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Original Article

Assessing shellfish harvesting and stakeholder perspectives on trade in Bangladesh's largest wetland

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Abstract
The trade of freshwater shellfish is growing but has received insufficient attention from researchers. In this study, we examined various aspects of shellfish harvesting (catch amount and composition, socio-economic profiles of shellfish collectors, distribution channels and perceptions of major stakeholder groups) over a six-month period (October 2023 to March 2024) in the largest wetland of Bangladesh, the Chalan Beel. The daily shellfish catch was higher during the low-water period (October – December; 10.7 ± 3.3 kg person^{-1}) than during the dry period (January – March; 0.6 ± 0.2 kg person^{-1}) (*t*-test: $t = -32.4$, $p < 0.001$). Catch composition varied significantly across groups (ANOVA: F = 10823, $p < 0.001$). Freshwater snails (primarily *Pila globosa*) contributed the most (70.1%) to the total catch, followed by mussels (primarily *Lamellidens marginalis*; 19.7%) and crab (*Cancer pagurus*; 10.2%). Three key actor groups involved in shellfish distribution were crab collectors, traders and consumers. Most collectors (65%), traders (54%) and consumers (89%) disagreed that shellfish are an important component of the aquatic environment. All traders and 96% of collectors agreed that shellfish collection and trade are profitable, whereas all consumers maintained a neutral standpoint. All consumers agreed that shellfish are good food, while the majority of collectors (93%) and traders (93%) remained neutral. Additionally, all consumers and most collectors (67%) and traders (73%) supported harvesting shellfish from other aquatic ecosystems. The results of this study are expected to be useful in formulating appropriate policies for wetland and resource management.

Keywords: Chalan Beel; freshwater shellfishes; molluscs; shellfish value chain; wetland

1 | INTRODUCTION

Shellfishes are important part of any aquatic ecosystems (Gutiérrez *et al.* 2003; Patel and Kurhe 2023). They contribute to water and soil chemistry, primarily through decomposition of their calcareous shells (Říhová *et al.* 2018; Jo *et al.* 2020). Due to their roles for sustainability and aquatic ecosystem preservation, shellfishes are considered highly important for achieving UN's Sustainable Development Goals (Mesquita *et al.* 2024). However, shellfishes are important food sources for human also and one of the key groups contributing to the global food security (Azra *et al.* 2021).

Shells of shellfish are common sources of important inorganic nutrients for agricultural crop production (Hotopp 2002; Jo *et al.* 2020; Mor-Mussery *et al.* 2024; Potortì *et al.* 2024). Therefore, the mass removal or deposition of freshwater shellfish from or into an ecosystem can alter water and soil productivity (Yang *et al.* 2020;

Popović *et al.* 2023), and such actions on a large scale are not desirable for ecosystem health. However, mass collection of shellfish is a common phenomenon in many parts of the world, primarily in developing countries (Sasikumar 2013; Nahid *et al.* 2014; Ghosh *et al.* 2017; Singha *et al.* 2025). Shellfish are primarily collected for human consumption (Halwart 1994; Mi-Jung *et al.* 2012; Ghosh *et al.* 2017), but their use as animal feed (e.g. for fish, shrimp and ducks) is also common (Bombeo-Tuburan *et al.* 1995; Nath *et al.* 2008; Islam *et al.* 2013).

For effective management of aquatic ecosystems, it is important to understand the human dynamics (e.g. knowledge, perception and attitude) of stakeholder groups (Kashmi *et al.* 2025; Khatun *et al.* 2025), especially those involved in shellfish collection. Unfortunately, no study has yet examined these aspects of shellfish, particularly when they are harvested from freshwater ecosystems. In this study, we investigated the socio-economics, knowledge, perceptions and attitudes related to freshwater shellfish in the largest wetland of Bangladesh— the Chalan Beel. We hypothesised that shellfish harvesting varies across months in the study area. We also hypothesized that the perceptions of shellfish stakeholders do not align with the principles of sustainable management of shellfish and aquatic ecosystems.

2 | METHODOLOGY

2.1 Study area

This study was carried out in the largest wetland of Bangladesh– the Chalan Beel (Galib *et al.* 2009). Snails and crabs are being harvested extensively in different parts of this wetland for the last few years (Singha *et al.* 2025).

2.2 I Identification of the stakeholder groups

Wetland areas in Tarash Upazila (sub-district) of Sirajganj district and Singra Upazila of Natore district were visited weekly between October and December 2024 to identify the people involved in shellfish harvesting from the wetlands. This time of year is when shellfish are harvested most intensively (Singha *et al.* 2025). We spoke with individuals involved in shellfish collection, trade and consumption, as well as other local residents, and identified three primary groups of shellfish stakeholders: (i) shellfish collectors, individuals who directly collect shellfish from the wetlands by hand; (ii) shellfish traders, those who purchase shellfish from collectors and sell them to consumers; and (iii) shellfish consumers, people who consume shellfish. It is important to note that some individuals play dual roles. For example, collecting shellfish themselves while also purchasing from other collectors. However, for the purposes of this study, we excluded stakeholders with dual roles.

2.3 Shellfish harvesting

We collected harvest data from 110 shellfish collectors during two periods: between October and December 2023 (the peak shellfish harvesting season in the Chalan Beel; Singha *et al.* 2025) and between mid-January and mid-March 2024 (the lean harvesting season). Harvest data were recorded monthly, with three surveys conducted during October – December and three during January – March. Data were collected in the first week of each month during the October – December period and in the third week of each month during the January – March period. In each sampling week, mean shellfish catch data were calculated based on total shellfish catch recorded over four consecutive days. During this data collection, information on shellfish value chain was also collected to identify the shellfish distribution channel.

2.4 Determination of perception and attitude of stakeholders towards wetland shellfishes

We interviewed 330 stakeholders (shellfish harvesters, n = 110; traders, n = 110; and consumers, n = 110) to assess their knowledge and perceptions regarding shellfish. We also collected basic socio-economic data (e.g. monthly income before and after their engagement in the shellfish collection, secondary income details, age, education, family members and financial loan status) were also collected through a pre-developed questionnaire (Shalehin *et al.* 2022; Kashmi *et al.* 2025). Before each interview, respondents were assured that the data would be used solely for research purposes and that their identities would remain confidential. A 5-point Likert scale (−2: strongly disagree; −1: disagree; 0: neutral/no answer; 1: agree; 2: strongly agree) was used to assess stakeholders' perceptions and attitudes toward the shellfish harvesting and related issues (Kashmi *et al.* 2025; Khatun *et al.* 2025).

2.5 Data analysis

A *t*-test was employed to examine differences in shellfish catch between peak and lean periods. It was also used to analyse the income data of shellfish collectors before and after their engagement in the shellfish collection venture. Whereas, one-way ANOVA was employed to examine the differences in catch competition (three levels: snails, mussels and crabs).

All data analyses were performed in statistical software R (R Core Team 2024) with an α level of significance of 0.05. Before every analysis, data were checked for their suitability for the parametric tests used and, if assumptions were not met, they were transformed on a log scale (Clarke 1993; McDonald 2014; Galib *et al.* 2018).

3 | RESULTS

3.1 Shellfish harvesting and demographic profile of the shellfish collectors

Shellfish catch amount differed between sampling periods (*t*-test: $t = -32.4$, $df = 109$, $p < 0.001$; Table 1). The mean

(± SD) daily amount of shellfish caught during October – December was 10.7 ± 3.3 kg ha^{-1} whereas, this figure was 0.6 ± 0.2 kg ha^{-1} during January – March period (Table 1). Shellfish catch composition also varied across groups (ANOVA: F = 10823, df = 2, 327, p < 0.001; Table 1). Snails (primarily *Pila globosa*) formed the highest proportion of the total catch (70.1%) followed by mussels (primarily *Lamellidens marginalis*) (19.7%) and crab (*Cancer pagurus*) (10.2%) (Table 1).

TABLE 1 Shellfish harvesting and demographic profile of the shellfish collectors in the largest wetland of Bangladesh– the Chalan Beel (n = 110).

Issues	Mean±SD (range)
Shellfish catch and composition	
Experience (years)	6.9±3.4 (2–13)
Daily catch (kg person^{-1})	
Oct–Dec	10.7±3.3 (4.7–20.3)[a]
Jan–Mar	0.6±0.2 (0.3–1.0)[b]
Catch composition (%)	
Snails	70.1±2.0 (60–80)[a]
Crabs	10.2±1.5 (5–20)[b]
Mussels	19.7±1.8 (10–25)[c]
Demographic profile of shellfish collectors	
Age (years)	42.7±10.5 (23–76)
Education (schooling year)	0.6±1.7 (0–8)
Monthly income (thousand BDT)	20.6±3.2 (11–30)
Training on any subject (%)	0
Financial Loan (%)	
Yes	100
Loan source – NGO	100
Monthly income (BDT)	20600±3200
Before (shellfish harvesting)	16491±2715
After	20605±3162
Membership of any association (%)	0
Household assets and facilities (%)	
Mobile phone	100
Internet	7.3
Electricity	100
Refrigerator	97.3
Television	85.6
Motorcycle	0
Bicycle	6.4
Boat	95.5

Different superscript letters for daily catch and catch composition indicate significant differences, determined through t-test and ANOVA respectively. If significant differences in results were obtained, Tukey HSD post-hoc test was also employed to identify differences across group components. 120 BDT = 1 USD (approximately).

The mean (± SD) age and experience of the shellfish collector was 42.7 ± 10.5 years and 6.9 ± 3.4 years respectively (Table 1). They had extremely low level of education (mean schooling year: 0.6 years) (Table 1). Mean monthly income was BDT 20600 ± 3200 and none of them had any training from any organisation or any organisational membership. Interestingly, all of the shellfish collectors had financial loans from non-government organisations (Table 1). However, most of them had their own boats (95.5%) and television (85.6%). All of the shellfish collectors had mobile phone (100%) and use electricity at the household (100%) (Table 1).

The shellfish trade channel in the study area was relatively simple. Three groups of shellfish distribution channel actors were identified: (a) shellfish collectors, (b) traders and (c) consumers (Figure 1). Shellfish collectors included both local residents, typically from neighbouring villages, and ethnic groups who travelled from distant districts (e.g. Joypurhat and Dinajpur). The latter group usually arrived at the shellfish collection sites by truck with their family members during the October to December period. These individuals were the consumers of shellfishes collected from the study area. They also purchased shellfish directly from local collectors and traders (Figure 1).

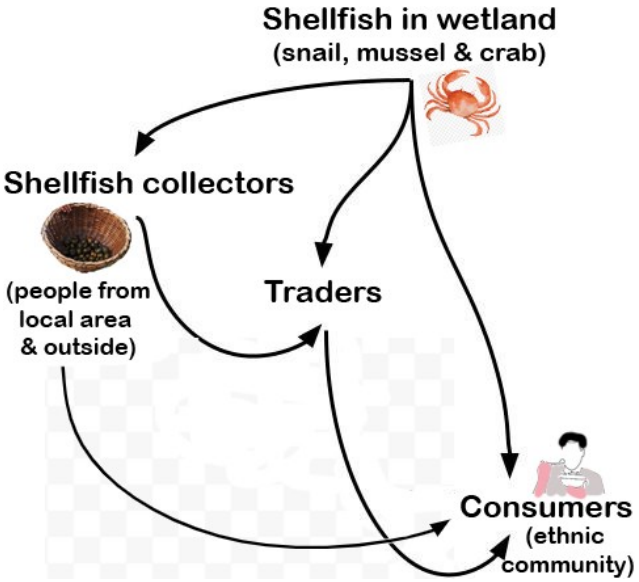

FIGURE 1 Distribution channel of the shellfishes in the Chalan Beel– the largest wetland of Bangladesh.

Monthly income of the shellfish collectors increased after their engagement in the shellfish harvesting than before (t-test: t = 10.2, df = 217, p < 0.001; Figure 2). The mean monthly income of the collectors before the shellfish harvesting was BDT 16491 ± 2715 (range: BDT 9000 – 24000) whereas it was BDT 20605 ± 3162 (range: 11000 – 30000) after their engagement in the shellfish collection (Figure 2).

3.2 Perception and attitude of stakeholders towards wetland shellfishes

Most of the shellfish collectors (65%), traders (54%) and consumers (89%) disagreed that shellfishes are important component of the aquatic environment. Only 11% shellfish collectors and none of the traders and consumer agreed that shellfishes are important component of the environment (Figure 3). All traders and 96% shellfish collectors agreed that shellfish collection and trade is profitable whereas, all consumers maintained a neutral standpoint in this regard (Figure 3).

All shellfish consumers agreed that shellfishes are good food. However, majority of both of the shellfish collectors (93%) and traders (93%) maintained a neutral standpoint in this regards (Figure 3). Interestingly, despite their involvement into the shellfish business, a small proportion of the shellfish collectors (7%) and traders (6%) did not agree to this statement that shellfishes are good food (Figure 3). All consumers and majority of the shellfish collectors (67%) and traders (73%) agreed that shellfish should be collected from other aquatic ecosystems (Figure 3).

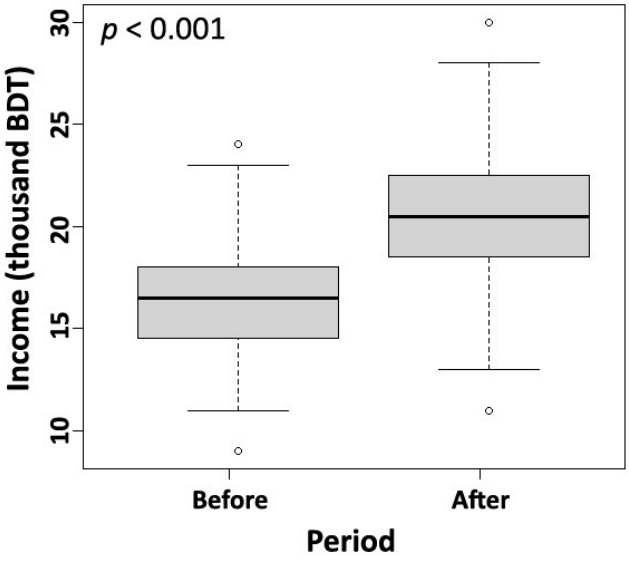

FIGURE 2 Boxplot showing changes in monthly income of the shellfish collectors in the Chalan Beel– the largest wetland of Bangladesh. Before represents time when shellfish collectors were not involved in shellfish collection. Midline within the box is the median; upper and lower limits of the box represent the third and first quartile (75th and 25th percentile) respectively.

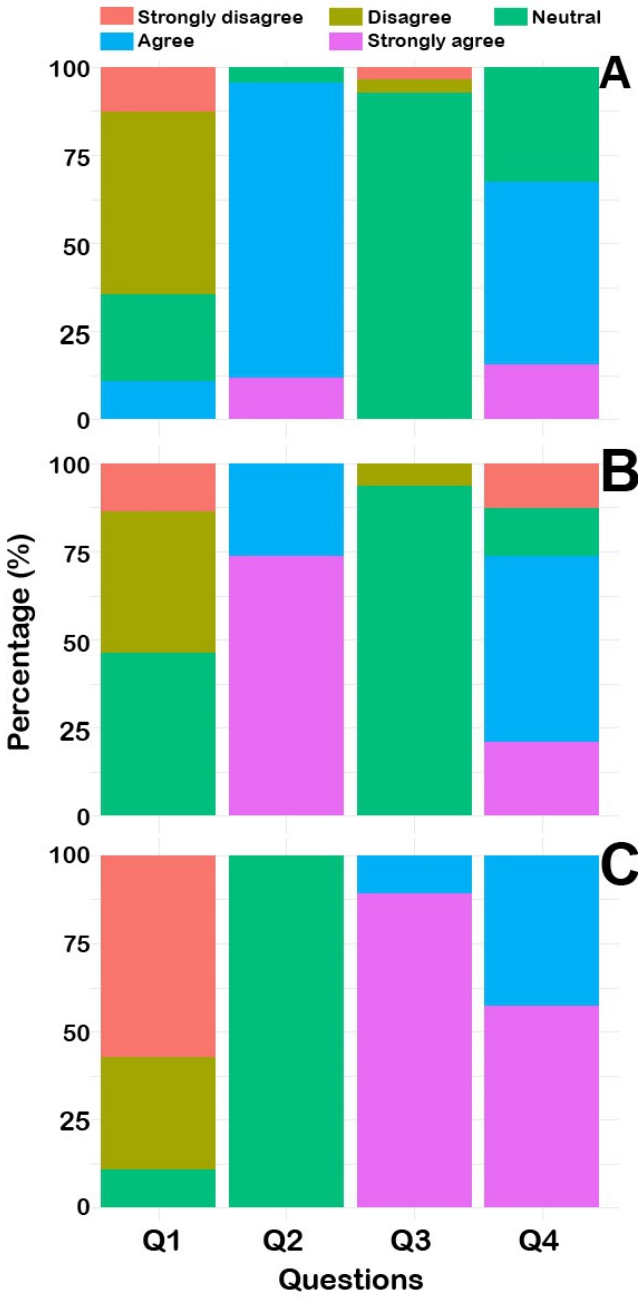

FIGURE 3 Responses of the key shellfish stakeholder groups (A, shellfish collectors; B, traders; C, consumers; *n* = 330, 110 for each group) to study questions/statements (Q1 – Q4)). Q1, shellfishes are good for the environment; Q2, shellfish trade is profitable; Q3, shellfishes are good food; Q4, shellfishes should be harvested from other wetlands.

4 | DISCUSSION

The study results confirmed all our hypotheses: that shellfish harvesting varied across months and that stakeholders' perceptions do not align with the sustainable management of shellfish and wetland ecosystems.

4.1 Shellfish harvesting and demographic profile of the shellfish collectors

It is no surprise that the amount of shellfish caught differed between sampling periods. The higher catch observed during October to December is primarily due to the low and decreasing water levels in the wetland. Shellfish, primarily snails, remain attached to aquatic vegeta-

tion and become more vulnerable to harvesters when water levels drop during the post-monsoon season (i.e. October to December). The decreased water level also allows harvesters to effectively use their hands, fishing nets, and traps, thereby increasing the shellfish catch.

On the other hand, in January to March, most water in the wetland dried up in the study area and shellfishes remain available in the deeper parts of the wetland only. As most of wetland areas are privately-owned, the owners do not allow harvesters to collect shellfishes from the lands as they either plant agricultural crops (Hossain *et al.* 2024) in their plots or use it for katha fishing (Das *et al.* 2022; Hossain *et al.* 2025). Katha fishing is a non-selective fishing method in which deeper areas of any aquatic ecosystem is facilitated with aquatic vegetation and / or bamboo poles with a view to creating an improved habitat for the wild fishes where they take shelter and caught by the people during low water period (Welcomme 1979; Das *et al.* 2022; Hossain *et al.* 2025).

Freshwater snails formed the highest proportion of the total shellfish catch. In freshwater habitats across Bangladesh, especially in wetlands, freshwater snails are being harvested extensively for human consumption and animal feeding (Nath *et al.* 2008; Singha *et al.* 2025). In Bangladesh, shellfishes are not popular as human food among mainstream population except shrimps. This is primarily due to both social and religious restrictions, especially among Muslims (Ferdoushi *et al.* 2010; Rahman *et al.* 2020). Therefore, ethnic minority people are the primary consumers of snails, mussels and freshwater crabs in the country (Singha *et al.* 2025).

Shellfish collectors were mostly middle-aged. Their experience with shellfish collection indicated that the venture was relatively new (<10 years) in the study area. Unfortunately, the respondents had extremely low level of education. These findings are believed to be a representation of the country's overall fishermen's scenario as similar findings were also reported in numerous studies (e.g. Flowra *et al.* 2009; Islam *et al.* 2013; Galib *et al.* 2016).

No training of the respondent shellfish collectors indicates a complete lack of institutional collaborations and cooperation between the shellfish stakeholders and authorities concerned. Trainings are widely recognised tools for increasing the knowledge and changing the attitude of the respondents, especially those are related to any conservation programmes (Ardoin *et al.* 2020; Kashmi *et al.* 2025; Khatun *et al.* 2025). Burden of financial loan is a common problem among fishing communities in Bangladesh (Shalehin *et al.* 2022; Galib *et al.* 2023) and the shellfish collectors were no exception as revealed in this study. It has been reported that financial loan can influence people to get involve in indiscriminate resource harvesting, often following illegal means (e.g. Shalehin *et al.* 2022).

Most of shellfish collectors had their own boats. In the study area, most of the people have their own boats as, during rainy season, the whole area inundates and they cannot move without boats. Moreover, for people engaged in shellfish or fish harvesting, a boat is a must. All of the shellfish collectors had mobile phone and use electricity at the household. Mobile phone is very common these days, even in the hands of the poor people in Bangladesh. As shellfish consumers are not local, collectors need to contact their buyers from distant places and a mobile phone is really helpful in their trade.

The relatively simple trade channel for shellfish in the study area reflects limited engagement by local people in the associated business. This was evident in the study, which recorded only three stakeholder groups. Shellfish collectors included both local residents, typically from neighbouring villages, and ethnic groups who travelled from distant districts (e.g. Joypurhat and Dinajpur). The latter group usually arrived at the shellfish collection sites by truck with their family members during the October to December period. These individuals are mostly poor and often rely on freely available food sources, especially for animal protein. Snails, mussels and crabs are considered highly nutritious and are therefore widely collected and consumed by poor ethnic minority communities (Singha *et al.* 2025).

4.2 Perception and attitude of stakeholders towards wetland shellfishes

Most of the shellfish collectors, traders and consumers disagreed that shellfishes are important component of the aquatic environment. It is often the case that stakeholders willingly or unwillingly reject the fact that might go against their livelihood options (Khatun *et al.* 2025). This might have happed in this case as well. Although stakeholders generally agreed that shellfish collection and trade is profitable but the retail price is still to low and a large amount is needed to generate a handsome amount money.

There is no surprise that shellfish consumers agreed that shellfishes are good food. Compared to other animal protein sources (e.g. fish, chicken or other animal meats) in the markets, price of harvested shellfishes in the Chalan Beel (snails, mussels and crab) is very low which might have attracted the low income groups of people including the shellfish consumers in this study. However, shellfishes are well-known for the nutritional properties. For example, crabs are considered an excellent source of protein and it contains essential amino acids, unsaturated fatty acids, minerals and other micronutrients (Chen 1990; Gokoolu and Yerlikaya 2003). Moreover, compared to other animal source foods, the perceived protein quality of crab meat is considered more favourable (Derosier 1963; Zaitsev *et al.* 1969)

The majority of shellfish stakeholders agreed that

shellfish should be collected from other aquatic ecosystems, primarily due to the free access to wetlands for shellfish collection and trade. Currently, this activity has not come under the attention of the government or other responsible organisations or personnel, and therefore, there is no regulation over this venture. However, it can be anticipated that if more aquatic ecosystems are exploited for shellfish collection, the ecosystems may suffer significant damage, particularly to their fisheries and agricultural productivity.

Finally, some potential limitations need to be acknowledged. Firstly, freshwater shrimp are also available in the Chalan Beel and are considered shellfish species (Singha *et al.* 2025), but they were not included in this study. We only considered shellfish species harvested by hand, those not caught using traditional fishing nets or traps by professional fishermen.

5 | CONCLUSIONS

Chalan Beel is already facing threats from multiple stressors (e.g. Hossain *et al.* 2009; Galib *et al.* 2018; Kashmi *et al.* 2025). To ensure sustainability, the mass removal of shellfish should be halted immediately, and appropriate management policies must be developed. Training programmes for shellfish stakeholders are essential to raise conservation awareness among the concerned parties. Since shellfish aquaculture is a common and widely adopted method for shellfish supply worldwide (e.g. O'Beirn *et al.* 2013; Azra *et al.* 2021; Mahari *et al.* 2024), reliance on wild stocks of freshwater shellfish should be reduced by promoting aquaculture. However, the consumption of certain shellfish (e.g. snails) may lead to foodborne illness, especially when consumed uncooked or undercooked (Phillips 2021; Abera and Adimas 2024; Taylor *et al.* 2025). Therefore, excessive consumption of these species should be closely monitored. long-term monitoring of the study wetland is also recommended to assess the impacts of shellfish collection.

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CONFLICT OF INTEREST

The author declares no conflict of interest.

AUTHORS' CONTRIBUTION

G Singha: fieldwork, data analysis and draft manuscript writing; MN Islam: conceptualisation and supervision; SM Galib: conceptualisation, supervision, critical review of the manuscript.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on a reasonable request from the corresponding author.

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