'Fish for all' versus 'fish of choice' – growth, instability and stakeholders' responses for enhancing fish production in major lakes of Kashmir

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The production of indigenous fish *Schizothorax*, locally called 'Kashir Gad', in the Dal and Wular lakes of Kashmir, India has been declining. The composition is in favour of the prolific breeder carps at the expense of the local traditional species. Studies carried out on trend lines, compound growth rates, Coppock's instability index backed by contingent valuation of the situation by multiple stakeholders for fish production reveal a need for mid-course correction in policy framework and restoration of the socio-economic-cultural heritage of the stakeholders of these lakes.

Keywords: Coppock's instability index, compound growth rate, contingent valuation, fish production, *Schizothorax* species.

SCHIZOTHORAX is a genus of cyprinid fish from Central and East Asia. The scientific name means 'cleft-breast', from ancient Greek *schízeïn.* Although *Schizothorax richardsonii* is widely distributed along the Himalayan foothills and previous studies have indicated that it is abundantly and commonly found, recent observations over the last 5–10 years indicate drastic declines in many areas of its range due to introduction of exotics, damming and over-fishing. While in some areas the declines are more than 90%, the overall reduction is inferred to be less than 50% with similar rates predicted in the future. The species is therefore assessed as Vulnerable. However, there is a strong belief that if alien species introductions are carried out throughout its range, this species may completely be displaced by exotic salmonids[1].

The population of *Schizothorax* in lakes of Kashmir is on decline owing to increased carp fish production. Now, the Dal lake is more of a tourist delight than a source of livelihood for local fishers. The Lakes and Waterways Development Authority (LAWDA) of Kashmir[2] has not involved itself in saving a puny fish that the locals would do well to sacrifice, in a compromise between some fish on their plate than none. The Santek Report[3] does not consider the fish, fisheries and livelihood of the fishes of Kashmir in its perspective envisioned for tourism in Kashmir (Figure 1). This article reports the tradeoffs involved, the compromises and latent aspirations of stakeholders in the lake fisheries of Kashmir.

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Materials and methods

Data and sampling

The Dal and the Wular lakes were selected for the study. The Wular lake is the largest freshwater lake in India and the Dal lake is most important from the point of view of tourism. They support around 70% of lake fishery of Kashmir.

A total of 360 respondents were used for this study. The stakeholders were divided into primary and secondary categories. The primary stakeholders were defined as those who derive their income directly from the fishery of lakes of Kashmir, and the secondary stakeholders as those who have an indirect stake over the lakes and its fisheries. The primary stakeholders were fishers (50 from Dal lake and 60 from Wular lake respectively), traders (7 and 23), and hotels and houseboats (25 and 5). Secondary stakeholders consisted of fish consumers (50 each from Dal and Wular lakes), 30 tourists, 30 staff members of the Department of Fisheries (DoF), Jammu & Kashmir (J&K) and 30 faculty of Department of Fisheries, Sher-e-Kashmir University of Agricultural Sciences and Technology-Kashmir. The primary data were collected on a pre-tested questionnaire, incorporating the questions required for satisfying the objectives. The survey was conducted between October 2012 and January 2013. Secondary data were collected from various published sources, and officials of DoF, Srinagar, Sopore and Bandipora. Data were also collected from the LAWDA, Srinagar.

Exponential smoothing or unequally weighted moving average model

This is a popular method for calculating a smoothed time series, whereas in single moving averages, the past

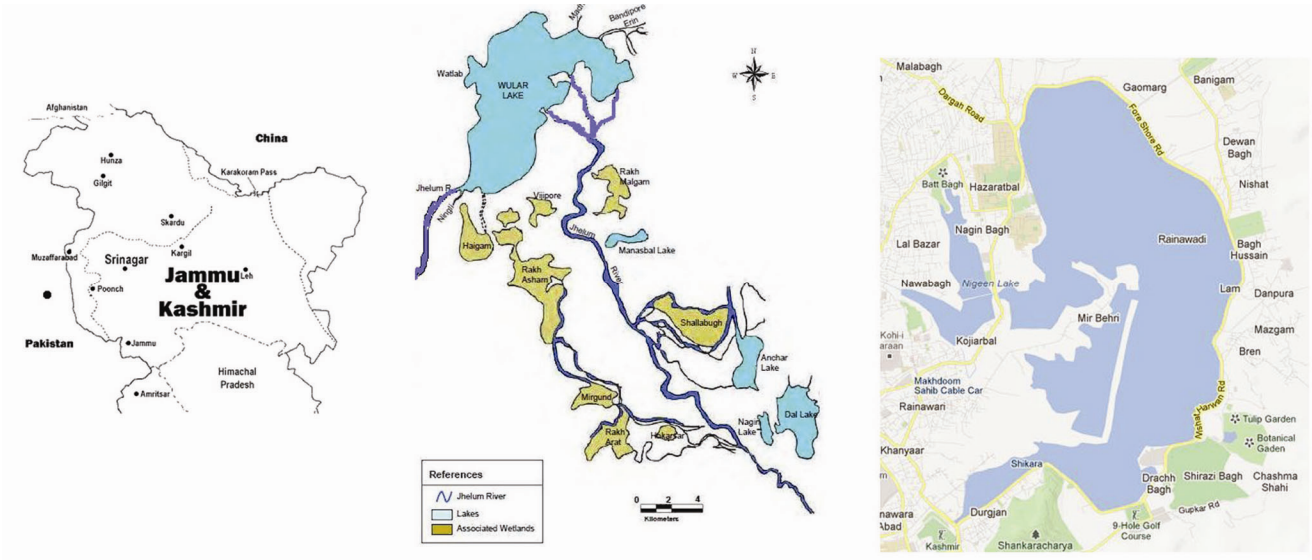

Figure 1. Locality of the study area.

observations are weighted equally. Exponential smoothing assigns exponentially decreasing weights for the earlier observations.

At each period t, an exponentially smoothed level, L_t is calculated, which updates the previous level, L_{t-1}, as the best current estimate of the unknown constant level, β_0, of the time series.

For any time period t, the smoothed value/forecasted value S_t is obtained by

$$L_t = \alpha L_t + (1 - \alpha)L_{t-1}, \qquad 0 < \alpha \leq 1,$$

where L_t is the revised estimate of the level at time t. α the weight placed on current time-series value or smoothing constant, Y_t the current time series value, $(1 - \alpha)$ the weight placed on the last estimate for the level, and L_{t-1} is the last estimate for the level. The value of the smoothing constant, α, is selected by the modeller. Higher values of α allow the time series to be swayed quickly by the most recent observation. Lower values keep the smoothed time series 'flatter', as much weight will not be given to the most recent observation. Usual values of α are between about 0.1 and 0.8 (ref. 4).

For forecasting, the level, L_t, calculated at time period t is the best estimate for the unknown constant, β_0 at time t. Since it is the best estimate of β_0 it will be the forecast for the next data value of the time series, F_{t+1}.

Compound growth rates

The model can be written as

$$\log Y_t = A + B_t + \epsilon',$$

where

$$A = \log Y_0; \quad B = \log(1 + r) \quad \text{and} \quad \epsilon' = \log \epsilon.$$

Then the unknown parameter constants A and B are estimated by the method of ordinary least squares. Thus, once B is estimated, the compound growth rate (CGR), r is given by

$$r = \exp(\beta) - 1.$$

The growth rates were estimated using Microsoft Excel 2010.

Coppock's instability index

Tesfom (unpublished) used Coppock's instability index (CII) of the form

$$\text{CII} = \text{anti ln } \sqrt{\ln V - 1} \times 100,$$

where

$$\ln V = n - 1^{-1} \sum \left[\left(\frac{\log X_{t+1}}{X_t} \right) - m \right]^2,$$

and

$$m = n - 1^{-1} \sum \left(\frac{\log X_{t+1}}{X_t} \right),$$

where X_t is the index at time, t, n the no. of years in the series, and V log or ln V is the logarithmic variance of the series.

CII is a better measure of instability in comparison to coefficient of variation, as this index takes into account time trends of the data while measuring the instability in the variability of the data[5]. The thumb rule of interpreting

CII is that if the estimated index is less than 50, then the instability is relatively low; otherwise it is high.

Contingent valuation method

Contingent valuation (CV) is regarded as one of the most accepted methodologies for estimating the willingness to pay (WTP) of the concerned stakeholders while addressing a particular socio-economic phenomenon. Studies conducted so far using CV have addressed only the primary stakeholders[6–8]. In the present study, the WTP of different stakeholders impacted by increasing pollution in the lakes of Kashmir has been estimated using a variant of the logit model, wherein the odds ratio in a binary response model is utilized. The generalized form of Logit model is given below

$$Z_i = \ln (\text{ODDS}) = \ln\left[\frac{P_i}{1-P_i}\right] = a + \beta X_1 + \beta X_2 \ldots + \beta X_n,$$

where $Z_i = \log$ odds of WTP/stimulus index and $X_1, X_2, X_3 \ldots X_n$ are the independent variables. Since the logit model is constrained by the necessity of having to define the dependent variable in a binary form, it was used for analysing the variables that determined the stakeholders' WTP for the sustainability of the lake fishery system in Kashmir. Eight different logit models were constructed to explain the relationships independently in both the lakes.

In case of the Tobit model, the advantage is its capacity to accommodate both binary and actual observed values. This enabled the construction of a composite model for estimating the variables as well as the absolute amount that influence the WTP of both sets of stakeholders for both lakes. The generalized form of the Tobit model is given below

$$Y_i^* = X_i\beta + \epsilon_i,$$

$$Y_i = Y_i^* \quad \text{if} \quad Y_{i>0}^*,$$

$$Y_i = 0 \quad Y_{i\le 0}^*.$$

where Y_i^* is the latent dependent variable, Y_i the observed dependent variable, X_i the vector of the independent variables, β the vector of coefficients, and ϵ_i's are assumed to be independently normally distributed[9]: $\epsilon_i \sim N(0, \sigma)$ (and therefore $y_i \sim N(X_i\,\beta, \sigma)$).

Results and discussion

Contribution and performance of fisheries

A total waterspread of 389,261 ha produced 19,000 tonnes of fish in J&K in 2010–11. Of the total waterspread area available, 3.5% is under lakes and ponds. The Dal and Wular contribute almost 70% to the total fish production in the state. In addition, the J&K fisheries contribute about 0.48% to India's total freshwater fish production (Figure 2), and 31% of the total cold water fish produced in the country (Figure 3)[10].

The declining share of J&K in national fish production is due to reduced fish production in the state and not because of the increase in contribution of other states in the country. With a contribution of 23% by the primary sector to the gross state domestic product (GSDP), which includes the contribution of fisheries, the fisheries sector is getting enough attention as an important activity allied to agriculture[11].

Lake fisheries in Kashmir

A decline in local fish (*Schizothorax*) catches in the lakes of Dal and Wular has been reported[12,13]. Although one of

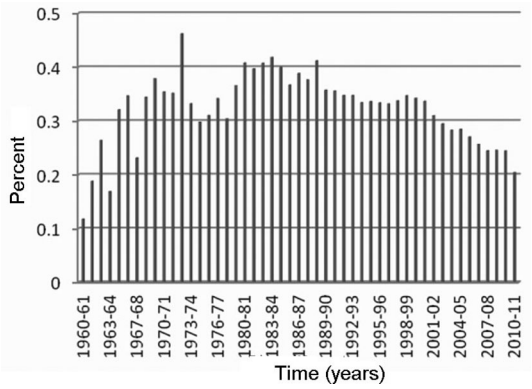

Figure 2. Contribution of Jammu & Kashmir (J&K) to India's total fish production (%). Source: ref. 13.

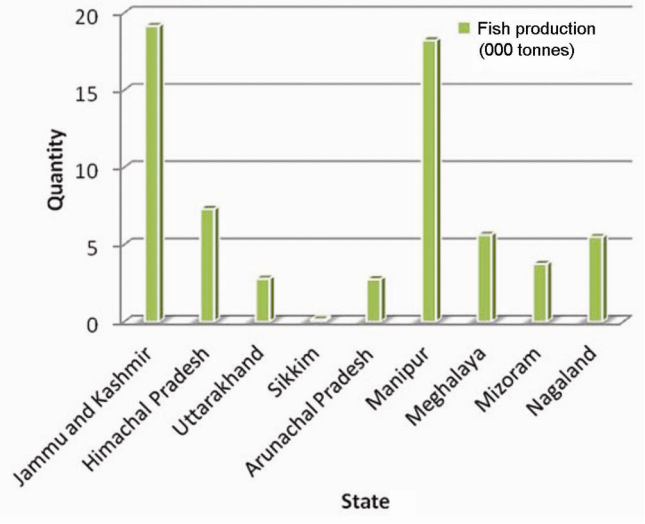

Figure 3. Contribution of J&K to cold water fisheries (2010). Source: Ref. 10.

the objectives of the DoF is to promote endemic fisheries, the accidental introduction of carps in Dal lake and heavy siltation in Wular lake have led to a consistent decline in the production of *Schizothorax*.

The introduction of common carp to a large extent has been responsible for shoring up fish production in Kashmir lakes. However, since 2004–05, there has been a dramatic fluctuation in total fish production in the Kashmir lakes. This can be attributed largely to increase in pollution in these lakes. Qureshi[14] hypothesized that there were sufficient grounds for stakeholder animosity in this matter and that the multiple stakeholders are willing to pay for alleviation of pollution and enhancement of fish production in the lakes of Kashmir.

There are about 750 houseboats in Dal lake, registered with the Tourism Department. These prime tourist attraction, especially for foreign tourists and those outside the valley tourists. A barge known as Doonga and Shikara services each houseboat. The houseboats are not moored in a systematic manners, although they are provided with water, electricity and telephone facilities. Due to lack of proper sanitary disposal systems, the wastewater from these houseboats directly goes into the lake without any treatment and causes severe water pollution.

In addition to introduction of carps, negative external factors like tourism and excessive fertilization of vegetable crops on floating gardens leading to algal blooms have all led to a consistent decline and destruction of the breeding grounds of *Schizothorax*.

The dwellers who have settled in the Dal lake area form a part of the history of the lake. Lawrence[15] reports in the book: '*The Valley of Kashmir* that the half amphibious dwellers on the Dal lake practised cultivation on floating gardens and demb lands in the late 19th century and had property rights on the marsh land and related water channels. Their main occupation was to collect wild products of Dal lake and grow vegetables for the city consumption. They were registered as tenants and revenue was collected daily from them by the state administration. The cultivators of the Dal lake were called Mir. Behris. In due course, the number of dwellers has been continuously growing, their families have got extended and the occupations have diversified. The lake-dwellers have been part and parcel of the lake ecosystem and have consequently caused certain stresses on it. The hamlets on which they reside within the lake have been discharging uncontrolled and untreated liquid and solid waste into the lake since ages, which has caused its pollution and subsequent degradation.'

'The floating gardens of the lake have been extended resulting in narrowing of the waterways and reduction in the clear water expanse. The tendency of conversion of floating gardens into solid land masses by dumping mud and weed from the lake onto them has resulted in solid land masses prone to further encroachment by the lake-dwellers. This activity, however, has been restricted towards the western shore area behind Dole Demb. The population settlements in the Dal lake area are of three types – those who live in the peripheral areas of the lake, those who stay in the Doonga boats and those who are the inhabitants of the hamlets. The total population living in the lake peripherals at present is estimated to be about 3 lakhs. About 7500 people live within the houseboats and 1 lakh people live in the hamlets. Besides, there is a floating population of tourists who stay in the houseboats in the Dal lake. Human settlement within the lake and its periphery is one of the main contributing factors to its pollution.'

On the one hand, the primary stakeholders, the fishers and those who derive primary income from lake fishery are in favour of *Schizothorax* fishery. On the other, there is an urgent need to increase fish production from the lakes to meet the ever-increasing demand of local consumers, irrespective of the species[14]. The priorities get further complicated when we weigh the objectives of the DoF vis-à-vis the Department of Tourism (DoT)[16]. The question boils down to whether the lakes need to serve the interest of the primary stakeholders, the fishers or they should serve the larger interest of the state economy by generating increased revenue from tourism.

Trends in fish production

Table 1 provides data on total fish production in the lakes of Dal (1980–2012) and Wular (1990–2012). Total fish production in the Dal lake has remained almost constant during 1980–2012. The maximum recorded catch was 475.65 t in 2003–04 and the minimum 262.03 t in 2007–08. In the Wular lake, whose waterspread was once 252 sq. km and has now shrunk to 24 sq. km, an all-time high of 5820 t in 2006–07 and a minimum of 1800 t in 2007–08 was recorded. It can be seen from the data that severity of fluctuations in catch is more pronounced in the recent years than in the past.

The severity in fluctuations in catch statistics was pronounced and was underscored by the best fit given by exponential smoothing in both cases[4].

The *Schizothorax* is a red-listed species[1]. The International Union for Conservation of Nature (IUCN) has recorded that the rate of decline in *Schizothorax* fishery has been greater in recent years than that in the past. The sudden drop in catch during 2007–09 seems to reflect the threshold year *Schizothorax*, after which the species has not recovered (Figure 4 *c*).

Data on *Schizothorax* production (Table 1) lead to the same conclusions. Maximum *Schizothorax* production was 253.5 t in the Dal lake in 1980–81 and 1900 t in the Wular lake in 2006–07, and the lowest 23.71 t in the Dal lake in 2007–08 and 500 t in the Wular lake in 2007–08 (ref. 17).

Figure 4 *c* shows a declining trend in *Schizothorax* production. The exponential smoothening for *Schizothorax*

Table 1. Total fish production, *Schizothorax* and carp production in Dal (1980–2012) and Wular lakes (1990–2012) (tonnes)[2,13]

	Total catch		*Schizothorax* catch		Carp catch	
Year	Dal lake	Wular lake	Dal lake	Wular lake	Dal lake	Wular lake
1980–81	113.2	–	253.5	–	113.2	–
1981–82	112.3	–	252.2	–	112.3	–
1982–83	110.2	–	248.5	–	110.2	–
1983–84	105.3	–	246.3	–	105.3	–
1984–85	124.3	–	242.5	–	124.3	–
1985–86	120.2	–	240.3	–	120.2	–
1986–87	132.3	–	214.2	–	132.3	–
1987–88	155.1	–	212.2	–	155.1	–
1988–89	160.3	–	220.3	–	160.3	–
1989–90	187.7	–	233.2	–	187.7	–
1990–91	182.5	2700	235.2	1110	182.5	2700
1991–92	192.3	2900	232.5	1130	192.3	2900
1992–93	201.32	3100	225.6	1150	201.32	3100
1993–94	205.2	3300	216.7	1170	205.2	3300
1994–95	210.5	3500	214.8	1190	210.5	3500
1995–96	229.7	3220	212.6	1560	229.7	3220
1996–97	243.12	2580	225.2	760	243.12	2580
1997–98	242.1	3530	219.3	1470	242.1	3530
1998–99	240.1	3310	221.12	1420	240.1	3310
1999–00	245.4	3780	219.2	1000	245.4	3780
2000–01	253.55	3650	169.03	1200	253.55	3650
2001–02	262.27	3910	174.12	1020	262.27	3910
2002–03	272.02	3510	181.34	1170	272.02	3510
2003–04	282.97	3390	192.38	1310	282.97	3390
2004–05	216.1	3510	190	1410	216.1	3510
2005–06	222.04	4100	206	1050	222.04	4100
2006–07	250.01	3920	221	1900	250.01	3920
2007–08	238.32	1300	23.71	500	238.32	1300
2008–09	244.73	1270	45.67	600	244.73	1270
2009–10	401.92	1390	68.13	800	401.92	1390
2010–11	276.5	1250	60.15	1010	276.5	1250
2011–12	–	1410		1030	–	1410

Source: DoF, J&K.

production data with damping factor 0.7 enabled us to establish a declining trend with no sharp fluctuations. The decline in the population of *Schizothorax* in Wular may be attributed to disturbances caused to the ecology of the lake owing to the construction of the Uri Power Plant which was commissioned in 1997 (ref. 18).

Carp production in the Dal lake was maximum during 2009–10 with 401.92 t and in the Wular lake with 4100 t during 2005–06 (Table 1). It was lowest in the Dal lake during 1983–84 with 105.3 t and in the Wular lake during 2010–11 with 1250 t. In absolute numbers, the quantity of landings in Dal lake appears to be evenly increasing during the entire period considered. Also, the production of carps in Wular has been erratic, especially in the end years (Figure 4 *b*).

Institutional and infrastructural arrangement in J&K fisheries

The official institutional arrangement at the state level for the development and management of fisheries, is made among the DoF, the Krishi Vigyan Kendras (KVKs) and R&D in the universities. This is supplemented by schemes and subsidies offered by the National Fisheries Development Board (NFDB). The Directorate of Coldwater Fisheries and Research (DCFR) also plays an important role in supplementing the contribution of research in the development of lake fisheries of Kashmir[10].

The DoF, J&K is the nodal agency that takes care of fisheries development in the state. Established in 1900, the objectives and mandate of the Department were formalized in 1978, which included sport fisheries and conservation, infrastructural development and establishment of district-level offices. It also included the development of endemic fisheries, better marketing facilities, development of hill stream and recreational fisheries, and introduction and implementation of welfare schemes. It appears from the investment pattern in the fisheries sector that this sector was identified as a growth sector from the year 2002–03.

It should be noted that the DoF earns substantial revenue (Figure 5). In 2012, it earned about INR 500 lakhs from the sale of trout. Also, trout is cultured only by the Government and this revenue is a monopoly income of

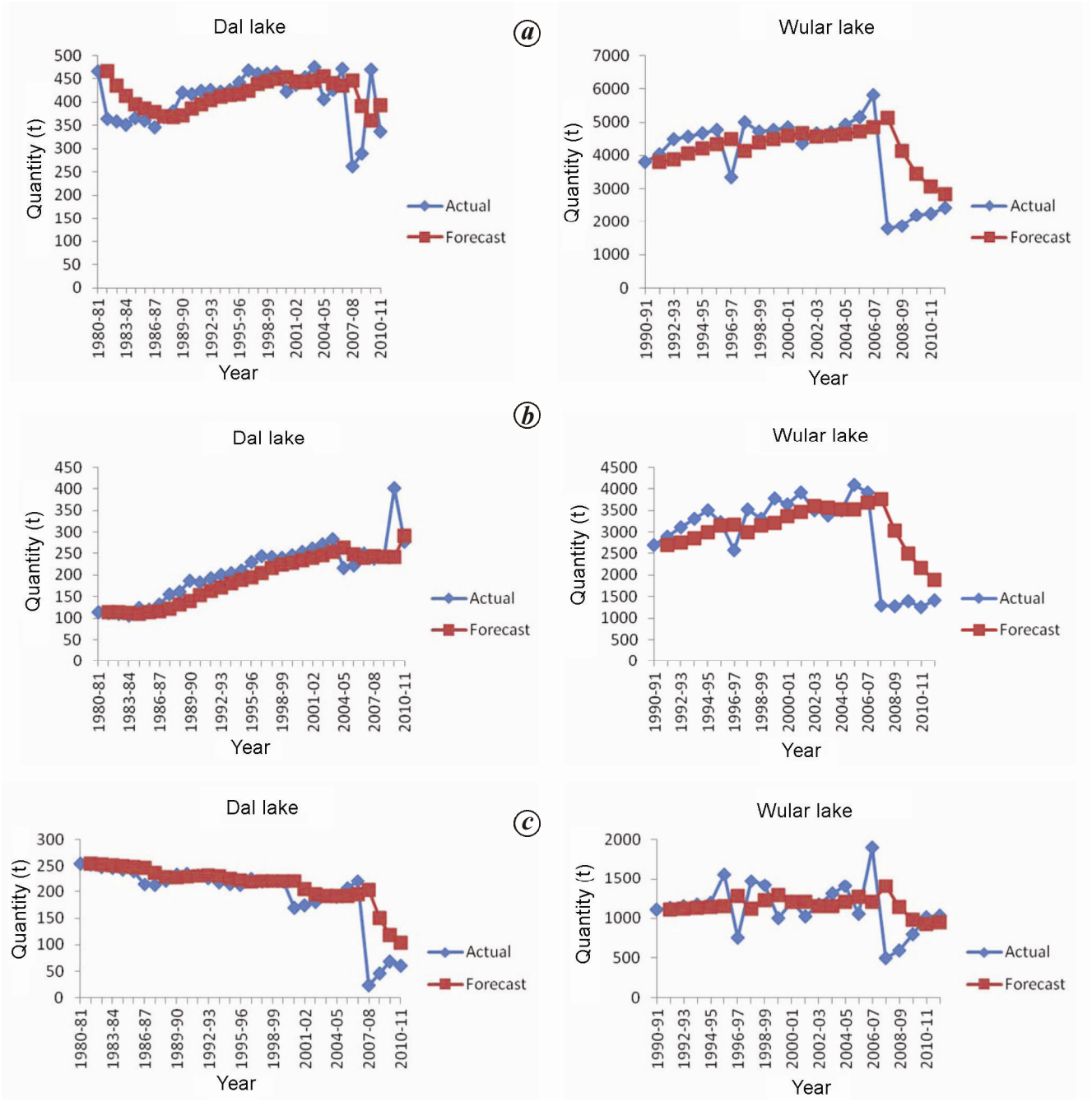

Figure 4. Exponential smoothened actual and forecast total fish catch (***a***), carp catch (***b***) and *Schizothorax* species catch (***c***) data in Dal and Wular lakes[12].

the state[19]. Therefore, tourism of the lake fishery seems to have priority over safeguarding the interests of primary stakeholders who are earning their livelihoods through fishing in the lakes of Kashmir.

The number of fishing licenses in the state has shown a steady increase from 1970–71 to 2009–10 (Figure 6). This does not in any way indicate flourishing fishery, because licensed fishers are eligible for compensation from the Department during the ban period. Despite this, a ban on the lake fishery from March to May every year has been announced to encourage the breeding of the local species, *Schizothorax*. It may be noted that the dispensation of compensation itself acts as an incentive for registration of a large number of people as fishers who are non-fishers and have registered only for availing the compensation offered by the Department during the ban period[13]. Therefore, the number of active fishers has actually remained more or less the same over several decades. It may also be noted that the maximum number of licenses has been issued in Srinagar followed by Bandipora (Figure 7).

Table 2 shows the compound growth rate (CGR) of carp, *Schizothorax* and total fish production in the Dal and Wular lakes. Growth rates for fish production in the Dal lake have been worked out for the period 1980–2010 and for the Wular lake from 1990 to 2010. It can be seen from the table that total fish production in the Dal lake has registered a negative CGR of 0.34% for the period 1980–90, while the growth rate for the period 1990–2000 was 1.39%. Again for the period 2000–10, fish production in the Dal lake showed a negative CGR of –2.89%. It can be noted that the decline in total fish production in the Dal lake was largely contributed by a decline in local fish species production, which had decreased by as much as –14.39% during the period 2000–10. At the same time the decadal fish production for carp in the Dal lake was 5.86%, followed by 3.54%, which further declined to 1.49% in the three decades for which CGR was estimated. This indicates a decline in fishery in the Dal lake. Though the total fish production may be increasing in the Dal lake, the rate of growth of carp production is on a decline. This clearly indicates that despite the measures taken by the DoF, total fish production from the Dal lake is showing a declining trend.

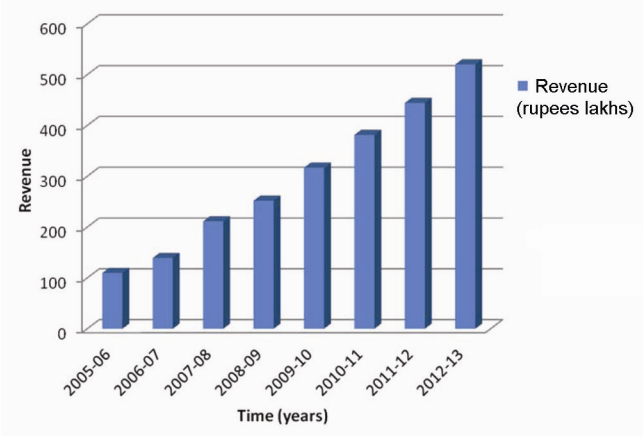

Figure 5. Total revenue earned by Department of Fisheries, Kashmir[12]. Source: Department of Fisheries, J&K, 2012–13.

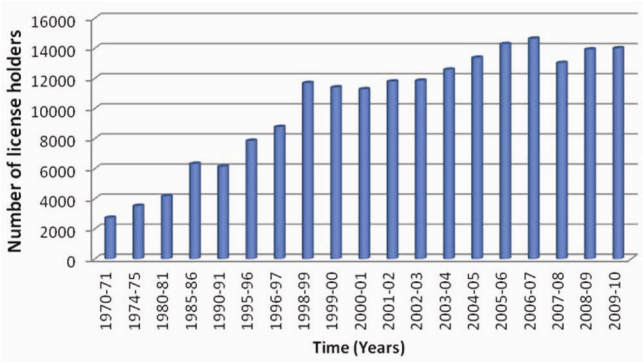

Figure 6. Number of fishing license holders in J&K[13]. Source: Department of Fisheries, J&K, 2009–10.

In case of the Wular lake, the total fish production registered a CGR of 1.7% during the decade 1990–2000 and a negative CGR of 8.78% during 2000–10. It may be noted that the decline in the growth rate was dramatic for both *Schizothorax* and carp fish production. This implies that despite the large area occupied by the Wular lake the total fishery has actually declined, even though the DoF has been carrying out desiltation and implementation of the ban. Hence the main point is to address the basic

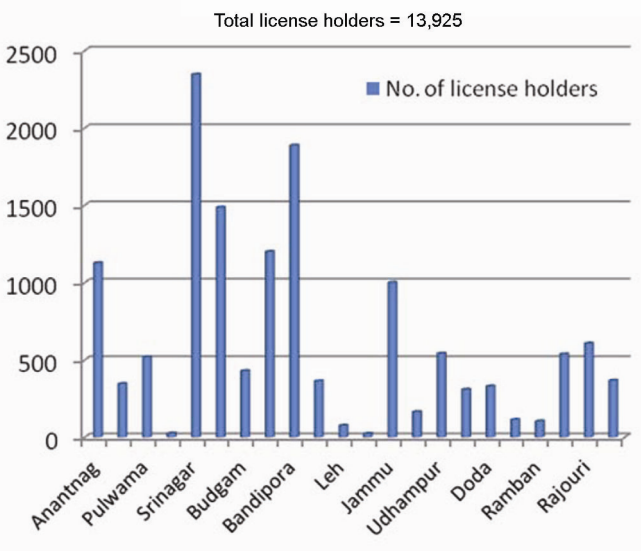

Figure 7. District-wise license holders in J&K[12]. Source: Department of Fisheries, J&K, 2009–10.

Table 2. Compound growth rate of fish production in Dal and Wular lakes

Lake	Period	Carp	*Schizothorax*	Total
Decade 1				
Dal	1980–1990	5.863	–1.751	–0.344
Wular	1980–1990	–	–	–
Decade 2				
Dal	1990–2000	3.538	–0.617	1.387
Wular	1990–2000	2.318	0.524	1.700
Decade 3				
Dal	2000–2010	1.489	–14.391	–2.890
Wular	2000–2010	–11.563	–3.723	–8.782

Table 3. Coppock's instability estimates of fish production in Dal (1980–2010) and Wular (1990–2010) lakes

Lake	Period	Carp	*Schizothorax*	Total
Decade 1				
Dal	1980–1990	67.29	23.25	26.18
Wular	1980–1990	–	–	–
Decade 2				
Dal	1990–2000	45.44	19.72	25.53
Wular	2000–2010	52.15	26.33	41.16
Decade 3				
Dal	2000–2010	26.94	119.35	48.00
Wular	2000–2010	92.96	12.05	72.08

Table 4. Log odds values of variables and logit models of primary stakeholders

Variables	Dal fishers	Wular fishers	Traders	Hotels/houseboats
Income (INC)	0.043	0.142	1.002	9.09
Family size (FS)	8.94	0.33	–	–
Time spent on lakes (TS)	0.216	3.413	–	–
Age (AGE)	0.297	–	0.801	–
Willingness to spend extra time (WTS)	–	0.162	–	–
Type of stakeholder (TYSTK)	–	–	–	0.027

Models:

Dal fishers = $\ln \frac{P_i}{1-P_i}$ = 1.942 – 3.137INC*** + 2.191FS** – 1.532TS** – 1.214AGE*

Wular fishers = $\ln \frac{P_i}{1-P_i}$ = 4.554 – 1.95INC*** – 1.819WTS** + 1.228TS* – 1.10FS*

Traders = $\ln \frac{P_i}{1-P_i}$ = –21.813 + 0.002INC** – 0.222AGE*

Hotels and houseboats = $\ln \frac{P_i}{1-P_i}$ = –25.138 – 3.616TYSTK*** + 2.207INC*

where P_i is the probability of WTP of stakeholders, and ***, **, * indicate significance at 1%, 5% and 10% respectively. Figures in parenthesis are log odds values.

question of the trade-off between the increasing revenues that add to the coffers of the Government and restoration of a fishery enabling the resurrection of an age-old traditional, socio-economic and cultural heritage of the lakes of Kashmir[17].

Table 3 shows the CII of fish production in the Dal and Wular lakes[4,5]. The estimated growth rates of total fish production in the Dal lake have been relatively stable in the sense that they do not show much variation within the time frame of the data analysed. But in the case of Wular lake it can be seen that for the last decade, CII is 72.08, which indicates a definite trend in the instability of fish production for the period 2000–2010. This is substantiated by the high and negative CGR of carp production in the Wular lake for the same period. As far as instability in local fish production is concerned, it can be seen that it is very high in the case of local species, which is again substantiated by the high and negative growth rate during the same period, i.e. 2000–10. The instability in carp production in both the lakes for almost all the periods considered was high. It was 67.29 for carp in the Dal lake during 1980–90, and 52.15 in the Wular lake for 1990–2000–10. Again the instability was high for carp fish production during 2000–10. These estimates of high instability in carp production could be attributed to inherent factors which influenced the CGR estimates.

Qureshi Neha[14] used contingent valuation to estimate the WTP of multiple stakeholders for enhancing fish production in the lakes of Kashmir[6,7,20,21]. The stability of income is directly related to the WTP of the stakeholders for the restoration of *Schizothorax* production. The results of the log odds (approach) logit[8,9] models also support the conclusions that we could draw from the trend analysis. Table 4 indicates that stability and size of income are inversely proportional to WTP of the stakeholders, e.g. the Dal lake fishers not willing to pay for the restoration of *Schizothorax* production compared to fishers of the Wular lake. The Dal lake attracts maximum number of tourists and floating population throughout the year and hence a regular supply of any fish that would satisfy the visitors is welcome, than to pay for making a conscious effort towards the restoration of *Schizothorax* production. This is again obvious from the fact that the incomes of the Dal lake fishers are more stable owing to increased contribution of carp fish production.

The contribution of carp production in the Wular lake is still unstable, if we relate this result to the one obtained from the estimated trends. The location of the Wular lake is the enabling factor for the fishers to express their willingness to pay three times more for the sustainability of fishing in the lake, compared to those who spent less time in fishing as exhibited by log odds ratio of 3.43. The log odds ratio indicates the extent to which the WTP varies. The socio-cultural background backed by a low level income equilibrium of the Wular fishers proved to be the driver for WTP for sustainability of *Schizothorax* fisheries in Kashmir. Similarly as the age of Dal lake fishers is concerned, the odds in favour of WTP reduced by 70%, since beta coefficient is negative and the odds ratio is 0.297 (1 – 0.297 × 100 = 70%). The WTP of traders also increased with the increase in income and had a proportional relationship as log odds ratio is 1.

Again, the odds in favour of WTP decreased (odds ratio 0.80) as the age of the traders increased. The youth among the traders are more conscious about the misplaced priorities compared to their elders. The logit model in case of traders indicated an increased awareness for restoration of fish production in the lakes of Kashmir in

favour of the local species. Though this particular inference is not reflected in terms of numbers, we have recorded enough personal observations of the respondents.

Despite the fact that the income of the surveyed hoteliers and houseboat owners indicated that the odds in favour of WTP increased by as much as nine times; the hoteliers were likely to pay 37 times more compared to the houseboat owners. The income generated from fisheries-related cuisines, being more significant and consistent, resulted in the increased likelihood of the hoteliers to pay substantially higher amounts. The latent faith of hoteliers in the various attempts being made for restoration of lake fisheries in Kashmir in general and *Schizothorax* in particular is significant.

Composite Tobit model

The Tobit model was employed to measure the significance (extent) and value (amount) of WTP of the stakeholders, for the restoration and sustainability of *Schizothorax* fishery in the Dal and Wular lakes. The dependent variable in the Tobit model was the contribution that the stakeholders made towards WTP in monetary terms.

The overall WTP for all stakeholders taken together was INR 40/month (Table 5). Table 5 also presents the sample mean of the independent variables such as age, income, education and time spent on lakes by the stakeholders, which influences the WTP for the sustainability of *Schizothorax* fishery in both the lakes.

Based on the results of the Tobit model, income, time spent and stakeholders (traders) emerged as significant variables (Table 6). The results were as expected, as WTP of the primary stakeholders was basically influenced by their income levels. The coefficients of the Tobit model are not interpreted directly as in case of OLS regression coefficients, but as coefficients of the latent variable. The results reveal that one unit increase in the income of stakeholders will increase the predicted value (latent variable) by 0.067 unit. Thus it implies that as income increases, the WTP of primary stakeholders also increases.

One unit increase in the time spent on lakes decreased the predicted value by 1.21 units. Results show that the influence of negative impact of time spent on lake by the Dal lake fishers was considerable on the WTP of the primary stakeholders as well in the composite model. Therefore, despite the fact that the Wular fishers are willing to spend more time on fishing, and the traders are willing to spend more time on trade, the influence of response of the Dal lake fishers with respect to their WTP for the sustainability and development of *Schizothorax* fisheries in the Kashmir lakes was the common denominator, that resulted in a negative and significant coefficient of time spent on the lakes by the primary stakeholders in the Tobit model.

A comparison between the different primary stakeholders revealed that the predicted value of WTP for traders was 83.9 units higher than that of the fishers. The WTP of traders (primary stakeholders) is positive and significant in the composite model. This may be related to the emergence of income as a significant and positive variable. The role of the traders in influencing the income and consequent response of the concerned stakeholders to WTP was because of the fact that they occupy the pivotal position in the supply of fish in the local markets of Kashmir.

Conclusions

Growth in terms of real welfare which ought to be reflected by the flourishing growth in *Schizothorax* fishery has been replaced by giving priority to increasing total fish production in the lakes of Kashmir irrespective of the species produced. Even this approach does not seem to bear results with the declining carp production in recent times. In order to restore the prime production of *Schizothorax* species in the Dal and Wular lakes, it is important to improve the water quality. The efforts of LAWDA need to be more focused in terms of implementation of various programmes. The most important point

Table 5. Sample mean of the dependent and independent variables of primary stakeholders in the Tobit model

Variables	Sample mean
Dependent variable	
WTP (INR/month)	40
Independent variables	
Age (years)	41.2
Income (‘000’)	41
Education (no. of years)	5.5
Time spent on lakes (h)	10.2

Table 6. Tobit results of WTP for primary stakeholders

Variables	Primary stakeholders
Constant	16.58
Beta coefficient value	
Age	0.401
Income	0.067***
Education	–0.004
Time spent on lakes	–1.209**
Traders	83.3***
Hotels/houseboats	–1.6
	Secondary stakeholders
Constant	–76.48
Beta coefficient value	
Age	0.478
Income	1.538***
Education	12.732***
Time spent on lakes	0.223
Consumers	–190.573***

*** and ** indicate significance at 1% and 5% levels respectively.

that has to be taken into account is the balance of stocks of local species (*Schizothorax*) and carps which occupy the same water space. Special care need to be given to ensure a sustainable and growing stock of the local species and lowering of carp fish productivity. Carp culture could be promoted as a separate freshwater aquaculture activity in other derelict water bodies, which would yield good income and keep the supply chain of fish to the markets going.

The restoration of *Schizothorax* fishery in the lakes of Kashmir will ensure growth in socio-economic and cultural terms and sustainability of a balanced fishery[22,23]. A well-designed plan of action for the restoration of *Schizothorax* fishery is the need of the hour. Also, there is an urgent need to develop hatchery technology for *Schizothorax*. Ranching programmes, concerted efforts to reduce the dominance of carps and institutionalization of lake fisheries of Kashmir by establishing suitable end-to-end supply chain arrangements need to be envisaged and implemented. Until such measures are implemented in letter and spirit, restoration of lake fisheries may not yield enough fish to consumers, leave alone producing the fish of choice.

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