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Research Paper

DIVERSITY OF ZOOPLANKTON AND MACROBENTHIC INVERTEBRATES OF TWO PERENNIAL PONDS IN JAMMU REGION

Sharma, K. K. [1], Sarbjeet Kour[2] and Neha Antal[3]

[1]Professor, Department of Zoology,
University of Jammu, Jammu, J&K-180006
[2]Assistant Professor, Department of Zoology,
University of Jammu, Jammu, J&K-180006
[3]Ph.D Scholar, Department of Zoology,
University of Jammu, Jammu, J&K-180006.

Abstract

An ecological study was carried out so as to study diversity of zooplankton and macrobenthic invertebrates in two perennial ponds of Jammu region (Jakh Pond and Dilli Pond). In all 29 species of zooplankton were identified from Dilli pond whereas 25 species from Jakh pond viz., protozoan, rotifera, cladoceran, copepods and Ostracods. Among macrobenthic invertebrates 23 species were identified from Dilli Pond and only 13 were from Jakh pond. Ponds were also investigated monthly for various physico-chemical parameters viz., Depth, Transparency, pH, Water temperature, Air temperature, Dissolved oxygen, Free carbon dioxide, Carbonates, Bicarbonates, Calcium, Magnesium, Chlorides, Phosphates, Sulphates and Nitrates and they showed well marked monthly variations with distinct maxima and minima. From the comparative study between two ponds, high value of physico-chemical variations and low faunal diversity were recorded in the Jakh pond, whereas low value of physico-chemical variations and high faunal diversity were recorded in the Dilli pond. The record of various pollution indicator species in both the ponds infers the eutrophic nature and dark future of both the ponds, if no effective measures are taken.

Key words: *Diversity, Protozoa, Cladoceran, Ostracods and Macrobenthic invertebrates*.

INTRODUCTION

Aquatic habitat of Jammu region include a vast network of lentic water bodies like lakes, ponds, paddy fields, ditches, tanks etc., which harbor variety of plants and animals. These aquatic organisms ranging from invertebrates to vertebrates serve as important indicators of water quality and ecosystem health. Aquatic diversity of these lentic water bodies mainly encompasses of planktonic fauna (zooplankton and phytoplankton) and macrobenthic invertebrate fauna. Zooplanktonic fauna consist of protozoa, rotifera, cladocera, copepoda and ostracoda. These are the free floating organisms and play an integral role in the aquatic food chain[1]. Thus, playing a meaning full ecological role in all functional aspects of an aquatic ecosystem. Macrobenthic invertebrates are extremely diverse and inhabit bottom sediments of the water body. Presently encountered macrobenthic invertebrates include Annelida, Arthropoda, Insecta, Mollusca etc. Apart from being a segment in food chain they act as

barometer for measuring the overall biodiversity in any aquatic ecosystem. These ubiquitous benthic organisms react strongly and often predictably to human influences in aquatic ecosystem[2]. They have an important function in transitional ecosystem, by filtering phytoplankton and then acting as food source for larger organisms such as fish, thereby linking primary production with higher trophic levels. The diversity and abundance of zooplankton and macrobenthic invertebrates varies with seasons showing much influence of physico-chemical status of water body and both faunal diversity and physico-chemical values plays significant role in assessing the water quality.

Keeping in view the importance of zooplankton and macrobenthic invertebrates, the present research work has been designed to identify and inventorize the zooplanktonic and macrobenthic invertebrates diversity of two lentic water bodies of Jammu region. This is an attempt to generate the basic information of entire ecology and the present condition of the ponds so that database of listing the aquatic organisms can be prepared and effective strategies for conservation and management may be drawn for future.

MATERIAL AND METHODS

Study area

Jakh pond

The Jakh pond is situated in the district Samba of Jammu division and is located roughly 34 kms from University of Jammu. The pond is rectangular with concrete stairs along the circumference and is surrounded by human habitation and National highway I-A. Though the pond is believed to be sacred yet it is not free from anthropogenic influences.

Dilli Pond

Dilli Pond is a natural pond and located at a distance of about 8 kms from University of Jammu. It is a perennial and shallow water body. Run-off containing fertilizers, agricultural waste, sewage and detergents, animal dung silt and decomposed organic matter enrich the pond with nutrients that supports the growth of aquatic macrophytes.

Methodology

During the course of the present study, four stations were selected. The seasonal analysis of physico-chemical parameters was made every month over a period of one year i.e., Aug, 2013 to July, 2014 following standard methods[3,4,5,6,7].

Measurement of parameters like pH, FCO_2, DO, CO_3^{2-}, HCO_3^-, Cl^-, Ca^{2+} and Mg^{2+} was done on the spot within two hours of water sample collection. Other parameters like phosphates, nitrates and sulphates were assessed in the laboratory. The various methods followed for the determination of different physico-chemical parameters is as under:

I) PHYSICAL PARAMETERS

Atmospheric Temperature and Water Temperature: Air and water temperature was recorded with the help of a mercury centigrade thermometer while avoiding its direct exposure to the sunlight[8].

Transparency: The transparency of the water was noted by secchi disc of 20 cm in diameter (painted black and white on the upper surface) and computed by the formula[8]:

$$T = \frac{X+Y}{2}$$

Where, T = Transparency in cms

X = Depth at which the disc became invisible

Y = Depth at which the disc reappeared while pulling the rope upward.

Depth: The measurement of depth was made from the bottom of pond vertically upto the upper surface of water by a meter rod.

II) CHEMICAL PARAMETERS

i) Chemical parameters of water

pH: pH of water samples was determined with the help of a portable field pH meter (Hanna).

Dissolved Oxygen: Dissolved oxygen was determined by sodium azide modification of Winkler's method[9].

Free Carbon Dioxide, Carbonates and Bicarbonates: Carbonates and Bicarbonates were estimated following A.P.H.A. [9].

Chlorides: Argentometric method using Potassium chromate as indicator was used for the determination of chlorides[9].

Calcium, Magnesium and Total hardness: The estimation was done by the EDTA-titrimetric method suggested in A.P.H.A. [9].

Nitrates: Nitrates were estimated by Phenol Disulphuric acid method using spectrophotometer[9,10,11].

Phosphates: Total phosphate was determined by stannous chloride method using spectrophotometer[9,10].

Sulphates: Sulphates were estimated by Turbiditimetric method using spectrophotometer[9,10].

III) Biotic parameters

Qualitative and Quantitative Analysis of Zooplankton

Zooplankton were collected by filtering 20 litres of water through the plankton net of standard bolting silk cloth no. 25/mesh size 0.03-0.04µm. finally the volume of planktonic concentrate was adjusted to 20 ml and preserved by adding 5% formalin. The samples were brought to the laboratory for identification following Pennak, Ward & Whipple and Adoni[12,13,9].

The quantitative analysis of zooplankton was calculated by the formula:

$$\text{Number/ ml} = \frac{C \times 1000}{A \times D \times F} \ m^3$$

Where,

C = No. of organism counted
A = Area of field
D = Depth of field (mm)
(S-R Depth) = 1mm
F = No. of fields counted

Qualitative and Quantitative Analysis of Macrobenthic Invertebrates

The sample collection shall be made using an Ekman dredge and the collected samples will be washed through sieve no 40 (256 meshes/cm^2) and macrobenthic invertebrates will be transferred to vials containing 5% formalin or 70% ethyl alcohol for further identification. Preserved samples of macro benthic invertebrates will be identified according to Ward and Whipple, Pennak, Tonapi and Adoni[13,12,14,9]. However, for quantitative analysis, species-wise individual counting was done in the whole sample or sub sample. The number of benthos per unit area would be calculated using the formula:

$$\text{Benthos No. /m}^2 = \frac{N}{A \times S} \times 10000$$

Where, N = Number of organism collected per sample
A = Biting area of sampler (15 X 15 cm)
S = Number of samples taken

RESULTS AND DISCUSSION

Zooplankton

In an aquatic ecosystem zooplankton play a critical role by not only being primary consumers but also that they themselves serve as a source of food for higher organisms. Zooplankton provides main food for fishes at all the stages of life and can also be used as indicators of the trophic status of water body[15,16]. From the present study, a total 25 species of zooplanktonic fauna were encountered from Jakh pond. Out of 25 species of zooplankton, 2 species belonged to Protozoa, 13 species to Rotifera, 5 species to Cladocera, 5 species to Copepoda. A total of 29 species were found from Dilli pond during the present study. Out of 29 species of zooplankton, 2 species belonged to Protozoa, 14 species to Rotifera, 8 species to Cladocera, 4 species to Copepoda and only 1 species to Ostracoda (Table 1). But from the view on table class wise percentage contribution of zooplankton in both the ponds showed variation

(Table 2 and Fig. a). But again Rotifera contributed maximum species diversity in both the ponds throughout the study period.

The sequence of dominance of zooplankton classes in Jakh pond was recorded in the hierarchy as:

Rotifera > Cladocera = Copepoda > Protozoa

Whereas the sequence of dominance of zooplankton classes in Dilli pond was recorded in the hierarchy as:

Rotifera > Cladocera > Copepoda > Protozoa > Ostracoda

When critically analysed for each class the qualitative study showed species of *Difflugia* and *Centropyxis* were the most common species among the class Protozoa while as among the Rotifera class *Brachionus calciflorus, Brachionus caudatus, Brachionus quadridentatus, Keratella tropica, Philodina, Filinia longiseta, Filinia opoliensis* and *Testudinella* were dominant and common in both the ponds. *Cerodaphnia* sp., *Alona* sp., *Daphnia* sp. showed dominance among Cladocera and *Mesocyclops leuckarti* and *Nauplius* were recorded during most of the seasons among Copepoda. Class Ostracoda had only one representative, *Onchocypris pustulata* throughout the study period that also only in Dilli pond.

Comparative analysis among two ponds indicates high species richness in Dilli pond which may be attributed to plentiful organic matter and detritus in this pond due to more anthropogenic stress along with rich macrophytic vegetation which provide food and shelter for the planktons[17,18,19,20,21].

Apart from differential species presence there is seen a alarming state of both these ponds as presence of *Difflugia* sp., *Brachionus angularis, Brachionus falcatus, Keratella cochlearis, Keratella tropica, Lecane luna, Bosmina* sp., *Chydorus sphaericus, Daphnia sp.* and *Mesocyclops leuckarti* in both the ponds indicates the higher trophic status of the pond as these species are indicator of eutrophication[22,23].

Macrobenthic Invertebrates

Macrobenthic invertebrates are the important constituents of pond ecosystem and are useful bio-indicators in understanding the ecological health of an aquatic ecosystem. Odiete discussed the use of benthic macroinvertebrates in the assessment of freshwater bodies[24].

In present study, a total 13 species of macrobenthic invertebrates were encountered from Jakh pond (Table 3), Out of which 2 species belonged to Annelida, 8 species to Arthropoda, and 3 species to Mollusca whereas 24 species were found from Dilli pond (Table 3) with 9 species belonged to Annelida, 12 species to Arthropoda and 3 species to Mollusca. Overall assessment indicates that during the present investigation class Arthropoda was dominated among all the macrobenthic groups in both the ponds.

Class wise percentage contribution of both the ponds also infers that Arthropoda being maximum contributor to species diversity in both the ponds throughout the study period (Table 4 and Fig. b).

Hierarchy of dominance when formulated showed variation in two ponds and the sequence of dominance of macrobenthic invertebrate phylum in Jakh pond was as:

Arthropoda > Mollusca > Annelida

And that in Dilli pond was as:

Arthropoda > Annelida > Mollusca

Estimating diversity and richness in both ponds ranks high macrobenthic diversity and richness in Dilli pond as compared to Jakh pond which may be attributed to moderate fraction of sand, silt, detritus and organic matter, less water depth and presence of macrophytic and vegetation in this pond[18,25,20,26,27,28].

Comparison of both the ponds showed, qualitatively species of *Tubifex* and *Aelosoma* were the most common species among the phylum Annelida while as among the Arthropoda phylum *Berosus, Hydroglyphus, Chironomus, Pentaneura and Eristalis* were the species which were dominant and common in both the ponds. Mollusca namely *Physa* and *Indoplanorbis* were showed their presence in both the ponds.

Physico-chemical parameters

All physicochemical parameters studied showed well marked fluctuation with distinct maxima and minima (Table 5 & 6). Throughout the year both the ponds have alkaline pH which is helpful for the growth and flourishment of zooplanktons and macrobenthic invertebrates.

CONCLUSION

Physico-chemical and other biological parameters hint towards the polluted status of water body. Presence of *Tubifex* sp., *Chironomus* sp., *Pentaneura* sp., *Brachionus* sp., *Cyclops* sp., *Mesocyclops* sp. etc are indicator of Pollution. The record of various pollution indicator species in both the ponds infers the dark future of both the ponds, if no effective measures are taken. Awareness among local people, effective co-ordination among management authority, removal of algal & *Lemna* blooms, addition of freshwater and regular dredging of sediments are essential for present use and future management of these ponds.

Table 1: List of various Zooplankton present in Dilli and Jakh pond (+ sign: presence and – sign: absence)

Zooplankton	Pond	
Protozoa	Dilli	Jakh
Centropyxis hemisphaerica	+	-
Centropyxis ecornis	+	+
Difflugia lebes	-	+
Rotifera		
Brachionus calciflorus	+	+
Brachionus angularis	+	-
Brachionus caudatus	+	+
B. quadridentatus	+	+
Brachionus rubens	+	-
B, falcatus	-	+
B. forficula	-	+
Keretella tropica	+	+
K. cochlearis	-	+
Asplanchna intermediata	-	+
Philodina sp.	+	+
Euclanis sp.	+	-
Testudinella sp.	+	+
Filinia longiseta	+	+
Filinia opoliensis	+	+
Lecane inopinoata	+	-

Platyias quadricornis	+	-
Polyarthra sp.	-	+
Monostyla sp.	-	+
Cladocera	Dilli	Jakh
Cerodaphnia reticulata	+	+
Cerodaphnia cornuta	+	-
Alona retangula	+	-
A. Guttata	-	+
Chydorus sps.	+	+
Daphnia pulex	+	-
Daphnia similis	+	-
Daphnia magna	+	-
Daphnia sp.	+	+
Leydigia sps.	-	+
Copepoda		
Mesocyclops leukarti	+	+
Tropocyclops sp.	+	+
Cyclops sps.	-	+
Eucyclops sps.	-	+
Heliodiaptomus sp.	+	-
Nauplius sp.	+	+
Ostracoda		
Onchocypris pustulata	+	-

Table 2: Class wise species diversity contribution of zooplankton in Jakh and Dilli pond

Class	Jakh pond	%	Dilli pond	%
Protozoa	2	8	2	6.90
Rotifera	13	52	14	48.28
Cladocera	5	20	8	27.59
Copepoda	5	20	4	13.79
Ostracoda	0	0	1	3.45
Total	25	100	29	100

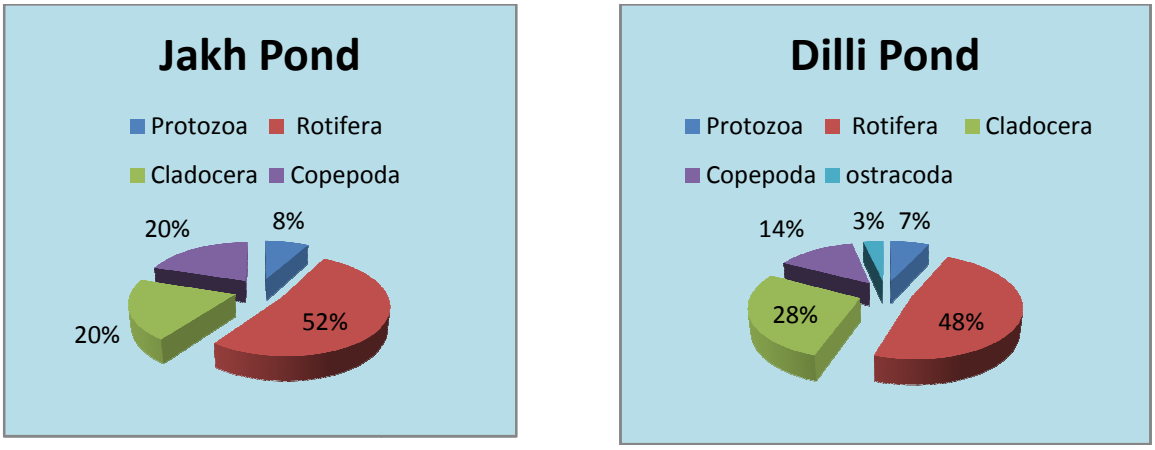

Figure a: Class wise percentage composition of zooplankton of Jakh and Dilli pond

Table 3: List of macrobenthic invertebrates (+ sign: presence and – sign: absence)

NAME OF ORGANISM	Dilli pond	Jakh pond
Phylum – Annelida		
Class – Oligochaeta		
Family – Tubificidae		
Tubifex tubifex	+	+
***Aelosoma* sp.**	+	+
Family – Naididae		
Dero digitata	+	-
***Nais* sp.**	+	-
***Chaetogaster* sp.**	+	-
Class Hirudinea		
***Hirudinaria* sp.**	+	-
Phylum – Arthropoda		
Class – Insecta		
Order – Coleoptera		
Family – Hydrophilidae		
Berosus fairmeri	+	+
Helochares sp.	-	+
Family – Dytiscidae		
***Hydroglyphus* sp.**	+	+
Family – Elmidae		
Ordobrevia sp.	-	+
Order – Hemiptera		
Family – Nepidae		
Laccotrephes maculates	+	-
Family- Corixidae		

Corixa sp.	-	+
Order – Diptera		
Family – Chironomidae		
***Chironomus* sp.**	**+**	**+**
***Pentaneura* sp.**	**+**	**+**
Family – Ceratopogonidae		
***Culicoides* sp.**	**+**	**-**
Family – Syrphidae		
***Eristalis* sp.**	**+**	**+**
Order – Ephemeroptera		
Family- Baetidae		
***Baetis* sp.**	**+**	**-**
Phylum – Mollusca		
Class – Gastropoda		
Family – Physidae		
Physa acuta	**+**	**+**
Family- Thiaridae		
Melanoides tuberculata	**-**	**+**
Family – Planorbidae		
Gyraulus ladacensis	**+**	**-**
Indoplanorbis exustus	**+**	**+**

Table 4: Class wise species diversity contribution of macrobenthic invertebrates in Jakh and Dilli pond

Class	Jakh pond	%	Dilli pond	%
Annelida	2	15.38	9	37.5
Arthropoda	8	61.54	12	50
Mollusca	3	23.08	3	12.5
Total	13	100	24	100

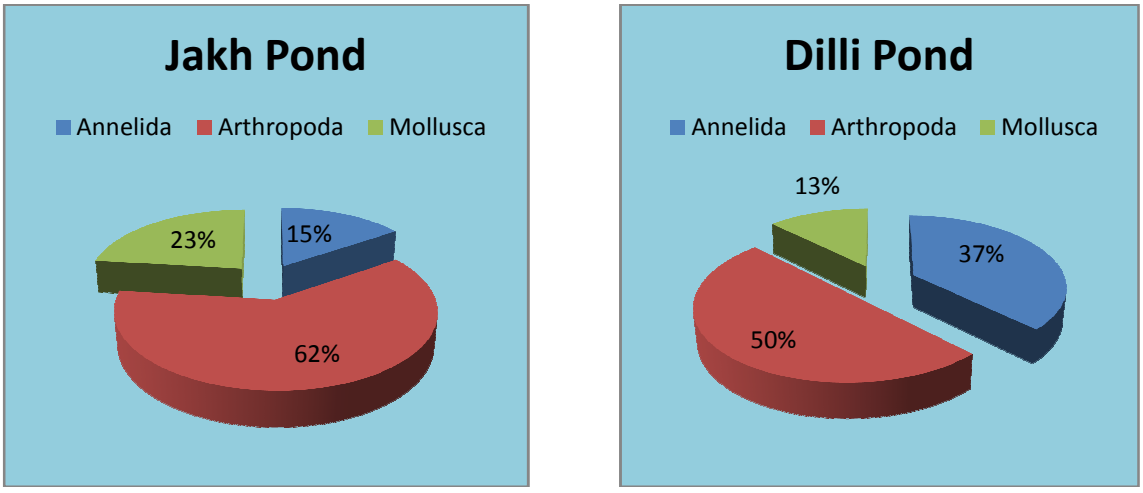

Figure b: Class wise percentage composition of Macrobenthic invertebrates of Jakh and Dilli pond.

Table 5: Physico-chemical parameters of Jakh Pond during 2013-2014.

Parameters	Unit	Months (Aug, 2013 – July, 2014)											
		Aug.	**Sept.**	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May.**	**Jun.**	**Jul.**
Depth	cm	98	100	30	86	82	79.5	82	97	126	110	100	97
Transparency	cm	48	47.5	30	60	61.5	63	55	87	97	96.5	84	91
Air temp.	˚C	32	29	27.8	26.5	18.5	24	22	20.5	34.5	35	33	29
Water temp.	˚C	31	27.5	27	20.5	16	18	19	23	31	29.5	29	30.5
pH		8.4	8.1	6.6	7.5	7.4	7.2	7.4	7.5	7.8	7.2	7.1	7.0
FCO_2	mg/l	-	9	A	10	12	6	10	14	8	6.0	6.0	4
Carbonates	mg/l	4.8	-	12	-	-	-	-	-	-	-	-	-
Bicarbonates	mg/l	11.71	200.08	285.48	287.92	424.56	385.52	396.22	448.96	380.64	248.88	131.76	19.52
DO	mg/l	8.4	8.4	6.4	6.8	2.0	3.6	4.2	5.2	7.6	12	9.2	8.8
BOD	mg/l	2.4	3.3	4.6	6.4	1.2	1.34	2.2	4.8	6.4	7.6	6.8	7.6
Chloride	mg/l	56	38	22	52	79	58	60	65	75	90	64	72
Calcium	mg/l	21.03	19.34	19.34	10.09	25.23	16.82	28.32	39.53	15.14	13.46	12.66	13.46
Magnesium	mg/l	29.40	37.10	56.05	60.73	57.54	53.75	56.62	63.78	63.87	43.87	44.55	45.33
Total Hardness	mg/l	142	172	250	260	262	238	253	302	278	194	196	200
Sulphate	mg/l	0.00192	0.00191	0.00197	0.00189	0.00186	0.00192	0.00191	0.00191	0.00188	0.00184	0.00202	0.00212
Nitrate	mg/l	0.57250	0.57260	0.57264	0.57246	0.57250	0.57246	0.57246	0.57246	0.57271	0.57250	0.57260	0.57250
Phosphate	mg/l	0.0224	0.00672	-	0.02239	0.02262	0.0212	0.01781	0.01887	0.0231	0.021	-	-

Table 6: Physico-chemical parameters of Dilli Pond during 2013-2014.

Parameters	Unit	Months (Aug, 2013 – July, 2014)											
		Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.
Depth	cm	26	32	26	35	35	33	33	35	54	36	40	43
Transparency	cm	26	27	26	35	32.5	33	33	32.5	49	36	40	41
Air temp.	˚C	32	30	27	19.5	16	21	20	20	36.5	32	33	32
Water temp.	˚C	30	31	29	20	17	17	17.5	21	33.5	31	30.5	31
pH		8.4	8.0	7.9	8.0	7.7	7.5	7.2	7.8	10.6	7.2	7.2	7.1
FCO_2	mg /l	-	10	-	6	8	9	9.4	10	-	10	10	14
Carbonates	mg /l	7.2	-	9.6	-	-	-	-	-	16.8	-	-	-
Bicarbonates	mg /l	29.28	75.64	114.68	143.96	202.52	204.96	208.24	212.28	136.64	168.36	97.6	17.08
DO	mg /l	8.0	7.2	6	5.2	3.6	5.2	6.0	8.0	7.2	4.4	7.2	10
BOD	mg /l	5.2	4.7	4.4	3.2	1.6	1.5	3.2	5.2	6.0	1.2	2.8	4
Chloride	mg /l	46	22	7	22	49	28	30	34	28	113	65	41
Calcium	mg /l	41.21	37.85	26.91	11.77	38.69	42.89	40.22	40.37	21.03	33.64	30.28	21.87
Magnesium	mg /l	11.86	14.13	18.73	32.62	28.02	25.54	24.25	23.24	18.70	21.47	20.83	18.99
Total Hardness	mg /l	90	96	104	146	154	148	140	136	98	122	116	100
Sulphate	mg /l	0.00189	0.00183	0.00177	0.00178	0.00177	0.00189	0.00188	0.00186	0.00176	0.00182	0.00184	0.00190
Nitrate	mg /l	0.57247	0.57253	0.57253	0.57255	0.57247	0.57247	0.57247	0.57248	0.57241	0.5725	0.57254	0.5724
Phosphate	mg /l	0.0083	0.0	0.0	0.0	0.0083	0.00912	0.1738	0.1746	0.0149	0.0140	0.0	0.0

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