

Fishing methods in upper Ganga River system of Central Himalaya, India

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Abstract

Present study on fishing methods in the upper Ganga River system was conducted during the period 2010-2012. Upper Ganga river system consists of two major rivers basins viz. Alaknanda and Bhagirathi rivers and number of their 1st and 2nd order tributaries which flows through Garhwal region (Central Himalaya). This large network of fluvial water resources harbours rich Ichthyofaunal diversity. The varied potential of fish resources from these water bodies permits the utilization of wide array of fishing methods. Most of the fishing methods of the Garhwal region are primitive, based on indigenous traditional knowledge and well suited to turbulent nature of the streams. In present study eighteen fishing methods and gears have been documented from the upper Ganga River system. Study observed season, habitat and species specificity of the fishing methods. The utilization of crude and unscientific fishing methods is frequent in the streams of remote areas resulting into decline in fish resource. All the fishing methods employed in upper Ganga River system are classified into four types. The classification is based on their utilisation up to the level which will allow the sustainable harvesting and proper management of valuable fish resources.

Keywords: Fishing methods, hill streams, Central Himalaya, Ganga River system

INTRODUCTION

The upper Ganga River system lies in Garhwal region (Latitude 29°26' to 31°28' N; Longitude 77°49' to 86°06' E) of central Himalaya with total geographical area of 30,090 sq. Km (Nautiyal *et al.* 1993). The Alaknanda and Bhagirathi rivers are two major drainage systems constituting the upper Ganga River system with some of their important glacial fed and spring fed tributaries viz. Mandakini, Nandakini, Pinder, Birahi, Dhauliganga, Bhilangana, Assiganga, Takoli, Khanda etc. draining from high mountains to the foot hills (Singh and Agarwal 2013). This vast drainage network endows rich diversity of fishes providing livelihood for large number of people living in remote hilly areas of Garhwal. However, a sharp decline in the fishery resources are experienced in past few year (Agarwal and Singh 2009, Agarwal *et al.* 2011). This decline of fishery resources in the rivers and

streams of upper Ganga River system is largely by the habitat degradation and unsustainable exploitation by the use of some traditional, unscientific fishing methods and gears. The ever-increasing human population is the main cause of illegal and irrational high fishing pressure on the aquatic ecosystems. Fishing effort has been intensified without considering the size and species of fish. Such activities not only degrade the target fish population by changing the population size and structure, but also affect other species linked to it in the food chain. The pattern and regulation of fishing methods and gears varies depending on the target species, fishing ground, climate and water velocity. The torrential water bodies with high water velocity in hills had specificity to allow some of the traditional methods which are ineffective in slow moving water bodies of plains. Thus there is need to study nature of various traditional fishing methods employed in these torrential

waters, their way of operation and impact on fish resources that may lead to selective fishing for their proper management. The fishing methods employed in various hilly regions of India have been described from time to time (Srivastava *et al.* 2002, Gurumayam and Choudhary 2009, Pravin *et al.* 2011, Devi *et al.* 2013). The fishing methods used in rivers and streams of Garhwal Himalaya is poorly worked out (Badola and Singh 1977, Dobriyal *et al.* 1992, Nautiyal and Lal 1994). The present study is made to study thoroughly, the various indigenous traditional fishing methods operated in upper Ganga River system of Garhwal with their specificity to season, species and habitat type.

METHODOLOGY

The study was focused in the upper Ganga River system (Figure 1) for the period 2010-2012. Extensive field survey was conducted for the gathering of primary data. Information regarding the indigenous traditional fishing methods, their nature, operation and regulation, catch composition encountered with them was collected through personal interview and detailed discussion with local fishermen as well as resident of different areas. The information collected during the field survey was then compared with secondary data from various sources. Different fishing methods employed were also photographed.

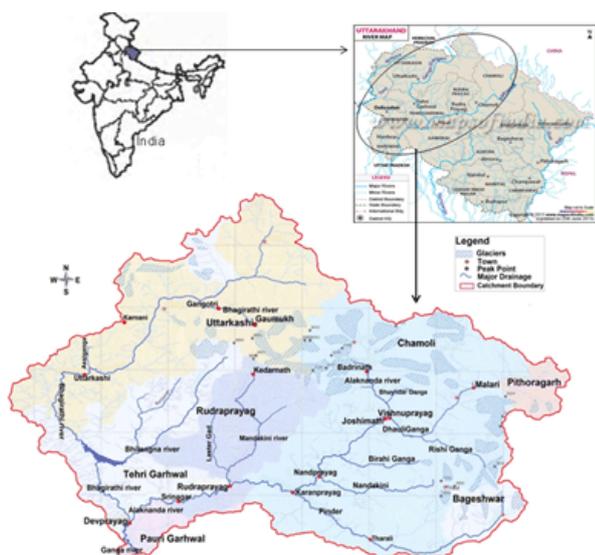


Figure 1: Map showing the upper Ganga River system

After collection of primary data various fishing methods operated in the streams and rivers of upper Ganga River systems were classified into various categories. Species, season and habitat specificity of different fishing methods was also observed during the survey period.

RESULTS AND DISCUSSION

Most of the fishing methods employed in rivers and streams of upper Ganga River system are traditional and simple but very well suited to turbulent nature of these hill streams. Screening of literature revealed that some of the traditional methods operated in the study area are also utilised in hilly streams of other areas in Indian uplands with slight modification in the fabrication of gears and their operation (Srivastava *et al.* 2002, Gurumayam and Choudhary 2009, Pravin *et al.* 2011, Devi *et al.* 2013). Different fishing methods observed during study have been broadly classified as conventional, commercial, destructive and recreational fishing methods. The most of the fishing methods are season, species and habitat specific and are also categorically described in Table 1.

1. Conventional fishing methods

Various conventional fishing methods were frequently used in the rivers and streams of upper Ganga River system and were predominantly used to catch fishes for domestic consumption and not as a profession. Most of the methods under this category were eco-friendly while some of them were destructive too. The application of these methods depends on behaviour, abundance and habitat use by the fishes (Srivastava *et al.* 2002). Efficiency of these methods is also related to the season, locations and type of the stream.

1.1 Barricade: This method is also called as Maze or Bamboo trap. The design of this trap varies according to river geometry. It may be conical, cylindrical or basket type made up of bamboo sticks. The main principle of this method is to trap the fish in a cage. For luring the fish, any type of bait is kept inside the trap. The trap is installed in small streams for short or long duration preferably in evening hours and left for overnight. The lured fish coming to bait cannot escape from the cage, hence get entrapped. After sometime the cage is drawn out of the river with entrapped fishes.

1.2 Fatiyala: It is a rectangular shaped net made up of strings attached with two sticks. During the operation it seems as triangular net as its one side is kept close. It is about 1 meter long and 60-70 cm wide. The open rim of net has 30-50 iron beads for dipping. During the operation time, fisherman holds both the sticks of net in his hand and moves the net in water to collect fishes. The net is closed from one side to form a pouch and the fishes get collected in this pouch. The method is used in the shallow turbid water to catch small sized fishes. After applying of poisonous herbs mixed with mud, making water very much turbid, this method is frequently employed. This method was also observed

very commonly used in Aglar stream of river Yamuna during traditional fish festival 'Maund mella' in Uttarkashi district of Garhwal region (Figure 2).



Figure 2: Fatiyala

1.3 Goda: It is an old traditional but very effective method commonly used in the small, torrential streams viz. Assiganga, Henwal, Balkilla, Bal Ganga, Nail Chami, Laster etc. The 'Goda' is made up of bamboo strips or fabricated from locally available spiny or non spiny shrubs. It has a conical mouth with length ranging from 1.0-1.5 m and opening diameter 30-50 cm. The 'Goda' is kept at a place dominated by boulders with fast moving water where artificially diverted or natural current fall from a high level through a narrow single drainage. The fishes migrating either for spawning or feeding or locally up and down moving, get entrapped in the Goda. Entrapped fishes are unable to escape from the trap due to fast current of falling water and incurved strips and weeds. Goda is generally fixed during night time and the drawn out during morning hours with number of large and small sized fishes. Mostly *Tor*, *Schizothorax*, and *Barilius* are found trapped in the Goda (Figure 3).



Figure 3: Goda

1.4 Hammering: In the streams of high gradient and velocity, many fishes get their shelter underneath the stones and boulders. In such locations hammering method is highly effective. In this method a big stone or a hammer (locally called as 'ghun') is stroked with full force over the stone or boulder. The fishes hiding underneath stone or boulder either gets killed or injured and float on the surface of water. The floating fishes are collected easily with the hands. This method is highly effective during summer and winter months when level of water is less in small shallow streams because striking may not be so effective in deep water (Figure 4).



Figure 4: Hammering

1.5 Hand picking: This is a traditional and highly skilled method used in shallow streams when the water level is very less. In this method the fisherman follow the moving fishes and when the fishes get hide under the stone, fisherman insert their hand swiftly under the stone or boulders and catch the hiding fishes. Only a skilled man uses this technique of fishing. This method is generally used to catch *Pseudecheneis*, *Glyptothorax*, *Barilius* and some *Noemacheilus*. Several time children may be observed using this method of fishing in shallow streams having stones and boulders (Figure 5).



Figure 5: Hand picking

1.6 Kandayala: It is a locally fabricated conical shaped elongated net (Figure 6). 'Kandayala' net is about 2.0-3.0 m long with a bag like structure behind. It has a wide mouth with diameter ranging from 40-60 cm which gets narrow towards the tail. The rounded mouth shape is adjusted using the sticks. This net is effective mostly when the stream water is highly turbid. To catch fishes net is fixed in stream. Fishes moving in the turbid water enter into it and due to water flow can't come outside from the long tail of the net. After sometime, net is taken out of stream with number of fishes. This method is used in typical stream habitat (run, riffle and rapid types of stream habitats).



Figure 6: Fishing with Kandayala (left) and a Kandayala (right)

1.7 Mosquito net: This is also one of the traditional fishing methods used by local peoples in which mosquito net or fine meshed cloth is used to catch fishes. Two men hold the two ends of net on one side of stream, while third person standing in the opposite direction disturbs the water and fishes to move towards the net. After gathering of sufficient number of fishes over the net, the latter is lifted up and fishes get collected. This method is not vastly successive as fish catch is very low. It is used in the shallow stream with low velocity in pool type of habitat.

1.8 Pot/thali method: Pot method is used in the shallow water bodies, mostly in rivulets during summer and winter seasons. In the foot hill of Dehradun this method is known as Katori method (Uniyal and Kumar 2006). In this method a shallow or somewhat deep utensil which may be bowl, plate, thali or any other pot is used. The mouth of this pot is covered by a thin cloth either with a single or 5-10 holes depending on the diameter of the pot mouth. Bait of wheat flour or rice is sprinkled near the holes and also on the bottom of utensil. The pot is then placed at the bottom of slow moving stream. The smaller fishes swimming near the bank of river assembles around the pot for consuming the flour and also voluntarily enters inside the pot through the holes. After some time pot is removed from the stream and number of fishes are collected. This method is used to catch small sized fishes viz. *Barilius* and fingerling of *Schizothorax* spp (Figure 7).



Figure 7: Pot or thali

2. Commercial Fishing Methods

The commercial fishery in upper hilly regions is limited but people do fishing for own consumption and up to certain extent to meet their daily economic needs. However, fishermen in the foothills of Garhwal region have authorised licence for fishing and thus do commercial fishery on the large scale. Fishing methods used for commercial purpose are operated both in day as well as night time. The baur and gill net are fixed overnight and recovered during early morning hours with large number of fishes while atwal, cast net, hooks and water diversion methods are operated during the day time. Most of these commercial fishing methods will not pose any threat to the fish stock if practised with limitations (Srivastava *et al.* 2002). However the fishermen ever try to over exploit these fishery resources.

2.1 Atwal: It is also a common traditional method, somewhat similar to baur method except the use of long wood rod in this method. Atwal (Figure 8) consists of long nylon cord or a string on which number (20-30) of nylon fibrous loops of varying size are present. The diameter of loops present on string varies from 2-6 cm. The nylon cord is attached with long wooden rod to control the net. To catch fish, the *Atwal* is thrown into deep water slipping over the corner of the wooden rod with its one end kept in hand for pulling out the net at the time entangling of fish. Stone may be tied with loop for proper dipping of net. Fishes of both small and large size are captured with this method. This method is used in all seasons and varying habitat types.

2.2 Baur: Baur (Figure 9) is most common traditional method also known as 'Phans' or 'Fandi'. It is most frequently used and very effective method operated in the hill stream of Garhwal. Similar method is defined by another name suraka operated in Kumaon region (Srivastava *et al.* 2002). The 'Baur' consists of a thick nylon string bearing 15-25 loops of fine nylon thread

tyed at regular intervals of 15-20 cm. These loops are made in such a way that knot of the loop can easily slip to reduce the diameter of loop to tighten the fish. The length of rope varies from 3-6 meter while the diameter of fibrous loops varies from 3-8 cm. Small stones are tied after each 5-6 loops, which act as sinker. The baur is fastened to submerged rocks on both ends across the stream. The fishes moving up and down of stream get entangled in the loops of baur. When the fish try to passes through the loops, by the activity of their fins the loops starts narrowing ultimately entangles the fish. The baur is used in riffle, run and rapid habitat with fast water. Number of baur are fixed during the night time and recovered during early hours with large number of fishes. The method is very efficient for catching the bottom dwelling fishes mainly *Schizothorax*, *Schizothoraichthys*, *Garra*, *Glyptothorax*, *Pseudecheneis*, *Crossocheilus* spp.



Figure 8: Atwal



Figure 9: Baur/Phans

2.3 Cast net: Cast net (Figure 10) is commonly known as jaal . In the eastern part of India (Arunachal Pradesh) it is known as Esaap (Chaudhuri *et al.* 2008). It is a circular net and is widely used fishing gear across the country. The operation of this net is successive in all type of water bodies and varying habitat. In upper Ganga River system it is used in shallow section of slow moving

streams. The cast net is made up of strings with a circular rim. The rim is weighted by about 100 metallic beads for the quick sinking and to withstand fast currents. The diameter of cast net used in the study area range from 1-2 m with mesh size 1-5 cm. To catch fishes fishermen throws their net moving upwards from down in the stream and catch them after several attempts. While operating this method, sometimes the fishermen keep bait (flour, cow dung etc.) in somewhat deep stream to attract large number of fishes. After accumulating of number of fishes the fishermen throws their net over that place and number of fishes gets trapped in a single throw. Whereas occasionally fishermen disturb the boulder after throwing net, fishes coming out of boulder get entrapped. Cast net is used mainly in shallow and turbid water. It is used by individual fisherman and the returns of this method are poor.



Figure 10: Cast net

2.4 Gill net: Gill net (Figure 11) is locally known as Mahajaal. It is most widely used fishing method throughout India, due to simplicity in its operation and fabrication. In Manipur state this method is known as Lang method (Devi *et al.* 2013). It is a single wall rectangular net made up of polyamide (nylon monofilament). The gill net operated in the stream of upper Ganga River system has length varying from 5.0-10 m depending on width of stream with mesh size varying from 5.0-8.0 cm and height 40-50 cm depending on stream depth. To catch the fish net is spread across the stream by means of rope fastened at the banks. In the deep stream air filled tubes are also used for fixing of net. The gill net is used mainly during evening and morning hours or sometime net is fixed overnight and recovered in early morning. The fishes moving up and down in the stream get entrapped in spread net. This method is very effective and operated in pool and run and sometime riffle habitat resulting into capture of large number of fishes. Fishes viz. *Barilius*, *Tor*, *Schizothorax*, *Schizothoraichthys*, *Crossocheilus* and

Garra spp. are captured with this method. This method is used in almost all seasons except during heavy monsoon. However, Nautiyal and Lal (1994) have used atwal as synonym for the gill net not differentiating both of these different methods in their operation as well as fabrication.



Figure 11: Gill net

2.5 Water diversion: This method is commonly used in study area and is applicable only in small streams. In this method stream water is diverted to artificial course by blocking it with mud, boulders, sand, logs, clay or any available materials. Diverted water accumulates there in the pools of artificial channel. Fishes entering into pools along with diverted water are caught usually by draining out the water from pools. This method is used in fast flowing water of stream where fishes may also be moved with high water flow.

3. Recreational Fishing Methods

Peoples are also engaged in fishing for their entertainment in some streams of upper Ganga river system. Angling was started in first half of twentieth century by the introduction of brown trout and rainbow trout in the upland waters (Sehgal 1999). The best known sport fishes are *Tor* and *Salmo* spp. Exotic trout *Salmo trutta fario* was introduced in Dodital Lake by Britishers in 1869. Now it is well acclimatized in Assiganga stream and Dodital Lake. The fishing for the recreational purpose is allowed strictly underlines the catch and release policy. Fishing with barbless hooks is recommended to avoid tissue damage. Landing nets are also provided for this purpose.

3.1 Hook and line: Hook and line (Figure 12) method is simplest fishing method, which consists of a hook connected with line with or without bait. This method can be practised by anyone with minimum skill in fluvial as well as stagnant water. Hook is generally made up of copper or iron tied with nylon string. Sometime more than one hook (5-10 hooks) may also be used by the

fisherman. The bait is offered with hook to entice the fish, which can be lifted thereafter. Bait (wet flour, rice bran, earthworm and nymph of beetle or small fishes) is attached on the tip of hook, which is then thrown into water for 1-2 hours or sometime for a long time. Fishes attracted engulf the hook with bait. The Hook get intrude in the buccal cavity of fish which is hanged on hook and cannot escape and is pulled out soon. This method is used throughout the year by local people for enjoying the fishing. The *Tor*, *Schizothorax* and *Salmo* spp. are mainly caught by this method. However, sometime *Barilius*, *Mastacembelus*, *Glyptothorax*, *Pseudecheneis* spp. are also caught.



Figure 12: Hook and line

4. Destructive Fishing Methods

To cope up with ever-increasing human population and advancement in technology, aquatic ecosystems are exploited continuously by high, illegal and irrational fishing. This irrational fishing will yield more fishes in less time with very little efforts. These fishing efforts have been intensified without considering the size and species of fish. Such destructive activities indiscriminately kill not only the target fish population but the entire life stages of fishes along with entire aquatic organisms. These fishing methods are used for large scale commercial purposes. Destructive fishing methods observed in the study area during present study period includes:

4.1 Bleaching powder: Bleaching powder generally used for purification of drinking water is easily available in the market. It is commonly used method to kill the fishes using bleaching powder and is effective in stagnant or semi stagnant water. This method is used when the total water discharge in stream is low (winter and summer). To kill the fishes, bleaching powder is mixed in water in large quantity. Due to its toxicity large number of fishes including their juvenile and fingerlings stages gets killed soon after its application, which comes to the water surface. Floating fishes are collected

easily with hands. Despite fishes other aquatic flora and fauna is also affected seriously.

4.2 Dynamite: This is most common fishing method used not only in the streams of upper Ganga river system but in most of north eastern states of India. It is crudest technique of fishing in which explosives are used. Dynamite is acquired by fishermen from road construction organisations. In this technique explosives are wrapped in polythene, lighting and then throwing it amidst the deep stream pool or riffle site having plenty of fishes. Due to terrific sound of explosive, large number of fishes (including fry, fingerlings, and juveniles) get killed or paralysed in very short span of time, which comes to the water surface and are collected with hands. This method is applicable throughout the year in all seasons. It is used for large scale fishing in a short time span and is considerably responsible for decline in fish abundance and diversity.

4.3 Electric current: This is modern developing technique for fishing observed in the study area. In this method electric wire is connected to the main power on electric pole or sometimes connected to the portable generator. Wire is then passed along the river bank and is connected with naked wire dipped in the stream water. As the current is passed to the stream, electric field is developed up to certain distance in the stream. In the region of electric field all the fishes (fry, fingerlings, juvenile and brooder) either get killed or paralysed, which later on float on the water surface and easy to catch with hands. The fishes which escape netting by hiding under the rocks are caught easily using electric current. Many necessary precautions are needed for applying the electric current. This method is also considerably responsible for destruction of fish population.

4.4 Poisonous plant extracts: Fishing with poisonous plant extracts is also very common method which includes the use of some ichthyotoxic plant. Use of ichthyotoxic plants were frequently observed, these include: Timru (*Xanthoxylum* sp.), Sulla (*Euphorbia* sp.), Rambans (*Agave americana*), Mainu (*Randia* sp.), Ghass (*Polygonum* sp.), Khinna (*Sapium* sp.), Jamun (*Syzygium* sp.). On the other hand, Negi and Kanwal (2009) described 13 plants, which are significantly utilised as fish toxicant in the streams and rivers of Garhwal Himalaya. In this method mainly plant leaves and bark are used which are grinded well. Thereafter it is applied directly into stream water in large quantity, due to which stream water becomes much turbid. Fishes either become unconscious or get killed and float on the surface water, which are collected using locally fabricated Kandayala and Fatiyala nets.

Table 1: Species and season specificity of different fishing methods

Fishing methods	Area of operation	Season of operation	Catch composition
Conventional methods			
Barricade	Shallow torrential streams in rapids & run habitat	S,W,A	Species which keeps moving up and down in the stream viz. <i>Tor</i> , <i>Barilius</i> , <i>Schizothorax</i>
Fatyalala	Small stream in pool, riffle & rapids habitat	S,W	Paralysed fish from the river bank <i>Barilius</i> , <i>Tor</i> , <i>Garra</i> , <i>Schizothoraichthys</i> , <i>Schizothorax</i> , <i>Noemacheilus</i> , <i>Glyptothorax</i> , <i>Pseudecheneis</i> spp.
Goda	Small torrential streams in rapids, runs & falls habitat	S,W,A	<i>Tor</i> , <i>Barilius</i> , <i>Schizothorax</i> and <i>Schizothoraichthys</i> , spp.
Hammering	Shallow streams in pools & riffles habitat	S,W	<i>Schizothorax</i> , <i>Glyptothorax</i> , <i>Pseudecheneis</i> , <i>Tor</i> and <i>Noemacheilus</i> spp.
Hand picking	Shallow streams in pools & riffles	S,A	<i>Barilius</i> , <i>Noemacheilus</i> , <i>Glyptothorax</i> , <i>Pseudecheneis</i> spp.
Kandayala	Torrential rivers in riffles & rapids habitat	M,A	All the fish species paralysed by using poisons
Mosquito net	Small streams in pools & riffles habitat	S,W	Fingerlings stages of <i>Schizothorax</i> , <i>Barilius</i> , <i>Tor</i> , <i>Mastacembelus</i> spp.
Pot	Small streams in pool habitat	S,W	<i>Barilius</i> and fingerlings of <i>Schizothorax</i> spp.
Commercial methods			
Atwal	Large & small rivers in riffles, rapids & runs habitat	S,A,W	<i>Schizothorax</i> , <i>Schizothoraichthys</i> , <i>Garra</i> <i>Pseudecheneis</i> , <i>Glyptothorax</i> and <i>Crossocheilus</i> spp.
Baur/Phans	Large & small rivers in riffles, rapids & runs habitat	S,A,W	<i>Schizothorax</i> , <i>Schizothoraichthys</i> , <i>Garra</i> <i>Pseudecheneis</i> , <i>Glyptothorax</i> , <i>Crossocheilus</i> and <i>Botia</i> spp.
Cast net	Large & small rivers in riffles, rapids & pools habitat	S,A,M,W	<i>Schizothorax</i> , <i>Schizothoraichthys</i> , <i>Tor</i> , <i>Barilius</i> , <i>Salmo</i> , <i>Crossocheilus</i> and <i>Garra</i> spp.
Gill net	Large & small rivers in riffles & pools habitat	A,W,M	<i>Barilius</i> , <i>Schizothorax</i> , <i>Schizothoraichthys</i> , <i>Tor</i> , <i>Garra</i> and <i>Crossocheilus</i> spp.
River diversion	small shallow streams	S,A,W,M	All fish species present in the diverted river
Recreational methods			
Hook and line	Large & small rivers in pools habitat	S,A,W,M	<i>Tor</i> , <i>Barilius</i> <i>Salmo</i> , <i>Mastacembelus</i> , <i>Schizothorax</i> , <i>Glyptothorax</i> , <i>Pseudecheneis</i> <i>Crossocheilus</i> spp.
Destructive methods			
Bleaching powder	Small, shallow streams in all type of habitats	S,A,W	All the fish species along with other biota existing in the habitat
Dynamiting	Large & medium river in riffles, rapids & runs	S,A,W,M	All the fish species along with other biota existing in the habitat
Electric current	Medium & small river in pools, riffles & rapids	S,A,W,M	All the fish species along with other biota existing in the habitat
Poisonous plant extracts	Medium & small stream in all type of habitats	S,A,W	All the fish species along with other biota existing in the habitat

S=summer, A=autumn, W=winter, M=monsoon

This method may affect some non target species of the river and stream. The incalculable loss of fingerlings and small fishes occurs due to poisoning of river. This method is applicable in small streams with low discharge. This method is also very common in Aglad stream of Uttarkashi district during the common festival Maund mella. The hundreds of peoples accumulate there on that very day and celebrate this day, which results into killing of several quintals of fishes. This festival seriously deteriorates the fish fauna of that particular stream.

CONCLUSION

The streams and rivers of upper Ganga River system vary in their topography and water discharge. Therefore, variation in application of gears has been observed in these rivers. A total of 18 fishing methods and gears are employed in these streams and rivers to catch fishes for own consumption and commercial purpose which are classified into four categories (conventional, commercial, recreational and destructive). Most of the conventional fishing methods are eco-friendly except hammering and pot methods. All the commercial fishing methods are also eco-friendly if practiced with certain limitations. The use of various destructive fishing methods has resulted into remarkable decline in fish catch of many streams of upper Ganga River system and is continuously posing serious threat to resident fish fauna. Thus for the proper management of rapidly declining fish resources, there should be strict ban on the use of destructive fishing methods and only scientific methods for sustainable fishing should be allowed.

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