

Publication status: This preprint has not been published elsewhere.

Where are we going to fish today? Factors that influence the decisions of crab fishermen (*Ucides cordatus*) for choosing their fishing grounds: contributions to the territorial management of Marine Protected Areas

Daniesse Kasanoski, Emilie Coudel, Frédéric Mertens

<https://doi.org/10.1590/SciELOPreprints.15275>

Submitted on: 2026-03-04

Posted on: 2026-03-09 (version 1)

(YYYY-MM-DD)

Where are we going to fish today? Factors that influence the decisions of crab fishermen (*Ucides cordatus*) for choosing their fishing grounds. Contributions to the territorial management of Marine Protected Areas

Danieszse KASANOSKI¹, Emilie COUDEL² and Frédéric MERTENS³

¹Centro de Desenvolvimento Sustentável (CDS). Universidade de Brasília (UnB). Brasília. Brazil
danikasanoski@gmail.com <https://orcid.org/0000-0003-2129-723X>

²Unité Mixte de Recherche Savoirs, Environnement et Sociétés (UMR SENS). Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD). Montpellier. France
<https://orcid.org/0000-0001-8272-8051>

³Centro de Desenvolvimento Sustentável (CDS). Universidade de Brasília (UnB). Brasília. Brazil
<https://orcid.org/0000-0002-1449-8140>

ABSTRACT: Users of natural resources, such as artisanal mangrove crab (*Ucides cordatus*) fishers along the Amazonian coast, must make daily decisions about where to go to access the natural resources on which their livelihoods depend. However, the factors guiding these choices are not always evident and are not necessarily purely rational. A deeper understanding of these factors can contribute to improved territorial management and to the strengthening of governance in Marine Protected Areas. The objective of this study is to identify the factors that influence the choices made by mangrove crab fishers living in Amazonian mangroves when deciding which areas of the mangrove to fish. The methodology combines ethnographic research with focus group discussions. The results indicate that fishers do not choose fishing locations at random, but rather rely on a set of interconnected economic, social, technological, and cultural factors. This decision-making process results in a clear community-based division of fishing areas. The findings presented here support the formulation of management agreements and public policies aimed at improving the governance of Brazil's Marine Protected Areas.

Keywords: Marine Protected Areas, Mangroves, Spatial dynamics of fishing, Territorial management.

INTRODUCTION

Marine Protected Areas (MPAs) are territorial management instruments designed to regulate the use of space. However, they are often established without an in-depth understanding of the spatial dynamics of the natural resource users they encompass, which tends to result in an oversimplification of spatial interactions. The lack of such understanding can lead to negative management outcomes, including a mismatch between formal regulations and actual patterns of territorial use. In many cases, decision-makers rarely consider whether fishers are willing or able to modify their spatial practices (Hønneland, 2000; Teh, Teh & Meitner, 2012; Holland & Sutinen, 2000). In more critical scenarios, this disconnect may also result in negative consequences for ecological resources themselves (Suuronen et al., 2010).

One type of Marine Protected Area in which this problem becomes particularly evident is the Marine Extractive Reserves (Reservas Extrativistas Marinhas – RESEX) located along the coast of the state of Pará, in the Brazilian Amazon. In this region, artisanal mangrove crab fishing constitutes one of the main economic and subsistence activities and has been practiced for generations (Glaser, 2003). The creation of Marine RESEX along the Pará coast is partly associated with the long-standing existence of conflicts over mangrove crab fishing territories, which have been documented since earlier periods (Brazil, 2012, 2014; Diele, 2000; Domingues, 2008).

Both the scientific community and fishers themselves have identified signs of an intensification of this activity over the past 30 years, which has increased human pressure on crab stocks. Evidence of overfishing in areas close to fishing communities has been reported by several authors, including Domingues (2008) and Oliveira (2015). In addition, a trophic flow model developed for the region indicated that the biomass of mangrove crab extracted exceeded the species' natural replacement rate, suggesting resource overexploitation (Wolff et al., 2000). There are also indications that fishers have expanded their fishing areas in response to increasing scarcity in locations closer to their communities (Borges, 2019; Oliveira, 2015). This process is exacerbated by the fact that the region where the RESEX are located offers few employment alternatives beyond the exploitation of fishery resources (Glaser & Diele, 2004).

The increasing pressure on mangrove crab stocks may intensify fishing conflicts, particularly when newly frequented areas are perceived as traditional territories of other communities, regardless of whether they are located inside or outside the formal boundaries of the RESEX (Oliveira, 2015). This situation raises questions regarding the property regimes governing mangrove crab fishing territories in the mangroves of the Pará coast. These regimes are characterized by a hybrid model, oscillating between open access and community-based property. Under open-access conditions, new fishers may enter the activity without restriction, allowing anyone to fish in any area of the mangrove. In contrast, community-based property regimes involve mechanisms that exclude external users (Domingues, 2008). Some authors describe these territories as provisional fishing spaces in which property rights are not

transmitted across generations. In such cases, use rights are temporary and remain valid only as long as the fisher occupies the area (Oliveira & Maneschy, 2014).

Given this context, an in-depth understanding of the spatial dynamics of mangrove crab fishers and the factors influencing their decision-making is essential for more effective territorial management. Such understanding enables the development of rules governing space use that are better aligned with the practices and needs of resource users, thereby increasing both the feasibility and acceptance of management measures (Abbott & Haynie, 2012; Fulton et al., 2011; Smith & Wilen, 2003; Hilborn, 2007).

Objective of the study

This study aims to identify the factors that explain space use by mangrove crab fishers and to analyze how these factors are associated with their spatial dynamics.

In the first section of the article, we review the factors identified in the literature that help explain fishers' decisions regarding the choice of fishing locations. We then describe the methodological strategy adopted. Finally, we present the empirical results, first characterizing the spatial distribution patterns of fishing areas and subsequently analyzing the factors identified through fieldwork.

What lies behind the choice of fishing locations?

From the perspective of classical economic theory, fishers are often portrayed as rational agents who redistribute fishing effort across space until profits are equalized. However, in small-scale fisheries, variations in costs and profits are not always consciously perceived, as they may be too marginal to be noticed. In such contexts, some fishers continue to frequent certain fishing areas even when these generate relatively low economic returns, particularly when the areas are located close to their communities of residence (Beitl, 2014, 2015). Moreover, areas with higher resource abundance are not necessarily the most frequented, especially when access to them is difficult (Borges, 2019; Oliveira, 2015). There are also cases in which fishers avoid fishing grounds that are already occupied by other users (Teh et al., 2012).

Beyond economic considerations, ethnoecology provides important insights into fishers' behavior. Accumulated knowledge and the sharing of information about resource abundance and size, as well as about the time elapsed since the last visit to a given area, help reduce the randomness of fishing and make the activity more predictable and efficient (Domingues, 2008; Oliveira, 2015; Araújo, 2006). Information sharing thus constitutes a strategy that can significantly reduce the time spent searching for productive areas, increasing fishing efficiency (Barnes et al., 2019b; Bodin et al., 2006). Such information is typically shared informally through interactions among friends, relatives, and neighbors

(Turner et al., 2014), and knowledge held by older and more experienced fishers tends to be especially valued (Domingues, 2008; Oliveira, 2015).

However, information does not circulate evenly among all fishers. Power relations and social proximity mean that certain forms of knowledge remain restricted to specific social circles, such as close kin, leaving some fishers excluded from access to what may be considered privileged information (Domingues, 2008; Oliveira & Manesch, 2014).

Fishers' decision-making is also shaped by individual preferences for particular fishing locations, which may stem from the type of fishing gear used (Wiyono et al., 2006) and from the adaptation of fishing techniques to the specific environmental and physical conditions of a given place (Campling et al., 2012). Geographic and environmental factors therefore play an important role in shaping spatial choices. Studies of different fishing modalities show that fishers often display well-defined spatial preferences, contributing to the stability of these choices over time (Begossi, 1995; Seixas & Begossi, 1998; Holland & Sutinen, 2000). In traditional fishing communities, the primary mode of spatial appropriation is customary use, which constitutes a key explanatory factor for understanding the spatial dynamics of fishing (Diegues, 2005). In many coastal societies worldwide, customary rules are deeply embedded in social structures and evolve alongside them, defining which areas may be accessed by the community, which uses are permitted at different times of the year, how territories should be managed, who may be excluded, and how monitoring and sanctions are enforced (Ostrom, 2005; Rotich et al., 2016).

Finally, traditional ecological knowledge plays a central role. This knowledge refers to a deep and sophisticated understanding of local ecology that is developed and transmitted over time through close social relationships, such as those among friends, relatives, and neighbors. It represents one of the main resources mobilized by communities that depend directly on natural resources (Berkes, 2008). According to Teh et al. (2012), all fishers demonstrate some degree of knowledge about their fishing environments, ranging from general descriptions to highly detailed information. In the case of mangrove crab fishers, this knowledge guides specific fishing practices, such as recognizing sexual dimorphism between males and females and interpreting environmental cues that accurately signal the onset of the species' reproductive period (Domingues, 2008; Souto, 2007). This enables selective fishing—primarily targeting male crabs—and the anticipation of mating periods.

As demonstrated above, fishers' spatial choices are influenced by a set of interrelated factors: (i) economic factors, associated with the pursuit of income optimization; (ii) social factors, including perceptions of safety, risk avoidance, reduction of uncertainty, individual preferences, local ecological knowledge, and communication; (iii) environmental and geographic factors, such as proximity to residence and the suitability of practices to local conditions; (iv) technological factors, related to the fishing techniques employed; and (v) cultural factors, linked to customary use. Given this diversity, isolating the effect of a single factor on fishers' decision-making is challenging. Nevertheless, it is

precisely this multiplicity of factors that enables fishers to adapt their strategies to fluctuations in resource abundance (Beitl, 2014, 2015).

METHODOLOGY

Six *Ucides cordatus* (uçá crab) fishing communities (A, B, C, D, E and F) distributed along the mangrove forests of the state of Pará participated in this study. Three of these communities (B, C and D) are associated with the Caeté-Taperuçu Extractive Reserve (RESEX), two (E and F) with the Arai-Peroba RESEX, and one (community A) was not associated with any specific RESEX at the time the research was conducted. The Caeté-Taperuçu and Arai-Peroba are federal extractive reserves located near the municipalities of Bragança and Augusto Corrêa, in the state of Pará.

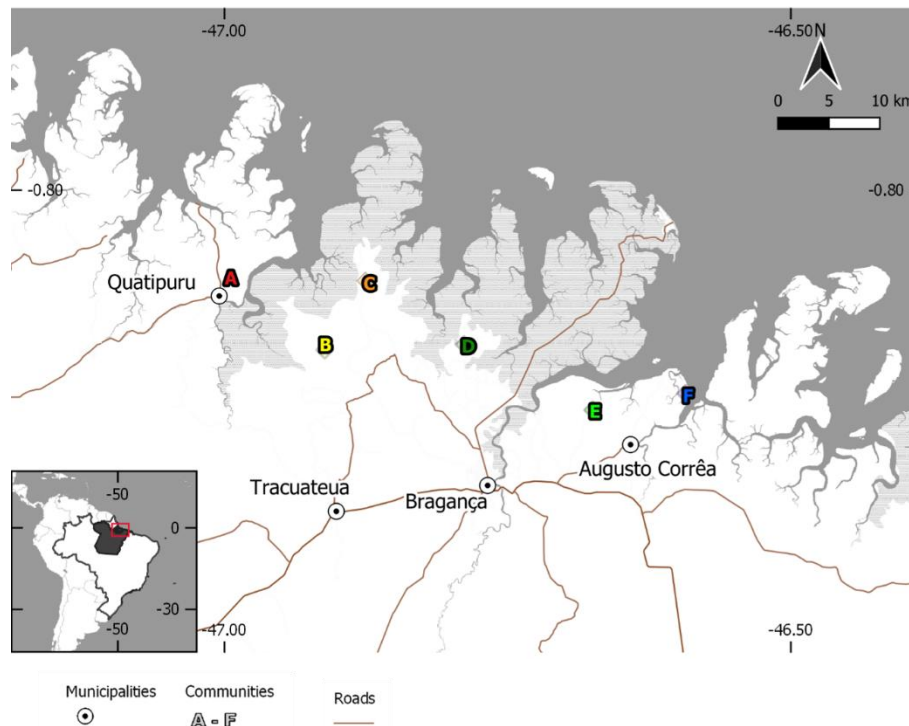


Figure 1. Map of the study area (prepared by Karl Koerner based on field data).

The communities were invited to participate in the study due to their geographical location near the territorial boundaries separating municipalities, which allowed for a regional understanding of spatial resource use. In addition, the fishing population, fishing practices and techniques, as well as commercialisation, transport and fishing frequency related to uçá crab harvesting vary among these communities. Parallel to this, the first author has been conducting research in the region since 2016,

aiming to understand how community members perceive the Extractive Reserves and their regulatory frameworks.

Data collection: interviews, focus groups and participant observation

The data analysed in this study were collected between October 2019 and January 2020, during four months of ethnographically grounded fieldwork conducted by the first author. This fieldwork included weekly visits to the communities (two to three times per week), participation in fishing expeditions (two in total: one boat-based expedition in community D and one on-foot expedition in community B), visits to community ports to observe the scale of uçá crab landings and to assess the importance of this activity to local economies, visits to local markets, and informal conversations with a range of actors. Together, these activities generated substantial observational material that supported the development of the research.

In the initial phase of the fieldwork, twelve key informants were individually interviewed, including fishers, community representatives and managers from the Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio). The interviews focused on uçá crab fishing. These initial interviews were essential for identifying locally used expressions, jargon and terminology related to the socio-ecological system, uçá crab fishing and local culture. During this phase, a review of the scientific literature on uçá crab fisheries was also conducted.

In the second phase of the fieldwork, one focus group was facilitated in each community to carry out participatory mapping with uçá crab fishers (Figure 2) and to identify the factors explaining fishers' choices of fishing locations. Each focus group lasted an average of 2 hours and 30 minutes, and a total of 73 fishers participated, with an average of 12 participants per group. Fishers were invited to participate in the focus groups through their community representatives. In some focus groups, participants already knew each other or belonged to the same fishing group, which contributed to higher levels of participation due to pre-existing relationships of trust.



Figure 2. Participatory mapping of fishing locations. Source: personal archive.

Most focus group participants were professional fishers, aged between 14 and 77 years, with fishing experience ranging from 3 to 47 years. At the beginning of each focus group, participants were asked for permission to photograph and audio-record the sessions. They were also informed about the authorisation granted by ICMBio (No. 71794-1) and about the Free and Informed Consent Form approved by the Research Ethics Committee.

The focus groups were guided by a semi-structured guide covering the following themes: fishing practices, frequently used fishing locations, and factors associated with the choice of fishing grounds. To understand the spatial pattern of resource use, participants were invited to map the fishing locations they frequented. Participatory mapping was conducted using a base map printed on canvas, which included the mangrove peninsulas of the region, communities, municipalities and locally collected reference points, such as the names of rivers, communities, ports and geographical features. The map covered an area of approximately 4,800 km². The vector image used to produce the map was based on OSM Transport data, using the SIRGAS 2000 geographic coordinate system, obtained from the OpenStreetMap cartographic database <https://www.openstreetmap.org/#map=10/-0.9928/-46.7468> and edited using the open-source software QGIS.

During the participatory mapping process, it became evident that the spatial boundaries of fishing grounds are fictitious and not clearly defined, even by the fishers themselves. Therefore, fishing grounds were jointly defined based on their access points, which were adopted as reference points for each fishing location. Access points are identified through geographical references associated with sections of watercourses, including river headwaters, tributary arms and river mouths, as well as creeks (igarapés), channels (furos), sandbanks (croas), beaches and islands.

Data treatment and analysis of textual and spatial data

Data derived from interviews, participant observation conducted over four months of fieldwork, and focus groups were processed and systematised. Textual data from interviews and focus groups were transcribed with the assistance of Express Scribe and analysed using ATLAS.ti, based on the following analytical categories: fishing locations; social interactions among uçá crab fishers, including conflicts and the factors associated with them; fishing practices; and rules-in-use governing access to space and resource use.

Data generated during the focus groups related to the participatory mapping of fishing locations were plotted in a Geographic Information System (GIS) (Kasanoski, 2022). Fishing locations that were assigned more than one name were unified, and locations that were no longer used were excluded from the analysis. A cartogram was then produced to represent the spatial distribution of fishing locations

used by the communities participating in the study. The number of fishing locations mentioned by each community was quantified and used as a proxy for the spatial extent of each community’s fishing territory.

RESULTS AND DISCUSSION

Spatial patterns of mangrove use in the Amazon and associated factors

The results of this study reveal the existence of a spatial pattern in the distribution of fishing locations used by coastal uça crab fishing communities in the Amazonian mangroves.

As shown in Figure 3, six clusters of fishing locations were identified, each predominantly used by a single community. These fishing locations vary in their spatial configuration, ranging from highly concentrated to more dispersed patterns. Locations used by more than one community are indicated by coloured circles, with each colour corresponding to a specific community. Areas that appear “empty” on the map do not necessarily represent unused or unfished spaces; rather, they may be utilised by other fishing communities that did not participate in the study and are therefore not represented in the mapping exercise.

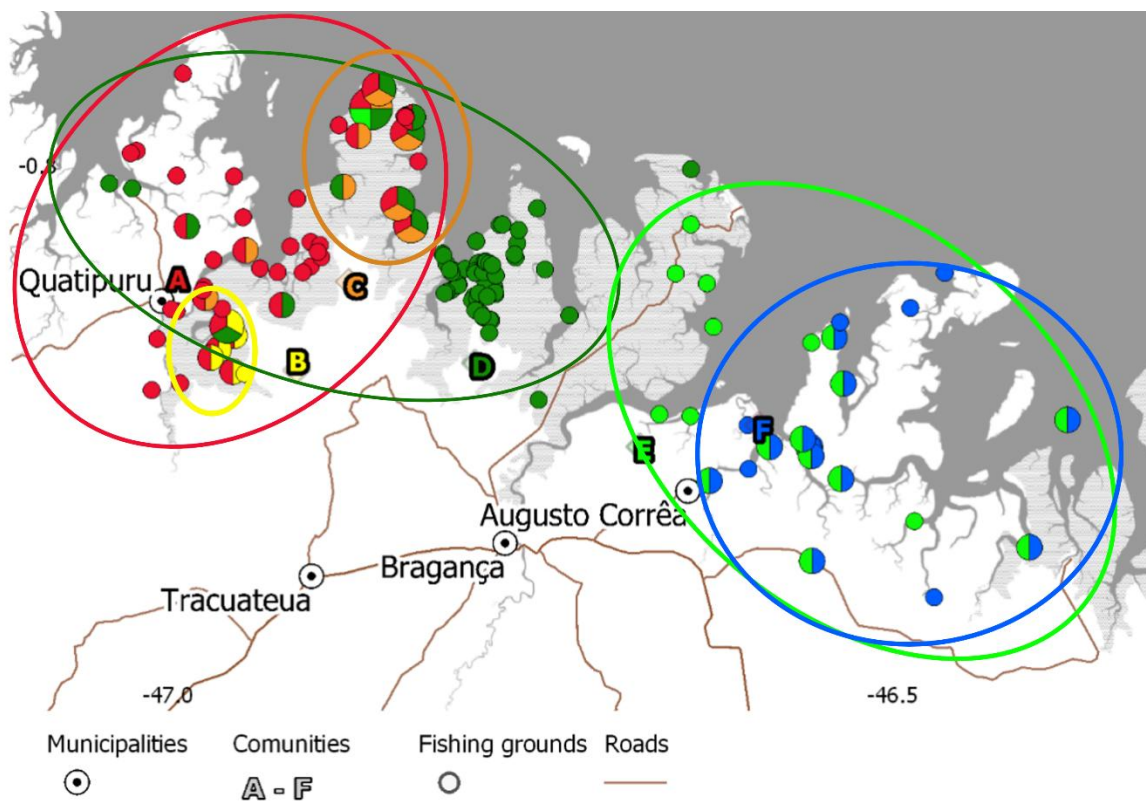


Figure 3. Spatial distribution of fishing locations reported by the uçá crab fishing communities. For clarity, the same colour is used to represent both each fishing location and the community that reported it (prepared by Karl Koerner).

Demographic factor: size of the fishing population

Community A mapped 50 fishing locations and has an estimated fishing population of approximately 200 fishers, resulting in an average of four fishers per fishing location. Communities B and C mapped 7 and 17 fishing locations, respectively, and have fishing populations of 20 and 30 fishers, corresponding to relatively low averages of fishers per fishing location (2.85 and 1.8). Community D mapped the largest number of fishing locations ($n = 92$) and, compared to the other communities, has the second-largest fishing population (300 fishers), resulting in an average of 3.26 fishers per fishing location. Community E mapped one of the smallest numbers of fishing locations (39); however, it has the largest fishing population (400 fishers), resulting in the highest average number of fishers per fishing location (10.3). Community F presents the lowest average number of fishers per fishing location (0.66), with only 20 fishers and 30 fishing locations cited.

Table 1. Fishing locations by community

Communities	A	B	C	D	E	F
Number of fishers	200	20	30	300	400	20
Number of fishing locations reported	50	7	17	92	39	30
Average number of fishers per fishing location	4.00	2.85	1.80	3.26	10.30	0.66

The number of fishing locations reported by a community is related to the number of uçá crab fishers it contains. Communities with larger fishing populations tend to require a greater number of fishing locations to meet individual fishing demands, resulting in a broader set of fishing locations being used. This pattern is confirmed by the ratio between the number of fishers and fishing locations, which is highest in the most populous communities (A, D and E), indicating greater pressure on fishing grounds in these areas.

Fishing locations used by communities with larger fishing populations may experience reduced fallow periods, defined as the time fishers wait before returning to a given location to fish again. According to

the fishers, the ideal fallow period required to ensure the recovery of crab populations is approximately 21 days; however, in practice, fallow periods are often as short as five days. This reduction occurs due to the high density of fishers, who return to the same locations earlier than recommended, thereby increasing pressure on crab stocks. Fallow periods allow for the natural replenishment of uçá crab populations, as illustrated in the following quotation:

“Let’s say an igarapé has five points, which are the harvesting spots. If I go to one today, another person will go to a different one tomorrow. It’s still the same igarapé, just different points. When we arrive at a point that’s already been worked, the tendency is to move on and try to find a better spot. Because if I haven’t been to a point for twenty days, and nobody else has either, it’s certainly going to be good. Before leaving, you already think about whether someone has been there or not. Say you plan to go to Lima; if it’s been a month since you last went and no one else has gone, it will be full of crabs. But if people passed through before that month, it’ll be exhausted.” (Focus group B, 2020)

As pressure on nearby fishing grounds increases, communities may be driven to seek more distant fishing locations, in some cases beyond their primary fishing region, resulting in an expansion of the areas exploited. When this occurs, the likelihood of overlapping use with other communities increases, as does competition for access to the resource.

Although community location and fishing population size partially explain the distribution of fishing areas for most communities, these factors alone are insufficient to account for all observed patterns. Other factors, social, technological, economic and environmental, also contribute to shaping spatial use. These factors are detailed below.

Technological factor

Means of transport

Uçá crab fishers typically access fishing grounds either on foot or by boat. When fishing by boat, vessels may be non-motorised (canoes) or motorised (rabeta or boat) (Figure 4). The rabeta is a smaller and more agile vessel, while the boat is larger and slower.



Figure 4. Motorised transport used by fishers (A and B: rabeta; C: motor boat). Source: personal archive.

The mode of transport directly influences a community’s capacity to reach particular fishing locations: fishers travelling on foot have a more limited range than those using motorised transport. Among motorised vessels, the rabeta offers greater efficiency because it is smaller, more powerful and capable of navigating shallow and narrow channels.

During low tide, certain areas become impassable, and fishers may need to remain at fishing sites until navigability is restored. As one fisher explained during a focus group: *“There are headwaters that boats can’t get into. With the rabeta, you can go all the way in.”*

The use of the rabeta as a means of transport can confer a competitive advantage over other transport modes. Together with demographic factors, this helps explain why community A, which uses rabeta boats, cited a larger number of fishing locations that are more spatially dispersed, whereas community B, which uses boats, cited fewer and more concentrated fishing locations.

Fishing techniques

Nearly all participating communities use the same fishing technique: arm-catching assisted by a hook. The hook is a tool consisting of a handle with a metal hook at the lower end, allowing fishers to reach burrows that would otherwise be inaccessible by hand alone (Figure 5).



Figure 5. Uçá crab fishing using a hook. Source: personal archive

Its use increases capture success, particularly in areas where crab burrows are deeper. Burrow depth varies according to soil type and season, as explained by one fisher:

“Now it’s summer and the mangrove is dry. You can catch crabs by hand. In winter, if you try, it’s only with the hook. A one-and-a-half-metre pole with metal wrapped around the tip so you can pull it out. Got it?”

Despite the widespread use of hooks, one community (C) does not use this tool. As a result, its fishing activity is restricted to areas where hand-catching is feasible—namely, sandy soils with shallower burrows. After community B, this community cited the smallest number of fishing locations.

Work modality factor: day trips versus overnight excursions

The predominant work modality among uçá crab fishers involves daily trips to fishing grounds, with return to the community on the same day. However, some communities also practise pesca de baixada, whereby fishers travel to more distant areas and stay overnight near fishing grounds, using temporary shelters located on sandbanks and islands. From these provisional bases, fishers make repeated incursions into the mangroves over several consecutive days. The catch is either collected directly at the site by a designated person or transported to a nearby port. This organisational arrangement allows fishers to reach more distant locations.

As shown in Table 2, communities that cited more distant fishing locations are precisely those that practise this modality (A, D and E). The presence of distant fishing grounds may reflect the expansion of fishing areas, as suggested by Borges (2019) and Oliveira (2015), and may also be influenced by encouragement from fishing patrons who finance trips to distant fishing grounds (Oliveira & Maneschy, 2014).

Behavioural factor: risk avoidance

Communities that access fishing grounds by water take navigation risks into account, preferring routes that offer greater protection from adverse weather conditions, such as strong winds. This preference enhances safety and helps explain why fishers from community A cited fewer locations to the north of the municipality of Quatipuru, opting instead for areas located on the opposite peninsula. As one fisher explained:

“For us it’s harder to go this way because here we’re on the Atlantic side and the wind hits hard. Going that way, the sea spray hits the canoe sideways. This way it hits head-on, and we can face it. That side is riskier. Here it’s protected from the wind. Over there, you take the full impact.”

New transport technologies have enabled access to areas previously unfished, not only by extending travel range but also by altering perceptions of safety through increased engine power and risk prevention (Teh et al., 2012).

Economic factor: forms of commercialisation

In the study region, crabs are commercialised either in natura or processed artisanally by community members or in small processing units (Figure 6). The form of commercialisation influences fishing practices. Communities that cited a larger number of fishing locations were those that commercialise processed crab (A, E and F). This is because in natura crab must be sold quickly due to its shorter shelf life and is primarily marketed through open-air markets, which typically occur twice a week. Consequently, in natura commercialisation is closely tied to market schedules and indirectly contributes to lower fishing frequency.



Figure 6. A: bundle of crabs; B: batch of one hundred crabs; C: artisanal processing of uça crabs. Source: personal archive.

In contrast, communities that process crab do not depend on markets for sales. Processed crab can be frozen and stored, extending its shelf life and sales period. However, processing increases fishing effort, as producing 1 kg of crab meat requires, on average, 100 in natura crabs.

When crabs are commercialised in processed form, size ceases to be a criterion for consumer choice, unlike in natura crab, where visual appeal strongly influences purchasing decisions. In processing-oriented communities, reduced concern with crab size may lead to more frequent returns to the same fishing locations, reducing fallow periods below the ideal 21 days. Because processing requires large quantities of crab, fishers tend to intensify harvesting and shorten intervals between fishing trips, increasing pressure on the resource.

Table 2 shows that communities practising “*pesca de baixada*” coincide with those engaged in processing (A and E), those using motorised transport, those citing fishing locations outside their main area of concentration, and those citing a greater number of fishing locations.

Crab processing has emerged as a strategy for increasing fishing income by adding value to the product and involving other family members in the activity. At the same time, it intensifies pressure on crab stocks by increasing demand and enabling the processing of smaller crabs, as size no longer affects consumer choice (Nascimento et al., 2015). It also intensifies work routines, as processing can occur more frequently due to storage capacity.

Evidence suggests that pressure on uçá crab populations has increased. Wolff et al. (2000), using a trophic flow model for the region, demonstrated that more crab biomass is being harvested than produced. Signs of overfishing near communities further corroborate this trend (Domingues, 2008; Oliveira, 2015). We found a positive correlation between commercialisation form, transport mode and crab processing.

Social factors: oral and visual communication

Uçá crab fishers move through different mangrove areas in search of crabs, but this movement is neither random nor entirely individual. Fishing involves coordination and communication among fishers, functioning as a strategy to optimise fishing effort. Fishers within the same community exchange information about fishing conditions—such as crab abundance and size—particularly at ports before and after fishing trips. Information sharing is more common when fishing quality is low, whereas details about highly productive sites are not always shared, as a strategy to enhance individual success.

Communication occurs primarily through verbal exchanges but also relies heavily on visual cues. As fishers explained: “What signals a spot is the track. If we see tracks, we usually don’t stop—we move on.” While travelling to fishing grounds, fishers observe human tracks and the presence of other boats to assess whether a location has been recently used. Tracks are most visible at low tide and gradually fade, allowing fishers to estimate how recently an area was fished. As one participant noted: “Before leaving, you already think about whether someone has been there.”

Based on shared information, visual observation and accumulated experience, fishers decide where to fish. For those fishing in groups, decisions also incorporate collective knowledge and consensus. This combination of strategies plays a key role in organising and distributing fishing effort across locations. As fishers noted: “*We communicate so we don’t go the following week where they went, and they don’t go where we went.*” “*By talking, we end up knowing when someone fished in a certain igarapé.*”

Fishers avoid simultaneously using already occupied or recently exploited fishing grounds, thereby seeking to balance effort and catch rates and optimise efficiency. Returning to a location occurs only if previous catches were considered worthwhile; otherwise, fishers shift to new areas.

Through oral and visual communication, fishers coordinate their efforts and avoid concentrating in a single region, which would be counterproductive. This behaviour aligns with economic theories on fisher behaviour and effort allocation (Teh et al., 2012). Communication can enhance fishing efficiency (Barnes et al., 2019a; Bodin et al., 2006; Crona & Bodin, 2006), and previous studies have shown that communication is integral to uçá crab fishing strategies (Domingues, 2008; Oliveira & Maneschy, 2014).

Cultural factor: customary use and local knowledge

Customary use is intrinsically linked to local ecological knowledge and fisher preferences. As one fisher explained: “I’ll explain why I like going there. Sometimes I set my net along the edge, and I already know the points there, so I go where I know.” Another fisher stated: “Some people do better on one side of the mangrove, others on the other. Some go one way, some go the other.”

Thus, spatial division among uçá crab fishing communities can be interpreted as a naturally emerging, endogenous process. However, customary patterns may change over time due to interactions between commercialisation form (processing), work modality and transport, particularly as specific vessels enable access to areas previously unreachable.

Customary fishing areas are maintained through mutual respect. Nevertheless, as shown in Figure 3, some fishing locations are used by more than one community, suggesting territorial competition. In such cases, verbal intimidation may be used to assert control. If fishers from different communities encounter one another, intentional actions to disrupt fishing may occur, including theft of crabs from unfamiliar boats and, in extreme cases, physical confrontations.

Changes in social and technological factors can undermine the stability of customary use areas, potentially leading to increased conflict due to the expansion of fishing territories, as noted by Oliveira (2015). Territorial conflicts among uçá crab fishers have been reported along the entire mangrove coast of Pará (Brasil, 2012, 2014; Diele, 2000; Domingues, 2008), and several communities express concern about declining crab abundance in their fishing areas.

CONCLUSION

This study aimed to understand the spatial dynamics of uçá crab fishing communities by analysing where, how and why fishers choose their fishing locations, which regions are used more or less intensively, and which economic, environmental, social and technological factors influence their spatial decision-making. The results reveal a clear spatial pattern in the distribution of fishing locations, composed of six clusters of sites predominantly situated within the same region. The observed pattern does not depend on a single explanatory factor; rather, different factors help explain the spatial use of different communities to varying degrees.

Customary use, for instance, plays a significant role in shaping the delimitation of fishing areas, and social mechanisms reinforce dominance over specific spaces. These mechanisms include practices of verbal intimidation and, in some cases, direct conflicts between groups from different communities. These dynamics are explored in greater detail in Kasanoski (2022).

The combined analysis of the identified factors provides a comprehensive understanding of how mangrove areas are used by uçá crab fishers and how certain dynamics may lead to transformations in customary use areas. By understanding this spatial dynamic—where, how and why fishers move, which areas they use more or less intensively, and which factors influence their decisions—conservation and sustainability policies can be made more effective if they adopt a territorial management approach that accounts for the greatest possible diversity of influencing factors.

For example, it is important to recognise the existence of different markets for uçá crab and the specific role of *in natura* commercialisation. In addition, fostering stronger communication among communities may strengthen shared resource management. Therefore, understanding these spatial dynamics is essential for more effective territorial management and for conservation policies that are better adapted to local realities, ultimately increasing their effectiveness and long-term viability.

LITERATURE CITED

- Abbott, J. K., & Haynie, A. C. (2012). What are we protecting? Fisher behavior and the unintended consequences of spatial closures as a fishery management tool. *Ecological Applications*, 22(3), 762–777. <https://doi.org/10.1890/11-1319.1>
- Araújo, A. R. da R. (2006). Fishery statistics and commercialization of the mangrove crab, *Ucides cordatus* (L.), in Braganca - Pará - Brazil. (Tese de doutorado). University of Bremen.
- Barnes, M., et al. (2019). Social-ecological alignment and ecological conditions in coral reefs. *Nature Communications*, 10(1), 2039. <https://doi.org/10.1038/s41467-019-09994-1>
- Barnes, M. L., Mbaru, E., & Muthiga, N. (2019). Information access and knowledge exchange in co-managed coral reef fisheries. *Biological Conservation*, 238, 108198. <https://doi.org/10.1016/j.biocon.2019.108198>
- Begossi, A. (1995). Fishing spots and sea tenure: Incipient forms of local management in Atlantic forest coastal communities. *Human Ecology*, 23(3), 387–406. <https://doi.org/10.1007/BF01190138>
- Beitl, C. M. (2014). Navigating over space and time: Fishing effort allocation and the development of customary norms in an open-access mangrove estuary in Ecuador. *Human Ecology*, 42(3), 395–411. <https://doi.org/10.1007/s10745-014-9655-7>
- Beitl, C. M. (2015). Mobility in the mangroves: Catch rates, daily decisions, and dynamics of artisanal fishing in a coastal commons. *Applied Geography*, 59, 98–106. <https://doi.org/10.1016/j.apgeog.2014.12.008>
- Berkes, F. (2008). *Sacred ecology* (2 ed.). Routledge. <https://doi.org/10.4324/9780203928950>
- Bodin, Ö., Crona, B. I., & Ernstson, H. (2006). Social networks in natural resource management: What is there to learn from a structural perspective? *Ecology and Society*, 11(2). [10.5751/ES-01808-1102r02](https://doi.org/10.5751/ES-01808-1102r02)
- Borges, R. (2019). Assessing spatial management of mangroves and small-scale fisheries in protected areas on the Brazilian Amazon coast (Tese de doutorado). University of Bremen.
- Brasil. (2012). *Plano de Manejo da Reserva Extrativista Marinha de Caeté-Taperacu, PA (Diagnóstico)*. Instituto Chico Mendes de Conservação da Biodiversidade. https://www.gov.br/icmbio/pt-br/assuntos/biodiversidade/unidade-de-conservacao/unidades-de-biomas/marinha/lista-de-ucs/resex-marinha-de-caete-taperacu/arquivos/resex_caete_taperacu_pm_plan.pdf
- Brasil. (2014). Estudo socioambiental referente à proposta de ampliação da Reserva Extrativista Marinha Arai-Peroba, Estado do Pará. Instituto Chico Mendes de Conservação da Biodiversidade.
- Campling, L., Havice, E., & McCall Howard, P. (2012). The political economy and ecology of capture fisheries: Market dynamics, resource access and relations of exploitation and resistance. *Journal of Agrarian Change*, 12(2–3), 177–203. <https://doi.org/10.1111/j.1471-0366.2011.00356.x>
- Crona, B., & Bodin, Ö. (2006). What you know is who you know? Communication patterns among resource users as a prerequisite for co-management. *Ecology and Society*, 11(2), 7. <http://www.ecologyandsociety.org/vol11/iss2/art7/>
- Diegues, A. C. (2005). *Maritime anthropology in Brazil*. Núcleo de Apoio à Pesquisa sobre Populações Humanas e Áreas Úmidas Brasileiras (NUPAUB - USP). https://nupaub.fflch.usp.br/sites/nupaub.fflch.usp.br/files/inline-files/maritime_compressed.pdf

- Diele, K. (2000). Life history and population structure of the exploited mangrove crab *Ucides cordatus cordatus* (Linnaeus, 1763) (Decapoda: Brachyura) in the Caeté estuary, North Brazil (Tese de doutorado). University of Bremen.
- Diele, K., Koch, V., & Saint-Paul, U. (2005). Population structure, catch composition and CPUE of the artisanally harvested mangrove crab *Ucides cordatus* (Ocypodidae) in the Caeté estuary, North Brazil: Indications for overfishing? *Aquatic Living Resources*, 18(2), 169–178. DOI: <https://doi.org/10.1051/alr:2005018>
- Diele, K., & Simith, D. J. B. (2006). Salinity tolerance of northern Brazilian mangrove crab larvae, *Ucides cordatus* (Ocypodidae): Necessity for larval export? *Estuarine, Coastal and Shelf Science*, 68(3–4), 600–608. <https://doi.org/10.1016/j.ecss.2006.03.012>
- Diele, K., & Koch, V. (2010a). Comparative population dynamics and life histories of North Brazilian mangrove crabs, genera *Uca* and *Ucides* (Ocypodoidea). In U. Saint-Paul & H. Schneider (Eds.), *Mangrove dynamics and management in North Brazil* (Vol. 211, pp. 111–134). Springer. https://doi.org/10.1007/978-3-642-13457-9_18
- Diele, K., & Koch, V. (2010b). Growth and mortality of the exploited mangrove crab *Ucides cordatus* (Ucididae) in N-Brazil. *Journal of Experimental Marine Biology and Ecology*, 395(1–2), 171–180. <https://doi.org/10.1016/j.jembe.2010.08.029>
- Domingues, D. (2008). Análise do conhecimento ecológico local e do sistema produtivo como subsídio para gerar instrumentos de gestão da atividade de exploração do caranguejo-uçá (*Ucides cordatus*) nos manguezais da Reserva Extrativista Marinha Caeté-Taperaçu, Bragança - PA (Dissertação de Mestrado). Universidade Federal do Pará.
- Fulton, E. A., et al. (2011). Human behaviour: The key source of uncertainty in fisheries management. *Fish and Fisheries*, 12(1), 2–17. <https://doi.org/10.1111/j.1467-2979.2010.00371.x>
- Glaser, M. (2003). Interrelations between mangrove ecosystem, local economy and social sustainability in Caeté Estuary, North Brazil. *Wetlands Ecology and Management*, 11(4), 265–272. <https://doi.org/10.1023/A:1025015600125>
- Glaser, M., & Diele, K. (2004). Asymmetric outcomes: Assessing central aspects of the biological, economic and social sustainability of a mangrove crab fishery, *Ucides cordatus* (Ocypodidae), in North Brazil. *Ecological Economics*, 49(3), 361–373. <https://doi.org/10.1016/j.ecolecon.2004.01.017>
- Glaser, M., & Oliveira, S. (2004). Prospects for the co-management of mangrove ecosystems on the North Brazilian coast: Whose rights, whose duties and whose priorities? *Marine Policy*, 28, 224–233. <https://doi.org/10.1111/j.1477-8947.2004.00092.x>
- Hilborn, R. (2007). Managing fisheries is managing people: What has been learned? *Fish and Fisheries*, 8, 285–296. https://doi.org/10.1111/j.1467-2979.2007.00263_2.x
- Holland, D. S., & Sutinen, J. G. (2000). Location choice in New England trawl fisheries: Old habits die hard. *Land Economics*, 76(1), 133–149. <https://doi.org/10.2307/3147262>
- Hønneland, G. (2000). Compliance in the Barents Sea fisheries. How fishermen account for conformity with rules. *Marine Policy*, 24(1), 11–19. [https://doi.org/10.1016/S0308-597X\(98\)00058-X](https://doi.org/10.1016/S0308-597X(98)00058-X)
- Nascimento, J. R. do, Domingues, D., & Barboza, R. S. L. (2015). A cadeia produtiva do caranguejo (*Ucides cordatus*): Os desafios para seu manejo frente às pressões do mercado no território da RESEX marinha Caeté-Taperaçu, Bragança, Pará. *Revista Saúde e Ciência*, 4(2), 299–309.
- Oliveira, F. P. de, & Maneschy, M. C. A. (2014). Territórios e territorialidades no extrativismo de caranguejos em Pontinha de Bacuriteua, Bragança, Pará. *Boletim do Museu Paraense Emílio Goeldi. Ciências Humanas*, 9(1), 129–143. <https://doi.org/10.1590/S1981-81222014000100009>

- Oliveira, F. P. de. (2015). Análise da percepção dos extrativistas estuarino-costeiros sobre o zoneamento da extração do caranguejo-uçá (*Ucides cordatus*) e da madeira nos manguezais da RESEX-Marinha Caeté-Taperaçu, Pará, Costa Amazônica Brasileira (Dissertação de Mestrado). Universidade Federal do Pará.
- Rotich, B., Mwangi, E., & Lawry, S. (2016). Where land meets the sea: A global review of the governance and tenure dimensions of coastal mangrove forests. USAID.
- Seixas, C. S., & Begossi, A. (1998, June). Do fishers have territories? Use of fishing grounds at Aventureiro (Ilha Grande, Brazil). In *Crossing Boundaries. Seventh Conference of the International Association for the Study of Common Property* (pp. 10-14). <https://dlc.dlib.indiana.edu/dlc/bitstream/handle/...>
- Smith, M. D., & Wilen, J. E. (2003). Economic impacts of marine reserves: The importance of spatial behavior. *Journal of Environmental Economics and Management*, 46(2), 183–206. [https://doi.org/10.1016/S0095-0696\(03\)00024-X](https://doi.org/10.1016/S0095-0696(03)00024-X)
- Souto, F. J. B. (2007). Uma abordagem etnoecológica da pesca do caranguejo, *Ucides cordatus*, Linnaeus, 1763 (Decapoda: Brachyura), no manguezal do Distrito de Acupe (Santo Amaro-BA). *Biotemas*, 20(1), 69–80.
- Sultan, R. (2020). Fishing location choice and risk preferences among small fishers – Implications for fisheries management policies. *African Journal of Agricultural and Resource Economics*, 15(2), 140–156. [10.22004/ag.econ.307626](https://doi.org/10.22004/ag.econ.307626)
- Suuronen, P., Jounela, P., & Tschernij, V. (2010). Fishermen responses on marine protected areas in the Baltic cod fishery. *Marine Policy*, 34(2), 237–243 <https://doi.org/10.1016/j.marpol.2009.07.001>

CRedit authorship contribution statement

Daniessa Sannara Kasanoski: Conceptualization, Data curation, Validation, Formal analysis, Investigation Methodology, Writing original draft. **Emilie Coudel:** Writing – review & editing, Visualization, Validation, Funding acquisition. **Frédéric Mertens** Validation, Supervision.

Declaration of conflict of interest: The authors declare that there are no conflicts of interest to disclose.

Data availability statement: Data will be made available on request.

Table 2. Factors shaping the spatial use of Amazonian mangroves

Factor	Indicator	A	B	C	D	E	F
Number of fishing locations reported	–	50	7	17	92	39	30
Social	Fishing population size	Tens		✓	✓		
		Hundreds		✓		✓	✓
Technological	Work type	Daily trips		✓	✓	✓	✓
		Overnight fishing (base camp)		✓		✓	✓
	Fishing frequency per week	–		5	3	2	5
	Transport	On foot					
		By boat – Non-motorised (canoe)					
		By boat – Motorised					
		– Rabeta		✓		✓	✓
Social	Risk avoidance	✓					

Factor	Indicator	A	B	C	D	E	F
Economic	Marketing type	Fresh (in natura)	✓	✓	✓		
		Processed		✓			✓
Technological	Fishing technique	Hand-collecting*				✓	
		Hook*		✓	✓		✓
Social	Communication (oral and visual)	✓	✓	✓	✓	✓	✓
	Customary use	✓	✓	✓	✓	✓	✓
	Local ecological knowledge and preferences	✓	✓	✓	✓	✓	✓
	Local management (rotation and fallow periods)						
Environmental	Environmental conditions (tide cycle, soil characteristics, land/water access)	✓	✓	✓	✓	✓	✓

✓ indicates the presence of the factor for the community.

Hand-collecting: collecting crabs manually by hand.

Hook: use of a tool with a hook to reach crabs in deeper burrows.

This preprint was submitted under the following conditions:

- The authors declare that the necessary Terms of Free and Informed Consent of participants or patients in the research were obtained and are described in the manuscript, when applicable.
- The authors declare that the preparation of the manuscript followed the ethical norms of scientific communication.
- The authors declare that they are aware that they are solely responsible for the content of the preprint and that the deposit in SciELO Preprints does not mean any commitment on the part of SciELO, except its preservation and dissemination.
- The authors declare that the data, applications, and other content underlying the manuscript are referenced.
- The deposited manuscript is in PDF format.
- The authors declare that the research that originated the manuscript followed good ethical practices and that the necessary approvals from research ethics committees, when applicable, are described in the manuscript.
- The authors declare that once a manuscript is posted on the SciELO Preprints server, it can only be taken down on request to the SciELO Preprints server Editorial Secretariat, who will post a retraction notice in its place.
- The authors agree that the approved manuscript will be made available under a [Creative Commons CC-BY](#) license.
- The submitting author declares that the contributions of all authors and conflict of interest statement are included explicitly and in specific sections of the manuscript.
- The authors declare that the manuscript was not deposited and/or previously made available on another preprint server or published by a journal.
- If the manuscript is being reviewed or being prepared for publishing but not yet published by a journal, the authors declare that they have received authorization from the journal to make this deposit.
- The submitting author declares that all authors of the manuscript agree with the submission to SciELO Preprints.