Impact of seasonal variations on catch composition in small-scale fisheries.

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Introduction

Seasonal variations significantly influence the productivity, species composition, and economic outcomes of small-scale fisheries. These fisheries, which provide livelihoods and food security for millions of people globally, are especially sensitive to changes in environmental conditions due to their localized operations, limited technological capacity, and reliance on traditional knowledge. Unlike industrial fisheries that can adjust fishing grounds and gear types in response to ecological changes, small-scale fishers often operate within a fixed range and depend on predictable seasonal patterns. Understanding how seasonal variations affect catch composition is essential for ensuring sustainable fisheries management, optimizing fishing strategies, and preserving marine biodiversity [1].

Seasonal changes in temperature, rainfall, ocean currents, wind patterns, and freshwater inflows directly influence fish distribution, abundance, and behavior. In tropical and subtropical regions, distinct wet and dry seasons are common, while temperate regions experience changes driven by winter and summer cycles. These environmental fluctuations alter the productivity of coastal ecosystems, impact primary production, influence the spawning and migration of fish, and ultimately shape the composition of catches [2].

In small-scale coastal fisheries, the timing and intensity of monsoons are among the most critical factors affecting catch composition. For instance, in South Asia, the southwest monsoon brings heavy rainfall, increased river discharge, and nutrient-rich waters that boost plankton productivity. This leads to a surge in the abundance of small pelagic species like sardines, anchovies, and mackerels, which feed on zooplankton. Consequently, during and immediately after the monsoon season, fishers often report higher catches of these fast-growing, short-lived species. In contrast, the pre-monsoon and post-monsoon periods may see an increase in demersal species such as croakers, catfish, and flatfish, as these species move into estuarine and nearshore areas for feeding and spawning [3].

Catch composition also shifts due to the reproductive cycles of target species, which are typically synchronized with seasonal environmental cues. Many fish species spawn during specific months when conditions are favorable for egg development and larval survival. For example, species like mullets, breams, and groupers may migrate to shallow coastal or estuarine areas during the spawning season, making them more accessible to small-scale fishers. During these periods, fishers adapt their gear and fishing strategies to target aggregating spawners. After the spawning season, the abundance of juveniles in the nearshore environment can increase, potentially leading to higher catches of sub-adult fish, especially when small-mesh nets are used [4].

Seasonal changes in water temperature also affect fish behavior and metabolic rates. In colder months, the activity of many species slows down, reducing their catchability. Conversely, in warmer periods, increased metabolic demands may drive fish to feed more actively, making them more vulnerable to capture. For example, reef fish in tropical areas are often more abundant in the catch during warmer months when their feeding activity peaks. Likewise, benthic invertebrates like crabs, shrimp, and lobsters may exhibit seasonal peaks in abundance tied to temperature-dependent molting or reproductive cycles [5].

In estuarine and lagoon-based small-scale fisheries, seasonal freshwater inflows from rivers and streams significantly alter salinity levels, turbidity, and nutrient concentrations. These changes influence the distribution of euryhaline species capable of tolerating a wide range of salinities, such as tilapia, milkfish, and some species of prawns. During the wet season, high freshwater input may push marine species farther offshore, while estuarine and freshwater species dominate the catch. In contrast, during dry seasons with high salinity and reduced river flow, marine species may encroach further into estuarine zones, diversifying the catch. These seasonal salinity gradients are particularly influential in deltaic regions and coastal lagoons [6].

Wind patterns, driven by seasonal changes, also affect fishing operations and species availability. Calm seas during certain seasons allow small-scale fishers to venture further offshore and access deeper fishing grounds. In contrast, strong winds and rough seas during monsoon periods may limit fishing to protected areas or result in complete cessation of activities. Seasonal wind-driven upwelling, as seen in regions such as the west coast of India and parts of West Africa, brings nutrient-rich deep water to the surface, supporting dense phytoplankton blooms and attracting pelagic fish species. During these upwelling periods, catch composition shifts in favor of species such as sardines, horse mackerels, and tuna, which follow the food-rich currents [7].

Cultural and religious practices linked to seasonal events can also indirectly influence catch composition. In many

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fishing communities, traditional calendars dictate the timing of fishing bans or festivals that coincide with spawning seasons or periods of rough weather. These seasonal pauses in fishing effort can allow for partial recovery of stocks, altering the species and size composition of subsequent catches. Furthermore, local market demand often varies seasonally, affecting which species are targeted and retained. For instance, certain species may fetch higher prices during festivals or tourist seasons, incentivizing fishers to focus on those species when available [8].

Seasonal changes in catch composition have both ecological and socio-economic implications. From an ecological standpoint, the targeted capture of spawning aggregations or juveniles during specific seasons can lead to recruitment overfishing and long-term stock depletion. Species that are only seasonally abundant may be more vulnerable to overexploitation if fishing pressure is concentrated during their peak availability. Conversely, periods of low catch diversity may reduce the resilience of fishing communities and ecosystems, especially if fishers rely heavily on a few dominant species during those times [9].

Economically, fluctuations in catch composition affect income stability and market dynamics for small-scale fishers. During high-yield seasons, fishers may experience a surplus of certain species, leading to price drops and potential post-harvest losses due to inadequate storage and processing facilities. In low-yield seasons, income uncertainty may increase, leading to livelihood insecurity and pressure to overfish less abundant species. Seasonal catch variation also influences employment opportunities along the value chain, affecting fish vendors, processors, and transporters.

Adaptation to seasonal catch variation is a hallmark of traditional small-scale fisheries management. Fishers often rotate gear types, shift fishing grounds, and change target species in response to changing environmental conditions. For example, gillnets may be preferred during periods of high pelagic abundance, while traps and hand lines may be used to target demersal or reef-associated species in other seasons. Knowledge of local ecology and seasonal patterns is passed down through generations, enabling communities to adjust practices and optimize effort. However, climate change poses a significant threat to the predictability of these seasonal patterns, potentially disrupting established fishing rhythms and community adaptation mechanisms [10].

Conclusion

In conclusion, seasonal variations play a pivotal role in shaping the catch composition of small-scale fisheries. These variations are driven by complex interactions between environmental factors, species life histories, cultural practices, and socio-economic dynamics. While traditional knowledge and adaptive practices have helped small-scale fishers navigate seasonal changes, increasing environmental uncertainty due to climate change and overfishing demands a more robust and integrated management response. By aligning fisheries governance with seasonal ecological rhythms, supporting community-based adaptation, and enhancing post-harvest resilience, we can improve the sustainability and productivity of small-scale fisheries in the face of changing seasonal realities.

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