also reduced. Most of the people are now using public supply water for meeting their domestic requirements.
5	Trends of species occurrence over the years. Is there any species that has diminished?	Prawns, golden fish and *sone** fish are not found any more. Mahseer and *kharat** fish have reduced in number. Migratory birds also appear less in number.
6	Any new addition of Exotic species (flora/fauna)?	Mrigal was introduced few years ago but it is not seen anymore. *Kiran, Lanchi&PatharChatta** are the new fish varieties seen.
7	Is there any change in the ecosystem of habitat structure? Any changes in the flow of water?	The flow of river has reduced. At many locations it is now possible to walk across the river. Contaminants in water spoil vegetable crops. People have started growing teak, eucalyptus and poplar as these are hardy species and provide economic gains. Fishing is done mostly in winter or rainy season now as there is less fish catch in summers.
8	Are the local communities facing any health problems?	Yes, when they use the river water they get skin diseases like itching, rashes. Animals also fall sick. They develop skin and foot diseases. Spots are seen on some of the fish now.
9	What are the major anthropogenic influences for the river pollution?	Untreated sewage discharge from STP plant, sand mining and solid waste disposal are the major anthropogenic causes of river pollution.
10	What are the common fishing practices available in the region?	Using common net and sometimes fishing rod for household requirement.
11	Amount of fish catch and during which season?	Fish catch has reduced. Fishing is done in winter and rainy season now.
12	How is the aesthetic value of the region affected?	Discharge of untreated sewage has made the water dirty and smelly. Water is not fit for domestic or agricultural requirements. Lot of people used to come here earlier for bathing but now very few people come that too occasionally.
13	Suggestions of the locals to remediate the identified key issues.	The people interviewed felt that the above causes can be negated by maintaining proper flow and by stoppage of waste discharge into the river particularly from the STP. ****These are local names of fishvarieties***.

Summary of Survey Findings:

During the survey the respondents stated that the water is very dirty and the flow is also less on non-snan days. At many locations it is now possible to walk across the river. *Discharge of effluents from the STP at Jagjitpur is a big problem. It makes the river water grey and smelly.*

Earlier the river water was used for domestic as well as agricultural purposes. Now it is not even fit for agricultural purpose because the contaminants in water spoil their crops. People have started growing eucalyptus, poplar and shisham for economic gains. Sand mining from the river is also done for economic benefits. The local people use the river sand for construction purposes.

Prawns and golden fish are not found any more in the river. Fish catch has reduced. Generally fishing is done in rainy season now as more fish flows down the river from upstream in this season. Migratory birds are seen till March in this region. However their numbers have reduced. People do not use this water for bathing or for domestic purposes as it causes rashes and other skin problems. Animals also fall sick. They get skin infection. The people interviewed felt that the above causes can be negated by stoppage of untreated sewage discharge into the river.

II. Water Quality Monitoring:

Parameters Tested At The Site & In The Lab.: Colour, odour, turbidity, pH, temperature, ammonia, conductivity, nitrates, hardness, chlorides, phosphorus, DO, BOD, total & fecal coliform. Benthic monitoring was also carried out.

Type of Sample: Grab

Sampling Technique: Samples were collected from the outside curve of the river at Jagjitpur (Co-ordinates29°53.162N 78°08.386E) after wading into the centre current without disturbing the bottom sediments and facing upstream of the river, against

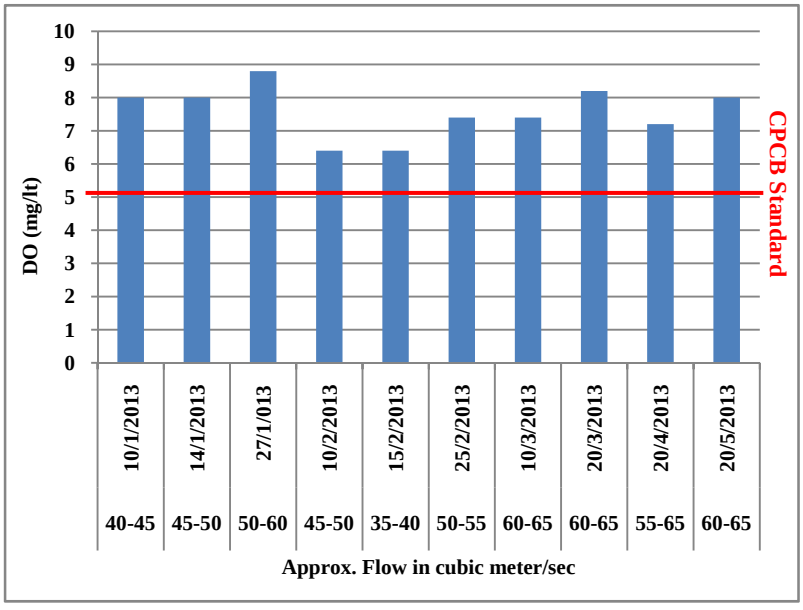
the flow of water. Samples were collected from about 30 cm depth after rinsing the sample containers with the river water. Field tests like colour, odour, temperature pH, ammonia, turbidity, conductivity DO, phosphate and coliform were performed at the site and sample containers were labeled properly for laboratory testing.

Testing Procedure: The field tests were performed using the water testing kit provided by WWF. The laboratory parameters were tested at PSI's laboratory using standard APHA procedures.

Minimum and Maximum Values Obtained

S.No	Parameters	Minimum Value Obtained	Maximum Value Obtained
1	pH	6	8.8
2	Temperature	12	24
3	Turbidity (NTU)	30	94
4	DO (mg/l)	6.4	8.8
5	Total Coliform (MPN/100ml)	152000	480000
6	Fecal Coliform (MPN/100ml)	98500	240000
7	Nitrate (mg/l)	0.03	<10
8	Ammonia (mg/l)	0.7	2
9	Conductivity (µmho/cm)	179	278
10	BOD (mg/l)	10.8	13.6
11	Phosphorous (mg/l)	>0.5	1.89
12	Hardness (mg/l)	104	240
13	Chloride(mg/l)	17.7	41.46

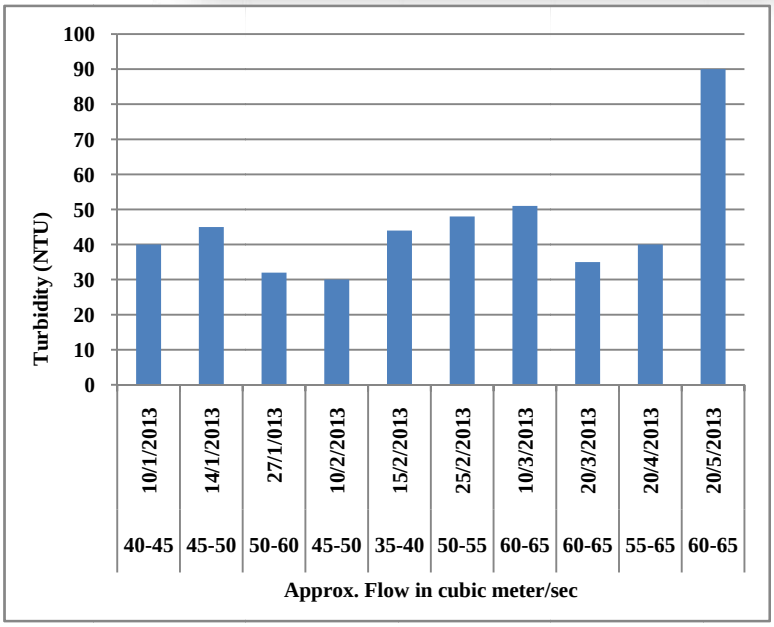
Results and Discussion: The values of dissolved oxygen were found to be satisfactory according to the CPCB norms (See Annexure-I). However, fluctuation in the values was observed. The DO values ranged from 6.0-8.8 mg/l indicating variation in the flow and discharge of sewage water. It was noticed that the DO increased with the increased flow in the river.



The BOD obtained was found to be around 12mg/l on all the sampling dates which is more than the CPCB standard of 3mg/l for mass bathing. Higher BOD values indicate that the river is polluted with organic content. Presence of nitrates in water stimulates

biochemical oxygen demand and the process of eutrophication. Inadequately treated sewage and fertilizers are the main sources of nitrate in rivers.

The average velocity of water was found to be 1.2 m/sec and the approximate flow was observed to be in the range of 40-65 m^3/sec which is considered to be inadequate for a mighty river like Ganga at Haridwar. The colour of the water was always found to be grey and opaque indicating pollution discharge into the river. Turbidity of water is an important water quality parameter. The turbidity measured using turbidity tube ranged from 30 to 90 NTU which is considered to be high. Fluctuating flows, extraction of sand and gravel, untreated waste discharge can generate turbidity as seen in the graph. Turbidity may affect the colour of water and also stimulate the growth of bacteria in water. Hence, turbid water is not suitable for aquatic life and human uses. Turbid water disturbs the aquatic food chain as well.The fecal coliform counts were found to be very high indicating disposal of sewage in the river.



Presence of phosphates in water could be due to natural sources like phosphatic rocks but high levels of it in water indicate use of chemical fertilizers in the nearby agricultural areas. Phosphorus causes algal growth (eutrophication) in water if the flow in water body is not adequate. Presence of ammonia indicates organic pollution. It is usually present in abundance near agricultural areas. It may also indicate sewage flow into the river. Hardness of water refers to the mineral content of water. The hardness values

obtained are in the range of 120-180 mg/l which indicates water having more calcium and magnesium concentration.

III. River Benthos

Physical and chemical tests yield data on present water quality. However, such data may not show the effects of past conditions and may not predict how biological organisms will respond to conditions over time. For this reason, benthic macroinvertebrates are widely used as indicators of water quality. They form an integral biological component of river ecosystems andoften reflect the qualitative character of flowing waters. They are good indicators of local conditions and site specific impacts on the health of the river.

Sample Collection: Composite samples were collected. Sampling was done for about an hour and a half on each sampling date from a stretch of about 100 ft. at the sampling site. Organisms found in the loose substratum werecollected by standing against the water current and disturbing the bottom organisms by shuffling with the scoop.For rocky/gravel bed area, organisms were collected from the stones.The organisms were preserved in 4% formalin solution for identification and SCI/DI calculations.

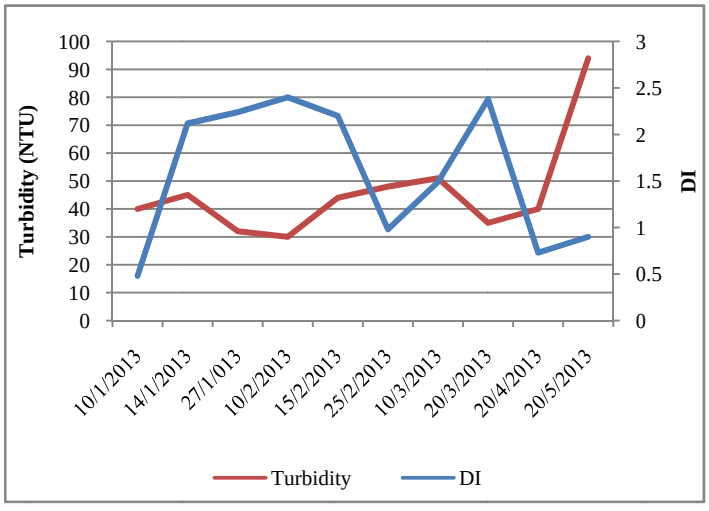
Calculations

The number of runs and the total number of organisms for each composite sample collected was recorded and the following calculations were done:

Sequential Comparison Index (SCI) = $\frac{\text{number of runs}}{\text{number of organisms}}$

Diversity Index (DI) = SCI x total number of species

Results & Discussion: Sequential Comparison Index (SCI) is a measure of the distribution of individuals among groups of organisms.This index relates to the diversity and relative abundance of organisms. The SCI score ranges from 0 to 1 and a score below 0.3 indicatepoor water quality. Similarly, Diversity Index (DI) measurement provides an indication of the number of varieties of organisms found in a particular stretch of water. It is based on



the concept that healthy streams show higher diversity while polluted streams show lower diversity. The Diversity Index ranges from 0 to 24 and a value less than 8 indicates poor water quality.

The benthic varieties collected from Ganga at Jagjitpur were all pollution tolerant varieties which feed on decaying organic matter (see table in the annexure).A large number of these species were found. This is because when pollution sensitive species are absent there is less of competition in the aquatic food web which saves the pollution tolerant species from predators and hence they become more in number.Large number of mollusk in water indicateshard water and also presence of organic waste in water.When the turbidity was low, the DI scores were found to be higher as seen in the graph. The calculated SCI and DI scores indicate poor water quality at the sampling site, i.e. the water does not have the capacity to support different varieties of organisms.

Conclusion: The objective of this study was to monitor the impact of release of flows during kumbh 2013 on the health of river Ganga through water quality analysis, benthic study and socio-cultural surveys. It is quite obvious from the water quality monitoring results and benthic study that the health of Ganga River at Jagjitpur is not good. The values of water quality parameters were found to be fluctuating with the fluctuating flows. The discharge of mixed sewage from the sewage treatment plant upstream of the sampling point was also taking place.

Not much can be concluded about theimpact of release of flows during Kumbh on the river health because the recovery of health of any ecosystem depends upon the severity of damage caused to it. More the damage more is the time taken for its recovery. The process of restoration of the ecosystem may take a couple of months or even years. Secondly, as there *was no* comparative sampling station upstream of the river it is difficult to conclude anything substantial about the effect of flows on river health during kumbh period. The study design, selection of parameters and socio-cultural survey questionnaire also need to be modified. However, this study did indicate/help us to understand the stressors on the river at the sampling station. The major stressors were the low capacity sewage treatment plant located upstream of the sampling point, sand mining activities and agricultural runoff which is causing turbidity, high BOD level ,fecal contamination and destruction of habitat for aquatic organisms.The presence of life forms in the river (all though mostly pollution tolerant species) indicate that the river is still alive and we can plan to improve its health.

Scope for Future Study: River health assessment is a vital component of the strategy to protect and enhance the value of riverine ecosystems. The signal of a healthy river should be associated with favourable riverbed, acceptable water quality and sustainable ecosystem. A systematic, consistent, national approach to river health assessment can provide a periodic audit of the nation’s river assets. Regular communication of river health information can support the implementation of appropriate river management actions.

Annexure-I

Data on Water Quality Monitoring

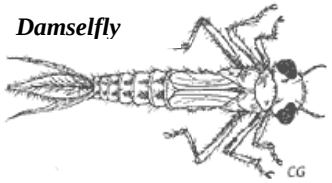
S. No	Parameters	SAMPLING DATES																				Desirable limits/reference value for river water (as per WWF monitoring protocol)
		10/1/2013		14/1/13		27/1/13		10/2/2013		15/2/13		25/2/13		10/3/2013		20/3/13		20/4/13		20/5/13		
		F	L	F	L	F	L	F	L	F	L	F	L	F	L	F	L	F	L	F	L	
1	Colour	Slig-htly Grey	Slightly Grey	Slig-htly Grey	Slightly Grey	Slig-htly Grey	Slightly Grey	Slig-htly Grey	Slightly Grey	Slig-htly Grey	Slightly Grey	Grey	Grey	Dark Grey	Dark Grey	Grey	Grey	Grey	Grey	Grey	Grey	
2	pH	6	6.8	6	6.8	7	7.1	7	7.1	7	7.5	>7.0	7.4	>7.0	7.5	>7.0	7.8	8.8	8	>7.0	7.6	6.5-8.5
3	Temperature (°C)	12	-	15	-	15.9	-	16	-	16	-	18	-	18.5	-	18	-	19.1	-	24	-	25
4	Turbidity (NTU)	43	40	45	45	35	32	30	30	45	44	48	48	51	51	35	35	40	40	90	94	
5	DO(mg/l)	8	8	8	8	8.8	8.4	6.4	6.4	6.4	6	7.4	7.2	7.4	7.2	8.2	8	7.2	-	8.0	8.4	Min. 5.0
6	TC MPN/100ml	-	1,52,000	-	2,11,000	-	185,000	-	2,90,500	-	3,06,000	-	4,80,000	-	4,80,000	-	2,40,000		480000	-	480000	
	FC MPN/100ml	P	98,500	P	108,000	P	106,000	P	1,46,000	P	1,57,000	P	2,40,000	P	2,40,000	P	1,10,000		240000	-	240000	
7	Nitrate (mg/l)	<10	0.04	<10	0.03	<10	0.03	<10	0.1	<10	0.03	<10	0.27	<10	0.2	<10	0.16	<10	0.38	<10	0.48	
8	Ammonia (mg/l)	Nil	Nil	1.0	0.9	<1.0	0.7	2.0	-	>1.0	-	2.0	-	2.0	-	>1.0	-	<1.0	-	>1.0	-	Max. 1.0
9	Conductivity µmho/cm	-	230	-	260	-	258	-	268	-	261	-	278	-	262	-	208		179	-	233	
10	BOD(mg/l)	-	10.8	-	11.5	-	12.8	-	12.6	-	12	-	12.8	-	12.2	-	11.2		13.33	-	13.6	*3mg/l or less
11	Phosphorous (mg/l)	0.5	1.89	0.5	1.21	0.5	-	>0.5	-	0.5	-	1	-	>0.5	-	0.5	-	<0.5	-	>1.0	-	0.1mg/l
12	Hardness (mg/l)	162	240	160	216	120	-	168	-	160	-	160	-	200	-	160	-	120	-	104	-	
13	Chloride (mg/l)	20	20	32	32	17.7	-	28.4	-	35.5	-	35.4	-	32	-	35.5	-	41.46	-	35.5	-	

*****P=Present; BOD value prescribed by CPCB

Annexure-II

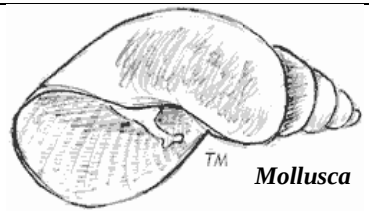
Data on Monitoring of Benthic-Macro-Invertebrates

S.No.	Name of the species,	Sampling Dates									
		10/1/2013	**14/1/13**	**27/1/13**	**10/2/2013**	**15/2/13**	**25/2/13**	**10/3/2013**	**20/3/13**	**20/4/13**	**20/5/13**
1	Damselfly(Lestidae)	1	-	-	-	-	-	-	-	-	-
2	Aquatic worm(Oligochaeta)	34	15	11	10	8	3	3	28	12	132
3	Molluscs(Lymnaeidae)	44	116	95	74	62	101	143	10	72	40
4	Leech(Hirudidae)	15	59	41	27	19	3	22	41	-	-
5	Water penny(Psephenidae)	-	5	-	-	-	7	27	3	-	3
6	Blackfly larva(Simulidae)	-	-	20	18	12	-	-	-	-	-
7	Midge Larva (Chironomidae)	-	-	-	-	-	-	3	1	-	-
8	Diving Beetle	-	-	-	-	-	-	-	-	3	-
	Total no. of individuals	**94**	**195**	**167**	**129**	**101**	**114**	**198**	**42**	**87**	**175**
	SCI	**0.12**	**0.53**	**0.56**	**0.6**	**0.55**	**0.25**	**0.3**	**0.48**	**0.244**	**0.30**
	DI	**0.48**	**2.12**	**2.24**	**2.4**	**2.2**	**0.98**	**1.49**	**2.38**	**0.732**	**0.90**

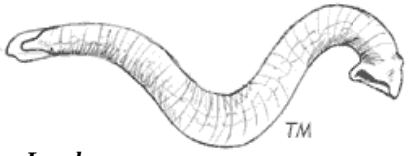


Damselfly

Aquatic Worm

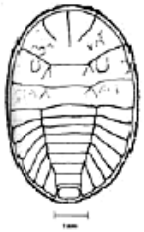


Mollusca



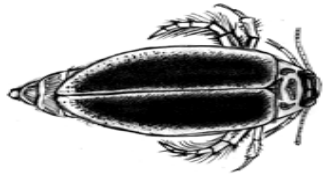
Leech

Water penny



Black Fly Larva

Midge Larva



Diving Beetle