
The artisanal fishery of *Caulolatilus princeps*: Impact on the ecosystem

Interactions of the artisanal fishery of the whitefish *Caulolatilus princeps* in the west coast of the Baja California Peninsula, Mexico

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INTRODUCTION

Small-scale (or artisanal) fishing is by far the largest marine industry in terms of employment, with between 100 and 260 million people worldwide engaged in the capture or processing of seafood (World Bank, 2012; Teh and Sumaila , 2013). Artisanal fishing is crucial from a socioeconomic perspective in developing countries, as it provides income, food, and employment. However, most fisheries lack the basic information (e.g., fishing gear, catch, and effort) needed to assess their status and management.

In Mexico, marine fisheries play a vital role in fishing communities and typically employ a variety of fishing gear adapted to the ecology of the target species. In the state of Baja California Sur (BCS), with its 2,705 kilometers of coastline in northwestern Mexico, fishing is essential, employing over 10,700 people and yielding an average annual catch of 155,000 tons of marine species.

The *Caulolatilus princeps* (Jennys, 1840), also commonly known as the "whitefish," is distributed from Vancouver, Canada, to the Gulf of California and from Ecuador to Peru, including the Galápagos Islands, and is found on sandy or muddy bottoms between 10 and 150 m deep (Fitch & Levenberg, 1971). Globally, Mexico is the main producer of whitefish (Gastélum-Nava et al., 2016). Particularly in the coastal zone of the Baja California Peninsula, *C. princeps* represents an important resource for artisanal fisheries, as it is caught year-round (Elorduy-Garay et al., 2005). However, the months of greatest fishing effort are from July to September, since afterwards, the fishing effort of the fishing cooperatives shifts towards the lobster, abalone and snail fishery which leaves a greater economic impact on the community.

The production of whitefish has been increasing, rising from 829 t in 2008 to 3,384 t in 2017 (SAGARPA, 2017). Leg catches on the west coast of the Baja California Peninsula (Fig. 1) were

relatively low; however, starting in the 1990s, production increased to the point of becoming one of the most important species in the artisanal fishery of Baja California Sur (Díaz, 1989). According to catch reports from the Federal Fisheries Offices, the national production of *C. princeps* in 2005 was 1,061 t, of which 1,022 t corresponded to Baja California Sur. Currently, on the Baja California peninsula, whitefish are caught by various cooperatives and fishing stakeholders, with the state of Baja California Sur (BCS) being the largest national producer of *C. princeps* (Table 1), contributing 95% in 2017 (DGSIAP, 2018). On the Pacific coast (Fig. 1), the fishery commonly uses traps and handlines, while in the Gulf of California, fishermen primarily use gillnets.

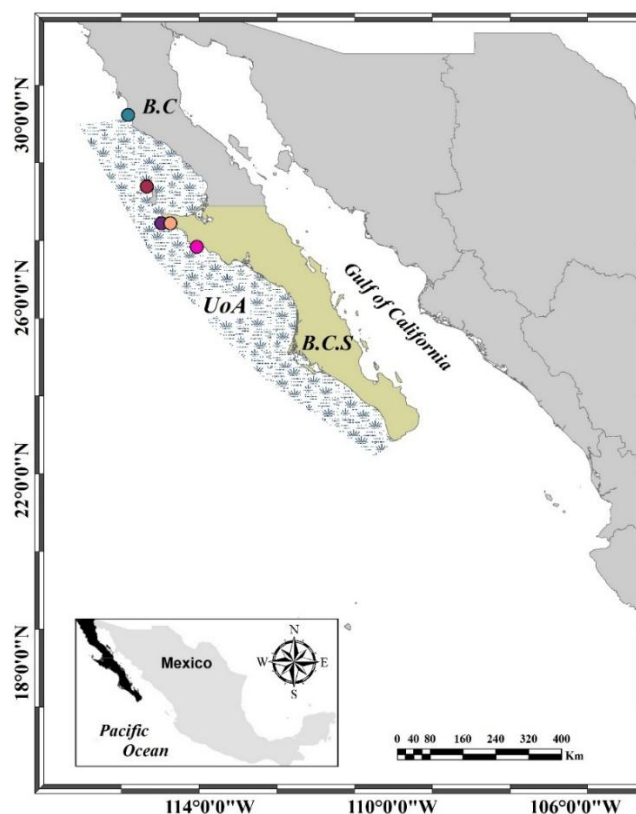


Figure 1. Location of the fishing area of *Caulolatilus princeps* and of the fishing cooperatives participating in the Fisheries Improvement Project.

In Mexico, fisheries management is governed by the General Law of Aquaculture and Sustainable Fisheries (LGPAS) (DOF, 2007). The LGPAS establishes the national policy for regulating fisheries through the Official Mexican Standards for Fisheries (NOM-PESC), which describe specific management measures for each species or group of species. The National Fisheries Charter (CNP) is another legally binding instrument used in Mexico for the management of all the country's fisheries, with annual updates (DOF, 2007). The CNP outlines the strategies

and actions that must be implemented to regulate fishing in Mexico, including information on fishing sites and gear, the status of stocks, and fishing effort (DOF, 2018). Furthermore, researchers from the Mexican Institute for Research in Sustainable Fisheries and Aquaculture (IMIPAS) develop and update fisheries management plans (PMP). Fisheries management plans include actions aimed at developing fishing activity in a sustainable manner and are based on biological, ecological, environmental, economic, cultural and social knowledge.

Table 1. Annual production of whitefish in the Baja California Peninsula and in the evaluation unit (UoA) of the whitefish fishery improvement project (Source: Statistical Yearbook of Aquaculture and Fisheries, 2024).

Year	BC State (t)	BCS State (t)	UoA (t)
2010	651.8	1568.9	1057.9
2011	450.7	1521.4	767.1
2012	412.0	1679.7	794.1
2013	322.6	1548.3	613.4
2014	491.2	2508.4	1195.1
2015	498.4	2944.4	1491.8
2016	250.1	2978.2	1225.4
2017	305.4	4089.9	1373.6
2018	471.5	1660.7	1063.3
2019	413.8	1609.6	1161.7
2020	583.0	1912.8	1500.8
2021	440.9	2003.8	1107.3
2022	589.2	1681.8	1093.8
2023	470.6	1771.5	1230.4
2024	468.6	1810.2	1407.2

The management of artisanal fisheries in Mexico, in most cases, fails to consider regional differences in fleet dynamics, resource distribution, and the impacts on resources and the ecosystem resulting from the spatial and temporal coexistence of different fisheries. Currently, the whitefish fishery lacks official regulations, despite being one of the most important in Baja California Sur. The 2006 National Fisheries Charter states that it is one of the fisheries at its maximum sustainable yield, regulated only by the issuance of fishing permits and the use of fishing gear. This document establishes the management measures for the fishery, which mainly consist of a permit for commercial fishing of scale fish, established fishing gear, fishing effort, and regulatory measures when annual catches decrease from 400 t in BCS. Although there is no management plan, currently the fishing cooperatives of the west coast of the Baja California Peninsula manage a minimum catch size of 33 cm.

The whitefish (*Caulolatilus* Although the whitefish (*Celtis princeps*) is one of the main species caught by artisanal fisheries in Baja California Sur, there are no studies evaluating the effects of fishing methods on its habitat or whether these methods guarantee the sustainability of

the fishery. Therefore, the main objective is to generate sufficient information to identify the principal effects of fishing gear on the ecosystem where the activity takes place. Fishing areas and the fishing gear used during capture activities were reviewed, which will allow for an analysis of the impact of the whitefish fishery on its habitat.

MATERIALS AND METHODS

Study area

The study area is located on the western coast of the Baja California Peninsula, Mexico, also known as the North Pacific, extending from Vizcaino Bay to Magdalena Bay (Fig. 1). The western coast of the Baja California Sur peninsula represents an area of high biological productivity and ecological diversity within the Mexican Pacific. This region is part of the California Current system, one of the most efficient upwelling systems globally, where the interaction between seasonal upwellings, bathymetric gradients, and transitions between temperate and tropical water masses generates highly dynamic oceanographic conditions (Walsh et al., 1974, 1977; Gaxiola-Castro et al., 2010; Durazo, 2015). The presence of short-period variations in anticyclonic circulation, with ocean gyres that intensify or weaken depending on the upwelling regime (Amador-Buenrostro et al., 1995), modulates nutrient availability and structures primary productivity in the region. These processes support a wide range of coastal and marine habitats, including rocky bottoms, macroalgal meadows, kelp forests, and mangrove systems, which provide refuge, food, and breeding grounds for numerous demersal species. Among these, *Caulolatilus stands out. The princeps* species is the target of a high-value artisanal fishery for various coastal communities. The interaction between oceanographic processes and essential habitats makes this region a natural laboratory for studying ecological resilience and fisheries sustainability. This area is affected by interannual variability phenomena that impact the abundance of fishery resources; among the most important are warming events such as El Niño and cooling periods such as La Niña (Murphree and Reynolds, 1995).

Characteristic of fishing gear

The artisanal whitefish fishery on the west coast of the Baja California peninsula uses rectangular-framed traps covered with plastic-coated galvanized wire. These traps have escape holes to allow undersized fish to escape and prevent ghost fishing, thus protecting juveniles. The external structure has two cone-shaped entrances (16 cm in internal diameter) and a post-shaped chamber for bait (fish entrails or sardines). During the day, 5 to 10 casts are made per trap. After each cast, the trap is left to rest on the substrate for 20 to 45 minutes, and then retrieved manually or hydraulically. The traps are equipped with biodegradable staples, which allow for their destruction if one is lost on the seabed. On the other hand, the handline, or line and hook, is another fishing method used by the fishing cooperatives belonging to the UoA when fishing for whitefish (Fig. 1). This fishing method consists of dragging a rig (an artificial bait) that simulates the swimming motion of a small fish and has a hook at the end, while in the handline, up to 5

hooks can be used per line.

RESULTS AND DISCUSSION

Several studies have addressed the physical and biological effects of fishing gear on marine habitats, with particular attention to the traps used in the lobster fishery. Goode et al. (2021) indicate that this method makes a negligible contribution to habitat degradation, attributable to two structural factors: the wide spatial distribution of fishing effort and the small physical footprint of each trap. This dispersion limits the accumulation of impacts in specific areas of the seabed. Additionally, Chuenpagdee et al. (2003), in a comparative assessment of fishing gear, conclude that traps do not generate significant negative effects on the physical structure or biological composition of the habitat, provided they are used responsibly and within appropriate management contexts. Furthermore, an experimental study conducted by Shester (2008) in red lobster fishing areas in Baja California evaluated the substrate composition inside and outside the trap placement zones. The results showed that there were no significant differences in benthic cover between areas where traps were placed and adjacent areas without fishing activity. Furthermore, the author states that this lack of impact was observed both immediately after placement and 24 hours later, which corresponds to the typical lifespan of traps in artisanal fisheries. The study concludes that lobster traps do not generate short-term changes in benthic habitat, provided they are used responsibly and for short periods. These findings support the inclusion of traps as a low-impact tool within sustainable fishing strategies, especially in artisanal fisheries operating in sensitive ecosystems.

Table 2. Generalized estimate of the effects of fishing on the ecosystem of different fishing methods - on a scale of 1 (not favorable) to 10 (favorable) with respect to the different factors related to the ecosystem (taken from FAO).

Ecosystem effects / fishing gear	Size selection	Species selection	Incidental mortality	Ghost fishing	Habitat effects	Energy efficiency	Capture quality	Effect Index
Gill holes	8	4	5	1	7	8	5	5.4
gillnets	2	3	5	3	7	8	5	4.7
Hand line	4	4	6	10	9	9	9	7.3
Longlines	6	5	6	9	8	8	8	7.1
Nasas	7	7	9	3	8	8	9	7.3
Traps	5	5	8	8	9	9	9	7.6
Spear, harpoon	8	9	5	10	10	8	9	8.4
Pelagic trawling	4	7	3	9	9	4	8	6.3
Demersal trawling	4	4	6	9	2	2	6	4.7
Beam drag	4	4	6	9	2	1	6	4.6
Shrimp trawling	1	1	7	9	4	2	6	4.3
Shooting net	5	5	6	9	4	5	8	6.0
Fence net	-	7	5	9	9	8	8	7.7
Hammock	2	2	5	10	6	9	9	6.1

The use of traps in artisanal target fisheries is widely perceived as a This practice has a low ecological impact, provided that appropriate management measures are implemented. The direct effect of these fishing gears on the seabed and associated benthic fauna depends on multiple factors, including the structural design of the traps, the density of their operation, the adoption of devices for reducing bycatch, and the systematic application of good anchoring and retrieval practices. From a sustainability perspective, strengthening these elements is essential to ensure that this fishing method operates within ecologically acceptable limits. The standardization of technical protocols, along with participatory monitoring of impact indicators, is a key strategy for minimizing disturbances to sensitive habitats and guaranteeing the long-term viability of this artisanal fishery.

The use of traps in artisanal fisheries has been highlighted for its ability to reduce bycatch, especially when escape devices designed to release juveniles and non-target species are incorporated. This improvement in the selectivity of fishing gear represents a significant step toward sustainability by decreasing pressure on vulnerable ecosystem components and preventing the overexploitation of non-commercial populations (Broadhurst , 2000; Campbell et al., 2010). Additionally, Shester and Micheli (2011) analyzed the ecological impacts of fishing gear used in small-scale fisheries in Baja California, Mexico, focusing on bycatch and habitat damage. They compared four types of fishing gear: lobster traps, fish traps, fixed gillnets, and drift gillnets. These authors found that fish and lobster traps have significantly lower discard rates. Lobster traps cause minimal damage to gorgonian corals and kelp , while fish traps have almost no impact on the habitat.

These studies suggest that optimizing trap design, strategically placing them in areas of low ecological sensitivity, and regulating fishing effort are key factors in mitigating negative impacts (Table 2). When integrated into adaptive management schemes, these measures can promote the recovery of affected habitats and strengthen the resilience of coastal ecosystems.

Handlines, while not particularly selective in terms of size and not very selective in terms of species, are commonly used in specific seasons or fishing grounds where experienced fishers can only catch one or very few species. Therefore, catches are usually dominated by a few target species. On the other hand, handlines are generally considered environmentally friendly fishing methods that produce high-quality catches (Table 2).

CONCLUSIONS

Trap fishing in the North Pacific region of Baja California Sur can be considered to have a moderate environmental impact, conditioned by the design of the gear, the intensity of the fishing effort, and the characteristics of the habitat. Its sustainability potential increases substantially when escape devices are incorporated and good anchoring, retrieval, and maintenance practices are applied.

The use of traps promotes greater selectivity and represents a significant ecological advantage by reducing the incidental capture of non-target species and juveniles. This characteristic, along with their low physical footprint, positions them as a tool compatible with ecosystem management approaches and habitat conservation.

Implementing adaptive management policies and participatory monitoring is essential to maintaining this type of fishing within ecologically sustainable limits. Regulating fishing effort, spatial zoning, and standardizing operational practices are key measures to mitigate cumulative impacts and promote the resilience of coastal ecosystems.

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