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Fish, food, and affordability: Nutritional and livelihood dimensions of marine fish consumption by low-income households in Contai coastal region, West Bengal

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Abstract
Marine fish play a vital role in the dietary and economic well-being of the households as economically weaker sections in society and region. Marine fisheries form a nutritional and economic lifeline for low-income households in the Contai coastal region of Purba Medinipur, West Bengal. Despite their importance, the links between species preference, affordability, nutritional contribution, and household food security remain under- documented. This study addresses these gaps through three objectives to document species preference and consumption patterns across coastal households, to assess the affordability of marine fish species using a Food Affordability Index (FAI), to evaluate nutritional quality and socio-economic relevance of commonly consumed fish. A stratified household survey (n=156) was undertaken, integrating species-wise price monitoring, FAI estimation, nutrient composition analysis (protein, omega-3 fatty acids, calcium, iodine, vitamin D), and the Household Food Insecurity Access Scale (HFIAS).
Findings reveal that affordable small pelagic and low-value demersal fish dominate consumption, contributing substantially to protein and micronutrient intake. The mean FAI demonstrated significant inter-coastal and inter-species variation, with low-cost species ensuring high nutrient returns per unit price. Nutrient-specific visualizations and radar plots highlighted stingrays and sardines as nutrient-rich, cost-effective species. However, food insecurity remains prevalent: 44% households are food secure, 38% mildly to moderately insecure, and 19% severely insecure (mean HFSS = 11.8). This reflects fragile access to marine fish amidst market fluctuations and ecological pressures.
The study emphasizes the dual role of affordable fisheries in sustaining household nutrition and local livelihoods. Policy recommendations include strengthening low-value fish supply chains, promoting nutrition-sensitive fisheries management, and integrating marine fish into regional food security planning.

Keywords: Marine fisheries, low-income households, Contai coastal region, species preference, nutritional security, Food Affordability Index, food insecurity planning

1. Introduction
Marine fisheries play a pivotal role in the coastal food economy of eastern India, particularly in the Contai coastal region of Purba Medinipur, West Bengal. Among low- income households, affordable marine fish species remain the dominant source of animal protein, supplying essential nutrients at a fraction of the cost of other protein-rich foods such as meat or poultry (ICMR-NIN, 2017). Their availability and relatively low price make them indispensable in household diets, functioning not only as a staple food but also as a buffer against economic shocks and livelihood uncertainties. Embedded deeply in cultural food practices, marine fish consumption is both a nutritional necessity and a socio-cultural tradition.
At the global level, aquatic foods are increasingly recognized as nutrient-dense dietary staples capable of addressing protein and micronutrient deficiencies. They provide high-quality protein, bioavailable minerals, and omega-3 fatty acids vital for cardiovascular health, cognitive development, and overall well-being (FAO, 2024; Robinson *et al*., 2022) [13]. In particular, small pelagic fish, often consumed whole, are exceptionally rich in calcium, iodine, and vitamin D. These nutrients are of special importance for maternal health, child growth, and the reduction of “hidden hunger” in resource-constrained

communities (Khan *et al*., 2023) [11].
Despite this recognized importance, limited research in West Bengal has examined the combined dimensions of species preference, nutritional quality, and socio-economic value of affordable marine fish. Most existing studies have focused on capture fisheries or trade dynamics, while overlooking how consumption patterns directly intersect with nutrition and household affordability. This lack of integrated evidence creates a gap in understanding the role of low-cost fish in food security and community resilience. Addressing this gap is crucial for informing fisheries management, public health nutrition, and coastal development policies aimed at ensuring both dietary security and livelihood sustainability (CMFRI, 2021).

2. Literature Review

2.1 Aquatic foods and nutrition

Marine fish, particularly small pelagic species, provide highly digestible protein and essential fatty acids, as well as critical micronutrients such as calcium and iodine. Studies in South Asia highlight their role in preventing protein-energy malnutrition and micronutrient deficiencies (Khan *et al*., 2023) [11].

2.2 Affordability and access

Small pelagic species such as sardines, anchovies, and Bombay duck are typically inexpensive and culturally embedded in coastal diets (Robinson *et al*., 2022) [13]. Their affordability makes them central to household food security strategies in low- and middle- income countries.

2.3 Socio-economic aspects

Fish consumption patterns in India are shaped by price, availability, and cultural preference (Salim *et al*., 2020) [14]. Low-income households often rely on these species for up to 60% of their total protein intake (CMFRI, 2021). In West Bengal, particularly in Purba Medinipur, daily fish consumption is high, but seasonal supply gaps and market price fluctuations present major challenges (Mathew & George, 1991) [12].

2.4 West Bengal and Contai fisheries context

The Contai coastal belt (Junput-Mandarmani-Petuaghat) hosts numerous landing centres dominated by small-scale fisheries. These fisheries face infrastructural challenges, especially in cold chain storage, which lead to reliance on traditional preservation methods such as drying (Bhanja *et al*., 2023) [2].

2.5 Gender and household nutrition

Women play a decisive role in purchasing and preparing fish for household consumption. Gender-inclusive fisheries planning and support for women-led retail can enhance both livelihoods and nutrition outcomes (ICSF, 2023).

3. Statement of Problem

Low-income households in the Contai coastal region increasingly struggle to access affordable marine fish because of overfishing, seasonal shortages, and unstable market prices. Although several low-cost species continue to sustain local diets, there is insufficient research documenting their consumption trends, nutritional value, and socio-economic importance. This knowledge gap restricts the ability of policymakers, fisheries managers, and public health planners to design evidence-based strategies that enhance nutritional security and strengthen coastal livelihoods. Without such insights, both community well-being and the sustainability of marine resources remain at risk.

4. Specific Objectives

1. To examine species preferences and affordability of marine fish consumed by low- income households in the Contai coastal region.
2. To assess the nutritional value of commonly consumed low-cost marine fish species
3. in relation to dietary needs.
4. To evaluate the socio-economic significance of affordable marine fish consumption for household food security and livelihoods.

5. Methods

5.1 Study Area and Sampling

The study was conducted in the Contai coastal region of Purba Medinipur, West Bengal, a major hub of marine fishing and consumption. A purposive sampling approach was applied to select five coastal markets (Contai, Digha, Junput, Tajpur, and Shankarpur), where affordable fish species are commonly sold. Data were collected through household surveys (n = 156 low-income households) and market surveys (n = 40 vendors). Households were selected based on income thresholds (below Rs. 12,000/- per month) to represent vulnerable communities dependent on marine fish for protein intake.
For the study, the different coastal fishing villages and markets are considered along the Contai coastal belt, including Hijli-Khejuri, Petuaghat, Junput, Shaula (Sherpur Jalpai), Dadanpatrabad, Mandarmani, Sankarpur and Digha of Purba Medinipur district in West Bengal.

Table 1: Major Surveyed Areas (Fishing Villages and Markets) throughout the Study Area

Major Marine Fishing Village/ Mouza	Address	Popular Marine Fish Markets	Address
Digha Mohana	Ramnagar-I CD Block	Digha Mohana	\Ramnagar-I CD Block
Sankarpur		Sankarpur	
Jaldha-Tajpur		Ramnagar	
Mandarmani	Ramnagar-II CD Block	Kalindi	Ramnagar-II CD Block
Dadanpatrabad		Balisai	
Dakshin Purushottampur		Pichhabani	
Shaula (Serpur Jalpai)	Contai-I CD Block	Contai Super Markets	Contai Municipality
Junput-Biramput		Mukundapur	Contai-I CD Block
Dariyapur-Petuaghat	Deshapran (Contai-II) CD Block	Rasulpur Ghat	
Daha Sonamui		Rasulpur Ghat	Khejuri-II CD Block
Kalinagar		Kalinagar	Deshapran (Contai-II) CD Block
Hijli-Nijkasaba	Khejuri-II CD Block	Janka	Khejuri-II CD Block
Khejuri-Battala		Vidyapith	
Talpati		Haria	Khejuri-I CD Block
Jaldha-Tajpur		Ramnagar	

Source: Author's Own Selection maintaining Coasta Region Delineation Rule

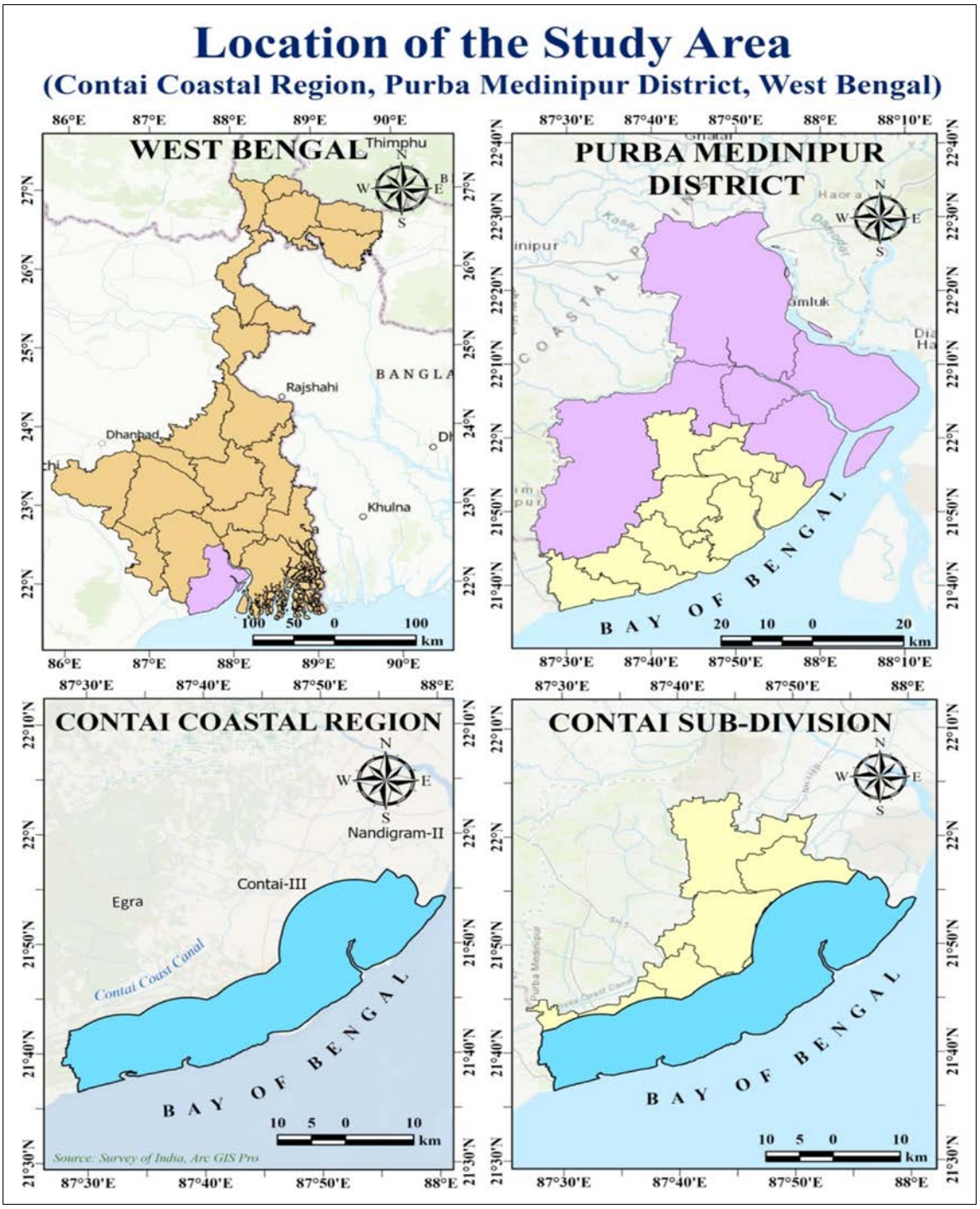

Fig 1: Location of the Study Area

Table 2: Different Coastal Sections with Surveyed Fishing

Major Coastal Sections	Major Coastal Blocks & Municipality	Major Marine Fishing Village/ Mouza	Major Marine Fish Markets
Digha-Sankarpur-Tajpur Coast	Ramnagar-I CD Block	Digha Mohana, Sankarpur, Ramnagar & Jaldha-Tajpur	
Mandarmani Coast	Ramnagar-II CD Block	Mandarmani, Dadanpatrabad, Dakshin Purushottampur, Kalindi, Balisai & Pichhabani	
Junput Coast	Contai-I & Deshapran (Contai-II) CD Blocks and Contai Municipality	Shaula/ Serpur Jalpai, Biramput, Dariyapur, Daha Sonamui, Rasulpur Ghat & Kalinagar	Contai Municipality, Junput, Mukundapur & Kalinagar
Hijli-Khejuri Coast	Khejuri-I & II CD Blocks	Rasulpur Ghat, Battala/ Khejuri & Talpati	Janka, Vidyapith, Kunjapur, Tetultala & Haria
Source: Author's Own Selection maintaining Coasta Region Delineation Rule			

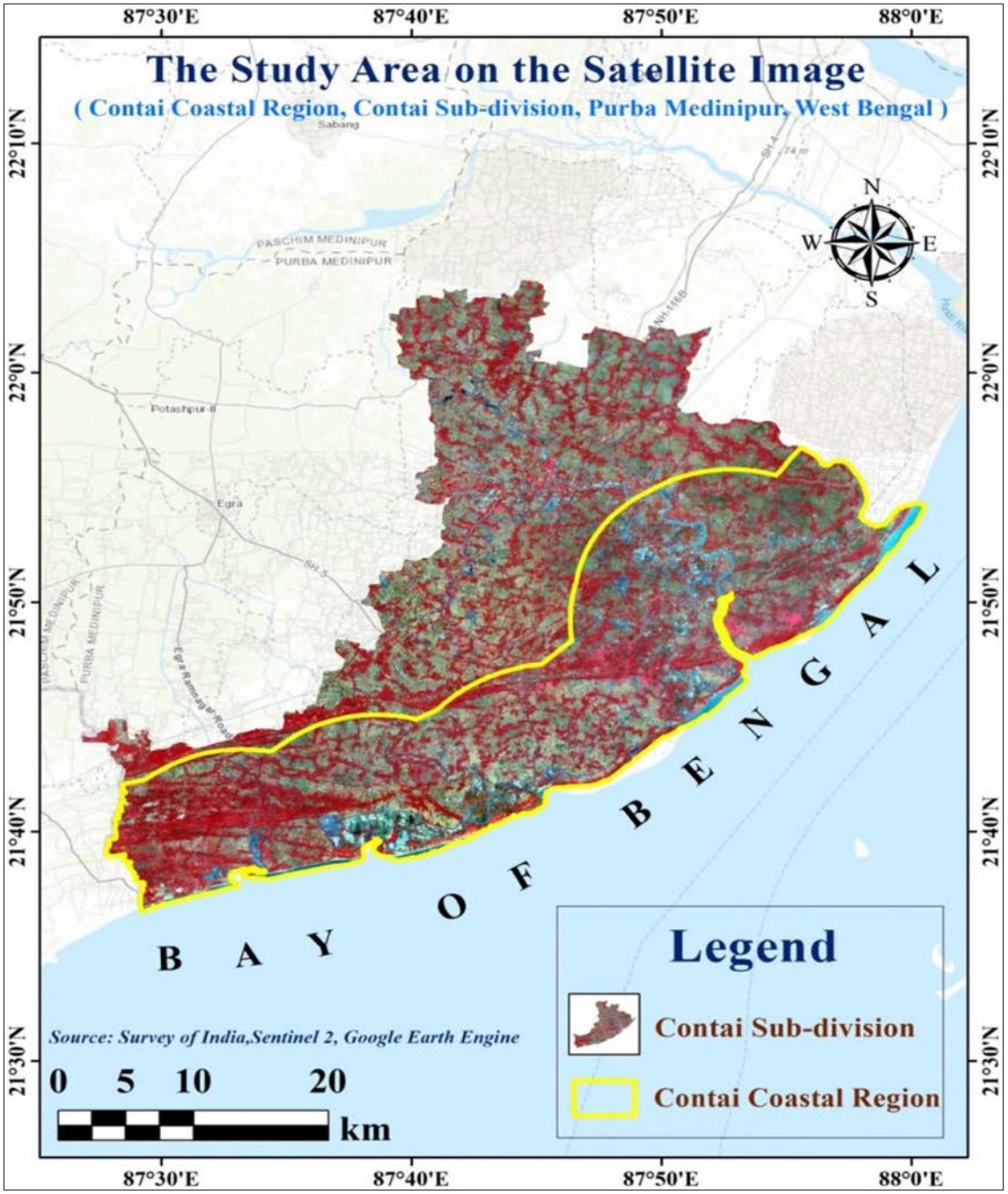

Fig 2: The Study Area on the Satellite Image

5.2 Data Collection

- **Household Surveys:** Structured questionnaires were used to gather data on species preferences, purchase frequency, average expenditure, and perceived affordability.
- **Market Surveys:** Price data for commonly consumed species were recorded across seasons to identify fluctuations and affordability constraints.
- **Focus Group Discussions (FGDs):** Conducted with fishing households and consumers to understand cultural and socio-economic significance of fish consumption
- **Nutritional Data:** Secondary data from the Indian Food Composition Tables (ICMR- NIN, 2017).

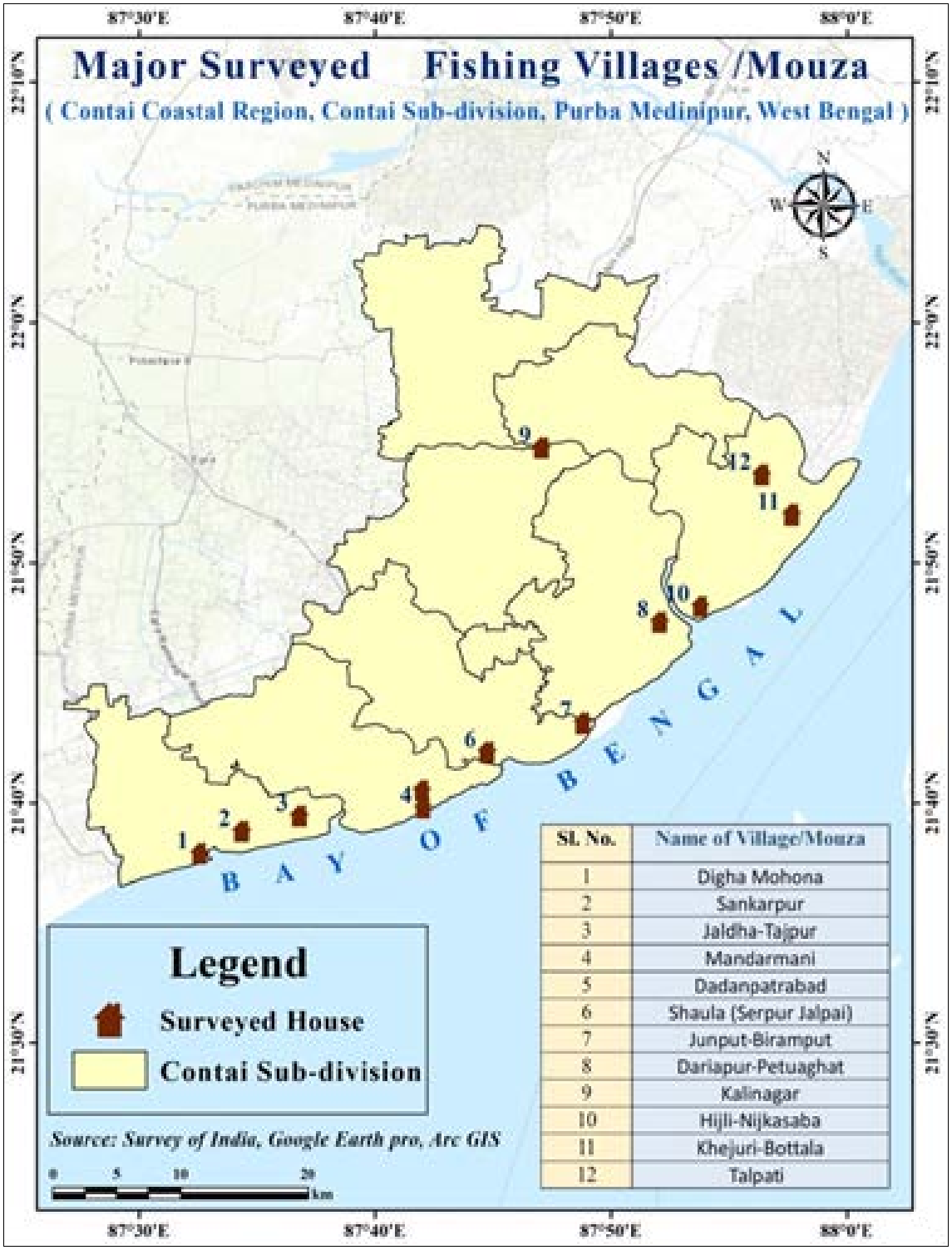

Fig 3: The Surveyed Coastal Villages in the Study Area for Household Survey

5.3 Fish Affordable Index (FAI)

$$FAI = \frac{\text{I II I I II nIIIIIII I I}}{\text{II I I}} \times 100$$

An FAI score ≤ 20% was considered affordable, while higher values indicated reduced accessibility for low-income households.

Categories of FAI based on FAO affordability guidelines:

- <40% = Highly affordable
- 40-60% = Affordable to moderately affordable
- >60% = Low affordability (financially burdensome)

5.4 Nutritional Analysis

Nutrient composition (protein, fat, calcium, iron, and omega-3 fatty acids) of selected low-cost fish species (e.g., Sardinella longiceps, Harpadon nehereus, Trichiurus lepturus) was compiled from ICMR-NIN (2017) and supplemented with laboratory proximate analysis of representative samples. Nutrient density scores and cost-to-nutrient ratios were computed to compare affordability of nutrients across species.

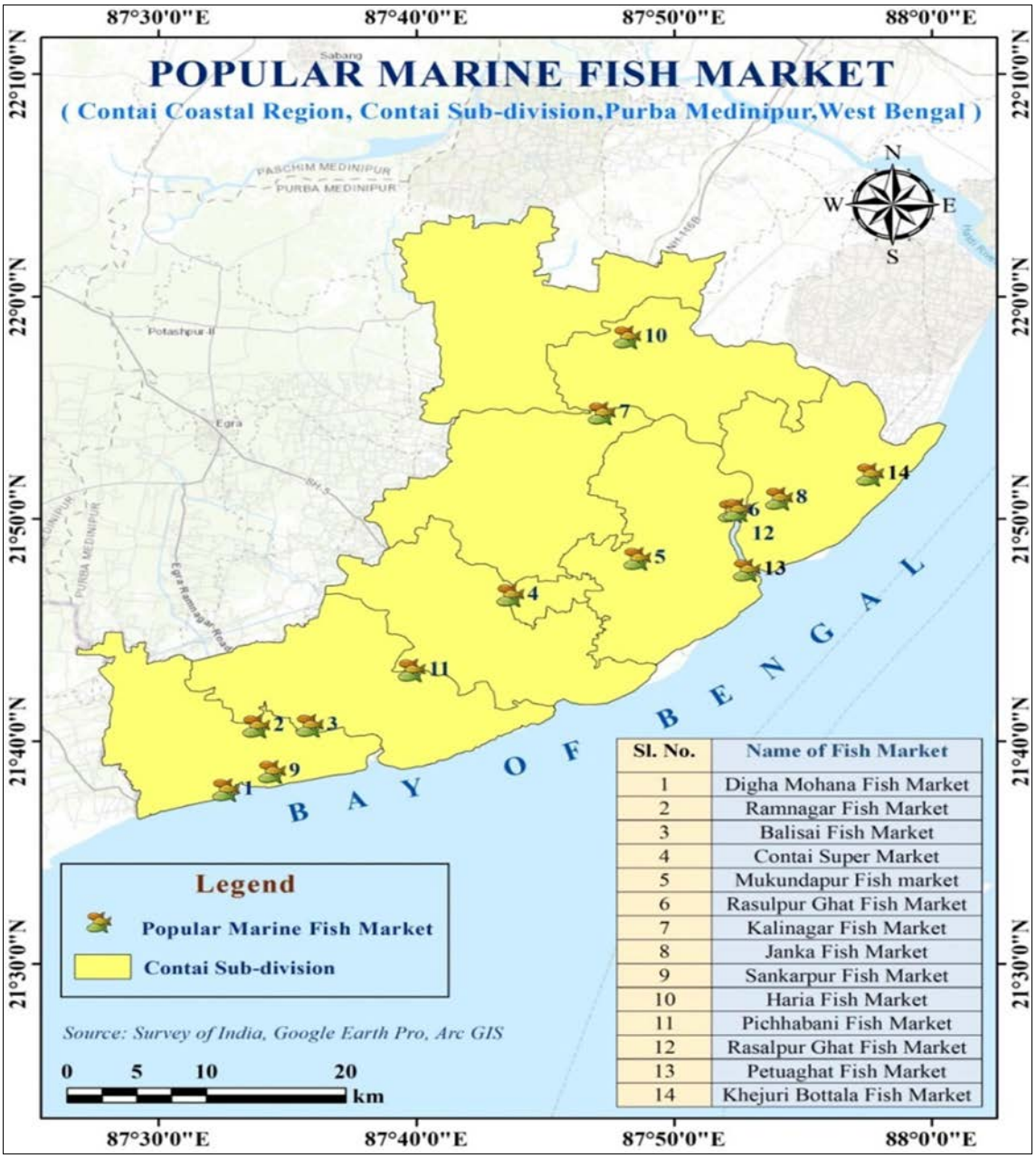

Fig 4: Popular Marine Fish Markets in the Study Area for Market/ Vendor Survey

5.5 Socio-Economic Assessment

Socio-economic data were analyzed using descriptive statistics and cross-tabulations. Indicators included:

- **Household Food Security Score (HFSS):** based on self-reported food sufficiency over the past month.
- Household Food Insecurity Access Scale (HFIAS), which scores responses to questions on food sufficiency. Each household gets a score from 0 (fully food secure) to 27 (severely food insecure). Household Food Security Category:
- **0 - 9:** Food secure
- **10 - 17:** Mild to moderate food insecurity
- **18 - 27:** Severe food insecurity
- **Contribution to Livelihoods:** role of fish consumption in dietary resilience, cultural practices, and informal trade

5.6 Data Analysis

- Descriptive statistics for preference patterns and socio-economic indicators.
- Cross-tabulation of income levels with consumption frequency.
- Comparative nutrient profile analysis.
- Quantitative data were analyzed using SPSS and MS Excel. Descriptive statistics (mean, percentage, standard deviation) were applied for affordability and nutritional assessment. Chi-square tests examined associations between income level and species preference. Qualitative data from FGDs were thematically analyzed to capture socio- cultural dimensions.

Results and Discussion

6.1 Species Preference

Table 3: Seasonality and magnitude of the availability of identified preferred low-cost marine fish species throughout the Contai Coastal Region

Sr. No.	Species Name (Scientific Name)	Common Name	Local Name	Magnitude of Availability/ Sufficiency of the Fish Species	Seasons/ Months of Availability (Seasonality)	Main Reasons for the Preferability of Affordable Marine Fishes
1.	Arius arius	Threadfin sea catfish	Aar Tyangra/ Nona Tangra/ Kanta Shimul	Moderate - High	Nov-Feb	Mild flavour, less bone
2.	Carangoides coeruleopinnnatus	Small Trevally/Coastal Trevally	Gang Chanda	Low - Moderate	Oct-Dec	Form flesh, Mild flavour
3.	Eleutheronema teteadactylum	Indian salmon	Korua/ Gurjali	Moderate	Sept-Dec	Mild flavour, firm and juicy flesh
4.	Elops saurus	Small lady fish	Korma/ Gaj Korma/ Chhenchua Balguri	Low - Moderate	Oct-Feb	Mild taste, soft texture, Easy cook
5.	Ephippus orbis	Orb Fish/ Round Spadefish	Doi chaka	Low	Oct-Feb/June- Sept	Mild flavour, versatile in cooking
6.	Escualosa thoracata	White sardine	Gang Murla/ Khoira	Moderate	Mar-June	Cheap, Tasty
7.	Gudusia chapra	Clupea Chapra	Chapila/ Mukundi	Moderate	May-Oct	Delicate flavour, culinary versatility

Table 4: Household Consuming Status of the Preferred Low-Cost Marine Fish Species in the Different Sections under Contai Coastal Region

Sr No.	Common Name	% of Household Consuming				
		Hijli-Khejuri Coast (Khejuri-I & II)	Junput Coast: Contai-I, Contai (M) & Contai-II/ Deshapran	Mandarmani Coast: Ramnagar-II	Digha-Sankarpur-Tajpur Coast: Ramnagar-I	Average
1.	Threadfin sea catfish	51	38	42	43	43.50
2.	Small Trevally/Coastal Trevally	40	37	42	34	38.25
3.	Indian salmon	38	45	46	48	44.25
4.	Small lady fish	36	40	39	42	39.25
5.	Orb Fish/ Round Spadefish	24	34	36	32	31.50
6.	White sardine	56	74	64	62	64.00
7.	Clupea Chapra	28	45	38	41	38.00
8.	Bombay Duck	63	70	72	73	69.50
9.	Yellow croaker	65	54	56	66	60.25
10.	White snapper/Sharp tooth job fish	41	39	43	44	41.75
11.	Torpedo scad	37	48	46	42	43.25
12.	Grey mullet	54	50	53	57	53.50
13.	Stingrays	45	38	32	47	40.50
14.	Small silver pomfret	50	49	48	54	50.25
15.	Sea tiger prawn	67	74	72	76	72.25
16.	Blackspot Threadfin	23	38	36	37	33.50
17.	Paradise Threadfin	64	65	68	70	66.75
18.	White mingo snapper	54	50	56	54	53.50
19.	Indian butterfish	36	46	42	45	42.25
20.	Indian Mackerel	56	47	44	54	50.25
21.	Indian oil sardine	34	40	37	40	37.75
22.	Fasa/ Phasa	22	47	45	46	40.00
23.	Hairfin anchovy	62	50	48	51	52.75
24.	Indian Anchovy/ Gold spotted anchovy	72	78	79	76	76.25
25.	White Anchovy	68	76	77	76	74.25
26.	Ribbonfish	58	60	64	65	61.75
27.	Indian lizard fish/Bengal monitor lizard fish	24	32	34	37	31.75
				50.33	52.30	50.03
	Total (N = 196: Households & Vendors)	46.96	50.52			
Source: Household and Market Survey, 2024-2025						

The household consumption patterns reveal strong regional and species-specific preferences across the Contai coastal stretches. On average, about 50% of surveyed households consumed the listed low-cost marine fishes, though the proportions varied significantly by species and coast.

- **High-consumed species:** Anchovies emerged as the most widely consumed, with Indian anchovy (76.25%) and White anchovy (74.25%) dominating household diets, followed closely by sea tiger prawn (72.25%) and Bombay duck (69.50%). These species are affordable, abundantly available, and nutritionally dense, making them critical to food security.
- **Moderately consumed species:** Species like yellow croaker (60.25%), ribbonfish (61.75%), grey mullet (53.50%), white mingo snapper (53.50%), and small silver pomfret (50.25%) reflected moderate popularity, often driven by seasonal availability and local market access.
- **Low-consumed species:** Fasa (40.00%), stingrays (40.50%), orb fish (31.50%), and Indian lizard fish (31.75%) registered relatively low household preference, possibly due to taste, handling difficulty, or cultural biases against certain varieties.
- **Regional variation:** Consumption levels were highest in Digha-Sankarpur-Tajpur (52.30%) and lowest in Hijli-Khejuri (46.96%), reflecting disparities in local fish landings, distribution networks, and consumer preferences. Junput and Mandarmani households showed mid-range but consistent consumption (≈50%).

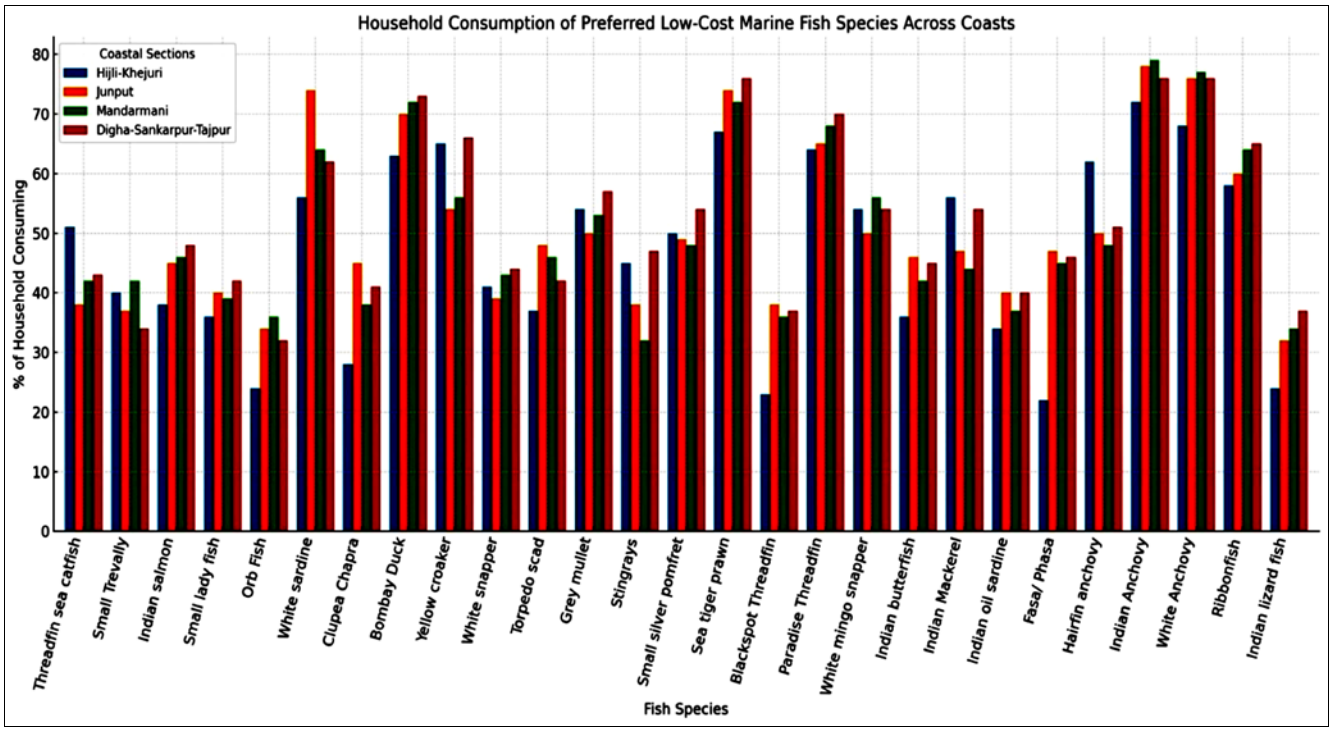

Fig 5: Comparative Household Consumption for Cost Marine Fish Species in Different Sections

Overall, the findings suggest that while anchovies, prawns, and small pelagic species are central to coastal diets, underutilized but nutritionally valuable species (e.g., stingrays, threadfins, orb fish) remain underrepresented in household consumption. This points to both opportunities for nutritional diversification and the need for policy interventions to stabilize market access and affordability.

6.2 Pricing Status of the Preferred Low-Cost Marine Fish Species

Table 5: Pricing Status of the Preferred Low-Cost Marine Fish Species in the Different Sections under Contai Coastal Region

Sr No.	Common Name	Price (Rs./-) per kg				
		Hijli-Khejuri Coast (Khejuri-I & II)	Junput Coast: Contai-I, Contai (M) & Contai-II/ Deshapran	Mandarmani Coast: Ramnagar-II	Digha-Sankarpur-Tajpur Coast: Ramnagar-I	Average
1.	Threadfin sea catfish	100-180	80-110	80-100	100-180	130
2.	Small Trevally/Coastal Trevally	80-120	80-110	80-120	70-120	95
3.	Indian salmon	120-180	120-180	160-190	140-190	155
4.	Small lady fish	100-160	160-180	160-180	140-190	145
5.	Orb Fish/ Round Spadefish	80-120	80-120	110-170	120-180	130
6.	White sardine	80-120	60-120	60-120	80-130	95
7.	Clupea Chapra	80-120	70-120	100-140	100-150	110

The pricing pattern of low-cost marine fish species across the Hijli-Khejuri, Junput, Mandarmani, and Digha-Sankarpur-Tajpur coasts reflects a combination of availability, seasonality, demand-supply dynamics, and local consumption preferences.

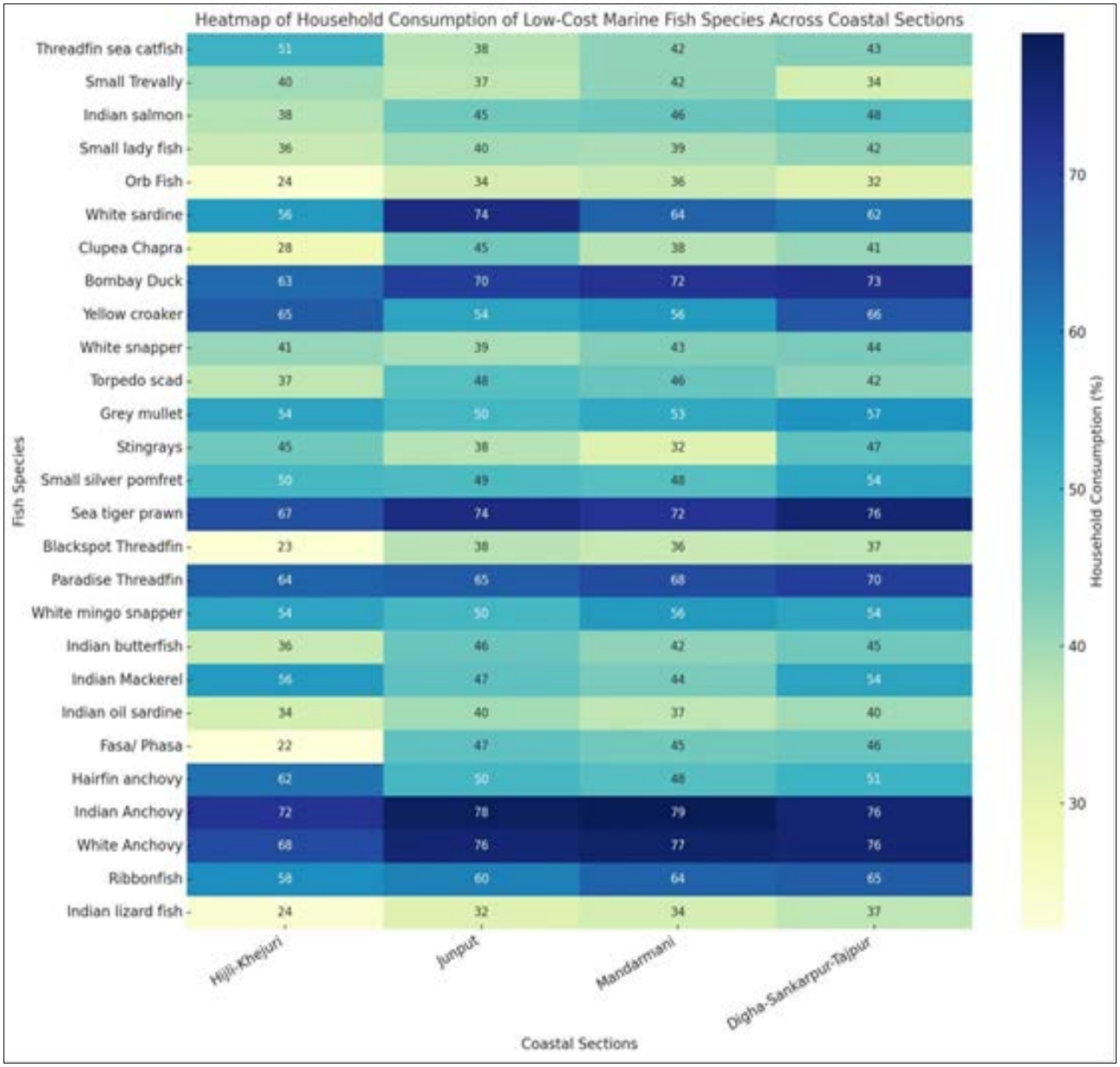

Fig 6: Household Consumption for Cost Marine Fish Species in the Different Sections

1. General Price Range and Affordability

- Prices of most species fall between ₹80-180 per kg, indicating their role as relatively affordable protein sources compared to premium marine fish (e.g., hilsa, large pomfret, tiger prawns).
- Exceptionally, some species such as stingrays (₹140-200/kg), grey mullet (₹120- 200/kg), and Indian salmon (₹120-190/kg) occupy the higher spectrum of the "low-cost" range, reflecting demand among middle-income fish consumers.

2. Inter-Coastal Price Variations

- Junput Coast shows a generally lower price range (₹60-120/kg for sardines, anchovies, Bombay duck, and prawns), suggesting stronger availability due to proximity to landing centres (Junput-Biramput, Shaula, Deshapran) and active small- scale fisheries.
- Digha-Sankarpur-Tajpur registers higher average prices, especially for yellow croaker (₹200/kg), stingrays (₹200/kg), and lady fish (₹190/kg), likely influenced by tourism-driven demand and higher vendor margins.
- Mandarmani Coast shows moderate-to-high prices, again reflecting its tourism-linked seafood demand and relatively smaller local landing compared to Digha.
- Hijli-Khejuri records wide price ranges (e.g., threadfin catfish ₹100-180, Bombay duck ₹50-120), showing its position as a major estuarine-coastal fish hub with high seasonal variability.

3. Species-Specific Insights

- Bombay Duck (Lote/Lohora) remains the cheapest option (₹40-150/kg), sustaining its role as the most accessible protein for lower-income households.
- Anchovies (Ruli/Amudi, Tapra) also remain highly affordable (₹40-120/kg), particularly in Junput and Mandarmani, supporting food security in fishing households.

- Croakers (Bhola), grey mullet (Khosla), and stingrays (Shankar), though still categorized as "low-cost", approach premium boundaries in tourist areas.
- Small silver pomfret (Rupchanda), although cheaper than large pomfret, still costs up to ₹180/kg, reflecting its aspirational value in household diets.

4. Socio-Economic Implications

- The data indicates that households in Junput and Hijli-Khejuri have relatively better access to cheaper marine protein due to direct landings.
- Tourism-influenced coasts (Mandarmani and Digha-Sankarpur-Tajpur) see price inflation, reducing affordability for local low-income households while catering to urban/tourist demand.
- This spatial disparity highlights the dual character of marine fish markets—balancing subsistence nutrition for locals and commercial seafood demand for outsiders.

5. Nutritional and Policy Relevance

- From a nutritional security perspective, sustaining the affordability of species like Bombay duck, anchovies, sardines, and threadfin catfish is critical.
- Policymakers must recognize the impact of tourism and market integration on local fish pricing, ensuring equitable access for fishing communities and low-income buyers through price stabilization mechanisms or local cooperative markets.

Table 4 reveals that while the Contai coastal fisheries still provide diverse low-cost marine fish, rising tourism and inter-coastal market variations risk making certain species unaffordable for local households. The dual pressure of nutritional dependence vs. commercial seafood demand is at the core of this dynamic, and any blue economy or food security strategy must address this pricing disparity.

6.3 Purchase Frequency Patterns in the Contai Coastal Region

Table 6: Mean purchase frequency (per week) of the Preferred Low-Cost Marine Fish Species in the Different Sections under Contai Coastal Region

Sr. No.	Common Name	Mean purchase frequency (per week)				
		Hijli-Khejuri Coast (Khejuri-I & II)	Junput Coast: Contai-I, Contai (M) & Contai-II/ Deshapran	Mandarmani Coast: Ramnagar-II	Digha-Sankarpur-Tajpur Coast: Ramnagar-I	Average
1.	Threadfin sea catfish	1.5	0.9	1	1.2	1.15
2.	Small Trevally/Coastal Trevally	1.8	1.9	1.5	1.5	1.68
3.	Indian salmon	1	1.9	1.5	1.7	1.53
4.	Small lady fish	1.4	2	1.8	1.9	1.78
5.	Orb Fish/ Round Spadefish	1	1.8	1.6	1.7	1.53
6.	White sardine	2.1	2.3	1.8	2.1	2.08
7.	Clupea Chapra	1.2	1.9	1.6	1.8	1.63
8.	Bombay Duck	1.9	3.1	2.6	2.8	2.60
9.	Yellow croaker	2.5	2.1	2.2	2.3	2.28
10.	White snapper/Sharp tooth job fish	2.1	1.9	1.7	2	1.93
11.	Torpedo scad	0.7	1.7	1.3	1.4	1.28
12.	Grey mullet	2.1	2.4	2	2.2	2.18
13.	Stingrays	1.7	1.1	1	1.8	1.40
14.	Small silver pomfret	1.6	1.8	1.5	1.6	1.63
15.	Sea tiger prawn	2.2	2.9	2.4	2.9	2.60
16.	Blackspot Threadfin	0.7	1.8	1.7	1.8	1.50
17.	Paradise Threadfin	2.3	2.7	2.1	2.6	2.43
18.	White mingo snapper	2.1	1.9	1.7	2	1.93
19.	Indian butterfish	0.6	1.5	1.1	1.3	1.13
20.	Indian Mackerel	2	2.6	2.1	2.3	2.25
21.	Indian oil sardine	1.4	2.3	1.9	2.1	1.93
22.	Fasa/ Phasa	1.1	1.9	1.5	1.8	1.58
23.	Hairfin anchovy	1.3	2.2	1.7	1.8	1.75
24.	Indian Anchovy/ Gold spotted anchovy	2.7	2.9	2.3	2.6	2.63
25.	White Anchovy	2.8	3	2.3	2.6	2.68
26.	Ribbonfish	1.8	2.2	1.9	2	1.98
27.	Indian lizard fish/ Bengal monitor lizard fish	0.8	1.6	1.1	1.5	1.25
Total (N = 196: Households & Vendors)		1.64	2.09	1.74	1.97	1.86

Source: Household and Market Survey, 2024-2025

The analysis of mean purchase frequency of low-cost marine fish species across the four coastal segments of the Contai region (Hijli-Khejuri, Junput, Mandarmani, and Digha-Shankarpur-Tajpur) provides important insights into localized consumption behavior, affordability, and cultural preference (Table 5). The overall household and vendor average shows that low-cost marine fishes are purchased 1.86 times per week, reflecting their significance as staple protein sources in coastal diets.

A striking trend is the high preference for anchovies (Ruli/Amudi), particularly Indian Anchovy (2.63 times/week) and White Anchovy (2.68 times/week). Their affordability, ease of cooking, and availability in bulk during peak fishing seasons contribute to this dominance. Anchovies are also nutritionally valued for their calcium and omega-3 fatty acid content, making them attractive to low- and middle-income households. Similarly, Bombay Duck (Babla/Lote) and Sea Tiger Prawn (Nona Chingri) record a purchase frequency above 2.5, highlighting their strong market presence despite slight price fluctuations.

Species such as Yellow Croaker (Bhola), Grey Mullet (Khosla), Indian Mackerel (Potol), and Paradise Threadfin (Tupsi) also show relatively high purchase frequencies (>2), suggesting a regional preference for mid-tier species that balance affordability with taste. These fishes often serve as alternatives when high-demand anchovy or sardine stocks fluctuate.

In contrast, certain species display comparatively low purchase frequencies, such as Indian Butterfish (Chandi/Karati, 1.13), Indian Lizard Fish (Kanua, 1.25), and Torpedo Scad (Gura, 1.28). Their limited demand can be attributed to factors such as bony texture, seasonal unavailability, or cultural disinterest. Notably, Stingrays (Shankar/Mulli) also record a lower purchase frequency (1.40), suggesting that although nutritionally rich (particularly in protein and calcium), they are less favored for regular household consumption, possibly due to cooking challenges and religious taboos in certain fishing communities.

A spatial contrast emerges across coasts. Junput and Digha-Tajpur show the highest mean purchase frequencies (2.09 and 1.97, respectively), while Hijli-Khejuri reports the lowest average (1.64). This reflects differences in market accessibility, income levels, and cultural eating patterns. For example, Junput markets act as redistribution nodes, receiving bulk landings from trawlers and supplying surrounding villages, which helps stabilize fish prices and increase weekly purchase capacity. Conversely, Hijli-Khejuri relies more on localized artisanal landings with seasonal fluctuations, reducing weekly household purchases.

From a socio-economic lens, the dataset illustrates the tight coupling of affordability, availability, and preference. Low-cost fishes (sardines, anchovies, Bombay duck, croaker, mullet) dominate household baskets, while high-value demersal species (pomfrets, snappers, butterfish) are purchased less frequently, often reserved for special occasions. This aligns with the findings of previous coastal livelihood studies in West Bengal, where marine fish consumption is not merely a dietary practice but also reflects household income resilience and local food culture.

Table 5 demonstrates that anchovies, sardines, Bombay duck, prawns, and croakers form the backbone of coastal food security in the Contai coastal region. Spatial variation further indicates that market connectivity and affordability play a stronger role than species availability alone in shaping purchase frequency. This insight contributes to understanding how low-cost marine fishes sustain both nutritional resilience and cultural continuity among fishing and non-fishing households in coastal Bengal.

6.4 Affordability of Low-Cost Marine Fish across Coastal Sections

The Fish Affordability Index (FAI) reflects the proportion of daily household income required to purchase one kilogram of a preferred marine fish species. In the Contai coastal region, the average FAI across all species and sections is 30.68%, meaning that nearly one- third of daily wages must be spent to purchase a kilogram of fish. This underlines both the nutritional importance and the economic strain of accessing marine protein for low-income households.

Spatial variation is evident. The Hijli-Khejuri coast consistently recorded higher FAIs (mean = 31.6), reflecting higher average fish prices (Rs.118/- per kg) combined with slightly lower daily incomes. In contrast, the Junput coast showed the lowest affordability (mean FAI = 28.0) due to lower mean fish prices (Rs. 106/- per kg) relative to household incomes. Mandarmani (mean FAI = 30.0) and Digha-Sankarpur-Tajpur (mean FAI = 33.1) lie in between, with the latter reflecting both tourism-driven market pressures and higher fish demand.

Species-wise contrasts further highlight affordability divides.

- The most affordable species include Bombay Duck (FAI = 22.9), Indian Anchovy/Gold spotted anchovy (21.3), and White Anchovy (21.3). These small pelagic fishes are purchased more frequently (see Table 5) and function as nutritional safety nets.
- In contrast, species such as Indian salmon (41.4), Stingrays (41.4), and Small ladyfish (41.1) exhibit much higher FAIs, indicating reduced affordability for poorer households despite their high nutrient value.

Intermediate species, including Grey mullet (37.5), Indian mackerel (36.2), and Paradise threadfin (37.5), represent fish of aspirational status: consumed less frequently due to price constraints but valued when affordable

Table 7: Affordability Index (FAI) of the Preferred Low-Cost Marine Fish Species in the Different Sections under Contai Coastal Region

Sl. No.	Common Name		Fish Affordability Index (FAI)																
			Hijli- Khejuri Coast (Khejuri-I & II)			Junput Coast: Contai-I, Contai (M) & Contai-II/ Deshapran						Manarmani Coast: Ramnagar-II			Digha- Sankarpur-Tajpur Coast: Ramnagar-I		Affordabilit		Affordabili ty Status
18.	17.	16.	15.	14.	13.	12.	11.	10.	9.	8.	7.	6.	5.	4.	3.	2.	1.		
White mingo snapper	Paradise Threadfin	Blackspot Threadfin	Sea tiger prawn	Small silver pomfret	Stingrays	Grey mullet	Torpedo scad	White snapper/Sharp tooth job fish	Yellow croaker	Bombay Duck	Clupea Chapra	White sardine	Orb Fish/ Round Spadefish	Small lady fish	Indian salmon	Small Trevally/ Coastal Trevally	Threadfin sea catfish		
110	150	115	100	125	170	140	120	100	130	85	100	100	100	130	150	100	140	Mean Cost per kg (Rs./-)	
375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	Average Daily Income (Rs./-)	
29.3	40.0	30.7	26.7	33.3	45.3	37.3	32.0	26.7	34.7	22.7	26.7	26.7	26.7	34.7	40.0	26.7	37.3	FAI (Rs./-)	
95	120	100	85	105	140	120	115	95	100	70	95	90	100	170	150	95	95	Mean Cost per kg (Rs./-)	
380	380	380	380	380	380	380	380	380	380	380	380	380	380	380	380	380	380	Average Daily Income (Rs./-)	
25.0	31.6	26.3	22.4	27.6	36.8	31.6	30.3	25.0	26.3	18.4	25.0	23.7	26.3	44.7	39.5	25.0	25.0	FAI (Rs./-)	
85	140	120	75	100	150	150	120	100	100	95	120	90	140	170	175	100	90	Mean Cost per kg (Rs./-)	
390	390	390	390	390	390	390	390	390	390	390	390	390	390	390	390	390	390	Average Daily Income (Rs./-)	
21.8	35.9	30.8	19.2	25.6	38.5	38.5	30.8	25.6	25.6	24.4	30.8	23.1	35.9	43.6	44.9	25.6	23.1	FAI (Rs./-)	
110	170	120	110	140	180	170	120	110	150	105	125	105	150	165	165	95	140	Mean Cost per kg (Rs./-)	
400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	Average Daily Income (Rs./-)	
27.5	42.5	30.0	27.5	35.0	45.0	42.5	30.0	27.5	37.5	26.3	31.3	26.3	37.5	41.3	41.3	23.8	35.0	FAI (Rs./-)	
25.91	37.49	29.44	23.94	30.40	41.41	37.47	30.76	26.20	31.03	22.92	28.42	24.92	31.59	41.06	41.40	25.26	30.10		
VHA	HA	VHA	VHA	HA	M- MA	HA		VHA	HA	VHA	VHA	VHA	HA	M- MA	M- MA	VHA	HA		
19.	Indian butterfish		20	375	32.0	110	380	28.9	110	390	28.2	110	400	27.5	29.16	VHA			
20.	Indian Mackerel		140	375	37.3	120	380	31.6	150	390	38.5	150	400	37.5	36.22	HA			
21.	Indian oil sardine		125	375	33.3	120	380	31.6	130	390	33.3	140	400	35.0	33.31	HA			
22.	Fasa/ Phasa		100	375	26.7	105	380	27.6	110	390	28.2	135	400	33.8	29.06	VHA			
23.	Hairfin anchovy		120	375	32.0	120	380	31.6	130	390	33.3	125	400	31.3	32.04	HA			
24.	Indian Anchovy/ Gold spotted anchovy		90	375	24.0	70	380	18.4	70	390	17.9	100	400	25.0	21.34	VHA			
25.	White Anchovy		90	375	24.0	70	380	18.4	70	390	17.9	100	400	25.0	21.34	VHA			
26.	Ribbonfish		125	375	33.3	110	380	28.9	120	390	30.8	140	400	35.0	32.01	HA			
27.	Indian lizard fish/ Bengal monitor lizard fish		120	375	32.0	110	380	28.9	150	390	38.5	150	400	37.5	34.23	HA			
Average (N = 196)			118	375	31.6	106	380	28.0	117	390	30.0	133	400	33.1	30.68	HA			
N.B.: VHA: Very Highly Affordable, HA: Highly Affordable & M-MA: Mild to Moderately Affordable																			
Source: Household and Market Survey, 2024-2025 & Data Analysis, 2025																			

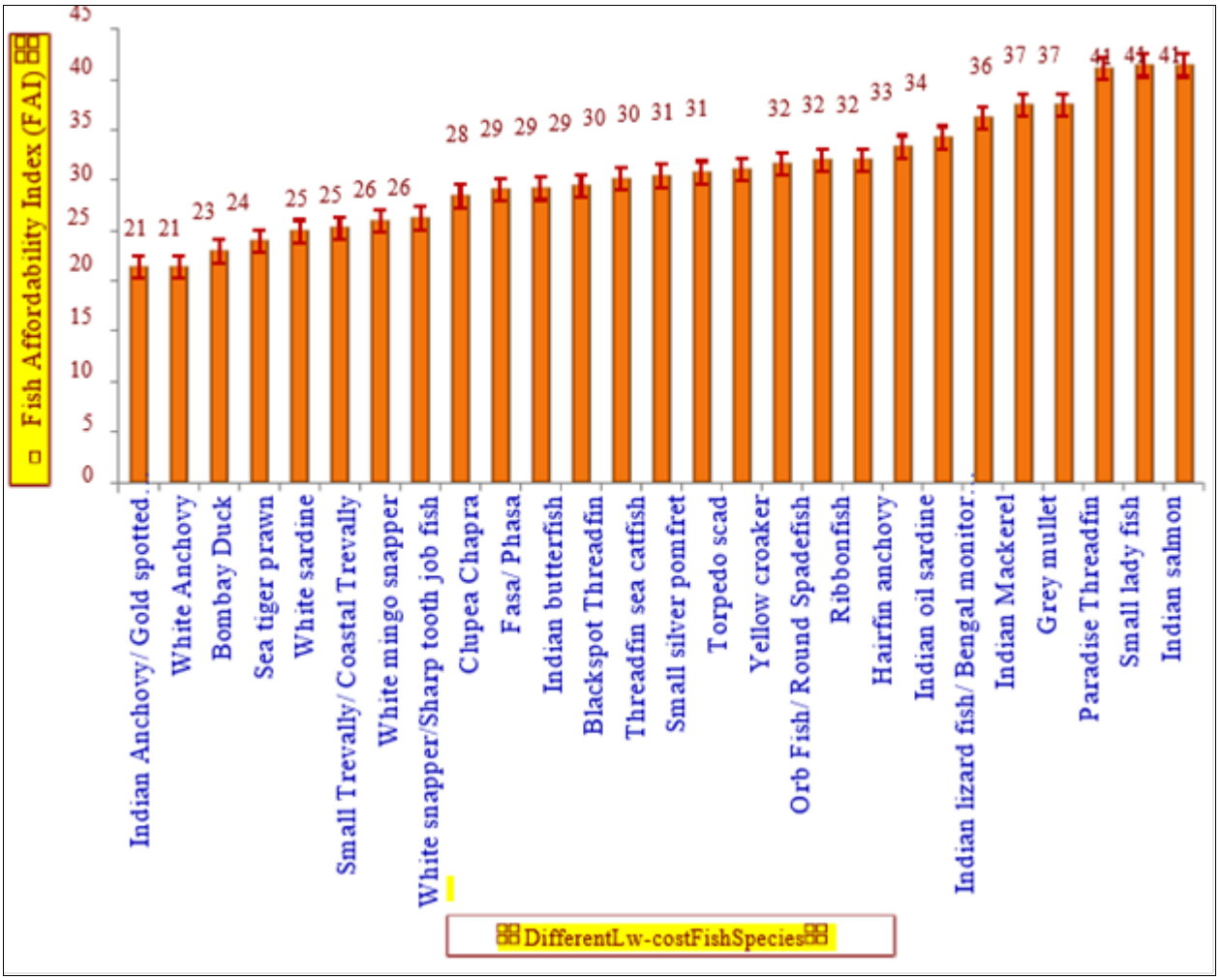

Fig 7: Fish Affordability Index by Species across Different Coastal Sections of the Study Area

These findings align with earlier observations from South Asian coastal fisheries (Robinson *et al*., 2022) [13], which emphasize how market price fluctuations directly influence protein access among artisanal fishing households. In the Contai region, where the mean daily income ranges only between Rs. 375-400/-, the purchase of high FAI species could be prohibitive, pushing households towards anchovies, sardines, and Bombay duck for regular consumption.

Policy implications emerge from this analysis. First, affordability patterns show that anchovy, sardine, and Bombay duck are nutritionally and economically critical for sustaining food security in the region. Second, the high FAIs of larger demersal and commercially valued species highlight the risk of nutritional inequity, where poorer households are excluded from accessing high-protein, high-micronutrient fish. Finally, targeted subsidies, improved local distribution, and community-based fish processing initiatives could reduce affordability gaps while ensuring both dietary diversity and fisheries sustainability.

6.5 Nutritional Contributions of Low-Cost Marine Fish

Table 8: Nutritional Profile of Preferred Low-Cost Marine Fish (per 100 g edible portion)

Sl. No.	Common Name	Local Name	Protein (g)	Omega-3 FA (g)	Calcium (mg)	Iodine (µg)	Vitamin D (IU)
1	Threadfin sea catfish	Nona Tangra / Aar Tyangra / Kanta Machh / Shimul Kanta	18	0.24	8-10	20-100	8-12
2	Small Trevally / Coastal Trevally	Gang Chanda	19	0.27	10	20-80	120-200
3	Indian salmon	Korua / Rawa / Gurjali	24	2.26	15	-	-
4	Lady fish	Korma / Goj Korma / Chhenchua Balguri	17.7	0.15	22.2	-	-
5	Orb Fish / Round Spadefish	Doichaka	20.3	0.165	16	-	-
6	White sardine	Gang Mural / Murla	18.5	1.2	250	75	210
7	Clupea Chapra	Chapila / Mukundi	17.4	0.659	473	-	-
8	Bombay Duck	Babla / Lote / Lotia / Lohora	17.2	0.9	180	60	180
9	Yellow croaker	Bhola	20.6	0.31	30-32	20-120	25-30

10	White snapper fish / Sharp tooth job fish	Chonok / Kunkuni	18.5	0.13	49.3	-	-
11	Torpedo scad	Gura	21	0.3	670	42	92
12	Grey mullet	Khosla	19.5	0.42	41	-	61
13	Stingrays	Shankar / Mulli	14.0	0	83	0	0
14	Small silver pomfret	Firka / Rupchanda	17.5	0.8	22	-	-
15	Sea tiger prawn	Nona Chingri / Lal Chingri	22	0.2	52-323	5	-
16	Blackspot Threadfin	Guchha	19	0.026	220.7	-	<200
17	Paradise Threadfin	Tupsi	18.7	1.036	-	-	-
18	White mingo snapper	Kunkuni	23	0.275	9-40	20-80	40-120
19	Indian butterfish	Chandi / Karati	17	-	22	-	0
20	Indian Mackerel	Potol	20.9	0.32	75-539	140	643
21	Indian oil sardine	Hurhuri / Sardin	19	-	382	-	190
22.	Fasa/ Phasa	Fasa/ Chokhdemra	20.5	0.66	103	-	-
23.	Hairfin anchovy	Tanpra/ Tapra	18	0.7	150	50	120
24.	Indian Anchovy/Gold spotted anchovy	Ruli/ Amudi	19	1.8	320	80	250
25.	White Anchovy	Ruli/ Amudi	20	1.45	147	-	69
26.	Ribbonfish	Pathiya/ Rupa Patia/ Kala Bansi	16.8	1.0	200	55	150
27.	Indian lizardfish/ Bengal monitor lizard fish	Gang Kanua	17	0.3	20-40	-	-
Source: Data Compilation as per Primary and Secondary Database (FAO, 2019 & 2024 and ICMR- NIN,2017)							

The nutritional analysis highlights a substantial diversity in the nutrient profile of low-
cost marine fish consumed across the Contai coastal region. Protein content is generally high, ranging from 14 g in stingrays to over 24 g in Indian salmon and white mingo snapper, underscoring their role as affordable protein sources for low-income households. Species such as Indian salmon (24 g) and torpedo scad (21 g) particularly stand out for their elevated protein density.

In terms of fatty acid composition, omega-3 levels show significant variation. While stingrays provide negligible amounts, oily species like Indian anchovy (1.8 g), white anchovy (1.45 g), and white sardine (1.2 g) emerge as critical sources of essential fatty acids that support cardiovascular and cognitive health. This reinforces the nutritional importance of small pelagic species that remain relatively affordable in local markets.

Calcium content is particularly remarkable in certain species, such as torpedo scad (670 mg), Clupea chapra (473 mg), and Indian oil sardine (382 mg), which far exceed the average calcium content of commonly consumed terrestrial foods. Such species are consumed whole or semi-whole (including bones), explaining the higher mineral contribution. Similarly, iodine availability, though inconsistently documented, is highest in Indian mackerel (140 µg) and anchovies (80 µg), offering dietary support against iodine deficiency disorders common in coastal and inland populations.

Vitamin D values also reveal striking contrasts: Indian mackerel (643 IU), Indian anchovy (250 IU), and white sardine (210 IU) function as key dietary sources, compensating for limited sunlight exposure or poor dietary diversity in vulnerable communities. In contrast, stingrays, butterfish, and other benthic or low-fat species contribute minimally to vitamin D intake.

Overall, these findings suggest that while all species provide baseline protein, the nutritional density of small pelagics (sardines, anchovies, scads) is far superior in terms of calcium, iodine, omega-3 fatty acids, and vitamin D. This elevates their importance not only as affordable food but also as public health assets in combating micronutrient deficiencies. For policymakers and nutritionists, these results reinforce the necessity of safeguarding access to such species through sustainable fishery management, equitable pricing strategies, and nutrition-sensitive interventions.

6.6 Household Food Security Score (HFSS)

Household Food Insecurity Access Scale (HFIAS), which scores responses to questions on food sufficiency. Each household gets a score from 0 (fully food secure) to 27 (severely food insecure).

Table 9: Household Food Security Status

Household Food Security Category	Number of Households	% of Households	Remarks on Household Food Security
0 - 9	68	43.59	Food secure
10 - 17	59	37.82	Mild to moderate food insecurity
18 - 27	29	18.59	Severe food insecurity
Total (N)	156	100.00	

- Mean HFSS = 11.8 (mild-moderate food insecurity on average)
- % Food secure households = 44%
- % Severe insecurity = 19%

The HFIAS analysis indicates that food insecurity is a widespread challenge among
the surveyed households. Out of 156 households, only 43.6% (68 households) fall in the food secure category (score 0-9), while a majority experience some degree of insecurity. Around 37.8% (59 households) are in the mild to moderate food insecurity range (10-17), suggesting irregular or insufficient access to preferred foods and occasional compromises in meal quality or quantity. Alarmingly, 18.6% (29 households) face severe food insecurity (18-27), reflecting frequent experiences of food shortage, hunger, or reduced meal intake.

The mean household food security score (HFSS = 11.8) places the overall community in the mild to moderate food insecurity zone, highlighting systemic vulnerability. The distribution indicates a dual reality: while nearly half of households maintain adequate food security, more than half (56%) are food insecure, with 1 in 5 households experiencing severe deprivation.

This pattern suggests that food security is fragile, with

significant segments of the population at risk of falling into deeper insecurity due to seasonal livelihood fluctuations, income instability, or shocks such as rising food prices or climate impacts. From a policy perspective, these findings call for targeted nutritional interventions, safety nets, and livelihood diversification to stabilize food access.

The study confirms that small pelagic fish species form a critical component of low- income diets in Contai, aligning with findings from other South Asian coastal communities (Khan *et al*., 2023; Robinson *et al*., 2022) [11, 13]. Nutritional profiles demonstrate their potential to address both macro- and micronutrient deficiencies. However, seasonal price fluctuations linked to fishing bans and monsoon weather pose risks to dietary stability (CMFRI, 2021). Infrastructure gaps in cold storage exacerbate post-harvest losses, limiting supply and inflating prices (Bhanja *et al*., 2023) [2].

Gender dynamics are central to fish access and preparation, echoing global SSF findings that women's roles in fisheries value chains should be supported to strengthen household nutrition (ICSF, 2023).

The findings highlight that low-income households in Contai rely heavily on small, affordable marine fish for nutritional and cultural reasons. The high protein and micronutrient

Major Findings

1. **Centrality of small pelagics in diets and budgets** Indian/white anchovies, white sardine, and Bombay duck dominate weekly purchase frequency (≥2-2.7 times/week on average) and exhibit the lowest FAIs (≈21-25%), confirming their role as the primary, affordable protein sources.
2. **Affordability pressure at one-third of daily income** The overall mean Fish Affordability Index (FAI) is ≈30.7% across species and coasts—i.e., one kilogram of fish costs roughly a third of daily wages—leaving little room for dietary diversity when prices rise.
3. **Coastal market gradient in prices and affordability** Junput shows the lowest median prices and FAIs (mean FAI ≈28%), consistent with landing-site proximity and shorter value chains. Digha-Sankarpur-Tajpur has the highest medians and dispersion (mean FAI ≈33%), reflecting tourism-driven mark-ups and greater volatility. Hijli-Khejuri is affordability-constrained (mean FAI ≈31.6%) with more seasonality.
4. Price volatility concentrated in a few "workhorse" species: Bombay duck, ribbonfish, and threadfin catfish display wide min-max ranges across coasts—indicative of monsoon/sea-state sensitivity and cold-chain gaps that amplify household risk.
5. **Nutrient density strongly favors small pelagics** Anchovies and sardines deliver high omega-3 (1.2-1.8 g/100 g), calcium (≥250-320 mg; higher when eaten bone-in), iodine (up to 80 µg), and vitamin D (≈190-250 IU). Torpedo scad, Clupea chapra and Indian oil sardine show exceptionally high calcium (≥382-670 mg), supporting bone health where dairy intake is low.
6. **Nutritional inequality risk with higher-FAI species** Indian salmon, stingrays, grey mullet, and paradise threadfin have FAIs ≈37-41%; these become occasional or aspirational purchases, constraining access to their protein and micronutrients for poorer households.
7. **Purchase frequency aligns with affordability and accessibility:** Coasts with better landings access (Junput/Deshapran) show higher average weekly purchases (≈2.09), while Hijli-Khejuri averages ≈1.64, underscoring the importance of local supply chains.
8. **Tourism exerts a systemic price premium:** In Digha-Mandarmani clusters, mid-tier species (croakers, small pomfret, mackerel) price up during peak tourism, crowding out low-income buyers exactly when sea conditions limit artisanal income.
9. **Information asymmetry at retail:** Large inter-vendor spreads and weak price transparency suggest search costs and bargaining disadvantages for low-income consumers, worsening effective affordability.
10. **Gendered value-chain opportunities underutilized** Women's SHGs are well placed for dried/salted/smoked fish processing of small pelagics but face working-capital and quality-control constraints that limit scale and nutrition-sensitive products.

Policy Recommendations

a. Stabilize Access and Prices for Nutrient-Dense "Safety-Net" Species

- **Community Fair-Price Windows at Landing Sites** Set up early-morning capped- margin stalls (anchovies, sardines, Bombay duck) in Junput/Deshapran with transparent price boards; earmark a share for ICDS/ MDM canteens and old-age homes.
- **Seasonal Price Moderation in Tourism Hubs:** Pilot displayed reference prices and voluntary retailer charters in Digha-Mandarmani during peak seasons; enforce clear unit pricing (₹/kg, grade, freshness).
- **Targeted Voucher/ EBT for Fish:** Time-bound digital vouchers for low-income households redeemable only for priority small pelagics, triggered when FAIs exceed pre-set thresholds (e.g., FAI>35%).

b. Reduce Volatility via Cold-Chain & Loss Reduction

- **Micro-grants for Ice Boxes and Insulated Crates** Prioritize artisanal boats and first-mile vendors in Hijli-Khejuri; couple with basic HACCP training to curb spoilage, smooth supply, and narrow min-max price bands.
- **Solar/Hybrid Flake-Ice Units at Primary Landing Centers:** Cooperative management with transparent fee schedules; link to SHG processors for day-old fish utilization (drying/curing) to limit distress sales.

c. Nutrition-Sensitive Processing and Women's Enterprise

- **Fortified Small-Fish Products through SHGs:** Support bone-in dried anchovy/sardine packs (calcium-dense) and ready-to-cook mixes; provide QA kits, packaging grants, and market linkages to school/ICDS kitchens.
- **Behavior-Change Communication (BCC):** Recipe demos on bone-in consumption and low-oil cooking to preserve omega-3 and calcium; integrate messages into ICDS, SHG federations, and fish markets.

d. Market Governance and Data Transparency

- **Daily e-Price and Landing Bulletin:** SMS/WhatsApp boards from harbor offices showing species, grade, and modal prices by coast; reduces search costs and helps public buyers time procurements.
- **Standardized Grading and Weighing:** Mandate calibrated scales and grade cards (size/freshness) at retail; penalties for mislabeling to protect low-income consumers from quality downgrades.

e. Fisheries Sustainability with Nutrition Goals

- **Align Seasonal Closures with Nutrition Planning:** Pre-position dried small pelagics and public procurement during closures; promote by-catch utilization protocols without undermining conservation.
- **Size-limit Enforcement and Selective Gear Promotion:** Protect juvenile small pelagics and maintain stock productivity, securing long-term affordability and nutrient supply.

f. Income Resilience for Fishing Households

- **Parametric Weather Insurance and Savings Nudges** Simple, mobile-based covers tied to wave-height/wind thresholds; seasonal savings matched by cooperatives to cushion lean months and avoid distress pricing.

9. Conclusion

This study underscores the critical nutritional and socio-economic significance of low-cost marine fish species in the Contai coastal region, where affordability, accessibility, and dietary diversity remain major challenges for low-income communities. The analysis highlights that while certain species such as Indian salmon, Indian anchovy, sardines, and mackerel provide superior protein, omega-3 fatty acids, and micronutrients, other inexpensive varieties like catfish, ribbonfish, Bombay duck, and clupeids play an equally vital role in ensuring food security and cultural continuity of coastal households. The affordability index further demonstrates that these species act as a "nutritional safety net" for vulnerable groups, especially during periods of seasonal scarcity and price fluctuations.

For society, the message is that sustaining the consumption of small, underutilized, and nutrient-dense species is essential to combating hidden hunger and supporting community health. For institutions, particularly nutritionists, health workers, and extension services, this research emphasizes the urgent need to integrate marine fish into dietary planning, school nutrition programs, and community awareness campaigns. For planners and policymakers, the findings point toward the necessity of adopting targeted fisheries management and pricing interventions, ensuring that nutrient-rich, affordable fish species remain accessible to the poor without compromising ecological sustainability.

Ultimately, safeguarding the dual roles of marine fish as both cultural food heritage and nutritional capital is indispensable for achieving equitable coastal development, resilience, and improved public health. By linking fisheries management with food security policies, this research provides a pathway toward a sustainable blue economy that nourishes both people and ecosystems.

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