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GROWTH PERFORMANCE AND FEED CONVERSION EFFICIENCY OF SIBERIAN STURGEON (*ACIPENSER BAERI*) AT MID-ELEVATIONAL ZONE

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ABSTRACT: The study assessed the growth performance, and feed conversion efficiency of adult Siberian sturgeon (*Acipenser baerii;* N=15) reared on-farm. It was intended to establish a baseline information for rearing sturgeon at a lower elevation at 500 masl. The sample used was a four years old cohort acquired from the Rainbow Trout Breeding Centre, National Research and Development Centre for Riverine and Lake Fisheries, Haa. The sample was maintained in a circular tank with a flow-through water system at a temperature varying between 14.00 to 24.30 °C. The growth performance was assessed monthly. The specific growth rate and feed conversion ratio recorded at the mid elevation of about 500 masl was 0.2% day^{-1} and 3.12, respectively.

Keywords: Aquaculture; elevational impacts; feed conversion ratio; specific growth rate

1. INTRODUCTION

Sturgeon a long-lived and slow-growing fish falling under the family Acipenseridae and order Acipenseriformes is primarily found in cold and temperate regions of the Northern Hemisphere, such as North America, Europe, and Asia. It generally inhabits rivers, estuaries, near-shore oceanic environments, and inland seas. Most Sturgeon species spend their adult life in the sea and migrate into freshwater for spawning (i.e., anadromous), whereas other species spend their entire life in freshwater (termed potamodromous) (Coppens International 2007). Historically, the Russian Federation and Iran were the main producers, with sturgeon harvested from the Caspian Sea (European Market Observatory for Fisheries and Aquaculture Practices 2021).

Siberian Sturgeon is a migratory species that adapts well to diverse environments, allowing it to thrive and attain satisfactory growth in various climatic zones and food supply (Sokolov and Vasilev 1989 in Pyka and Kolman 2003). Siberian Sturgeon is a species quite amenable to aquaculture due to its plastic nature, rapid growth rate, relatively short reproductive cycle (7-8 years), and is also resistant to many pathogens (Zarantoniello et al. 2021; Fisheries and Aquaculture in Europe 2012). However, Sturgeon undergoes prolonged sexual maturation (3-5 years) puberty extending from 10-30 years of age (Bardach 1972).

Sturgeon was considered a nuisance and subsequently, a by-catch in fisheries in the 1800s. However, now it is a prized commercial fish, valued for its caviar, high-quality meat, and ornamental purpose (Coppens International bv.2007). As a result, Sturgeon farming had increased remarkably and undergone vigorous development in the last decades (Coppens International bv. 2007).

Sturgeon efficiency for aquaculture production has been verified by extensive research on its growth performance in different types of production systems in tanks of varying sizes and shapes. Furthermore, it attains sexual maturity easily in captive rearing (Koksal et al. 2000). Currently, 36% of Sturgeon farms employ a flow-through system, followed by the recirculating system (21%), cage-systems (18%), and ponds and mixed systems comprising of the remaining 25% (EUMOFA 2021).

Sturgeon is valued for its caviar and quality of meat and has subsequently become a strong focus for aquaculture (Fisheries and Aquaculture in Europe 2012; Coppens International bv. 2007). Caviar is Sturgeon roe preserved with salt deemed a niche product and a delicacy (Fisheries and Aquaculture in Europe 2012). It differs in quality and price, both largely determined by factors such as pearl size, texture, colour, lucidity, uniformity, separation, fragrance, firmness, taste, and maturity. While a variety of caviar exists, those most highly prized are from beluga-like Kaluga sturgeon (*Huso dauricus*) and Siberian sturgeon (*Acipenser baerii*) (EUMOFA 2021).

Farming for caviar is expensive given the prolonged period required for production. It takes more than seven years for females to attain sexual maturity and these females must be slaughtered to extract the ova; however, now with advanced farming practices ova can be extruded from the females non-lethally (Fisheries and Aquaculture in Europe 2012).
Most Sturgeon species are considered endangered with some even reported as being critically endangered. The populations have declined significantly in the wild due to habitat degradation and fragmentation, both as a result of hydropower development and overfishing. Therefore, restocking of the species is of paramount importance for the conservation and management (Fisheries and Aquaculture in Europe 2012).

The National Research and Development Centre for Riverine and Lake Fisheries (NRDCR&LF; Haa), has conducted preliminary research trials on the growth performance of Siberian Sturgeon (*Acipenser baerii*) at 2600 masl, using 20,000 eggs imported from Thailand between 2016 to 2017. With initial success at Haa the Mahseer Conservation and Fish Monitoring Centre (MCFMC) located at mid-elevational zone at about 510 masl conducted a rearing trial to assess and establish baseline data on the growth performance and feed conversion efficiency.

2. MATERIALS AND METHODS

2.1 Study sites

The study was conducted at the MCFMC located at Taksha under Wangdue Phodrang district at an elevation of 510 masl (27°11'06.86" N, 90°04'18.13" E). The study site experiences a dry subtropical climate. The study was conducted from April 2020 to April 2021.

2.2 Samples and sturgeon management

A total of 15 Siberian sturgeon acquired from Haa with mean body weight and length of 459.30 ± 238 g and 48.5 ± 6.2 cm, respectively were used for the study. The small cohort in this study represented a pilot study to derive baseline data on the growth performance at given environmental conditions of farm. More importantly, a small sample size was selected as a precautionary measure given the uncertainties with survival and growth at the new environmental setup.

Fish were reared in an indoor rearing shed with partial exposure to natural light. Two circular fiber tanks (diameter 2 m; depth 0.65 m; water supplied continuously at 2.7 litres/ second) were used. Water temperature during the study ranged from 14-24.43 °C.

As quality feed and an ideal feeding regime are prerequisites for any fish culture, the fish were fed at 1.5% of body weight, fed four times daily at the feeding intervals (9:00 AM, 1:00 PM, 5:00 PM, and 10:00 PM). The feed used represented 4.5 mm pellet feed (BioMar Trout Feed) containing 39-42% crude protein. The details of feed composition used in this study are presented in Table 1.

Table 1: Proximate composition of fish feed

Feed constitutes	Content
Crude protein	39-42%
Crude lipid	28-31%
Carbohydrates (NFE)	16-19%
Crude fiber	1.1-3.3%
Ash	4-7%
Total phosphorus (P)	0.9%
Gross energy	23-26 MJ/Kg
Digestible energy	20.9 MJ/Kg

2.3 Data collection and analysis

Abiotic parameters such as water temperature, dissolved oxygen (DO), pH, and water temperature were recorded. DO was measured using a standard multiparameter kit (Model SDL150), pH using a standard Hanna pH meter (Model HI 98127). The readings were taken three times a day (9:00 AM; 1:00 PM; and 5:00

PM). Growth parameters on the total length (cm) and weight (g) were recorded monthly using a standard measuring scale and an electronic balance. In addition to the above growth parameters, feed conversion ratio (FCR) was also calculated (Lair and Needham 1988) using the formulae below:

Mean gain in length (cm):

Mean final length (cm) – Mean initial length (cm)

Mean gain in weight (g):

Mean final weight (g) – Mean initial weight (g)

Specific growth rate (SGR):

$$SGR\,(\%\,per\ day) = \frac{LogW2 - LogW1}{T} \times 100$$

(Lair and Needham 1988)

Where, W2 = mean final weight (g), W1 = mean initial weight (g), T is the culture period (days)

Feed Conversion Ratio (FCR):

$$FCR = \frac{Feed\ offered\,(kg)}{Weight\ gained\ (kg)}$$

Data was recorded monthly for fish growth and feed used during the experiment in a standard data sheet. The recorded data were compiled and analyzed using descriptive statistics in Statistical Package for Social Science (SPSS) to determine the mean and standard deviation of fish growth weight and length.

3. RESULTS AND DISCUSSION

3.1 Abiotic parameters

The mean water temperature recorded was 18.41°C which ranged between 14.00 to 24.43 °C. The mean dissolved oxygen and pH recorded were 6.35 mg/L (range between 5.35-7.75 mg/L) and 7.24 (range between 6.5-8.01) respectively (Table 2). The mean values of temperature and pH are found well within the optimum levels reported by Coppens International bv (2007).

3.2 Mean gain in length and weight

An increase in length and weight of the fish was observed during the experiment period (Figure 1). However, the rate of weight gain in the months of August, September, and October, were relatively low which could be attributed to multiple factors including environmental stress brought about by marked increase in water temperature (Table 3) during those three months. The fish were shifted to an open concrete pond with dimension of 20x30x1.5 m since water supply to indoor facility was erratic for three months. The study recorded average final weight and length gain of 2504.3 ± 952.2 g and 77.1 ± 7.2 cm, respectively (Table 3).

3.3 Specific growth rate (SGR)

The specific growth rate of the fish at the end of the study period was 0.2% day^{-1} (Table 2), slightly lower than 0.64±0.07 as reported by

Table 2: Mean values of *t*emperature, *d*issolved oxygen, and pH of water

Year	Month	DO (mg/L)	pH	Temperature(°C)
2020	Apr	7.55	7.40	17.41
	May	7.65	6.95	18.45
	Jun	7.75	6.50	19.50
	Jul	5.85	7.11	19.85
	Aug	6.60	8.01	24.43
	Sep	5.80	7.70	23.70
	Oct	5.35	7.23	20.35
	Nov	6.00	7.10	18.80
	Dec	5.95	7.20	15.50
2021	Jan	6.15	7.10	14.50
	Feb	5.90	7.00	14.00
	Mar	5.90	7.35	15.20
	Apr	5.70	7.40	16.00
Mean		6.35	7.24	18.41

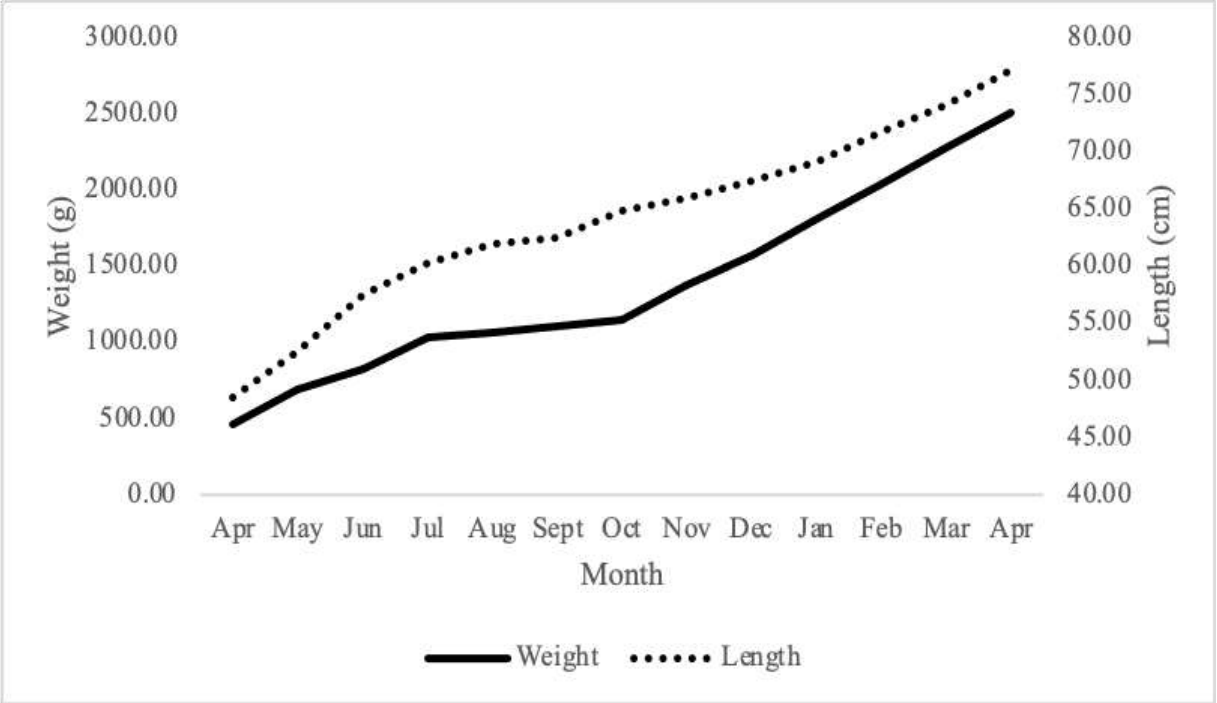

Figure 1: Trend of weight and length

Table 3: Mean values of growth, SGR, mortality and FCR

Year	Month	Weight (g)			Length (cm)			SGR	Mortality	FCR
		Mean ±SD	Max	Min	Mean ±SD	Max	Min			
2020	Apr	459.3±238	895	235	48.5±6.2	59	39	0.2	1	3.12
	May	459.3±238	895	235	52.5±6.2	67.6	46.4			
	Jun	818.2±320.2	1400	415	57.4±6.5	67.6	48.5			
	Jul	1028.5±379.7	1730	465	60.3±5.4	70	51			
	Aug	1063.5±379.5	1765	500	61.9±5.4	71.6	52.6		1	
	Sept	1103.5±383.7	1806.8	511.8	62.4±5.5	72.1	52.6			
	Oct	1142.5±420.4	1953.5	517	64.8±6.5	76.4	53			
	Nov	1373.5±420.4	2184.5	747.9	65.9±6.5	77.5	54.1			
	Dec	1571.2±676	3040	575	67.4±8.6	81.8	53.6			
2021	Jan	1809.2±676.03	3278	813	69.1±8.6	83.5	55.3			
	Feb	2033.5±807.2	3650	715	71.8±7.3	84	57			
	Mar	2274.5±897.2	3891	956	74.1±7.3	86.8	59.8			
	Apr	2504.3±952.2	4450	840	77.1±7.2	87	61			

Rad et al (2003) using the same feeding rate. This discrepancy could be attributed to differences in the stocking age, size, dietary content, and water temperature.

3.4 **Feed conversion ratio (FCR)**

SGR and FCR are two important indicators of feed management and determines the economic performance of aquaculture (Hung et al. 1989). A constant feeding rate of 1.5% body weight with minor adjustments accounting for mortalities was adopted across the study period. The overall FCR was 3.12 (Table 3). The results showed slightly higher FCR compared to that of Rad et al., (2003) (2.43±0.30) at the same feeding rate and range of water temperature (19-22 °C). The higher FCR in this experiment warrants the need for additional evaluation of the feeding regime on fish growth. Therefore, a study on different feeding regimes could be undertaken with larger sample size than the current study.

4. CONCLUSIONS & RECOMMENDATION

Sturgeon showed positive growth with a mean gain in weight and length of 2045 g and 28.6 cm respectively. Our results support the

hypothesis that Sturgeon farming is feasible at mid-level altitude that recorded higher FCR, but these must be interpreted with caution as other factors could have played confounding roles. However, the study offers a baseline for rearing Sturgeon at mid-elevation in Bhutan and follow up studies with larger sample size and varying feeding regimes are recommended to accurately assess growth performance.

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