frontiers | Frontiers in Marine Science

TYPE Original Research
PUBLISHED 06 August 2024
DOI 10.3389/fmars.2024.1419800

OPEN ACCESS

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RECEIVED 18 April 2024
ACCEPTED 08 July 2024
PUBLISHED 06 August 2024

CITATION
Vallejos T, Nahuelhual L, Gelcich S and Oyanedel R (2024) Situational crime analysis of poaching within Territorial Use Rights Fisheries (TURFs). *Front. Mar. Sci.* 11:1419800. doi: 10.3389/fmars.2024.1419800

Situational crime analysis of poaching within Territorial Use Rights Fisheries (TURFs)

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Introduction: Illegal, unreported, and unregulated (IUU) fishing poses a significant threat to marine resource management globally. Environmental criminology plays a vital role in understanding and mitigating IUU activities by focusing on the contextual elements surrounding these crimes. This study examines the dynamics of poaching within areas managed through Territorial User Rights for Fisheries (TURFs), with a specific emphasis on the loco (*Concholepas concholepas*) fishery in Chile.

Methods: Employing Crime Script Analysis (CSA) as the primary methodological lens, this research meticulously deconstructs the criminal process involved in TURFs poaching operations. CSA is used to identify key elements, providing a comprehensive understanding of poachers *modus operandi*. Additionally, by integrating CSA with Situational Precipitators of Crime (SPC), the study identifies critical factors such as environmental conditions, socio-economic disparities, and enforcement weaknesses that shape poaching opportunities within TURFs.

Results: The analysis reveals a complex interplay between SPC factors, underscoring their role in shaping poaching dynamics. Key findings highlight the importance of specific environmental conditions, socio-economic disparities, and enforcement weaknesses in facilitating poaching activities. The study identifies various tactics and strategies employed by poachers and the roles of different actors involved in the poaching process.

Discussion: Building upon these findings, the study proposes a comprehensive Situational Crime Prevention (SCP) framework aimed at effectively combating TURFs poaching. The framework emphasizes the importance of striking a careful balance between restrictive and inclusive measures to mitigate potential negative consequences. The study contributes valuable insights into understanding and addressing IUU fishing, particularly within TURFs in Chile.

KEYWORDS

illegal fishing, management areas, crime process, small-scale fisheries, environmental crime

1 Introduction

To understand how any crime is committed, environmental criminologists primarily focus on the contextual elements that impact individuals' immediate decisions to engage in non-compliant behaviors (Wortley and Townsley, 2017; Andresen, 2020). Within environmental criminology three key operational models, specifically the routine activity approach (Cohen and Felson, 1979), the rational choice perspective (Cornish and Clarke, 1987), and crime pattern theory (Brantingham and Brantingham, 1993) prove the theoretical basis of opportunity-based approaches to non-compliance.

Situational Crime Prevention (SCP) and Situational Precipitators of Crime (SPC) are two key instrumental frameworks which emerge within opportunity-based approaches to comprehending and addressing criminal behavior. Clarke (1980) first introduced the SCP framework, highlighting its event-focused nature aimed at reducing crime opportunities (Clarke, 1983). SCP encompasses a variety of techniques rooted in an understanding of the processes involved in committing a crime. In contrast, Wortley (1997) challenged the notion of opportunity in situational prevention, asserting its limitations in capturing the complexity of person-situation interactions. Subsequently, Wortley (1998) proposed a two-stage model of SCP, highlighting the interconnectedness of precipitating and opportunity regulating situations. Later on, Wortley (2017) defined SPC as "any aspect of the immediate environment that creates, triggers, or intensifies the motivation to commit crime". The evolution and expansion of SCP were notably influenced by recognizing the substantial role SPC plays in offender decision-making (Cornish and Clarke, 2003). Both situational crime approaches had been widely applied to wildlife and fisheries studies (Lemieux, 2014; Marteache et al., 2015; Petrossian et al., 2015; Moreto, 2019; Weekers and Zahnow, 2019; Weekers et al., 2020, 2021; Viollaz et al., 2021). While SCP and SPC do not focus on motivations but rather on the circumstances enabling criminal opportunities, comprehending how crimes are committed remains essential. One method to model crime occurrence is through the utilization of crime scripts (Cornish, 1994).

Crime script analysis (CSA) was initially formulated by Cornish in 1994, building on the idea that crimes are distinct events occurring in both space and time, but the actual commission of the crime unfolds within a broader context of numerous events. Cornish introduced the script-theoretic approach to crime analysis as "a way of generating, organizing and systematizing knowledge about the procedural aspects and procedural requirements of crime commission" (Cornish, 1994:160). CSA has demonstrated its utility in various research related to wildlife crime (see, Dehghanniri, 2019). By offering a systematic framework for examining the process of committing crimes, CSA expands our understanding of the decisions and actions associated with specific criminal activities, thereby informing the development of tailored situational prevention strategies.

Among environmental or so called green crimes, illegal, unreported, and unregulated (IUU) fishing poses a significant threat to the effective conservation of marine resources (Agnew et al., 2009; FAO, 2022). Within the domain of environmental conservation, IUU fishing encompasses a wide range of activities. Poaching can be considered a subset of illegal fishing practices (Plagányi et al., 2011). A general definition of poaching involves the unauthorized killing or removal of wildlife for trade or personal use and is commonly observed in protected or managed areas (Hill, 2015). In the fisheries sector, poaching occurs within marine protected areas or fishery management areas that possess formal or informal access rights (Sethi and Hilborn, 2007; Silvy et al., 2018). The implications of poaching extend beyond the act itself, as they undermine community-based natural resource management and co-management systems, thereby impeding social, ecological, and economic benefits (Samoilys et al., 2007; Harasti et al., 2019).

Fishing areas managed under a Territorial User Rights for Fisheries (TURFs) regime in Chile which assigns access rights for benthic resources to organized associations of artisanal fishers offer a unique form of co-management. In the early 1990s in response to overexploitation, the Chilean government established the TURFs regime based on sustainability criteria. Under TURF, organized fishers assume responsibility for managing their respective AMERBs, including access, withdrawal, management, exclusion, alienation, and intern-regulations to ensure sustainable practices (Castilla and Fernandez, 1998; Gelcich et al., 2010; Aburto et al., 2013). Loco (*Concholepas concholepas*) is currently the most valuable resource managed under TURFs (Castilla and Gelcich, 2008; Zuniga-Jara and Soria-Barreto, 2018). However, poaching poses a significant challenge to the effective management of TURFs. Studies have shown that loco illegal extractions can account for a substantial proportion of landings, ranging from 50% to 112%, of the total annual extraction (Bandin and Quiñones, 2014; Oyanedel et al., 2017; Donlan et al., 2020). Poaching involves the collection of loco within a management area by individuals who are not part of the organization; and unreported removal of loco specimens from TURFs by members of the organization (Oyanedel et al., 2017). Poaching also varies from opportunistic removal to a well-organized poaching operation for commercial purposes (Nahuelhual et al., 2023).

This study aims to explore the crime committing process of organized poaching inside TURFs, focusing on the case of the loco fishery in Chile. Our research approach integrates Crime Script Analysis (CSA) with the situational crime approach into a cohesive framework. We use CSA to identify the specific elements of the poaching process and the situational crime approach to explore potential situational prevention measures and design targeted interventions. The analysis will identify key situational factors influencing poachers' opportunities to engage in loco poaching within TURFs, while also highlighting gaps and challenges for management strategies aimed at reducing poaching.

2 Materials and methods

Research employed a mixed-methods approach to investigate poaching within TURFs areas. Data was collected through interviews with poachers, TURFs members, experts, and regional directors. Purposive sampling and snowball sampling were used. Qualitative thematic content analysis was conducted on the data.

2.1 Data collection

The data comprised preexisting text material (transcripts) obtained from three different instruments (Supplementary Table 1), applied to 34 TURFs members (fishers, divers, vessel owners and representatives); 5 experts (academics and NGOs); 3 self-declared TURFs poachers; 2 regional directors overseeing operations of Subsecretary of Fisheries and Aquaculture (SUBPESCA) and the National Service of Fisheries and Aquaculture (SERNAPESCA). Between 2019 and 2022, we visit 14 TURFs in Los Lagos region. The main locations were (from south to north): Chepu, Puñihuil, Mar Brava, Guabun, Yuste; Carelmapu, Queniur, Maullin, and Estaquilla (Figure 1).

Purposive sampling was strategically employed to select experts and government official possessing pertinent experience or knowledge regarding poaching practices. Additionally, to identify and engage potential participants directly related to the case of study (i.e., local actors), a multifaceted approach was adopted, utilizing snowball sampling, referrals, and social media channels. Only participants knowledgeable of the TURFs loco poaching context were included in the study. In-depth interviews were conducted in private locations to ensure confidentiality, and audio recordings were made with participants' consent. A key ethical consideration was to grant confidentiality and anonymity, which was explained in the written consent signed by each interviewee. We audio-recorded all the interviews and complemented the audios with notes.

Relevant questions included during the interviews:

1. What are the main forms of illegality in the extraction and commercialization of loco?
2. Can you describe the process for loco poaching inside TURFs?
3. What sort of tools and supplies are used during poaching operations?
4. How do legal and illegal fishers relate to each other?
5. What are poachers motivations?
6. How do poachers evade TURFs surveillance and formal enforcement?

Additionally, we conducted a systematic search of secondary data sources, including research and news articles (Supplementary Table 1). Our inclusion and exclusion criteria for determining which research articles and news sources to include in the secondary data gathering were based on the presence of relevant information for constructing the crime script related to loco poaching inside TURFs in Chile. We searched multiple databases, including academic ones like Google Scholar, Science Direct, and Microsoft Academic, as well as national news websites. We used a combination of keywords in both English (Poaching; Illegal fishing; Non-compliance; Artisanal fishing; Small scale fishing; Loco; Concholepas concholepas; TURFs; Management areas; Chile) and Spanish (Robo; Pesca illegal; Incumplimiento; Loco; Concholepas concholepas; AMERBs; Áreas de manejo, Chile) to find relevant articles. For research articles, our screening process initially involved titles and abstracts, followed by a review of the full texts of potentially relevant articles to make final selections. For news articles, we screened based on their titles and then reviewed the full text of potentially relevant news pieces for final selection. We included paragraphs from research articles results, key findings, discussion, and any relevant data on poaching loco within TURFs. For news articles, we included the full text. At the end of the process, we retrieved 17 research-relevant articles (Supplementary Table 2) and collected 74 news articles (Supplementary Table 3) both published between January 2000 and May 2023.

2.2 Data analysis

We analyzed field data through qualitative thematic content analysis, which is a method of analyzing written, verbal or visual

FIGURE 1
Main TURFs locations (blue circles) where interviews with local actors were conducted in Los Lagos region, Chile.

messages (Cole, 1988; Vaismoradi et al., 2016). A qualitative approach is more suited than a quantitative approach for analyzing data obtained from open-ended sources (as in our case) containing latent content (Ahuvia, 2000). Given the nature of our inquiry, we used manual qualitative content analysis since when data is complex, automated methods might be unable to draw on the same logical thinking as human coders, therefore producing a systematic bias (Conway, 2006). The data were systematically coded and categorized into thematic groups aligned with the nine categories of Crime Script Analysis (CSA) proposed by Cornish (1994), which served as the initial framework for theme categorization.

We followed three steps in the analysis (Oliveira et al., 2014), see Figure 2: (1) pre-analysis, (2) exploration and (3) treatment and interpretation. Pre-analysis involved defining the objectives of the content analysis, selecting the material (e.g. transcripts) according to its relevance in relation to the goal, reading the material to be analyzed and organizing the material for analysis (e.g. highlight transcriptions). The exploration stage involved defining the smallest unit of analysis (i.e. the portion of text to which the code is associated) which in our case were paragraphs.

Finally, in the treatment and interpretation step, we made inferences. To reduce potential bias, we checked the reliability of the coding using a stability criterion, repeating the coding process by the same person, and reproducibility criteria by repeating the process by another person (Krippendorf, 2004). Crime script categories acted as a first layer for code selection (Figure 2). A second layer of coding was left to open coding in order to infer crime script sub steps. A third layer for code selection corresponds to the four categories of SPC (Wortley, 2001). A fourth layer of coding was left to open coding in order to infer specific SPC factors. A fifth layer of coding corresponded to the six categories of SCP techniques (Cornish and Clarke, 2003; Freilich and Newman, 2014).

2.3 Crime script analysis (CSA)

Based on the conceptualization of Cornish (1994), CSA involved the analysis of nine sequential steps involved in committing a crime (Figure 3; Supplementary Table 4). The crime scripts were developed based on the analyzed data and described the step-by-step process involved in committing a poaching activity. The qualitative coding and analysis helped categorize the data and identify themes and concepts related to the crime scripts. The crime script interpretation involved examining the patterns and trends in the data and drawing conclusions about the factors driving poaching around TURFs fisheries. Key elements of the crime script, including motives, methods, targets, and locations, were identified, and given priority. To ensure the validity of the findings, member checking was conducted, involving the sharing of results with participants to validate the accuracy of the analysis.

2.4 Situational precipitators of crime (SPC) framework

The resulting coded narrative for each crime script stage were cross-referenced with the four categories of SPC (i.e., prompts; permissions; provocations; pressures). Additionally, the coding process involved a second layer of information resulting by identifying specific factors related to loco poaching inside TURFs.

2.5 Situational crime prevention (SCP) framework

We used the SCP approach (Clarke, 1980), to provide possible solutions for poaching loco inside TURFs. By first aligning the crime

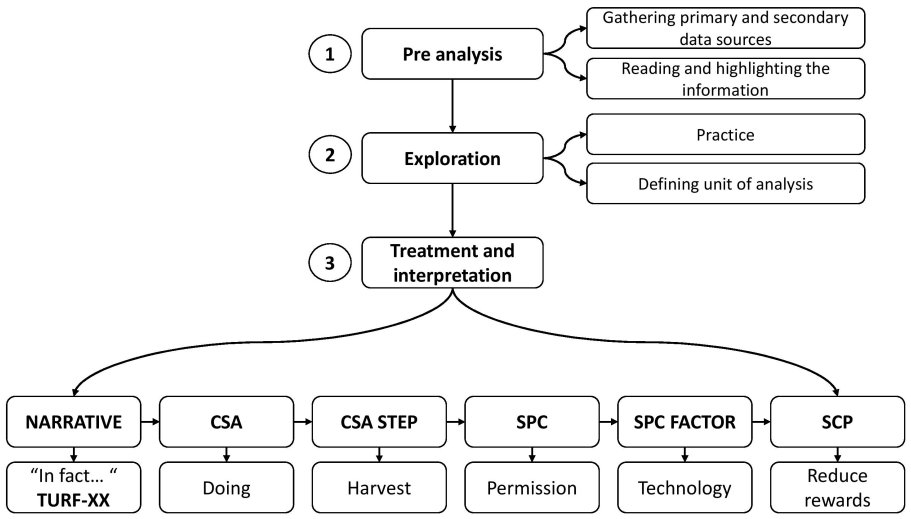

FIGURE 2
Process and steps of analysis. CSA, Crime Script Analysis; SPC, Situational Precipitators of Crime; SCP, Situational Crime Prevention.

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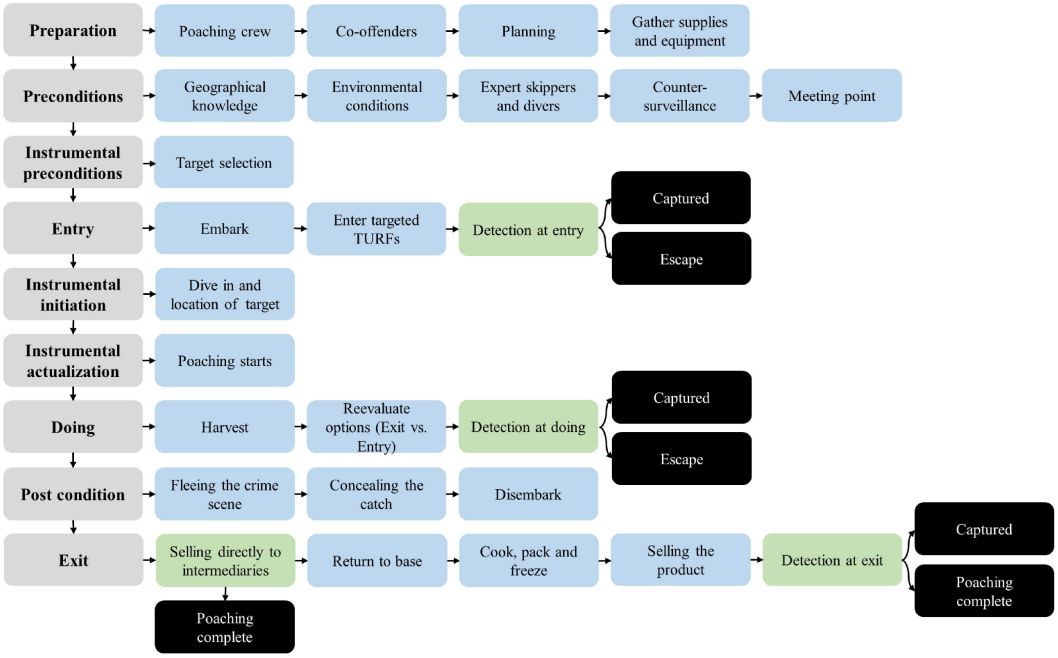

FIGURE 3
Crime script stages: Grey (crime script categories); Blue (activities that are common to most stages; Green (actions that occasionally occur); Black (operation endpoint); Arrows indicate the transition between operational phases. Circles indicates number of analyzed narratives are shown in each crime script stage.

script analysis the situational precipitators of crime framework, we were able to discuss possible solutions from the situational crime prevention (SCP) framework. SCP was composed of six major categories (i.e., increase effort; increase risks; reduce rewards; reduce provocations; remove excuses; provide opportunities) that were aligned with each found situational precipitator of crime. Finally, the results from this process were discuss in order to provide possible solution to the TURFs poaching situation from the SCP perspective.

3 Results

3.1 Crime script analysis of loco poaching inside TURFs

Summary of crime script stages is shown in Figure 3 and discussed in detail below. The sources of information for each step of the process of loco poaching inside TURFs are summarized Figure 4 and Supplementary Table 4.

Preparation (i.e., The acquisition of the necessary tools, selecting of co-offenders, as well as planning the operation).

Poaching crew: Poaching crews consist of a mix of individuals with specific roles, including registered artisanal fishers and non-registered individuals. The size the crew can vary, typically consisting of three up to five members per vessel, each assigned to critical roles. The crew structure comprises a skipper, accompanied by one to two divers responsible for harvesting. These divers receive support from sometimes two helpers. Poachers often collaborate with other poaching crews, leading to the formation of larger groups. Some reported cases have seen up to 15 vessels working together in synchronized efforts. Poachers collaboration not only enhances the overall efficiency resource extraction while also mitigates the risks of detection by law enforcement agencies.

Co-offenders: In addition to the crew directly involved in the poaching activities, there are other people that participate in the operation. Intermediaries are often involved, in some cases, during preparation stages by placing resource orders and financing poaching operations. In addition, poachers often establish connections with co-offenders who have access to valuable insider information. These informers could be individuals from outside (e.g., at port of enforcement) or inside the TURFs organization (e.g., guardians) who are willing to provide crucial details such as surveillance activities at TURFs or Navy enforcement movements at port. Poachers compensate these informers, ensuring a steady flow of information that aids in their strategic decision-making and helps them stay one step ahead of authorities. Furthermore, there is the possibility of involvement by other accomplices, playing roles in transportation, processing, or the sale of the illicit product.

Planning: Poaching operations involve multiple individuals and vessels working together (see poaching crew; co-offenders). Poachers plan the time and location of their operations to minimize the risk of detection and maximize profit opportunities (see target selection; geographical knowledge). Poachers plan their travel routes, using navigational tools, to travel to and from their target TURFs (see supplies and equipment). Poachers often operate during unfavorable environmental conditions taking advantage of the reduced visibility and decreased chances of being detected (see environmental conditions). Poachers might plan counter-surveillance techniques, such as monitoring the movements of authorities and TURFs surveillance.

FIGURE 4
Number of extracted narratives divided by crime script stages. Left, colored by source of the narratives. Center, colored by situational precipitators of crime specific factors. Factors are grouped by precipitator category, prompt factors in green colors; permission factors in red colors; provocation factors in yellow colors; and pressure factor in grey. Right, colored by situational crime prevention category. "Only descriptive" stands for narratives that didn't fall into any SPC or SCP category, however useful during CSA.

Gather supplies and equipment: Poachers use a variety of tools and equipment, including hookah diving gear, iron hooks, mesh sacs, knives, diving lanterns, GPS systems, radars, radios, and phones. Diving lanterns, activities satellite Global Positioning Systems (GPS) and radars are used for the localization of resource and TURFs during nighttime conditions. Moreover, poachers rely on radio and/or phones to establish communication with other poaching teams and other co-offenders. To access and exit TURFs areas, poachers employ lightweight glass fiber vessels (~7–12 meters long) equipped with powerful outboard engines (~150–250 Hp; see Figures 5B, D). Poachers are known to carry diverse types of arms to protect their illegal activities and fend off potential threats.

Preconditions (i.e., some pre-conditional steps may be taken to enable the commission of crime).

Geographical knowledge: Through experience and observation, poachers possess valuable insights into the coastline and TURFs geographic features (Figure 5A), such as bathymetric conditions, distribution of loco populations, location of TURFs, coves, ports, beaches, and other geographical features. The intimate understanding of the geography gives poachers a competitive advantage in locating and targeting loco at TURFs, embark and disembark at proper locations or escape and hide when detected by surveillance or enforcement authorities.

Environmental conditions: Poachers carefully monitor weather conditions to optimize their operations, considering crucial environmental factors for harvesting loco, including tides, currents, water visibility, winds, and time of day. Operating during unfavorable environmental conditions, such as night or inclement weather, poachers capitalize on reduced visibility and lower chances of detection. For example, they often conduct poaching during the night or early morning, reducing the likelihood of detection by enforcement or TURFs surveillance. Interviews indicate that poachers intentionally select adverse weather conditions to avoid co-enforcement presence at sea.

Expert skippers and divers: Successful offenders possess advanced skills and knowledge when poaching TURFs. They understand specialized techniques for navigation and diving during night and difficult weather conditions. Such expertise is often acquired through a combination of learning from experienced poachers and trial and error.

Counter-surveillance: Poachers employ various strategies to avoid law enforcement and TURFs surveillance. One prominent strategy involves continuous investments in enabling technology, such as high-powered engines, GPS, and diving lanterns. Additionally, avoidance strategies, such as operating during night conditions, in remote locations, or unfavorable weather conditions

FIGURE 5
Illustrates images of the Loco TURFs fishery, displaying tools and equipment that are deemed similar to those used by poachers. The image descriptions are as follows: **(A)** Coastal geography from Los Lagos region, Chile. **(B)** Vessel displaying complete equipment for loco harvest, including a gas-powered air compressor, a pair of yellow hoses, and hookah diving equipment. **(C)** Hookah diver equipped with a mesh sac and iron hook engaged in the harvesting of locos. **(D)** TURFs members participating in management activities.

are employed. Poachers and co-enforcement are engaged in a constant competition, resembling an "arms race" escalation, where each side strives to outwit the other by deploying innovative tactics and countermeasures.

Meeting point: Poachers gather at designated meeting points, such as process plants, coves, or ports, to organize equipment, coordinate their efforts, and finalize their plans for the operation. Meeting points include process plants, specific coves or ports and other informal places. Once prepared, they set off and embark on a convened discrete site, traveling discreetly along the shoreline toward their intended target TURF, keeping a low profile to avoid arousing suspicion.

Instrumental precondition (i.e., Identifying the suitable targets).

Target selection: Based on the narratives, several factors influence how poachers select targeted areas. Notable considerations include resource productivity, biological cycles, co-enforcement efforts, and geographical and physical features. Specifically, TURFs with a higher abundance of locos serve as an incentive for poachers, as the potential gain increases with the greater availability of resources in an area. Interviewers report that the geographical distribution of loco also influences the variation in poaching across different regions. The biological features of loco play a crucial role in poachers' decisions. Loco exhibits a marked annual biological cycle (for details, Manríquez and Castilla, 2018), leading to aggregations, dispersals, or migrations based on factors such as reproductive season and food availability. Consequently, poaching events are commonly reported in TURFs closest to the annual harvest, where loco reaches the preferred size and meat weight, and during the reproductive season when locos exhibit aggregative mating behavior. Another aspect that influences target selection is distance and accessibility. TURFs in remote locations (or difficult to guard) are preferred by poaching operations due the limited co-enforcement presence and increased response times. In contrast, TURFs located in easily accessible areas can also be vulnerable to other forms of poaching, such as opportunistic poaching. More accessible areas might attract higher rates of poaching due to factors like proximity to urban areas and ease of access (e.g., proximity to the coast). Furthermore, some TURFs operate with a de facto open access regime due to insufficient surveillance mechanisms which increases the chances of intrusion by poachers. Other conditions such as wave exposure and other demanding physical factors could affect poachers intrusion decisions, as; more exposed TURFs to physical condition could be target at certain conditions and times of the year.

Entry (i.e., The entry into the selected location(s) where the crime is to be committed).

Embark: once poachers embark to prevent potential detection, they conceal their equipment and avoid the use of bright lights. Poachers travel alongside the coastline often navigating difficult sea conditions, such as night or bad weather, using high-powered vessels and GPS technology to reach their targeted locations.

Enter targeted TURFs: After closing in the selected TURFs, once the absence of surveillance is verified, poachers enter targeted locations. Through their prior experiences and the inclusion of GPS devices, poachers choose specific diving locations.

Detection at entry: Once suspicious activity is confirmed by TURFs surveillance, a response team could be called into action, comprising navy enforcement officials and, in a few cases, SERNAPESCA officials. When poachers are detected, three main scenarios may unfold. a) Poachers evade contact: in some instances, poachers may escape before direct contact is established, subsequently reassessing their options, such as attempting entry

into alternative locations or exiting unsuccessfully. b) Confrontation by TURFs surveillance team: the TURFs surveillance team may directly confront poachers, potentially leading to a conflict. c) Capture by enforcement team: in the event of a confrontation, a enforcement team may capture the poachers, imposing the respective fines and citations as stipulated in Chilean anti-poaching laws (see BCN, 2018). It is important to note that, at this point, poachers have not legally committed a poaching crime as the collection of locos has not occurred. Consequently, poachers risk minor fines primarily for noncompliance with regulations related to embarking, crew, and equipment licenses and permits.

Instrumental initiation (i.e., Closing-in and approaching the target).

Dive in and location of target: After poachers have reached a diving spot the use of hookah diving equipment and diving lanterns is prevalent. Hookah gear includes a gas-powered air compressor, which delivers a continuous air supply through a hose, extending up to approximately 100 meters (Figures 5B, D). The diving depths typically range between 10 to 25 meters, where loco aggregations are part of rocky shore ecosystems.

Instrumental actualization (i.e., Engaging with the target).

Poaching starts: Poachers employ a variety of specialized tools, including metal hooks, and knives, to detach locos from their rocky habitats (Figure 5C). Upon locating desirable locos, divers place them inside mesh sacs. Once the sacs are full, they are handed off to helper (s), and then pass empty sacs back to the divers, facilitating the seamless continuation of the harvesting process. Interviewees consistently characterize poacher behavior as predatory due to their indiscriminate harvesting practices. Data reveal that TURFs members conducting post-poaching inspections report severe resource depletion. Also, evidence from enforcement seizures reveals that poachers often leave no resource behind, resulting in the capture of undersized locos, For instance, an interviewee mentioned that "SERNAPESCA proceeded to the weighing and counting of the resource, resulting in 160 kilograms of *Concholepas concholepas* meat, totaling 6,292 units, of which 90% were undersized" NEWS-62 (see Supplementary Table 4). Additionally, poachers could engage in multitarget poaching within TURFs. The array of valuable marine products available tempts divers to collect multiple species during their poaching activities, such as sea urchins, octopuses, conger eels and other valuable marine organisms.

Doing (i.e., Carrying out the intended crime).

Harvest: Throughout the operation, the skipper remains vigilant, avoiding the vessel from crossing the divers' hoses and scanning the surroundings for any signs of potential detection, such as on-shore light movements. Once the poachers have successfully cleared an area of loco, the divers emerge from the water. Interviews report that from a single vessel a substantial quantity of up to ~3000 individual loco specimens could be harvested in a single trip. The extraction process can vary in duration, taking anywhere between ~1 to 3 hours, depending on factors such as the crew's efficiency and the abundance of the resource. Castilla et al. (1998)report that resource densities in TURFs areas can result in a capture per unit of effort ranging between 90 up to 540 loco per hour, in contrast of the 20 locos per hour in open access areas (see also, Garmendia et al., 2021). Additionally, total calculated loco poaching could reach 12,600,000 units a year, corresponding to 112% of the national quota during 2017 (Romero et al., 2022).

Reevaluate options (Exit vs. Entry): Poachers assess their level of success. Depending on the outcome, they may opt to repeat the operation, select a different diving spot within the same area, consider entering multiple TURF, or exit and go back. Additionally, poaching parties in our studied locations are often composed of more than one vessel, meaning that often poachers choose to divide their efforts poaching different diving spots and TURFs areas.

Detection at doing: When poachers are detected by TURFs surveillance or Navy patrol teams, two primary scenarios unfold. High-speed pursuit or escape: Typically, a high-speed pursuit ensues, and poachers may manage to escape successfully. Alternatively, upon detection, an enforcement team may be alerted and mobilized either by sea or land. Enforcement response: The Navy team, upon detection, aims to confront poachers and imposes fines and citations for their illegal activities. In response to approaching enforcement, poachers often resort to drastic measures, discarding all evidence overboard. This risky tactic is employed to mitigate the severity of potential fines and punishments they may face. Some poachers may strategically use GPS markers to aid in retrieving evidence later, underscoring the calculated and resourceful nature of their operations. The evidence discarded by the poachers may either remain hidden or be revealed to the authorities. The presence of evidence triggers the enforcement of anti-poaching laws (see BCN, 2018), enabling authorities to take punitive actions against individuals involved in these illegal activities.

Post-condition (i.e., this entails leaving the crime setting or escaping from the crime scene).

Fleeing the crime scene: After successfully carrying out their poaching activities, poachers rely on high-powered vessels to swiftly escape from remote areas. To minimize the risk of detection, they navigate their vessels taking discreet routes that follow the coastal line, ensuring they remain hidden from Navy enforcement.

Concealing the catch: Poachers commonly engage in the practice of peeling shells as a method to maximize loco meat quantity and reduce the load during illegal activities. Poachers may choose to venture into open waters or hidden rocky formations to complete the process of peeling the shells. This practice has significant implications in the illegal trade of loco, affecting the market dynamics.

Disembark: Poachers often make a deliberate choice to disembark before sunrise at informal disembarking sites. The chosen locations typically include secluded beaches, hidden coves, or informal ports, where a co-offender may be waiting with proper transport (i.e., pick-up or truck). Such arrangement facilitates the swift transfer of the illicitly obtained catch and equipment back to their base of operations.

Exit (i.e., The decisions that need to be made post crime commission).

Selling directly to intermediaries: After disembarking, poachers may sell their catch directly to informal intermediaries as part of the illegal trade network. Intermediaries play a crucial role in

transporting, processing, and selling the illegally sourced loco, facilitating the distribution of the product. In this scenario, intermediaries offer a reduced price in cash for the loco, compared to prices of legal landings. By involving intermediaries, poachers mitigate their risk of direct contact with buyers and decrease the likelihood of attracting attention from authorities.

Return to base: Once poachers have successfully exited the crime scene, their next step is to bring their illicit loco catch back to their base of operations. Poachers may establish hidden locations at specific coves and ports or at concealed structures such as informal processing plants. Returning to base poses its own set of challenges and risks, as the poachers must remain vigilant to avoid detection by patrolling law enforcement officials. To minimize the chances of being seen, they may employ tactics such as taking indirect routes or utilizing other strategies to maintain a low profile. The base serves as a hub for storing equipment and preparing for future poaching expeditions.

Cooking, packaging and freezing: Poachers processing their catch typically do so at their base or home operations, utilizing makeshift kitchens and basic storage equipment. In contrast, loco that reach formal processing facilities benefit from advanced equipment, including cold storage rooms. The processing of loco demands skill and knowledge to handle the product properly. Cooking techniques such as cleaning, shucking, boiling, packaging, and freezing are employed to prepare the loco for transportation and marketing. The resulting product is typically packaged, containing around a kilo of the product or approximately 12 units per package.

Selling the product: The issue of loco poaching within Chile's TURFs adds an intricate dimension to the seafood chain within the country. Trade of illegally extracted loco essentially involves a de-facto open market where poachers and other co-offenders can easily sell their product. This problem involves a multifaceted network of individuals including poachers, processors, intermediaries, smugglers, sellers as well as wholesalers, restaurants, and seafood markets. The illegal trade includes distribution to different parts of the country, especially big cities, also involves international connections in the northern part of the country, which implies trading of loco to Peru laundering with the national loco landings and export to Asian countries (see also, González et al., 2006). The multifaceted aspects of the supply chain makes it difficult to ascertain the legitimate source of loco products. On a national level, consumers have little to choose from, demand mainly relies on illegally sourced loco to feed the market as most landing from TURFs end in export (see also, Castilla et al., 2016). Interviews reveal how poachers profit from a single poaching operation could easily exceed the annual revenues of TURFs members. For instance, for example, a successful poaching operation extract up to 3000 units of loco, sell in average from 1 dollar a unit (see Supplementary Table 4). Were the calculated annual losses of TURFs poaching could range between 7.4 to 15.3 million dollars, with an estimated poaching average of 98% of the legal quota (Romero et al., 2022).

Detection at exit: At this point, poachers, intermediaries, and/or other co-offenders could be detected during the processing or sale of the product. Enforcement could identify informal processing plants or black market activities and apprehend offenders, imposing the respective fines and citations outlined in the Chilean anti-poaching laws (see BCN, 2018). Offenders face significant fines and penalties associated with the sale and processing of illegally obtained seafood products.

3.2 Situational crime analysis emerging from the Crime Script analysis

Drawing from the CSA of loco poaching, we identify several key SPC that contribute to TURFs poaching (Figure 4; Table 1). Overall, results unveil the complex interplay and interconnectedness of SPC across CSA different stages, highlighting the multifaceted role of environmental factors in chapping the opportunities leading to poaching loco within TURFs.

Specifically, results reveal that prompt factors play a crucial role in the substantial profitability and effortless marketability of loco poaching. Key contributors are identified by aligning CSA and SPC consist of high rewards, black market, and demand to their direct influence on shaping the motivations and opportunities when analyzing the crime script of loco poaching within TURFs in Chile (i.e., high rewards, black market, and demand). While these factors are interconnected and can influence each other, they each represent distinct components within the Situational Precipitators of Crime framework. The black market provides the means for illegal transactions, demand drives the market forces behind illegal activities, and high rewards incentivize individuals to participate in criminal behavior. Specifically, the significant profits earned by poachers through the sale of their catch within established black market networks are particularly influenced by the national context, where formal loco landings are primarily intended for export. Therefore, illegally sourced locos meet the market demand within Chilean borders. Despite the presence of legal markets, the distinction between legally and illegally obtained locos becomes unclear, creating a *de facto* "open market". This scenario, consequently, streamlines the process for poachers and their partners to market their goods with little resistance.

Analysis shows that permissions factors within the Situational Precipitators of Crime framework are attributed to the facilitation of loco poaching within TURFs in Chile due to their role in creating conducive conditions and removing barriers to illegal activities (i.e., co-enforcement, penalties and regulations, Crowd anonymity, enabling technology, environmental conditions, distance and accessibility, and social norms). Limited co-enforcement, inadequate penalties and regulations, and challenges in enforcing TURFs management contribute to a permissive environment for poachers by allowing them to exploit gaps in surveillance and enforcement efforts. Enforcement of Territorial Use Rights in Fisheries (TURFs) is primarily conducted by Navy patrol teams, occasionally supported by the fisheries service and other institutions, while daily surveillance is handled by TURFs organizations. Despite government support, organizations face challenges due to high surveillance costs associated with technology. This co-enforcement context results in a gap between surveillance and enforcement, providing opportunities for poachers. The utilization of enabling technology by poachers,

10.3389/fmars.2024.1419800

TABLE 1 Summarizes factor analysis from the Situational Precipitators of Crime (SPC) framework.

Precipitators	Factors	Narrative
Prompts, situational factors that make criminal behavior more attractive or feasible (Wortley, 2001),	**High rewards:** Include the financial gains associated with successful loco poaching operations. The potential for significant profits motivates poachers to exploit the lucrative opportunities presented by the black market and demand dynamics.	*Custom and easy money because the areas are taken care of, and we know they have resource.* **POACHER-FB**
	Black market: This factor refers to the existence of an illicit market where illegally obtained locos are sold. It represents an environmental condition that facilitates criminal behavior by offering a channel for the disposal of poached goods. These range from straightforward, direct contacts between sellers and buyers to intricate relationships involving a mix of legal and illegal actors within the market chain.	*Because they have buyers for black abalone and little control from maritime authority.* **TURF-RA**
	Demand: This factor contributes to the motivation for poaching as offenders capitalize on the profitability of meeting this demand. Illegally extracted locos fulfill the market demand within Chilean borders, were consumers have little differentiation capacity between legal or illegal origin of the resource.	*I would dare to say that the domestic market probably has a quantity that is one or two times the amount that is exported. In other words, we could be talking about a level of illegality within that range.* **SUBPESCA-EA**
Permission, factors that weaken or remove the inhibitions or restraints individuals may have against committing a crime (Wortley, 2001)	**Co-enforcement:** This factor relates to the collaboration and coordination among enforcement agencies responsible for regulating and policing TURFs, such as the Navy, fisheries service, TURFs organizations, and other institutions, in enforcing regulations and deterring poaching activities. Inherent challenges create a favorable environment for poachers.	*However, what doesn't happen is that technical agencies within their respective jurisdictions, such as Health and Internal Taxes, take action regarding the detention of resources.* **SUBPESCA-EA.**
	Penalties and regulations: Refer to the legal measures and enforcement mechanisms in place to deter and punish loco poaching. This includes the severity of penalties for poaching offenses, the clarity and enforceability of regulations governing TURFs management, and the consistency in applying these measures. Weak penalties and lax enforcement of regulations can diminish their deterrent effect, thereby contributing to a permissive environment for poachers.	*During the three months of investigation when I was under nighttime house arrest, the police never came to check on me or my brother. You get it?* **POACHER-CH**
	Enabling technology: Encompasses the use of advanced tools and equipment by poachers. This includes geolocation technology, communication devices, navigation equipment, and other tools that enhance the efficiency and effectiveness of poaching operations. The availability and accessibility of such technology can influence the dynamics of loco poaching within TURFs.	*Can you believe they find boats worth twenty five million pesos stealing abalone? A boat with a two hundred and forty horsepower engine. Why? - To outmaneuver the patrol boats.* **EXPERT-CM**
	Crowd anonymity: Refers to the ability of poachers to operate within a group or crowd, thereby reducing the likelihood of individual detection and accountability. Organized poaching parties may exploit anonymity to carry out coordinated and clandestine activities, making it challenging for enforcement agencies to identify and apprehend offenders.	*They don't operate alone; there are two, three boats, and we only have one patrol. What can we do in that situation?* **TURF-JB**
	Distance and accessibility: Relate to the geographical characteristics of TURFs and surrounding areas, including the ease of access to poaching sites and the proximity to enforcement resources. Remote or inaccessible locations may offer sanctuary for poachers to evade detection and prosecution, while areas with limited surveillance coverage may be more susceptible to illegal activities.	*In more remote areas away from the coastline, during the day. Our area, generally, operates at night … and when … when the weather conditions are bad and the port is closed.* **TURF-CC**
	Environmental conditions: Encompass factors such as weather patterns, visibility, and natural obstacles that can affect the feasibility and success of loco poaching operations. Adverse weather or poor visibility may provide cover for poachers, while favorable conditions may facilitate easier access to poaching sites.	*We work the nights, freezing. Sometimes we arrive with our faces covered in frost, just to deliver the merchandise, to make a living.* **POACHER-RM**
	Social norms: Refer to the prevailing attitudes, beliefs, and behaviors within coastal communities regarding loco poaching and TURFs management. Acceptance or tolerance of poaching behaviors among community members can create a culture of impunity and enable the continuation of illegal activities.	*There isn't really a distinction between the illegal and legal ones, you know, because they are, to some extent, the same people. The same legal individuals who can extract resources legally are also the ones involved in illegal extraction; there isn't a clear separation there.* **EXPERT-WS**

(Continued)

TABLE 1 Continued

Precipitators	Factors	Narrative
Provocations, stimuli or events that provoke individuals and increase their motivation or justification for committing a crime. Wortley, 2001).	**Conflicts**: Refer to conflicts among TURFs, commonly known as "TURFs wars", where individuals or groups unlawfully exploit resources within designated TURFs, leading to disputes with those who possess legal rights to those areas. In our case, these conflicts can escalate into violent confrontations, resulting in injuries and even fatalities.	*How do we win this war, this battle? We don't have a crystal ball to say, "okay, we just have to shoot at these guys," but that already creates a war among fishermen, and it has always been said that this shouldn't happen.* **TURF-SH**
	Access to fishing rights: Limited access to resource rights creates a sense of unfairness and inequality among those who are excluded or were left with fewer rights, leading to disputes over resource access.	*I believe that from the moment these management areas were divided; that's when it started, because they began to protect the spaces where the best loco feeding grounds were.* **T URF-AY**.
	TURFs surrender: Poachers take advantage unattended areas. Specifically, due constant poaching TURFs organizations reduce their assets or "cash out" to continue managing the area, by selling their rights to an unapproved party, or by exploiting their resource to extirpation to secure an immediate windfall.	*They opened up areas that are no longer operational here because they tore them apart. They didn't have the resources to continue taking care of it.* **TURF-JC**
Pressures, situational factors that create perceived urgency or necessity for individuals to commit a crime (Wortley, 2001)	**Economic disparity:** Involve the economic struggles faced by fishing communities lead some individuals to turn to poaching as a means of making a living. This includes financial pressures or a sense of limited options to turn on.	*I've had problems here; I've been in jail in Maullín, they've taken away my boats, but I keep on fighting.* **POACHER-RM**

coupled with crowd anonymity, enables sophisticated and coordinated poaching operations, while geographical factors such as distance and accessibility, along with environmental conditions, further enhance the feasibility of illegal activities. Moreover, social norms within coastal communities play a significant role in normalizing and accepting poaching behaviors, perpetuating the permissive environment for loco poaching within TURFs.

On the other hand, conflicts, access to fishing rights, and TURFs surrender are considered provocation factors (i.e., conflicts, access to fishing rights, and TURFs surrender) within the Situational Precipitators of Crime framework when analyzing loco poaching within TURFs in Chile due to their role in exacerbating tensions, fostering perceptions of injustice, and creating opportunities for illegal activities. Limited access to resource rights can generate feelings of unfairness and inequality among excluded individuals, potentially leading to disputes and conflicts over access to valuable resources. The transition from open access to TURFs management systems can provoke fishers to engage in poaching activities as they navigate the changes in resource allocation and management practices. Additionally, conflicts arising from "TURFs wars" further escalate tensions, with unlawful exploitation of resources within designated areas resulting in violent confrontations and potential harm. Furthermore, TURFs surrender issues, where management organizations are forced to relinquish control due to persistent poaching pressures, create opportunities for poachers to exploit vulnerable areas with minimal risk of detection, further exacerbating the problem of loco poaching within TURFs.

Our analysis reveals some pressures trigger fishing communities to engage in poaching inside TURFs (i.e., economic disparity). Economic disparity is considered a pressure factor within the Situational Precipitators of Crime framework when analyzing loco poaching within TURFs in Chile due to its role in exacerbating financial struggles within fishing communities, thereby prompting individuals to resort to poaching as a livelihood strategy.

Finally, to effectively combat loco poaching within TURFs in Chile, it is essential to intersect these SPC with appropriate situational crime prevention strategies (Figure 3). SPC specific factors intersection with SCP strategies reveal how factors should be addressed from the situational crime prevention framework. For instance, prompts factors should be addressed in order to reduce rewards, given that prompt factors are closely related to each other (e.g., high rewards, black market and demand). While permission factors are diverse and have unique characteristics (e.g., co-enforcement; environmental conditions; social norms), and fall at different SCP strategies realms (e.g., increase risk, increase effort and remove excuses) and should be addressed from different angles. On the other side, provocations are closely related to SCP solutions such as providing opportunities and reduce provocations. Finally, pressures factors of economic disparity are closely related to SCP strategies of providing opportunities.

4 Discussion

The phenomenon of loco poaching within Territorial Use Rights for Fisheries (TURFs) in Chile represents a multifaceted challenge that demands comprehensive understanding and targeted intervention strategies. Over the years, numerous studies have delved into the intricacies of poaching within the loco fishery, shedding light on its organized and adaptive nature (e.g., Aburto et al., 2014; (Bandin and Quiñones, 2014; Gelcich et al., 2017; Oyanedel et al., 2017; Brozyna and Walsh, 2019; de Juan et al., 2022; Romero et al., 2022). By employing Crime Script Analysis (CSA) as a methodological lens we provided invaluable insights into the intricacies of TURF poaching. However, understanding the dynamics of criminal behavior goes beyond merely dissecting the sequence of events involved in poaching incidents. In this discussion, we elucidate the critical role of situational

precipitators of crime in influencing poaching behavior within TURFs, ultimately leading to the formulation of effective Situational Crime Prevention (SCP) strategies tailored to address the specific challenges posed by TURF poaching in the loco fishery of Chile.

4.1 Summary and findings from Crime Script Analysis (CSA)

Overall, CSA (Figure 3, Supplementary Table 4) reveals that loco poaching within TURFs in Chile involves a well-organized and adaptive crime, characterized by meticulous planning and strategic execution, involving a variety of specialized players and advanced technology, often found to work in difficult environmental conditions at remote locations, counting for substantial profit for its participants within well-established black market. The process begins with the preparation phase, with poaching crews and co-offenders, consisting of registered artisanal fishers and non-registered individuals, organized into specific roles. Drawing on their extensive knowledge of the geographical terrain, environmental conditions, and employing expert skills alongside counter-surveillance tactics, poachers strategically optimize their operations to evade detection and maximize profit. Target selection is a critical step, guided by factors such as resource productivity, biological cycles, and accessibility, with a focus on areas with higher loco abundance and minimal surveillance presence. Throughout the operation, poachers engage in predatory harvesting practices, depleting loco populations. Despite their efforts to remain undetected, poachers face the risk of being discovered by surveillance teams, which can lead to high-speed pursuits, confrontations, or capture by enforcement authorities. After a successful poaching operation, the illicitly obtained locos are then processed, and distributed through a complex network involving processors, intermediaries, smugglers, and sellers.

4.2 Situational precipitators of crime (SPC)

Our analysis reveals several key SPC that trigger loco poaching within Territorial Use Rights for Fisheries (TURFs) in Chile (Figure 4; Table 1). The transition from CSA to SPC unveils the complex interplay between socioeconomic, regulatory, and environmental factors that shape poaching opportunities. The discussion examines the role and interconnectedness of situational precipitators of crime from an environmental crime perspective. In the case of TURFs poaching, these elements align to increase the likelihood of criminal activity, shaping distinct crime patterns and hotspots, and influencing individuals decision-making processes. For example, the presence of valuable resources (prompt) coupled with economic pressures (pressure), perceived injustices (provocation) and limited co-enforcement (permission) create a powerful incentive for individuals to engage in poaching activities despite legal prohibitions. Which emphasizes how environmental factors, routine activities, offender decision-making, and spatial-temporal distributions collectively influence criminal behavior (Wortley and Townsley, 2017; Andresen, 2020).

Specifically, prompt factors play a significant role in driving poaching opportunities, including high profits, involvement of black market, and substantial demand for the illegally obtained locos. (Figure 4). The economic incentives emerge from the national context, in Chile a significant disconnect between the supply of legally sourced locos and domestic demand has emerged. Despite the existence of legal channels for the sale of locos, the lack of clear differentiation between the two sources has created a *de facto* open market, allowing poachers and co-offenders to operate with relative ease. Similar to other fisheries where legal and illegal products are not differentiated by consumers due seafood fraud practices (Petrossian and Pezzella, 2018; Lawrence et al., 2022; Nahuelhual et al., 2023).When prompts economic incentives align with SPC related factors, individuals are incentivized to engage in poaching within TURFs without fear of repercussions, making poaching an attractive option. For example, when co-enforcement is lax or ineffective, the prompt of potential profits becomes more compelling, reinforcing the permission factor and leading to increased poaching incidents. The draw of quick profits from poaching outweighs the perceived risks of illegal fishing activities (Schmidt, 2005; Ballesteros and Rodríguez-rodríguez, 2019), especially when coupled with the counterbalance situation between poachers and co-enforcement.

The analysis reveals several permission factors triggering TURFs poaching activities (Figure 4). Specifically, the effectiveness of co-enforcement efforts is crucial in understanding poaching incidence. Challenges in co-enforcing efforts at sea create favorable opportunities for poaching activities, as poachers can exploit gaps in surveillance and enforcement. The interplay between co-enforcement efforts, the costs of counter-surveillance strategies, and the profitability of illegal activity determines poaching opportunities (Arias et al., 2021). Advancements in communication and navigation technology have facilitated the coordination and planning of poaching activities within TURFs, making them more efficient and difficult to detect by co-enforcement efforts. The ongoing evolution and adaptation of the counterbalance context between TURFs poachers and co-enforcement underscore the complexity of such dynamics. As well, the prevalence of TURFs poaching is significantly influenced by the existing legal framework and severity of penalties. Interviewers report lenient regulations and insufficient penalties are commonly reported, such as: lack of evidence to prosecute, low fines; restitution of confiscated equipment. For instance, poachers often throw resources overboard to avoid the respective penalties. This emphasizes the pivotal role of the legal framework and associated penalties, highlighting the need for rigorous co-enforcement strategies to combat poaching effectively. Authors advice on stricter regulations and punitive penalties that could act as deterrents, dissuading potential poachers and reducing overall TURFs poaching incidence (Davis et al., 2017; Chávez et al., 2019). However, other authors rise concerns when establishing stricter regulations given a possible backlash response form poachers, as they can assume higher risks (Jentoft and Mikalsen, 2004; Jagers et al., 2012).

In the context of environmental crime, social norms can indeed play a significant role as a permissions factor, influencing individuals perceptions of what is acceptable or permissible behavior within a given social context. While environmental criminologists may not always explicitly consider social norms in their analyses, they are nonetheless a crucial aspect of understanding the situational precipitators of crimes such as TURFs poaching of loco in Chile. These insights align with the normative perspective emphasizing the influence of social norms, morals, and governance legitimacy on fishers' decision-making. For instance, fisher associations characterized by well-functioning TURFs demonstrate higher levels of mutual collaboration among members compared to non-affiliated fishers who lack cooperation and fail to adopt these pro-social norms (Gelcich et al., 2013). The shared norms and understandings within small scale fishing communities facilitate cooperation and mutual support, making it easier for poachers to circumvent regulations and engage in illegal activities (Ballesteros and Rodríguez-Rodríguez, 2018). Social norms within fishing communities may inadvertently provoke poaching behavior by condoning or tacitly accepting illegal practices.

Furthermore, spatial and temporal factors are particularly pertinent concerning permission-related aspects. Temporally, loco TURF poaching on a daily basis largely occurs during nighttime conditions. Seasonally, interviewers indicate how poaching events are closely linked with formal harvest seasons when loco populations are more abundant and during the biological reproductive season when locos aggregate. This aligns with findings from other poaching cases at management areas, where strong daily and weekly patterns have been consistently observed (Pala et al., 2018; Davis and Harasti, 2020; Weekers et al., 2020). Moreover, calm wind and sea conditions have been identified as facilitating increased levels of illegal activities in prior research (Pala et al., 2018; Davis and Harasti, 2020; Weekers et al., 2021). In contrast, our investigation highlights that loco TURF poaching often occurs amidst challenging sea weather conditions, including low temperatures, wind, fog, rain, and darkness. This underscores the adaptability of poachers to adverse environments and suggests a need for tailored enforcement strategies considering these factors.

On the other side, spatial factors. While previous authors have consistently observed a "distance decay" phenomenon surrounding wildlife crime and illegal fishing (Pala et al., 2018; Davis and Harasti, 2020; Weekers et al., 2021), our investigation indicates that poaching operations frequently occur in remote and difficult to reach locations to evade surveillance. We attribute these differences to the more sophisticated and organized nature of loco TURF poaching, in contrast to the recreational or opportunistic nature of the illegal activities examined in previous studies, including other illegal activities occurring around TURFs in Chile.

The spatial and temporal information revealed in our study underscores the importance of strategically redirecting enforcement and surveillance efforts to effectively combat poaching. Conversely, inadequate enforcement of management rules, combined with the spatial and temporal dispersion of fishing activities, emerges as a critical factor facilitating high levels of illegal fishing, as highlighted by Cavole et al. (2015). This emphasizes the necessity for targeted and adaptive enforcement strategies to address the complexities of loco TURF poaching and mitigate its detrimental effects on marine ecosystems and local communities.

On the other side, pressures, encompassing socio-economic constraints individuals face, can drive them toward poaching activities as a coping mechanism, particularly economic pressures like poverty. unemployment or limit livelihood opportunities (Arias et al., 2015; Nahuelhual et al., 2020; Lunstrum and Givá, 2020; Fabinyi, 2021). The prioritization of economic pressure frequently overrides ethical considerations, leading individuals to poaching within TURFs. Although a well-established legal framework and stringent penalties could deter potential poachers, in reality, regulations are lenient and penalties are insufficient, allowing poaching activities to persist despite the potential risks. Similarly, provocations, including historical allocation of fishing rights in the TURFs system in Chile can evoke feelings of resentment and injustice (Gelcich et al., 2013; Hauck and Gallardo-Fernández, 2013; Santis and Chávez, 2015; Nahuelhual et al., 2023), further incentivizing individuals toward poaching as a form of retaliation or economic survival. Disputes over limited access to resource rights serve as a significant provocation, sparking conflicts among excluded individuals who often choose to relay on poaching. resulting even in TURFs abandonment (i.e., TURFs surrender) by fishers organizations (Gelcich et al., 2017). Provocations and pressures synergize to create conditions conducive to poaching. Disputes over resource access rights or perceived injustices within fishing communities drive individuals to seek alternative livelihoods, including poaching (Hauck, 2011; Hauck and Gallardo-Fernández, 2013). Economic pressures, such as poverty or lack of employment opportunities, exacerbate these tensions, leading to a normalization of poaching behavior as a means of addressing shared economic hardships. Furthermore, the interconnection between provocations and pressures reinforces social norms as permission factor by normalizing poaching activities and reducing the perceived social stigma associated with such behavior.

Understanding these collaborative dynamics among SPC is crucial for developing comprehensive SCP strategies tailored to address TURF poaching challenges in Chile's loco fishery. Targeting these precipitators can disrupt conditions conducive to poaching and promote sustainable practices in TURF-managed fisheries.

4.4 Situational crime prevention (SCP)

To effectively combat TURFs poaching, various strategies can be employed. By elucidating the underlying precipitators from the crime script, we are better equipped to develop targeted interventions aimed at disrupting the conditions conducive to poaching TURFs (Figure 4).

Increasing effort essentially involves making the commission of the crime more difficult (Clarke, 1983, 1997). Increasing poaching effort would make poaching more resource-intensive, requiring more time, advanced equipment, or a higher number of people involved to find suitable places and conditions for their operations. Particularly, targeting permission-related elements such as

increasing patrolling efforts in areas where loco is more abundant, or at difficult to reach locations, and/or during specific environmental conditions (e.g., at night), aligns with the need for improved surveillance (see, increase risk). For instance, environmental conditions during patrols (e.g., at night; bad weather), as they influence the preparatory behaviors of potential offenders (Weekers et al., 2021). Additionally, legal measures can be employed to make poaching challenging, such as control access, strengthening TURF zoning laws can restrict unauthorized fishing vessels, particularly during specific hours. Similar measures are common when managing sea activities, such as closing ports and prohibiting navigation during adverse weather conditions.

Increasing the risk aims on detection and punishment for potential offenders (Clarke, 1983, 1997). In the context of TURFs poaching in Chile, the identified weaknesses in co-enforcement capabilities allow poachers to easily evade detection. Regulatory compliance literature advocates for reinforcing punitive structures through tactics like concentrated patrols, legal frameworks, and punitive measures (Nielsen and Meilby, 2013; Weekers et al., 2019; Oyanedel et al., 2020; Delpech et al., 2021). Improving co-enforcement has proven highly effective in combating TURFs poaching in certain cases (Chávez et al., 2019). However, concerns exist regarding potential backlash from poachers and the reluctance of distant fishers to participate in surveillance (Davis et al., 2015). The SERNAPESCA Modernization Law Project (Law n° 21132–2019) has strengthened Chilean anti-poaching measures by categorizing illegal fishing, processing, or commercialization of marine resources as criminal activities with sanctions ranging from fines to imprisonment. While this measure is an improvement to discourage poaching participation. Our suggestion is to prioritize the improvement of co-enforcement efforts at the TURFs system level, rather than focusing on individual TURF-specific solutions. It is essential to consider differences among preferred hot spots and temporalities among various poaching activities, accounting for opportunistic versus organized poaching and the specific features of the targeted resource, to plan interventions effectively. Authors strongly recommend to develop collaboration between state agencies and stakeholders in order to carry on such interventions and reduce poaching effectively (Petrossian et al., 2018; Kiruba-Sankar et al., 2019; Moutopoulos et al., 2020; Weekers et al., 2020). As well, the use of remote sensing technology, automated systems that detect and record poaching activities could centralize surveillance efforts and increase the risk for poachers (de Leeuw et al., 2010; Madin et al., 2019; Shao et al., 2021; Cope et al., 2023). While initial investments may seem costly, considering the significant investments TURFs organizations have already made in surveillance. Ongoing pilot projects using cameras are enhancing enforcement capabilities and providing court evidence (Oyanedel et al., 2017). With the availability of more affordable technology, additional opportunities may arise to support TURFs against outsider poaching.

Reducing rewards targets potential gains for poachers (Clarke, 1983, 1997). In our case, prompts along with permissions factors facilitates poachers' potential gains. Specifically, among prompts factors, resource demand acts as an important catalyst between the black market and high rewards. Disrupting market demand for illegally sourced locos by implementing measures to disrupt the market could significantly reduce poachers rewards and weaken black market incentives. In particular, most legally extracted loco is used for export, which results in illegally sourced loco subsidizing domestic consumption, establishing undesirable practices including the purchasing of illegal seafood and mislabeling (Haye et al., 2012; Nahuelhual et al., 2018; Colihueque et al., 2019). Aligned with the anti-trade viewpoint, there's a belief that seafood exportation negatively impacts food security and the economic prospects of local communities (Kent, 1997; Abila, 2003; Béné et al., 2010). This provides an opportunity to encourage domestic market to address the catalytic behavior of demand for high incentives and black market opportunities for illegally sourced locos. In our case, improving collaboration between enforcement, health, and tax agencies toward combating poaching could add decrease rewards along the value chain. Also, embracing traceability measures, such as tagging locos, requiring documentation, and monitoring markets for illegal sales would tightens control over the seafood trade, promoting social responsibility through the fair exchange of information from producers to consumers (Bailey et al., 2016; Young, 2016; Gelcich et al., 2017; Lewis and Boyle, 2017; Petrossian and Pezzella, 2018). In the same sense, regulating intermediaries is crucial to reduce poachers' trade opportunities and potential rewards, impacting also consumers and fishers dealing with illegal practices (Oyanedel et al., 2017; Nahuelhual et al., 2018). As well, reducing poachers rewards may involve increasing the cost of poaching (Delpech et al., 2021). As observed in this study, poachers' operational tactics constantly evolve due to investments in enabling technology, creating a counter-balance situation with co-enforcement efforts implemented by law enforcement and TURFs surveillance. Therefore, to further reduce poachers' rewards, enforcement efforts should effectively remove, confiscate, or destroy poachers' equipment, discouraging their participation in future poaching activities. Finally, we propose tailoring compliance messages to communities linked to specific local awareness areas where resources are often traded. This aligns with wildlife poaching research, where targeting bush meat sales and imposing market fines have proven more effective than hunting measures (Clayton et al., 1997; Damania et al., 2005).

Reducing provocations involves addressing environmental triggers that may encourage criminal behavior (Clarke, 1983, 1997). Provocations, such as access challenges and resource conflicts, significantly contribute to the perpetuation of poaching activities. In the context of TURFs poaching, historical perceptions of regulatory stringency, fairness, and legitimacy have been closely associated with illegal activities (Hauck and Gallardo-Fernández, 2013; Nahuelhual et al., 2023). Conflicts often arise among resource users in the form of TURFs wars, stemming from the historical allocation of access rights, which has left some organizations with less productive areas. Therefore, implementing measures to alleviate these provocations is essential. This could involve enhancing access to legal fishing grounds through improved spatial planning and stakeholder engagement, as well as addressing underlying conflicts over resource allocation through transparent and inclusive

decision-making processes. By addressing these provocations, stakeholders can create an environment conducive to lawful and sustainable fishing practices within TURFs, ultimately contributing to the effective management of marine resources and the mitigation of poaching activities (see also remove excuses).

Remove excuses focuses on removing justifications potential offenders might use to rationalize criminal actions (Clarke, 1983, 1997). When excuses are eliminated, individuals are more likely to self-regulate their behavior, reducing reliance on external enforcement mechanisms. According to Benson and Madensen (2007), removing possible excuses will prevent offenders from being able to neutralize feelings of guilt or shame. Considering that small scale fishers in Chile are often willing to meet group expectations toward poaching activities (Vallejos et al., 2023). By bolstering fishers' social norms, which are shaped by norms, morals, and legitimacy, we can positively influence fishers' decision-making processes (Sutinen and Kuperan, 1999; Gezelius, 2002; Nielsen and Mathiesen, 2003; Gezelius et al., 2011; Oyanedel et al., 2020). For example, certain small-scale fisheries in Norway and Newfoundland maintain high compliance rates without rigorous formal enforcement due to informal sanctions rooted in shared moral judgments within fishing communities (Gezelius, 2002, 2007). Excuses can be removed by setting clear rules and by giving guidance, instructions, and compliance assistance. For instance, tailoring compliance messages to different offender groups and guardians (Weekers and Zahnow, 2019). Furthermore, Van Erp (2013) suggest publicity sanction strategies, such as the disclosure of offenders identity, press releases that generate negative publicity for offenders, explaining the harm done to the environment and the fishery, or the public requirement to repair the environmental damage. By promoting a culture of ethical behavior and emphasizing the negative repercussions of poaching, we can foster a sense of responsibility and accountability among fishers, thereby reducing the incidence of illegal activities. Ultimately, by addressing the underlying motivations and justifications for poaching through a combination of educational initiatives, social reinforcement, and enforcement measures, we can effectively combat poaching and promote sustainable fisheries management practices.

Provide opportunities emphasizes creating alternatives that deter individuals from engaging in criminal activities (Freilich and Newman, 2014). In our case, addressing opportunities involves addressing both limited access and economic disparity. Improving the socioeconomic status of communities engaged in poaching is vital for reducing illegal activities (FAO, 2022). However, pursuing new opportunities within the fisheries sector poses challenges, particularly due to historical fisheries rights-based policies (Jentoft et al., 2017; Tam et al., 2018; Partelow et al., 2020; Lebedef and Chambers, 2023). For instance, the history of TURFs and resource rights allocation in Chile has limited pathways, especially for late registrants, especially women (Gelcich et al., 2005; Gallardo-Fernández and Saunders, 2018; Nahuelhual et al., 2019, 2023). Furthermore, TURFs internal regulations, imposing membership requirements and restricting access rights within TURFs organizations create barriers for new entrants, ultimately limiting opportunities for participation. To address conflicts and fostering opportunities for legal fishing activities potential solutions should focus on establishing clear and equitable fishing rights, ensuring fairness in TURF allocation and access, and promoting inclusive and sustainable fishing systems among small scale fishers. Additionally, alternative livelihoods, including training and support other activities such as aquaculture, sustainable fishing practices, or tourism-related endeavors, can be explored. It is crucial to note that these measures may impact new or opportunistic poachers rather than more organized individuals dependent on illegal activities.

As we consider the implications of our proposed Situational Crime Prevention (SCP) strategies, it's essential to reflect on the broader management and policy implications. By carefully balancing between restrictive and inclusive measures, we can effectively combat TURF poaching while mitigating potential negative consequences.

4.5 Management and policy implications

As we consider future of anti-poaching strategies around TURFs, uncertainties emerge concerning the balance between restrictive and inclusive measures. Stricter policies may lead to undesirable consequences, such as the evolution toward "green militarization" context (Lunstrum, 2013; Annecke and Masubelele, 2016; Gaynor et al., 2016; Mogomotsi and Madigele, 2017; Jones, 2021; Corkeron, 2023). In the Chilean TURF poaching case, armed security forces, cutting-edge technology, and fishermen's involvement in monitoring indicate a degree of "green militarization" characterized by the presence of weapons, violence, and injuries, exacerbating the issue. Despite its documented counter productivity and negative impact on social and ecological conservation efforts (Duffy, 2014; Witter, 2021), concerns persist about erosion of community trust, increased social conflict, and potential environmental damage by the implementation of poaching solutions.

When implementing solutions, management agencies should carefully allocate anti-poaching efforts to avoid counterproductive responses. Wortley (1998) distinguishes SCP strategies into "soft" and "hard" measures. Soft approaches aim to change the perception of poaching as an acceptable activity, addressing socio-economic pressures and creating alternative legal avenues. These measures include reducing rewards associated with poaching through trade regulations and traceability, enhancing fairness and transparency in law enforcement to remove excuses (Wortley, 1998; Cornish and Clarke, 2003). On the other hand, hard measures directly deter and prevent TURFs poaching by increasing effort, risk, and costs. Strategies include increasing patrolling efforts, utilizing remote sensing technology, and confiscating poachers equipment. These measures make the commission of the crime more difficult and resource-intensive, increasing the likelihood of apprehension and punishment for potential offenders. In the context of loco poaching within TURFs, the choice between soft and hard measures depends on specific circumstances of the crime and offender characteristics. Determined offenders may require a primary focus on hard opportunity-reduction strategies, strengthening security and

enforcement measures. However, situations may arise where both hard and soft approaches are necessary, working as complementary elements of a comprehensive crime prevention strategy. This complexity requires a nuanced and adaptable approach to address specific needs and motivations of offenders while safeguarding TURFs from illegal exploitation.

Our discussion critically reflects on the limitations of our study, acknowledging the inherent challenges of conducting research in clandestine and often dangerous environments. We propose paths for future research to address these limitations. Research opportunities lie in exploring specific socioeconomic factors driving individuals to engage in poaching, understanding temporal and spatial patterns of poaching activity, and assessing the effectiveness of both soft and hard crime prevention strategies. Furthermore, exploring the dynamics among different stakeholders involved in the loco resource trade and evaluating potential counterproductive effects of prevention measures are crucial aspects. Cross-disciplinary collaboration, cooperation, and temporal and spatial studies tracking changes in poaching patterns over time offer valuable avenues for addressing the complex issue of TURFs poaching effectively.

5 Conclusions

This study meticulously analyzed the process of loco poaching within a Territorial Use Rights for Fisheries (TURFs) system, providing a comprehensive understanding of the crime. While previous research has delved into TURFs poaching, our study stands out as the first to employ a crime analytical technique, allowing for a detailed breakdown of the crime-committing process into specific steps, factors, and potential solutions.

Crime Script Analysis reveal that TURFs poaching is both well-organized and adaptive, involving specialized actors, advanced technology, a well-established black market, and substantial profits for participants. Understanding the crime script emphasizes the necessity for nuanced interventions to effectively address the multifaceted nature of the crime.

The study highlights the collaborative nature of Situational Precipitators of Crime, particularly between provocations and pressures, and between prompts and permissions. This collaborative dynamic legitimizes and facilitates poaching activities, underscoring the need for multifaceted interventions.

The study reveals the necessity of a multi-faceted approach to reduce TURFs poaching, considering the relationship between restrictive and inclusive measures to avoid potential negative consequences addressing the specific needs and motivations of offenders when dealing with the implementation of Situational Crime Prevention strategies.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material. Further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by El Comité Ético Científico en Investigación con Seres Humanos/Universidad Austral de Chile. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

TV: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Software, Validation, Visualization, Writing – original draft, Writing – review & editing. LN: Conceptualization, Funding acquisition, Project administration, Supervision, Validation, Writing – review & editing. SG: Conceptualization, Resources, Supervision, Validation, Writing – review & editing. RO: Conceptualization, Supervision, Validation, Writing – review & editing.

Funding

The author(s) declare financial support was received for the research, authorship, and/or publication of this article. We thank the financial support of the following agencies and grants: FONDAP 15150003; Millennium Science Initiative Program ICN 2019–015, ANID/PIA BASAL FB0002, FONDECYT 1190207 and ANID doctoral funding program.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fmars.2024.1419800/full#supplementary-material

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