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Low-Cost Inshore Fishing Aggregate Devices for Artisanal Fisheries in Cabo Verde

Abstract

Cabo Verde (Cape Verde) is a nation composed of ten islands off the coast of West Africa, whose 600,000 population—80% of whom reside on coastlines, with only 10% of national land suitable for agriculture—relies heavily on marine resources for food security, livelihoods, and economic growth. The Cabo Verde exclusive economic zone (EEZ) is a thriving aquatic region with an annual catch potential between 36,000 and 44,000 tons, mostly composed of small pelagic species, demersals, and tuna (Fortes & Haraldsson, 2018); therefore, the fishing industry functions as a critical economic sector, and for rural communities, a pillar of survival. However, rising instances of illegal, unreported, and unregulated (IUU) fishing, especially by foreign vessels, has caused sharp declines in marine stocks, imposing serious threats on artisanal fisheries and rural communities (Turiyano & Coulibaly, 2020). Conventional government regulation and surveillance on IUU fishing is constrained by a lack of resources, and as artisanal fisheries are unable to effectively compete with industrial fleets, widespread food shortages have struck the country. This paper proposes a low-cost, inshore-adapted system of fishing aggregate devices (FADs) that would directly address the ongoing crisis by improving catch efficiencies for artisanal fishers within shallow waters inaccessible to industrial fleets. By focusing on increased technological access as a means of resilience, artisanal fisheries will be able to regain competitive viability in the industry, ensuring survival as long-term legislative and policy solutions develop.

Introduction and Context

Cabo Verde's 99.3% water territory (Garten, 2023) positions the fishing industry as a major portion of the economy and labor force, divided between artisanal operations and industrial fleets that serve vastly different markets. An estimated 6,283 individuals are employed full-time in marine artisanal fishing, along with 9,872 commercial agents (individuals and companies involved in commercial fishing), accounting for 5.2% of the active workforce. This branch supplies most domestically consumed fish, constituting 12% of the population's overall animal protein intake (FAO, 2025).

Despite the key role local fisheries play in supporting the population, a productivity gap reveals heavy imbalance between artisanal and industrial operations: in 2016, 91 registered industrial and semi-industrial fleets caught 9,840 tons of marine life, double the 4,400 tons that 1,688 artisanal fleets caught. This disparity has persisted for over a decade—between 2013 and 2023, 73% of annual domestic catches were landed by industrial and semi-industrial fleets (Delgado & Massingue, 2024). Nearly all industrial output is focused on exports to international markets, accounting for 50-60,000 tons (Tetteh Partey et al., 2019), or 80%, of Cabo Verde's total annual

exports, valued at approximately 61 million USD (Ísey, 2021)—contributing approximately 5.1% of the nation's GDP (Statistisches Bundesamt, 2024). Industrial fishing is therefore the primary focus of Cabo Verde's government and continues to dominate the country economically, even though artisanal operations are socially critical.

Crisis

Cabo Verde's industrial fishing sector operates within a European-oriented trade framework: currently, Spain, Portugal, and Italy represent 54.7%, 19.2%, and 18.8% of export purchases respectively (Lloyds Bank, 2022). Amicable relationships between the European Union and Cabo Verde mean that Europe not only accounts for 92.7% of Cabo Verdean fish exports, but also receive exclusive entry to the nation's waters to conduct fishing operations themselves. This trade structure operates through a consistently renewed Fisheries Partnership Agreement (FPGA), which provides European vessels licensed fishing access to the Cabo Verde exclusive economic zone for 5-year periods (Admin, 2024). The 2024 agreement authorized 56 Spain, French, and Portuguese fishing vessels into Cabo Verdean waters, in exchange for 3,900,000 Euros (Official Journal of the European Union, 2024). Repeated renewals and continued partnership has caused progressively increased foreign watercraft presence in Cabo Verdean waters and deepened the nation's heavy reliance on EU export revenues.

The unforeseen consequences of these fishery partnerships have created significant enforcement challenges for Cabo Verde's government: EU-Cabo Verde agreements have been criticized for insufficient monitoring mechanisms of European ships, with clashing regulatory standards limiting oversight of foreign vessels (Wabnitz & Harper, 2023) (Aquino, 2023). Although the Cabo Verde legislature convened to draft a national action plan to combat IUU fishing in 2024, budgetary constraints and low resource availability means the government does not have the capacity for strict enforcement, especially in rural areas, where much artisanal fishing occurs.

The effects have compounded; the combination of increased foreign fishing pressure and inadequate enforcement has drained the nation's marine resources. While in 2015, total fishery catches stood at 39,393 tons, in 2021, the number decreased to only 11,623 tons, despite growth in numbers of both artisanal and industrial fleets (Delgado & Massingue, 2024). The depletion is most severe where artisanal fishers traditionally operate: older fishermen recall historical median catches of 440 pounds, while the younger group report only 115 pounds per trip (Kessler, 2024), frequently citing the steep drop as the result of semi-industrial catches and illegal night-light fishing. As artisanal fishing becomes economically unviable, the most vulnerable communities are forced towards odd jobs like illegal sand mining for alternative sources of income (Mandard & Depardon, 2022), with the rural poverty rate rising to 44.3% (Turiyano & Coulibaly, 2020).

Non-governmental organizations have emerged to address policy gaps, but these efforts cannot replace functional regulation. Notable examples are "Guardians of the Sea," which currently documents illicit fishing practices and reports them to authorities (Project Biodiversity, 2024), and "Cabo Verde Fisheries Observer Programme," which collects data on annual catch volumes, effort, and adverse effects of fishing (Diame, 2022). Although these initiatives provide critical

information about IUU fishing patterns, they lack practical solutions; and with the West African region's fishery sectors projected to face among the world's highest levels of climate change-induced environmental stress (OECD, 2022), advocacy-based programs must be supplemented with operational interventions: fishery recovery must incorporate practical, livelihood-supporting technologies while longer-term policy reforms develop.

Proposed Intervention

While artisanal fishers face fundamental disadvantages against industrial vessels in offshore waters, Cabo Verde's fishing regulations provide an underutilized spatial advantage that theoretically protects artisanal fishers: industrial and semi-industrial vessels are restricted to offshore waters, while artisanal fishers have exclusive access to inshore coastal areas.



Figure 1: Map of suitability zones for onshore aquaculture on Boa Vista, a Cabo Verde island. (Mapping Cabo Verde Aquaculture Sustainability Zones, 2023)

Biological and economic factors indicate that inshore fishing may provide greater returns compared to attempts to compete in offshore zones: a study done by Menezes et al. demonstrates that marine species abundance and biodiversity decline rapidly below a 200 meter water depth, with fish density decreasing progressively as depth increases. While industrial fleets exploit offshore waters as they have the capacity to fish across great areas, this same strategy cannot be replicated by artisanal vessels operating small boats with limited fuel; therefore, locals focusing on inshore waters with higher species quantities would make for more economically viable yields.

However, current artisanal fishing methods cannot effectively utilize the economic viability of inshore waters. According to Kessler (2024) and Morrow (2018), most fishers currently either use handline fishing or pitch-bait fishing: a technique where a single fishing line is held with the hands to catch fish. This constrains fishers to smaller harvests at lower efficiencies, and as marine populations continue declining from overfishing pressures, losses are exacerbated.

Inshore zones can only be effectively capitalized upon through technologies that increase catch efficiency to levels that sustain fishing households. *Fishing aggregate devices*, or FADs (D Arun Jenish & R Velmurugan, 2023), offer

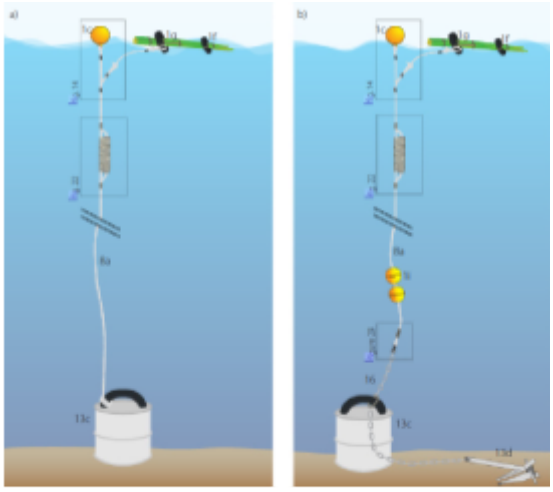

Figure 2: Basic Bamboo FAD design for lagoons and bays (left) and advanced bamboo FAD design for inshore environments (right). (Sokimi et al., 2020)

this capability: FADs are anchored or drifting structures placed in waters to attract fish, concentrating them in one location to enable large catch quantities simultaneously (Mossler, 2023). While today's industrial fisheries largely favor modern FADs with metal frames and GPS tracking (Tidd et al., 2023), traditional devices using natural wooden structures and nets are still commonly successfully employed among small-scale fishers (Marine Stewardship Council, n.d.). Fishing aggregate devices hold significant historical precedence, particularly in the Indo-Pacific regions where FADs have been deployed for centuries specifically to attract pelagic fish (Yusfiandayani, 2013)—tuna, mackerel, and sardines—this aligns with Cabo Verde's coastal species composition as well (Cabo International Partners, 2022) (Fortes & Haraldsson, 2018).

For Cabo Verde's artisanal sector, bay/lagoon FAD designs offer the highest practicality to leverage advantageous inshore fishing zones. Specifically, *bamboo FADs* have proven effective for Indo-Pacific fishermen, and are best deployed in locations with flat or gently-sloping bottom contours (Yusfiandayani, 2013), conditions characteristic of Cabo Verde's coastal zones.

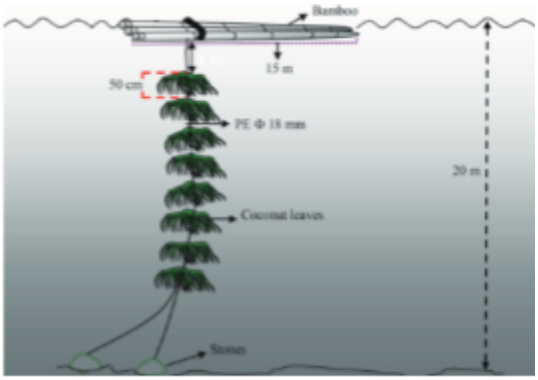

Figure 3: Shallow water fishing aggregate device as used in Banten. (Yusfiandayani, 2013)

Bamboo FADs represent a low-technology, low-cost solution that requires only commonly found regional materials. A standard design features a detachable bamboo upper floatation section that can be added or removed at will (Sokimi et al., 2020), while the bottom comprises of bamboo logs bound together with rope and optionally stabilized with materials such as car tires; the main mooring line anchors the structure to the seafloor.

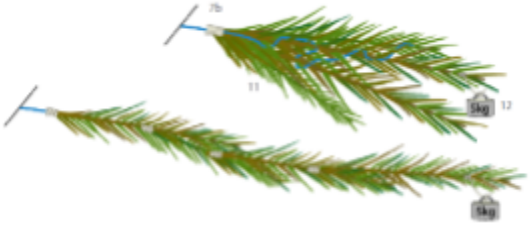

Figure 4: Coconut palm frond aggregators that connect end-to-end. (Yusfiandayani, 2013)

Adapting bamboo FAD designs to Cabo Verdean requires certain material substitutions for resources readily available on the islands, although the construction and deployment methodology remains standard. As bamboo does not grow in Cabo Verde, their stems can be replaced with palm tree logs (particularly coconut, fan, and date palms, which are found in abundance). Palm wood possesses useful qualities for marine construction: they're fast-growing and ideal for sturdy structures like bridges and boats, boasting high strength and resistance properties (Williams, 2023) while also being resistant to rotting and decay (Miles, 2024). Following traditional Javanese practices, Cabo Verdeans can also adopt the usage of coconut leaves, which are usually attached to the mooring line and work to attract schools of small fish (Yusfiandayani, 2013). When submerged, coconut fronds tend to become

covered in algae, establishing a microecosystem around the FAD structure and potentially drawing greater numbers of fish species to the deployment location.

Anchoring systems can also be adapted to different coastal environments across Cabo Verde's landscape. Cement blocks are typically used to anchor the FAD to the rocky coral bottom of Cabo Verde's coasts. If cement isn't available, substitutes can be found: in Cabo Verde's northern rocky landscape, abundant natural minerals found on the island surfaces, such as pozzolana (a key ingredient in the construction of cement) or basalt, can serve as effective alternatives (The Editors of Encyclopaedia Britannica, 2019). For the sandier landscape of the southern Cabo Verde islands, where minerals may not be as accessible, sandbags holding about 20 kgs of sand can be used instead (Yusfiandayani, 2013). If traditional ropes are unavailable to connect anchors to platforms, substitutes can be crafted from kaolin clay (used in rubber manufacturing) or the flexible wood from younger palm trees.

Conclusion

Fishing aggregate devices adapted to Cabo Verdean coasts provide artisanal fishers with low-cost interventions that communities can implement without rigorous technical assistance or significant financial investment. The modified FAD substitutes palm logs in place of bamboo, incorporates coconut leaves, and uses locally available anchoring materials that can be constructed and deployed without specialized training. Non-governmental organizations such as the aforementioned "Guardians of the Sea" and "Cabo Verde Fisheries Observer Programme" possess the community networks necessary to facilitate FAD distribution and adoption, especially to rural regions where government reach doesn't fully extend.

FAD value lies in its ability to address immediate overfishing-induced economic crises that artisanal communities face, without necessitating strenuous policy reform or high government investment. Inshore FADs take advantage of the competitive edge existing regulatory frameworks provide artisanal fishers, enabling them to increase catch efficiency within protected waters. While effective enforcement against IUU fishing is still needed, FADs serve as a bridge technology and survival mechanism as government capacity develops, maintaining food security and the fishing livelihoods of Cabo Verde's most vital yet undersupported communities.

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