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Distributional Analyses, Fishery Potential and Stock Assessment

of Fish Species of Doon Valley, Dehradun, Uttarakhand

Distributional analyses, fishery potential and stock assessment of fish species of Doon Valley was analysed for a period of two years at 20 sampling stations set of 5 rivers (Baldi, Song, Suswa, Tons and Asan) in Eastern and Western Doon valley. A total of 56 species, belonging to 5 Orders, 13 Families and 30 Genera were recorded during the present investigation. Spatial (= horizontal distribution) has been highlighted using Venn diagrams to show the number of shared and unique species for Eastern and Western Doon, separately. 41 species (73.21%) are common between East and West, whereas 13 and 2 species are found unique to Eastern and Western streams, respectively. In East, Baldi river shares all its species (30) with Song river. 4 species are common between Baldi and Suswa. Of 46 species from Song river, 37 species are common with Suswa. River Suswa, shows 24 and 13 species common with river Baldi and Song, respectively, whereas 8 species are exclusive representations, which include the 7 new records. In West, Tons and Asan have 27 species common, whereas, 5 and 11 species are exclusive to Tons and Asan, respectively. Temporal distribution is analyzed as per the altitudinal ranges occupied by fishes. Category I (300 - 500 m above msl) both in the East and West show maximum number of fish representatives as compared to those falling under Category II and Category III. Fishery potential of streams of Doon valley season-wise and station-wise has been evaluated in terms of Calculated Productivity Point system (CPP) values. The values come out to be maximum for the East as compared to West. In East itself, Suswa river showed more CPP values followed by Song and Baldi. In West, the maximum CPP values were observed at Asan. Increasing trend in CPP values from upstream to downstream stretches.

Key words: Distributional Analysis, Stock Assessment, Fishery potential, Doon valley.

The study highlights the distributional pattern of Doon Valley fishes.

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Introduction

Any aquatic ecosystem whether lotic or lentic is deemed healthy when it supports numerically sound fish population, particularly those preferred for the table, sport, or aquarium. Therefore, the assessment of fishery potential of an aquatic habitat and differentiation of different stocks therein, becomes an important aspect of any study focused on fish diversity evaluation. The scanning of literature has revealed that these aspects have been explored by a good number of workers but not as exclusive subject of study. As compared to marine environment the freshwaters have not been explored much in Indian context. Whatever information is available, that is sufficient to reveal the importance of such type of works and their adoption by future workers in the light of sustainable fishery development. Outside India, such studies on marine waters have been attempted by workers like Iles and Sinclair (1982); Sudarshan, *et al*. (1990), whereas workers like Ryder (1965); Gullard (1969); Cushing (1973); Henderson (1982); Wijeyaratne and Costa (1981); May *et al*. (1981); Wijeyaratne and Amarasinghe (1982) carried out similar studies on freshwaters. In India, such attempts were made in coastal areas by Gajbhiye *et al*. (1994). Singh *et al*. (1991); Sharma (1991); Uniyal *et al*. (2002) used the term 'fishery potential' but the contents of research papers simply deal with the check-list, estimating

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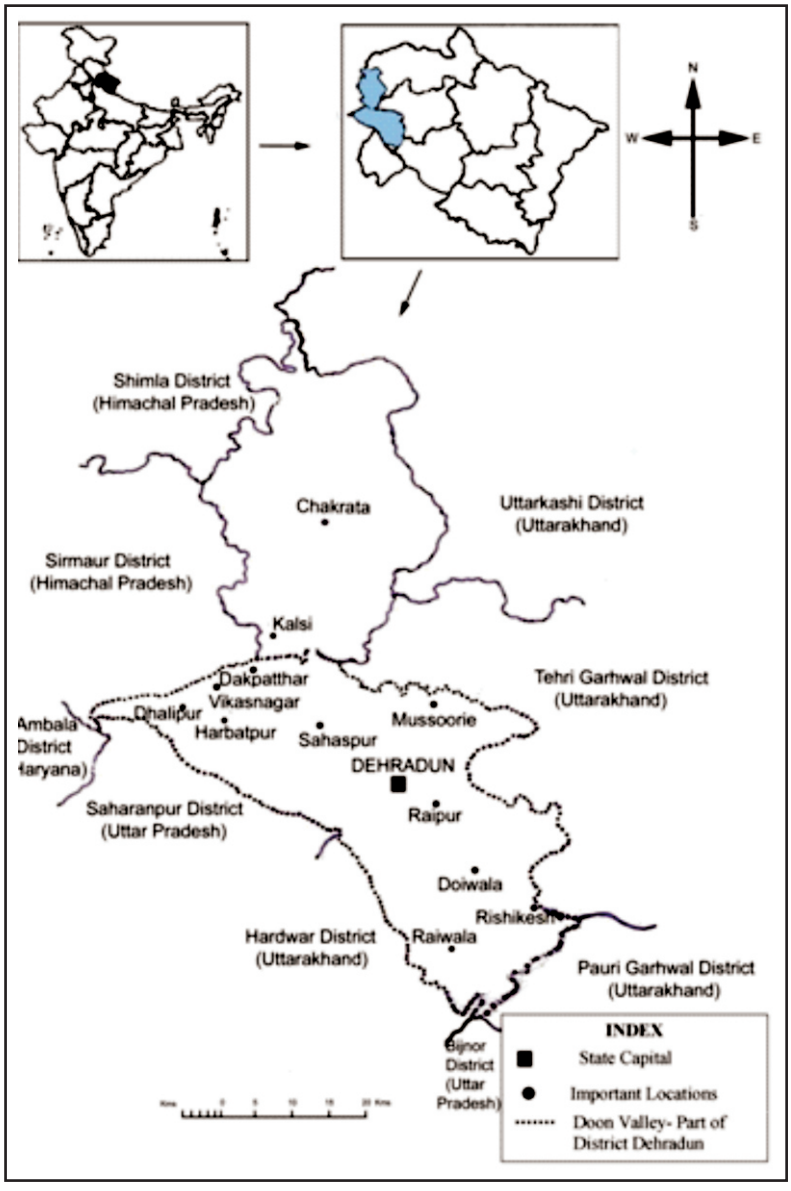

Fig. 1: Location of Doon Valley (Rana and Bhatt, 2014).

percentage, catch composition, *etc.* without revealing the use of mathematical tools to define/devise the 'fishery potential' in real sense as used by Dobriyal and Singh (1988) and Katiha *et al.* (1998); Arun (1998) in terms of Calculated Productivity Point System (CPP), Value of Catch and Abundance Index, respectively.

In essence, sustained works on this aspect appear deficient, more particularly for high altitude streams. So, the present work was carried out to assess the distributional pattern, fishery potential and stock assessment of fish species of Doon valley, Dehradun.

Material and Methods

Study area

Doon Valley, part of district Dehradun (latitude - 29°58′ and 30°32′ N and longitude - 77°35′ and 78°20′E) (Fig. 1) comprises of 2 main river basins, namely, the Ganga and the Yamuna river basin. The present study was carried out on these two river systems comprising of five main rivers *i.e.* Baldi, Song, Suswa, Tons and Asan (Fig. 2). Each river was divided into stretches along its length, according to altitudinal variations to adjudge the spatial and temporal interrelationships. Each stretch covering an approximate distance of about 4 - 7 km, was thus established as sampling sites. Fish samples were collected by employing standard gears, using variety of fishing nets of varying mesh sizes - gill nets, cast nets, drag nets with the help of trained fishermen on the sampling in the Eastern and Western part of Doon Valley, respectively (Fig. 2). Fish samples were preserved in 4% formalin and bought to the laboratory

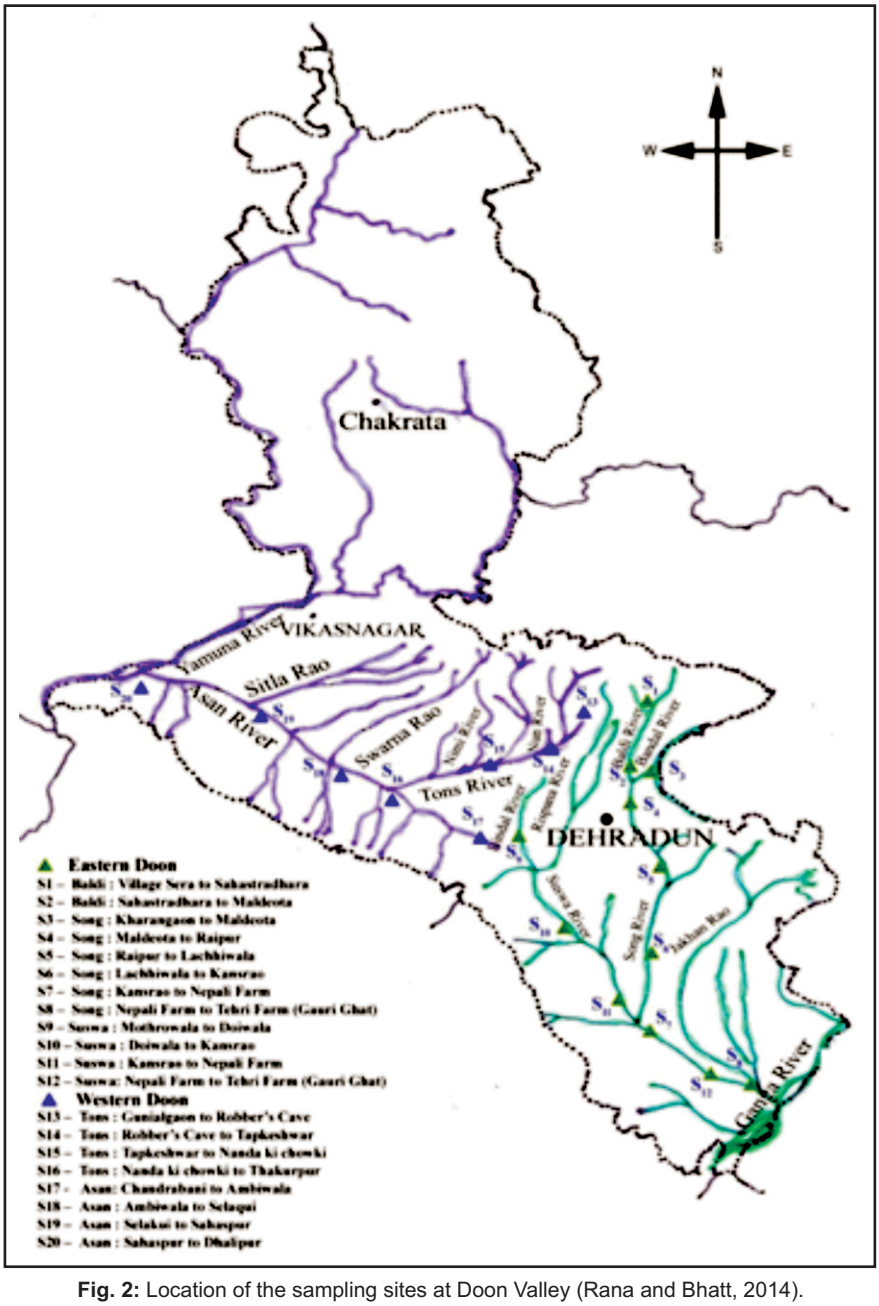

Fig. 2: Location of the sampling sites at Doon Valley (Rana and Bhatt, 2014).

for routine identification, meristic and morphometric analyses under the light of available standard literature and revisionary works (Day, 1878, 1889; Jayaram, 1981, 1999; Talwar and Jhingran, 1991; Vishawanath *et al.,* 2007). The fishery potential has been adjudged in terms of diversity on the basis of Calculated Productivity Point System (CPP), after assigning numbers to different densities of fishes (Dobriyal and Singh, 1988). This system is based on awarding points to express rareness, commonness, abundance and absence of a particular species as 0 = absent, number of specimens < 10 = rare, number of specimens between11-25 = common, number of specimens ≥ 25 = abundant. On the basis of data presented, the above point system was allotted to every species and CPP values for them were calculated for 2 years'. The mean values were calculated and used for presenting the observations in a Tabular form. The sum total of the CPP system has been regarded as indicative of fishery potential of a particular river. Stock assessment was adjudged on the basis of the number of individuals of a particular species sampled at different stations of different rivers, owing to the fact that as per the various indices calculated, the total number of individuals of all species in a sample forms an important part of the formulae (*i.e*. N) used and, obviously, plays an important role in devising species richness,

Table 1: Temporal distribution of Fish species.

Category I (300-500 m above msl)	Category II (500-800 m above msl)	Category III (800 m and above msl)
Puntius chola	*Puntius chola*	*Puntius chola*
Pethia conchonius	*Pethia conchonius*	*Pethia conchonius*
Systomus sarana	*Systomus sarana*	*Puntius sophore*
Puntius sophore	*Puntius sophore*	*Pethia ticto*
Pethia ticto	*Pethia ticto*	*Shizothorax richardsonii*
Puntius terio	*Chagunius chagunio*	*Shizothoracthys progastus*
Chagunius chagunio	*Shizothorax richardsonii*	*Labeo dyocheilus*
Shizothoracthys progastus	*Shizothoracthys progastus*	*Labeo dero*
Labeo dyocheilus	*Labeo dyocheilus*	*Barilius barna*
Labeo pangusia	*Labeo pangusia*	*Barilius bendelisis*
Labeo dero	*Labeo dero*	*Barilius vagra*
Aspidoparia jaya	*Aspidoparia jaya*	*Danio rerio*
Aspidoparia morar	*Aspidoparia morar*	*Devario devario*
Barilius barna	*Barilius barna*	*Esomus danricus*
Barilius bendelisis	*Barilius bendelisis*	*Rasbora daniconius*
Barilius vagra	*Barilius vagra*	*Crossocheilus latius latius*
Barilius tileo	*Barilius tileo*	*Garra gotyla gotyla*
Barilius shacra	*Barilius shacra*	*Tor putitora*
Danio rerio	*Danio rerio*	*Tor tor*
Devario devario	*Devario devario*	*Tor chelynoides*
Esomus danricus	*Esomus danricus*	*Lepidocephalichthys guntea*
Raiamas bola	*Raiamas bola*	*Acanthocobitis botia*
Rasbora daniconius	*Rasbora daniconius*	*Schistura montanus*
Crossocheilus latius latius	*Crossocheilus latius latius*	*Schistura rupecula*
Garra gotyla gotyla	*Garra gotyla gotyla*	*Schistura savona*
Tor putitora	*Tor putitora*	*Glyptothorax pectinopterus*
Tor tor	*Tor tor*	*Glyptothorax saisii*
Lepidocephalichthys guntea	*Lepidocephalichthys guntea*	*Clarias batrachus*
Lepidocephalichthys annandalei	*Acanthocobitis botia*	*Xenentodon cancila*
Acanthocobitis botia	*Schistura montanus*	*Mastacembelus armatus*
Schistura savona	*Schistura rupecula*	*Channa punctatus*
Amblyceps mangois	*Schistura savona*	
Glyptothorax pectinopterus	*Amblyceps mangois*	
Glyptothorax telchitta	*Glyptothorax pectinopterus*	
Clarias batrachus	*Glyptothorax saisii*	
Heteropneustes fossilis	*Clarias batrachus*	
Mystus tengara	*Heteropneustes fossilis*	
Mystus bleekeri	*Mystus tengara*	
Xenentodon cancila	*Mystus bleekeri*	
Macrognathus pancalus	*Xenentodon cancila*	
Mastacembelus armatus	*Macrognathus pancalus*	
Badis badis	*Mastacembelus armatus*	
Colisa fasciatus	*Badis badis*	
Colisa lalius	*Channa punctatus*	
Colisa labiosus	*Channa gachua*	
Channa punctatus		
Channa gachua		
Channa marulius		
Channa harcourtbutleri		

abundance, evenness *etc*. The criteria for stock assessment was centered on 2 types of species, firstly those which are large-sized and supposed to be of considerable food value (Table 4) and secondly those which are usually small-sized but play an important role in food chain as well as their utilization as bait, making pickles by the local inhabitants or considered of some ornamental value (Table 5). For the sake of convenience, top 10 species representing the above referred 2 categories are considered to derive conclusions about 'stock statuses'. The exotic accidental catches are left out of consideration for the said purpose.

Results

Venn diagrams are used to show the number of shared and unique species between Eastern and Western Doon Valley streams (Fig. 3). 41 species (73.21%) are common to East and West, whereas, 13 (*Cyprinus carpio*, *Puntius terio*, *Schizothorachthys progastus*, *Labeo pangusia*, *Barilius tileo*, *Raiamas bola*, *Lepidocephalicthys annandalei*, *Glyptothorax telchitta*, *Mystus tengara*, *Colisa lalia*, *Colisa labiosus*, *Channa marulius* and *Channa harcourtbutleri*) and 2 species (*Barilius shacra* and *Clarias gariepinnus*) are found unique to the Eastern and Western streams, respectively.

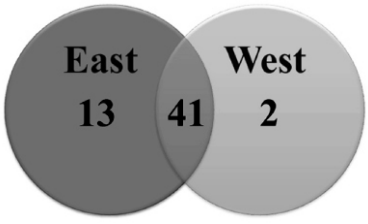

Fig. 3: Number of shared and unique species in Eastern and Western Doon.

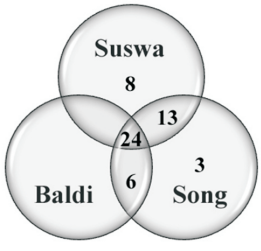

Fig. 4: Number of shared and unique species between streams of Western Doon.

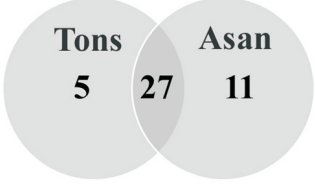

Fig. 5: Number of shared and unique species between streams of Western Doon.

Out of the 13 unique species of the East, maximum number (*i.e*. 8 species) is represented by Suswa (S_{11} - S_{12}).

Venn diagram plotted between 3 streams of Eastern Doon valley *viz*. Baldi, Song and Suswa (Fig. 4) shows that river Baldi shares its entire fish species (*i.e*. 30) with river Song. 24 species are found common between Baldi and Suswa. River Song represented by a total of 46 species had 37 species common with river Suswa whereas 3 species (*Cyprinus carpio*, *Barilius tileo* and *Raiamas bola*) are exclusive to its water of which *Barilius tileo* and *Raiamas bola* are endemic but *Cyprinus carpio* is accidental exotic. River Suswa, shows 24 and 13 species common with river Baldi and Song, respectively, whereas 8 species are exclusive representations, which include the 7 new records *viz*. *Puntius terio* (Hamilton), *Lepidocephalichthys annandalei* Chaudhuri, *Colisa fasciatus* (Bloch and Schneider), *Colisa lalia* (Hamilton), *Colisa labiosus* (Day), *Channa marulius* (Hamilton) and *Channa harcourtbutleri* (Annandale).

Venn diagram plotted for 2 streams of Western Doon valley *viz*., Tons and Asan (Fig. 5) shows that 27 species are common, whereas, 5 (*Tor chelynoides*, *Schistura montanus*, *Schistura rupecula*, *Glyptothorax saisii* and *Clarius gariepinus*) and 11 (*Systomus sarana*, *Puntius sophore*, *Chagunius chagunio*, *Labeo dyocheilus*, *Aspidoparia jaya*, *Aspidoparia morar*, *Barilius shacra*, *Tor tor*, *Amblyceps mangois*, *Mystus bleekeri* and *Colisa fasciatus*) species are exclusive to Tons and Asan, respectively.

On the basis of the collections of fishes from a particular station, located at a particular altitude, the distribution of species was analyzed as per the altitudinal ranges they occupy and put under 3 categories (Table 1).

Table 1 makes it apparent that the downstream sections of the rivers falling under Category I (300-500m amsl) both in the East and West show maximum number of fish representatives as compared to those falling under Category II and Category III. This is attributable to longitudinal, downstream addition of species rather than any sizeable reduction or loss of species. Of the above , Category I and III follow narrow range , the former being in the downstream sections while the latter exclusively at the higher altitudes. Category II has wider range, touching the limits of Category I as well as of Category III (Table 1).

Fishery potential of streams of Doon valley season-wise and station-wise has been evaluated in terms of Calculated Productivity Point system (CPP) values with the help of number of individuals' data. The CPP values have given the idea about the relative absence, rarity and commonness and abundance of fish species. On this basis, the values come out to be maximum for East (*i.e*. 83.5, Table 2) as compared to West (*i.e*. 63.5, Table 3). In East itself, Suswa river showed more CPP values (31.5-83.5) followed by Song (10.5-82.5) and Baldi (20.0-37.0) (Table 2). In West, the maximum CPP values were observed at Asan (16.0 - 63.5) than Tons (12.0-31.0) (Table 3). Increasing trend in CPP values from upstream to downstream stretches (Table 2, 3) has been on

Table 2: Two years' average CPP values of river Eastern streams in different seasons.

River	Stations	Summer	Rainy	Winter
Baldi	S1	27.5	20.0	31.0
	S2	35.5	24.5	37.0
Song	S3	27.5	35.5	26.5
	S4	10.5	24.5	19.5
	S5	31.5	27.5	34.0
	S6	45.0	49.0	44.0
	S7	82.5	66.0	81.5
	S8	65.0	59.0	64.0
Suswa	S9	36.0	35.0	31.5
	S10	35.5	45.0	41.5
	S11	83.5	57.5	83.0
	S12	82.0	80.0	79.0

Table 3: Two years' average CPP values of river Western streams in different seasons.

River	Stations	Summer	Rainy	Winter
Tons	S13	27.5	24.0	28.0
	S14	23.5	24.0	26.0
	S15	30.0	22.0	31.0
	S16	20.0	24.0	12.0
Asan	S17	20.5	16.0	22.0
	S18	27.0	22.5	31.0
	S19	43.5	42.0	41.5
	S20	63.5	43.0	62.5

Table 4: Two Years' mean CPP values of large-sized species of considerable food value.

	Eastern Doon			Western Doon	
	Baldi	**Song**	**Suswa**	**Tons**	**Asan**
Chagunius chagunio	-	11	16	-	7
Shizothorax richardsonii	14	15	-	11.5	7.5
Shizothoracthys progastus	3	11	5.5	-	-
Labeo dyocheilus	4	15.5	8	-	7
Labeo pangusia	-	9.5	6	-	-
Labeo dero	5	17.5	10	7.5	9
Raiamas bola	-	8	-	-	-
Crossocheilus latius latius	5.5	18	15	9	11
Garra gotyla gotyla	6	22	16	9.5	11
Tor putitora	6.5	23	14.5	8.5	11.5
Tor tor	-	21	11	-	7
Tor chelynoides	9	10	-	11.5	-
Glyptothorax pectinopterus	8	21	12	15	11
Clarias batrachus	3	17.5	12	10	9
Heteropneustes fossilis	-	19	13	7	7
Xenentodon cancila	6	24	23	8	10
Macrognathus pancalus	1	23.5	20	9	8
Mastacembelus armatus	4	21	21	6	9
Channa punctatus	3	21	24	11	15
Channa marulius	-	-	4	-	-
Channa harcourtbutleri	-	-	6	-	-

'-' = absence of species.

account of the fact that due to steep gradient more hillstream and coldwater loving fishes dwell in the upstream stretches whereas the fall in steepness slows down stream flow thus establishing conditions for habitation of more variety of fishes in isolated pools, slow running braided channels, weed infested swamps *etc*., (Tables 2 and 3).

The higher values of CPP of fish species observed (Tables 2-3) is also authenticated with the altitudinal pattern observed (Table 1). The downstream sections of the rivers *i.e*. Category I (300-500m amsl) both in the East and West had maximum number of fish representatives as compared to the upstream sections *i.e*. Category II and Category III. This is attributable to longitudinal, downstream addition of species rather than any sizeable reduction or loss of species. The CPP values exhibited an increasing trend beyond rainy months at all the stations, showing peak values during winters (Tables 2-3). This is accountable due mainly to lesser water current, more accumulation of nutrients beyond rainy months. These conditions established more favourable environment for fishes to dwell. However, stations S_4 and S_{16} of Song and Tons river, respectively showed lower values due to the fact that these stretches hold little or almost negligible amount of water through most part of the year.

The stock assessment has been done on the basis of two criteria - large-sized species, supposed to be of considerable food value and small-sized species playing an important role in food chain as well as their utilization as bait, making pickles by the local inhabitants or considered of ornamental value. The two year mean CPP values for large- and small-sized fishes have indicated the status of stock of top 10 species in decreasing order as follows:

Large-sized species: *Xenentodon cancila>Channa punctatus>Macrognathus pancalus>Tor putitora>Garra gotyla gotyla>Tor tor>Glyptothorax pectinopterus> Mastacembelus armatus>Heteropneustes fossilis* and *Crossocheilus latius latius* (Table 4). Small-sized species: *Barilius bendelisis>Lepidocephalichthys guntea> Acanthocobitis botia>Barilius vagra> Pethia conchonius > Pethia ticto >Amblyceps mangois>Badis badis>Barilius barna >Rasbora daniconius* and *Channa gachua* (Table 5).

The evaluation of the stocks (according to the number of individuals collected/observed) of the large-sized and small-sized fishes categorically indicate about the domination of species having carnivorous/ insectivorous/piscivorous tendencies. From amongst the large-sized fishes, the maximum stock showing *Xenentodon cancila* is purely piscivorous/crustivorous (feeding on small *Macrobrachium* sp.), a contention strengthened by the fact that the sampling stations where the stock of *Xenentodon cancila* was maximum (S_7, S_{11}, S_{20} *etc*.) were simultaneously dominated by small species like *Pethia conchonius*, *Pethia ticto*, *Barilius* sp. (youngs), *Rasbora daniconius*, *Esomus danricus*, *Devario devario*, *etc*., forming the possible food commodity for *Xenentodon cancila*. Interestingly, the stocks of large-sized species next in order *Channa punctatus*, *Heteropneustes fossilis,* are indicative of the fact that in due course of time, the habitat conditions of Doon Valley streams have changed

Table 5: Two Years' mean CPP values of small-sized species.

	East			West	
	Baldi	**Song**	**Suswa**	**Tons**	**Asan**
Puntius chola	-	11.5	12	3.5	9
Pethia conchonius	2.5	22.5	27	10.5	19
Systomus sarana	-	13	16.5	-	10
Puntius sophore	1.5	12	9	-	8.5
Pethia ticto	5.5	21.5	24	9.5	18.5
Puntius terio	-	-	3	-	-
Aspidoparia jaya	-	10.5	10	-	8.5
Aspidoparia morar	-	17.5	19	-	12.5
Barilius barna	4.5	20	22	10	12
Barilius bendelisis	17	37	31	16	19
Barilius vagra	12	31	26	14	18
Barilius tileo	-	17	-	-	-
Barilius shacra	-	-	-	-	7
Danio rerio	2	16.5	17	8	13
Devario devario	3	20.5	17	6	14
Esomus danricus	3	17	18	5	10
Rasbora daniconius	2.5	21	19	8	13
Lepidocephalichthys guntea	10	33	28	16	18
Lepidocephalichthys annandalei	-	-	-	-	-
Acanthocobitis botia	10	33	28	13	20
Schistura montanus	6	6	-	8	-
Schistura rupecula	6	8	-	9	-
Schistura savona	6	7	-	7	14.5
Amblyceps mangois	-	23.5	17	-	16.5
Glyptothorax saisii	6	9	-	6	-
Glyptothorax telchitta	-	-	3	-	-
Mystus tengara	-	9	8	-	-
Mystus bleekeri	-	9	7	-	6
Badis badis	-	19	23	8	15
Colisa fasciatus	-	-	16	-	6
Colisa lalius	-	-	9	-	-
Colisa labiosus		-	16	-	-
Channa gachua		14	21	8	7

'-' = absence of species.

in a manner as reflecting on the water quality, and inturn on the biota subsisting there. Against the fundamental norms, the stock of first consumer large-sized fish species (*i.e*., herbivorous) indicated a declining trend as supported by the number of individuals collected/observed *e.g*., those of *Garra gotyla gotyla*, *Crossocheilus latius latius*, *Labeo* sp., *Schizothorax richardsonii*, *Schizothorachthys progastus etc*., governed by 2 possible reasons, *viz*., firstly, some of them are de-limited by a particular altitudinal range, having relatively cold-water and rhithronic conditions (S_1, S_2, S_3, S_4, S_{13}, S_{14}). High altitude ranges (800-1000 m above msl) were found dominated by *Shizothorax richardsonii*, *Tor chelynoides* and *Schistura* sp. secondly, other species like *Garra gotyla gotyla*, *Crossocheilus latius latius*, *etc*., have been the dominating omnivorous stocks uniformly distributed along various stretches. Surprisingly, the stock of purely herbivorous species like *Labeo* sp., *Tor* sp., was observed to be at the lowest ebb, a condition not to be accepted for healthy aquatic ecosystem where the number of the herbivores should come out next to the producers as far as their number is concerned. This whole situation very well speaks of altered ecological conditions supporting hardy fishes (*Channa* sp., *Heteropneustes fossilis*, *Mastacembelus armatus*, *Macrognathus pancalus*) more than the clean water-loving delicate species. The mirror image of the above-referred facts can be looked into through the stocks verified for small-sized fishes, mostly having carnivorous/insectivorous/zooplanktivorous tendencies (*Puntius* sp., *Devario devario*, *Barilius* sp. *Colisa* sp.,), the herbivorous stocks (*Puntius sophore*, *Puntius chola*, *Rasbora daniconius*, *Esomus danricus*, *etc.*) being at the lowest level and occupying either isolated pools/puddles (S_8, S_{12}) or venturing to weedy/ marshy (S_8, $S_{12,}$ S_{20}) grounds where large-sized carnivorous/predatory fishes reside. The dominating stocks of *Lepidocephalichthys guntea* and *Acanthocobitis botia* (Table 5) amongst the small-sized ones, is owing to their bottom-dwelling uniform occurrence at almost all the sampling stations.

Discussion

Of late, there has been a practice to use Venn diagrams to visually depict the number of shared and unique species (Atkore *et al*., 2011) in different rivers of Eastern and Western Doon. In the present observations, majority of species (41) appeared common to both East and West (Fig. 3) and the maximum were unique to East (13) as compared to West where only 2 species were adjudged unique (but of these 2, the number may be reduced to 1 as *C. gariepinus*, from S_{15} is an exotic accidental catch).River-wise shared and unique species analysis from Eastern Doon (Fig. 4) indicates that all the 30 species from Baldi are shared (no unique species) with Song and Suswa but all 8 unique from Suswa include 7 new records. The least number of unique species from Song (*i.e*. 3) may be reduced to 2 (*Barilius tileo* and *Raiamas bola*) leaving apart *Cyprinus carpio* which is an exotic accidental catch from S_7.Maximum sharing (27 species) is also evident in the West (Fig. 5) with Asan recording 11 and Tons recording 5 unique species. The number of unique species from Tons may be reduced to 4 if exotic *C. gariepinus* is left out of consideration. The temporal distributional analysis has been done on the basis of the altitudinal location of sampling stations from where the fishes have been collected. On the basis of altitudinal ranges, an attempt has been made to categories (Table 1). The results show that Categories II and III are represented by the least number of species, whereas Category I both in the East and West show maximum number of fish representatives accountable mainly due to downstream addition of species (Table 1). The altitudinal distributional considerations have also earlier been attempted by Nautiyal (2001); Johal *et al*. (2001); Sharma and Mishra (2001); Uniyal and Kumar (2006) and Negi and Negi (2010), *etc.* The categorization of fish species, as per different altitudes, follows the trend adopted by Johal *et al*. (2001). Category III outlined here is equivalent to that earlier named as Mahseer zone by Singh *et al*. (1991) and torrential- stenothermal and placid-eurythermal- springfed by Nautiyal (2001) and Sharma and Mishra (2001). Uniyal and Kumar (2006) while working on the fishes of Asan set up the stations at altitudes and the fishes collected from these stations can be very well correlated with almost similar altitudinal range as has been observed here.

For the present study, CPP based on fish diversity was used arrive at any conclusion regarding the fishery potential of individual streams. On this basis, the values come out to be maximum in the East as compared to West, thus giving an indication that the former is more productive than the later. In the East itself, Suswa river emerges out to be the most productive followed by Song and Asan (Table 2). The present findings based on CPP for estimating fish potential give firm footing to the conclusions drawn by Dobriyal and Singh (1988).

When the present findings are wished to be evaluated in the light of the earlier works done in Doon valley and Garhwal and Kumaun Himalayas, unhesitatingly it can be said that no earlier work defines clearly about the fishery potential, except the works of Sharma (1991); Singh *et al*. (1991); Uniyal *et al*. (2002). Uniyal *et al*. (2002) who used the term 'fishery potential' but with a different view point. Their contention simply rested on giving classified list of fishes, CAMP status of fishes and giving suggestions on improving fish diversity. Sharma (1991) and Singh *et al*. (1991) also used the term 'Fishery Potential' while revelations made in the aforesaid works do not point at all towards fishery potential in terms of mathematical evaluations as for example done here by calculating CPP on the basis of fish diversity. There has been a keen interest among workers to work out fishery potential of any pond/lake/stream/reservoir/marine environment *etc*., by adopting various methods like fish catch per unit effort (Singh *et al*., 1991; Sharma, 1991; Sharma and Mishra, 2001; Uniyal *et al*., 2002), working out abundance on the basis of landing data and prices (Katiha *et al*., 1998), on the basis of percentage composition (Sharma and Mishra, 2001), Calculated Productivity Point System, CPP (Dobriyal and Singh, 1988) *etc*.

For the present study, CPP based on fish diversity appeared convenient to arriving at any conclusion regarding the fishery potential of individual streams. In this context, there is no denying of the fact that net-based CPUE could not be standardized because of the topography and accessibility of various parts of the rivers. Simultaneously, the catches by cast net could not be equated with those by mosquito-net made drag-net or gill-net. For the same reason of using CPUE criteria, abundance index method was also not deemed fit because of difficulty in deciding fishing unit (FU) as uniform for all sampling stations and also on account of the fact that FU is defined as the unit time (20 minutes) a gill-net of a particular mesh size is set in water, excluding the time spent for spreading and hauling the net. With the involvement of so much practically possible limitations in the aforesaid method of Abundance Index, the use of CPP seemed more appropriate and practically possible in any kind of ecosystem being studied from fish faunal diversity and potential point of view. The interest of various fishery workers also rests on working out the stock status in the aquatic ecosystem of their liking, whether the stock of a particular fish or various species inhabiting the ecosystem is to be assessed (Gajbhiye *et al*., 1994). As far as Doon valley and Western Himalayan region is concerned, stock assessing works may be cited are those of Joshi (1980), Sharma and Mishra (2001). Of all these works, the major tactics involved was to assess the stock on the basis of catch composition, which obviously is dependent on type of gear and crafts used. As has been elaborated under the discussion of fishery potential, CPP system has been found more convenient in assessing the stock, also. It is worth mentioning that no earlier attempt has done stock assessment on the basis of CPP. Using CPP for stock evaluation, the entire fish fauna can be split into 2 categories *i.e*., large-sized species of considerable food value (Table 4) and small-sized trash species (Table 5), of which the stock of small-sized species comes out to be more as compared to the large-sized ones. The domination of stock of small-sized fishes is also the content of the conclusion drawn in the studies conducted by Lakra *et al*. (2010) on river in Ganga basin. The possible reason attributable to this condition is the lesser holding capacity of deeper riverine regions, the favourable living and hunting grounds of large-sized fishes. Further, the stock of

carnivorous/insectivorous/piscivorous species shows clear cut domination over omnivorous or herbivorous species, as has also been observed by Das (2007) and Sarkar *et al*. (2010). A slight deviation from this has been observed by Fu *et al*. (2003), Das and Chakravarty (2007) and Lakra *et al*. (2010) who observed the dominance of omnivorous over carnivorous, herbivorous and planktivorous species. From the aforesaid and present observations, one thing becomes obvious that, as per the fundamentals, the trophic structure does not begin with herbivorous/ planktivorous species. The conclusions drawn herein indicate about the changes in the ecosystem, which support species tolerant to degradation (anthropogenic) and able to consume food of animal origin or a whole wide variety of sources in a changing ecosystem (Wilchert and Rapport, 1998). Not to be emphasized here that, in majority of rivers, the post-monsoon scenario of trickling streams (S_4, S_{16}) isolated braided channels (S_{12}, S_{15}), side pools and puddles (S_8, S_{12}), marshy conditions *etc*., support a variety of small-sized species. From amongst the top 10 large- and small-sized species, *Xenentodon cancila* tops the list of large-sized whereas *Barilius bendelisis* tops the list of stock of small-sized species.

दून घाटी, देहरादून, उत्तराखण्ड की मछली प्रजातियों का वर्गीकरणात्मक विश्लेषण, मत्स्य-क्षेत्र क्षमता तथा स्टॉक मूल्यांकन

दीपाली राणा, एस.के. गुप्ता एवं राहुल राणा

सारांश

पूर्वी और पश्चिमी दून घाटी में 5 नदियों (बाल्दी, सौंग, सुसवा, टौंस और आसन) के 20 प्रतिचयन स्टेशन सैटों में दो साल की अवधि के लिए दून घाटी की मछली प्रजातियों का वर्गीकरणात्मक विश्लेषण, मत्स्य क्षेत्र क्षमता एवं स्टॉक मूल्यांकन को विश्लेषित किया गया। वर्तमान अन्वेषण के दौरान 5 गणों, 13 कुलों और 30 वंश से संबंधित कुल 56 प्रजातियों को अभिलिखित किया गया। पूर्वी तथा पश्चिमी दून के लिए पृथक रूप से हिस्सेदार एवं विलक्षण प्रजातियों की संख्या दर्शाने के लिए वन डायग्राम का उपयोग करके स्थानिक (= क्षैतिज वितरण) की मुख्य-मुख्य बातें बताई गई। पूर्व और पश्चिम के बीच 41 प्रजातियां (73.21%) सामान्य हैं, जबकि पूर्वी एवं पश्चिमी सरिताओं के लिए क्रमशः 13 और 2 प्रजातियों को विलक्षण पाया गया। पूर्व में, बाल्दी नदी अपनी सभी प्रजातियों (30) का सौंग नदी के साथ बांटती है। बाल्दी एवं सौंग के बीच 4 प्रजातियां सामान्य हैं। सौंग नदी से 46 प्रजातियों में से 37 प्रजातियां सुसवा के साथ आम हैं। नदी सुसवा बाल्दी एवं सौंग नदी के साथ क्रमशः 24 और 13 प्रजातियों को आम दर्शाती है, जबकि 8 प्रजातियों का एकमात्र प्रतिनिधित्व हैं, जिसमें 7 नए अभिलेख शामिल हैं। पश्चिम में, टौंस और आसन में 27 प्रजातियां समान हैं जबकि 5 और 11 प्रजातियां क्रमशः टौंस और आसन के लिए विशिष्ट हैं। मछलियों द्वारा अधिवासित उन्नतांशीय रेंजों के अनुसार अल्पकालिक वितरण विश्लेषित किया गया। श्रेणी I (300-500 मी औसत समुद्र तल से ऊपर) ने पूर्व और पश्चिम दोनों में श्रेणी II और श्रेणी III के अन्तर्गत आने वालों की तुलना में मछली प्रतिनिधित्व की अधिकतम संख्या दर्शाई। दून घाटी की सरिताओं की मत्स्य क्षेत्र क्षमता को परिकलित उत्पादकता प्वांइट प्रणाली मानों (सी पी पी) के संदर्भ में मौसमवार तथा स्टेशनवार मूल्यांकित किया गया। पश्चिम की तुलना में पूर्व के लिए मान अधिकतम प्राप्त हुए। पूर्व में, सुसवा नदी ने ज्यादा परिकलित उत्पादकता प्वांइट मान दर्शाया इसके बाद सौंग एवं बाल्दी में रहा। पश्चिम में, आसन में अधिकतम परिकलित उत्पादकता प्वांइट (सी पी पी) मान प्रेक्षित किया गया। प्रतिस्रोत से अनुस्रोत खण्डों तक परिकलित उत्पादकता प्वांइट मानों में वर्धमान रूझान था।

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