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Executive Summary:

Hawai'i fisheries reveal seasonal dynamics and climate sensitivity of mahimahi (*Coryphaena spp.*) across the Central North Pacific

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Overview

Mahimahi (*Coryphaena spp.*) are an ecologically and culturally important fishery species in Hawai'i. They are fast-growing, short-lived pelagic predators that have supported fisheries and subsistence harvest for centuries, and they remain a significant component of modern commercial and recreational fishing. Despite their importance, mahimahi in the central North Pacific remain unassessed, and little recent research has evaluated their catch patterns, seasonal availability, or long-term trends in their abundance. We attempt to integrate several decades of fisheries data from two sectors of Hawai'i's pelagic fisheries—the deep-set longline (DSL) fishery and the near-island troll fishery—to investigate patterns in mahimahi catch rates, size structure, and environmental associations across the central North Pacific at various spatiotemporal scales. Together, these fisheries provide complementary perspectives from 20+ years of catch and effort data along with commercial dealer size records. We assess mahimahi catch patterns across contemporaneous, seasonal, and inter-annual scales to evaluate how fishing practices and environmental conditions influence catch rates and explore possible biological processes and climate-linked drivers of mahimahi availability.

Key Findings

Environmental influences on catch rates

Using generalized additive mixed models (GAMMs), we found that oceanographic conditions significantly influenced mahimahi catch rates across both fisheries. Higher catch rates were generally associated with warm surface temperatures (~23–27 °C), clear, oligotrophic waters with low turbidity, variable salinity (indicative of spatial water mass patterns), and positive sea level anomalies. These findings are consistent with previous studies indicating that mahimahi prefer warm habitats and clear waters where visual foraging is more effective. Models further highlighted pronounced seasonal signals across each fishery domain similar to those observed in nominal catch rates. Environmental variables at the scales observed (daily and 4-9 km spatial resolution) did not fully explain the strong seasonal patterns apparent in nominal catch rates, suggesting that biological processes such as migration, recruitment, and growth that our models are unable to fully represent may play dominant roles in shaping seasonal availability.

Strong and consistent seasonal cycles of migration and recruitment

Nominal mahimahi catch rates exhibited pronounced and persistent bimodal seasonality that shifted across latitudes and with proximity to Hawai'i. Two primary fishing seasons occur each year in spring and fall, typically between February-May and between August-December. The seasonal timing of fishing seasons shifts geographically, occurring earliest and latest in the year in the southernmost fishing domain

and closer together (later spring and earlier fall) at higher latitudes. This seasonality in mahimahi catch has persisted for decades in Hawai‘i’s fisheries and aligns with observations dating back to the 1980s and 1990s. Size distributions of mahimahi also revealed strong seasonal patterns consistent with recruitment and rapid growth. Taken together, the spatial, seasonal, and size patterns suggest a north-south migratory cycle across the central North Pacific. Evidence supports a conceptual model in which 1) recruitment into each fishery occurs between late winter and early spring, 2) fish grow and migrate northward through spring, resulting in high catch rates in both fisheries starting in the south and moving north throughout the season, 3) individuals reach higher latitudes stretching beyond the longline and troll fishing grounds in early summer, resulting in low catch rates in both fisheries, 4) fish return southward, recruiting into each fishery again between late summer and fall, 5) fish grow and continue migrating southward through fall, resulting in high catch rates in both fisheries starting in the north and moving south throughout the season. This migration pattern helps explain why mahimahi appear seasonally around the Hawaiian Islands despite relatively stable local ocean temperatures and conditions.

Long-term trends in catch rates and size

Abundance indices show long-term variability that indicates similar but shifted inter-annual trends across latitudes and proximity to Hawai‘i, with declining trends beginning slightly earlier in the more northerly fishery domains. In addition, mean size distributions have shifted toward smaller individuals over time in the more northerly fishing domains, suggesting possible changes in population structure.

Climate variability linked to mahimahi abundance patterns

Mahimahi catch rates were strongly correlated with the North Pacific Gyre Oscillation (NPGO), a basin-scale climate index associated with gyre circulation strength and fluctuations in salinity and nutrient levels. The relationship between catch rates and NPGO varied by time lag across latitudes and proximity to Hawai‘i. The northernmost domains showed strongest correlations with the contemporaneous NPGO index, the near-island troll domain showed the strongest correlations with the NPGO index two years earlier, and the southernmost domain showed the strongest correlation with the NPGO index four years earlier. The time lags associated with these relationships appear to track the movement of the North Pacific Tropical Water (NPTW) mass from northeast to southwest across the domain and its associated water property anomalies. Exploration into the underlying mechanisms behind these patterns suggest that climate-driven changes in local food availability and habitat variability (e.g. temperatures) may influence mahimahi populations across the basin, potentially affecting their availability to and/or habitat overlap with Hawai‘i’s fisheries.

Implications

Mahimahi are currently part of a broader pelagic management unit species complex in the U.S. Pacific Islands and have not undergone formal stock assessment in this region. No specific harvest regulations currently exist for the species in Hawai‘i. This study reveals environmental influences on catch rates, persistent seasonal migration patterns, and climate-driven variability in mahimahi populations across a broad region of the North Pacific, highlighting the importance of combining nearshore and offshore fisheries perspectives to understand highly migratory pelagic species.