

Spatio-Temporal Variations in Gut Content and Feeding Intensity of Pelagic Fishes Across Some Areas along the West Coast of Maharashtra

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Abstract: This study investigates the food and feeding habits of three pelagic fish species, *Harpadon nehereus*, *Coilia dussumieri*, and *Lepturacanthus savala*, along the west coast of Maharashtra, India. The objective was to examine spatial and seasonal variations in feeding intensity using gut content analysis. Specimens were collected over a 12 month period, and gut contents were quantified using displacement volume and gravimetric methods across four locations. Results indicated significant spatial and temporal variability in feeding intensity, with distinct seasonal peaks associated with monsoon driven environmental changes. *Harpadon nehereus* exhibited maximum feeding intensity in February, *Coilia dussumieri* showed an extreme peak in May at Uran, and *Lepturacanthus savala* demonstrated high variability with a peak in October at Deogad. Ratnagiri showed relatively stable feeding patterns, whereas Mumbai and Uran exhibited greater fluctuations, including periods of negligible gut content. These findings highlight the adaptive feeding strategies of pelagic fishes and their response to environmental variability, contributing to a better understanding of trophic dynamics and coastal ecosystem functioning.

Keywords: gut content analysis, feeding intensity, pelagic fishes, seasonal variation, Maharashtra coast, trophic ecology, and *Acetes spp.*

1. Introduction

Gut content analysis is extensively used to determine food and feeding habits of fish species. In fish ecology, the information about the feeding habits and diet composition of fish are important in managing the natural resources (Kido, 1996). Gut content analysis of fish gives us significant understanding of feeding patterns and quantitative assessment of feeding habits. Feeding habits of fishes are directed by diverse ecological components such as habitat, environmental conditions, behavior of fishes and their interactions within and with other species. Thus, a precise account of food and feeding habits gives the elementary understanding of the trophic interactions in aquatic food webs (Zanden *et al.*, 2000). According to (Seaburg 1957) study of food and feeding habits of fishes provides a wide idea of the migratory and shoaling habits of pelagic fish species.

For studying feeding habits of fish examination of stomach content is carried out and abundance of prey content is quantified (Robichaud DA *et al.*, 1991, Liao H *et al.*, 2001, Hovde SC *et al.*, 2002, Griffiths SP *et al.*, 2007). (Seaburg, 1957) groups the feeding habits of marine fishes in three major trophic categories: Carnivorous, Omnivorous and Herbivorous. Thus, feeding habit studies of fishes also offer knowledge about feeding ground and distribution patterns of fishes. Qasim SZ in 1972, highlighted existing knowledge of food and feeding habits of marine fishes in Indian waters also he accentuated the significance of chemical analyses of food of fishes as key element in understanding of dynamics of energy and its channeling to various trophic levels. Feeding habits of fishes characterized by many ecological factors such as environmental conditions of habitat, behavior of fishes, use of habitat, intake of energy and inter & intra-specific

interactions. Hence one can study trophic relations of fishes by studying food and feeding habits of fishes which is achieved by gut content analysis (Chipps and Garvey 2007). Therefore, a thorough account of food and feeding habits of fishes supplies the basic understanding of trophic interactions in aquatic food webs. Gut content analysis thus is used to understand various facets of fish ecology at individual, population, and ecosystem levels.

2. Material and Methods

Three species of fishes *Harpadon nehereus*, *Coilia dussumieri*, and *Lepturacanthus savala* were selected for the current study for period of 12 months from January (2016) to December (2016). Randomly ten number of fishes selected from each species under study. Samples were collected from fish landing centers across three locations – Mumbai, Uran and Ratnagiri along the west coast of Maharashtra. Gut of each fish was removed; stored in 5% formalin for subsequent analysis till it reaches laboratory. An incision was made along the longitudinal axis, and the contents were removed using a soft brush and collected in glass petri dish. Gut content and feeding intensity was measured in the form of Volume and weight of each gut removed from sample fishes. Volume of the gut was noted using displacement volume method and weight of content was also recorded by Gravimetric method.

3. Results

Gut content analysis of *Harpadon nehereus*

Mumbai shows a significant fluctuation in the gut content weights ranging from 0.09 g to 7.6 g. High peak in the month of February was observed, likely an outlier, compared to the

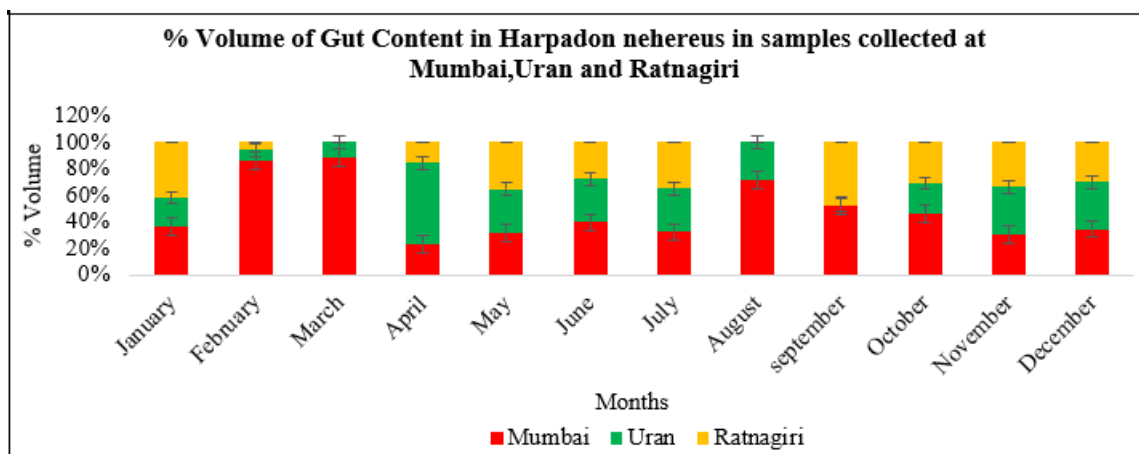
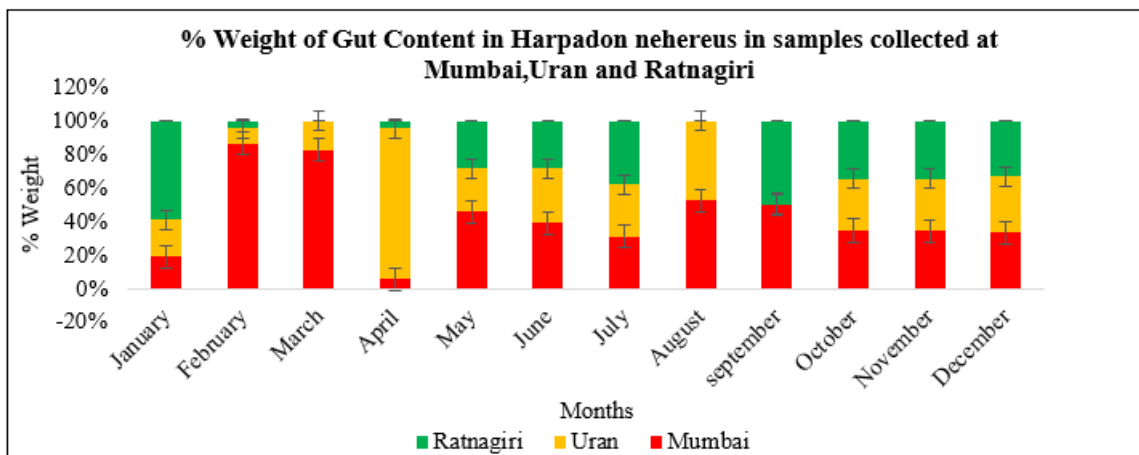
rest of the year. Uran and Ratnagiri show less significant but similar ranges varying from 0 to 2.75 g and 0 to 2.36 g respectively. This suggests more consistent gut content weight patterns, though some months showed negligible content.

Mumbai experienced a increased weight in February (7.6 g), which is significantly higher than any other value in the entire dataset. While Mumbai peaked in February, Uran saw its highest weight in April (2.75 g). Ratnagiri followed a different cycle, peaking earliest in January (2.36 g). Across all three locations, the weights become notably uniform and low from August to December. The values, however, varied between negligible and 0.1 g.

In the present study, each location shows a unique peak in volume of the gut content at different times of the year. Mumbai shows high gut content volume, 7.42ml in the month of February. This is the highest single value in the entire dataset and stands out compared to its yearly average. Uran shows high gut content volume in April at 2.56 ml. Ratnagiri

peaks earliest in the year during January at 1.92 ml. Besides the peak months, the volumes tend to converge and stabilize from May to July, all three locations have relatively similar volumes, generally staying within the 0.6 ml to 0.9 ml range. Ratnagiri recorded negligible volume in both March and August. Uran recorded negligible volume in September. These negligible values indicate periods of no or less food availability, contributing to the overall variability.

The present study shows, Mumbai as the location with the most variability, with the lowest 0.51 ml and highest 7.42 ml volume as compared to the other areas. Uran and Ratnagiri have a much narrower volume range, mostly under 1.0 ml, except for the peak months. The data shows a seasonal shifting pattern. The peak in the volume content begins in the south-coastal region (Ratnagiri) in January, moves up to the north-coastal region, Mumbai in February, and drops to Uran in April. By the second half of the year (August to December), the volumes in all three locations become more uniform, generally below 1.0 ml.



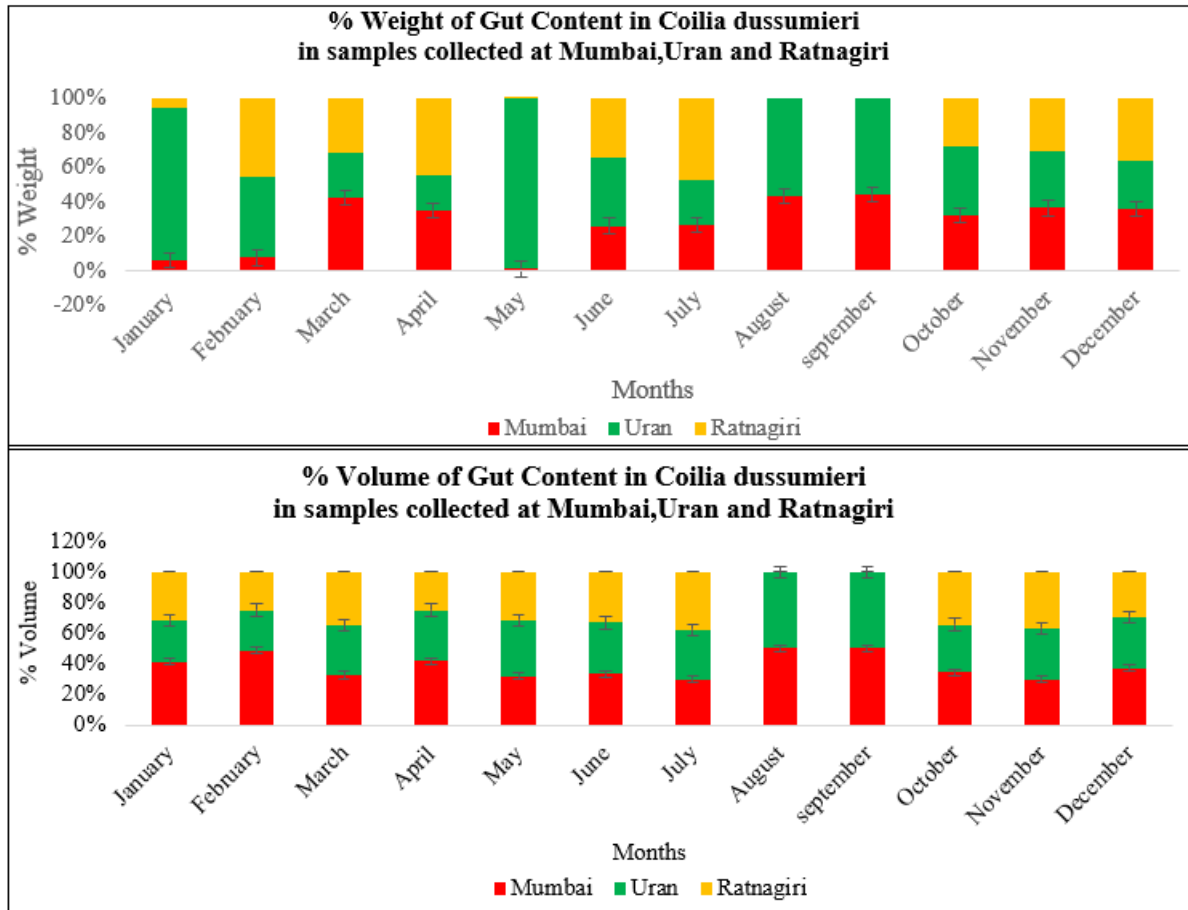
Gut content analysis of *Coilia dussumieri*

In the present study, Mumbai shows the most consistent location with weight of gut ranging from 0.11 g to 0.66 g. The weight stays relatively stable throughout the year, with a slight low in February (0.11 g) and a steady increase towards the end of the year, with highest peak in December (0.66 g). Uran shows the most significant fluctuation in gut weight content among all three locations. In May, the weight increases to 59.58 g, nearly an 80 times increase in the average weight as compared to the other months at this

location. In January it shows 7.15 g, while low values observed in March (0.26 g) and April (0.28 g). Ratnagiri exhibits moderate consistency with predictable pattern with moderate lows ranging from 0g to 0.67 g. Similar to *Harpadon*, Ratnagiri shows a "dormant" or negligible-weight period during August and September. The highest weights observed in the month of December (0.67 g) and February (0.66 g).

All three locations exhibit a synchronized trend where the volume is at its highest in January and then steadily declines through the first quarter. Mumbai (0.59 ml), Uran (0.39 ml) and Ratnagiri (0.45 ml) show peak in January. Further, a sharp drop in February, with volumes across all regions decreasing by approximately 44% to 62% within a month. From June to December, the data enters a state of high

stability. During these seven months, the volumes across all three locations fluctuate within a very narrow window of 0.08 ml to 0.14. The lowest volumes recorded across the entire study are 0.08 ml (Mumbai in November and Ratnagiri in December) and 0.09 ml (Uran in October, November, and December).

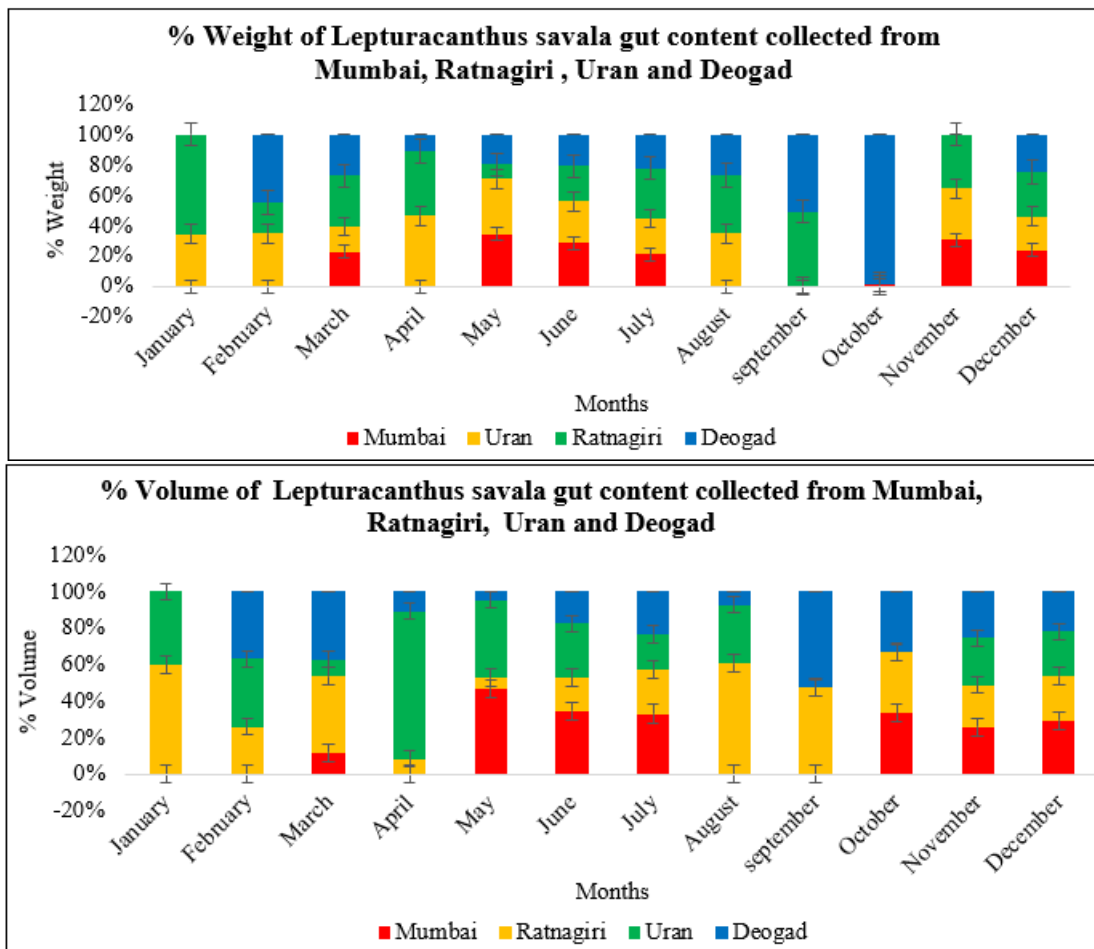


Gut content analysis of Lepturacanthus savala

At Deogad the most striking peak in weight of gut is observed to be 74.11 g in October. This is roughly 117 times higher than the Deogad value in December, representing an extraordinary surge that dwarfs all other locations. Mumbai reaches its maximum in May (1.41 g), but records negligible values for five separate months of the year, indicating high seasonal absence. Uran shows a peak in April (1.57 g) and May (1.49 g), suggesting a late-spring growth cycle. Ratnagiri shows peak in April (1.46 g) and January (1.39 g), maintaining a more consistent presence throughout the year than Mumbai or Deogad. Ratnagiri is the only location that did not record a single month with negligible values. Even its lowest point (0.23 g) is significant compared to the total negligible volume seen elsewhere. Mumbai is the only location showing negligible values in Jan, Feb, April, Aug, and Sept, which suggests a highly migratory or intermittent sample availability.

In this study, the volume set exhibits a coordinated increase during the monsoon months. Peak gut volumes are observed

in June at Mumbai (1.73 ml) and Uran (1.48 ml) respectively and in July (1.36 ml) at Mumbai and April (1.25 ml) at Uran. Ratnagiri reaches a significant peak in July (1.01 ml), though its global maximum is actually in January (1.5 ml). Deogad Shows its highest volume of the year in July (0.97 ml). The end of the year (September to December) marks a period of extreme uniformity and minimal volume for all locations. From October to December, all four locations converge into a narrow range of 0.09 ml to 0.12 ml. Mumbai remains the most "unstable" location regarding data availability, recording negligible values in January, February, April, and August through September. Both Mumbai and Uran record negligible volume in September, suggesting a regional "dry spell" or dormant period for volume measurement. Ratnagiri is the most consistent location, maintaining a measurable volume in every single month of the year without any "0 ml" gaps. Deogad has the lowest peak volume of the four, never crossing the 1.0 ml threshold, which contrasts sharply with its previous weight-based dataset where it had a massive 74 g peak.



4. Discussion

The current study shows distinct seasonal and spatial variations in the feeding intensity of three fish species under study which are *Harpodon nehereus*, *Coilia dussumieri*, and *Lepturacanthus savala* along the Western coast of Maharashtra highlighting the influences of various factors on their feeding ecology such as regional productivity, monsoon cycles and estuarine inputs.

The most noticeable peak for *H. nehereus* occurred in Mumbai in February, which also showed the highest variability. This significant increase results from nutrient enrichment and winter mixing in coastal waters. These factors raise plankton availability, which supports pelagic fish prey (K.J. Albin *et.al.*, 2022) such as *Acetes spp.* Increased feeding at Uran was delayed until April, and there was no food at all in September. This was likely due to monsoonal turbidity and estuarine influences that reduced prey availability (Fernandes, L. *et.al.*, 2018). In contrast, Ratnagiri had more consistent feeding with moderate peaks in January and generally low variability. This suggests that upwelling-driven productivity maintains prey availability more steadily throughout the year (Vinayachandran, P. *et.al.* 2021). These findings support earlier research that *H. nehereus* feeds opportunistically and shows significant spatial differences based on local prey availability (Anulekshmi, C. *et.al.*, 2024).

At Mumbai, *C. dussumieri* had a fairly stable feeding pattern. However, a sharp decline in February may show seasonal prey shortages or competition from other pelagic fish like

sardines and anchovies (Lindegren M, *et.al.*, 2013). Ratnagiri showed a more consistent pattern with seasonal lows in August and September. In contrast, Uran's extreme outlier in May (59.58 g) points to opportunistic feeding on dense prey groups, likely copepods, prawns, or fish eggs and *Acetes spp.* The low gut content volume, despite high weights at Uran, suggests it consumed high-calorie prey, which aligns with its general feeding strategy (Akhter, Mousumi, *et.al.*, 2024). These findings show that *C. dussumieri* is a broad-spectrum feeder but preferring *Acetes spp.* in its diet. It can take advantage of localized prey availability but is also sensitive to seasonal changes in prey supply.

L. savala feeding patterns showed moderate to high variability, with spatial differences. The seasonal presence of small pelagic shoals and crustaceans caused feeding intensity in Mumbai to peak during the late pre-monsoon and early monsoon months, specifically from May to July (Pallavi K. Pakhmode and Swapnaja A. Mohite, 2014). The occurrence of multiple zero values in other months indicates irregular feeding, likely due to a lack of prey or reproductive stress. At Uran, pre-monsoon productivity peaked in April and May, but feeding ceased in September. This highlights the harmful effects of monsoonal turbidity on predators that rely on vision. In contrast, Ratnagiri displayed relatively stable values with mild variations. Steady prey availability there was supported by upwelling (Melissa Fernández, *et.al.*, 2025). Therefore, *L. savala* appears to depend on the availability of seasonal shoals while benefiting from the more stable productivity conditions in Ratnagiri.

5. Conclusion

The study demonstrates that *Harpadon nehereus*, *Coilia dussumieri*, and *Lepturacanthus savala* exhibit significant spatial and seasonal variation in feeding intensity along the Maharashtra coast. Feeding patterns are strongly influenced by monsoon driven environmental changes, resulting in variable prey availability across locations. Ratnagiri provides relatively stable feeding conditions, whereas Mumbai and Uran show higher variability including periods of minimal feeding activity. The observed flexibility in feeding strategies indicates adaptive responses to fluctuating ecological conditions and highlights the importance of regional productivity in shaping trophic interactions. These findings contribute to improved understanding of coastal food web dynamics and support informed fisheries management strategies.

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