

This article was downloaded by: [University of Saskatchewan Library]

On: 03 January 2015, At: 10:56

Publisher: Taylor & Francis

Informa Ltd Registered in England and Wales Registered Number: 1072954 Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK



North American Journal of Fisheries Management

Publication details, including instructions for authors and subscription information:

<http://www.tandfonline.com/loi/ujfm20>

Fishers' Reasons for Poaching Abalone (Haliotidae): A Study in the Baja California Peninsula, Mexico

Ricardo Bórquez Reyes ^a, Oscar Alberto Pombo ^b & Germán Ponce Díaz ^c

^a Departamento de Biología Marina, Universidad Autónoma de Baja California Sur, Carretera al Sur Km 5.5, La Paz, Baja California Sur 23080, México

^b Colegio de la Frontera Norte, Km 18.5 Carretera Escénica Tijuana-Ensenada, San Antonio del Mar, Tijuana, Baja California 22560, México

^c Centro de Investigaciones Biológicas del Noroeste, and Centro Interdisciplinario de Ciencias Marinas, Instituto Politécnico Nacional, Apartado Postal 128, La Paz, Baja California Sur 23090, México

Published online: 08 Jan 2011.

To cite this article: Ricardo Bórquez Reyes, Oscar Alberto Pombo & Germán Ponce Díaz (2009) Fishers' Reasons for Poaching Abalone (Haliotidae): A Study in the Baja California Peninsula, Mexico, North American Journal of Fisheries Management, 29:1, 237-244, DOI: [10.1577/M06-032.1](https://doi.org/10.1577/M06-032.1)

To link to this article: <http://dx.doi.org/10.1577/M06-032.1>

PLEASE SCROLL DOWN FOR ARTICLE

Taylor & Francis makes every effort to ensure the accuracy of all the information (the "Content") contained in the publications on our platform. However, Taylor & Francis, our agents, and our licensors make no representations or warranties whatsoever as to the accuracy, completeness, or suitability for any purpose of the Content. Any opinions and views expressed in this publication are the opinions and views of the authors, and are not the views of or endorsed by Taylor & Francis. The accuracy of the Content should not be relied upon and should be independently verified with primary sources of information. Taylor and Francis shall not be liable for any losses, actions, claims, proceedings, demands, costs, expenses, damages, and other liabilities whatsoever or howsoever caused arising directly or indirectly in connection with, in relation to or arising out of the use of the Content.

This article may be used for research, teaching, and private study purposes. Any substantial or systematic reproduction, redistribution, reselling, loan, sub-licensing, systematic supply, or distribution in any form to anyone is expressly forbidden. Terms & Conditions of access and use can be found at <http://www.tandfonline.com/page/terms-and-conditions>

Fishers' Reasons for Poaching Abalone (*Haliotidae*): a Study in the Baja California Peninsula, Mexico

RICARDO BÓRQUEZ REYES

*Departamento de Biología Marina, Universidad Autónoma de Baja California Sur,
Carretera al Sur Km 5.5, La Paz, Baja California Sur 23080, México*

OSCAR ALBERTO POMBO

*Colegio de la Frontera Norte, Km 18.5 Carretera Escénica Tijuana-Ensenada,
San Antonio del Mar, Tijuana, Baja California 22560, México*

GERMÁN PONCE DÍAZ*

*Centro de Investigaciones Biológicas del Noroeste, and Centro Interdisciplinario de Ciencias Marinas,
Instituto Politécnico Nacional, Apartado Postal 128, La Paz, Baja California Sur 23090, México*

Abstract.—Although Mexico has a well-established legal framework regulating fisheries for the green abalone *Haliotis fulgens* and pink abalone *H. corrugata*, there is empirical evidence about a sizeable abalone black market and substantial sectors of fishing communities dedicated to poaching. An investigation was conducted about abalone poaching in a bay located off the Baja California Peninsula, Mexico. The main objective was to determine how poaching is perceived by abalone fishermen, particularly the attitudes of legal and illegal fishing groups and the factors that determine their perception of poaching. Abalone fishermen's perceptions and attitudes about poaching seem to be conditioned by a small number of factors that were identified through a discriminant analysis (e.g., deep-seated practices and knowledge about abalone fisheries; between-group violence; and the likelihood that a given poaching work day will fail due to capture by authorities, confrontation by legal fishermen, or insufficient abalone harvest). This investigation provides an indirect exploration of the abalone poaching phenomenon and the factors underlying this practice.

Our work is based on an investigation conducted in a bay located off the Baja California Peninsula, Mexico, from Punta Malcomb (south of San Ignacio lagoon) to the Arroyo El Conejo. In this area, abalone (*Haliotidae*) is harvested by three cooperatives founded in 1953, 1959, and 1969 (Vega-Velázquez et al. 1996). The main species, the green abalone *Haliotis fulgens* and pink abalone *H. corrugata*, contribute 4–10% of the total abalone harvest (by weight) along the Baja California Peninsula (León-Carballo and Muciño-Díaz 1996). The abalone is canned locally and then exported to the main market, Asia. For several years, the cooperatives in the peninsula fished under 1-year renewable licenses, but in recent times they were given 20-year licenses, at the end of which the performance of each cooperative will be reviewed to assess the convenience of license renewal.

The cooperatives in the study area struggle to comply with the fishing law and government provisions, including seasonal closures and harvest quotas. However, other cooperatives established in the northern part of the Baja California Peninsula show a greater

willingness to (1) control their members' activities (i.e., including their commitment to land the catch at the cooperative rather than selling it in the black market); (2) invest in important measures to discourage, fight, and monitor abalone poaching; and (3) provide unique social security benefits, including health care, retirement, and loans.

In general, the actions we take in relation to a specific phenomenon are based on our perception of that phenomenon, and the perception does not necessarily coincide with objective reality. The perceptions of two fishermen groups impacted by the poaching of green and pink abalones (cooperative members, referred to as cooperativists; and independent fishermen, referred to as libres fishermen) were analyzed to determine how the issue is perceived by each group and the factors contributing to or restraining illegal activities. For purposes of this investigation, fishermen were considered to be libres if they did not belong to any fishing cooperative. For the present analysis, we define perception as the mental process that organizes and interprets information gathered through the senses and that is characterized by being subjective, selective, and temporary; attitude is defined as the mental willingness—learned and structured by personal experienc-

* Corresponding author: gponce04@cibnor.mx

Received January 30, 2006; accepted November 28, 2007
Published online March 9, 2009

es—that triggers specific reactions of the individual toward specific situations, persons, or things.

Legal Framework for Abalone Harvesting

The history of the abalone fishery in Mexico is closely related to the settlement of fishing communities in the Baja California Peninsula's northwestern region. Production of abalone, mainly the green abalone and pink abalone, generates at least 20,000 direct and indirect jobs across the peninsula's four harvest zones or regions. Currently, 22 cooperatives own a license to harvest abalone. According to data published in the 2003 Annual Fishing Statistics (CNAP 2003a), the annual legal harvest during the early 2000s fluctuated around 500 metric tons (wet weight)/year; this production level is less than half that recorded at the beginning of the 1990s. The situation is aggravated by the lack of information about poaching (CNAP 2003b). Some sources claim that abalone poaching in Mexico accounts for as much as 550 metric tons/year (Gordon and Cook 2004). Abalone poaching leads to social, economic, and ecological problems. From the social standpoint, poaching creates conflicts between fishermen groups (libres fishermen and cooperativists), who have different perceptions about fishing rights and poaching, and conflicts among libres fishermen, who are excluded from licenses controlled by cooperatives and therefore are not allowed to harvest abalone.

Fishery management by the government and the federal administration has undergone many changes, including a reduction in infrastructure and staff, throughout the past three decades. To a great extent, the administrative responsibility to enforce the abalone fishing regulations lies with the National Aquaculture and Fishing Commission (Comisión Nacional de Acuacultura y Pesca [CONAPESCA]), the government agency responsible for the administration, regulation, and development of fisheries; the use, management, and conservation of fishing resources; and the development of aquaculture (DOF 2001). Among other responsibilities, the Ministry of the Environment and Natural Resources (Secretaría de Medio Ambiente y Recursos Naturales [SEMARNAT]) exerts an indirect control of fisheries, since it administers, regulates, and promotes the sustainable use of all of the country's natural resources except for oil and radioactive minerals.

In 2000, the functions of fisheries inspection and monitoring were transferred from SEMARNAT's Federal Attorney for Environmental Protection (Procuraduría Federal de Protección al Ambiente [PROFEPA]) to CONAPESCA, the government agency that controls fishing licenses, permits, and authorizations, despite the fact that the human and material resources

available to carry out this task are extremely limited. To support compliance with fishing rules, other government agencies, including the Ministry of the Navy, the Federal Attorney General's Office, the Federal Preventive Police, and other local police forces (judicial or ministerial forces of the States of the Mexican Republic), may aid in enforcing the provisions set forth in the Mexican Fishing Law, particularly regarding the sanctions included in it.

Over the past three federal administrations, the management and administration of fishing affairs have shifted from the ministry-of-state level to the under-ministry level and finally to the current commission level (i.e., CONAPESCA). This change has led to a significant reduction in infrastructure and staff allocated to the fisheries sector, resulting in adverse consequences for the production, promotion, commercialization, and monitoring issues related to the country's fishing and aquaculture resources and thus contributing to illegal fishing.

Fisheries Law Enforcement

There are a number of regulations aimed at protecting the marine flora and fauna by regulating fishing activities, which also provides a reasonably good legal structure for managing marine resources. There is a legal structure that regulates how, when, where, and who can harvest abalone (Mexican Fishing Law articles 4–8, 10, 11, 16–19, and 22–29; Mexican Official Standards 005-PESC-1993; Federal Penal Code 420 II Bis), but the regulations are virtually ignored. As with other fisheries (Anderson 1989; Sutinen et al. 1990), this is related to the limited number of enforcement staff available to monitor a huge coastline and is compounded by the lack of infrastructure and by other factors related to the federal and state jurisdictions. Abalone poaching has reached a high level of concern given its negative impact on the resource's status and on the economic and social situation of those fishing organizations that operate in compliance with the law.

Another factor that affects poaching is the perception that the most affected persons have about this issue. Studies of affected parties' perceptions in relation to the worldwide problem of abalone poaching (e.g., Tailby and Grant 2002; Gordon and Cook 2004) and illegal fishing (McCay 1981; Kuperan and Sutinen 1998) are scarce. Thus, we conducted this investigation with the aim of characterizing the knowledge about poaching in this specific geographical area.

The investigation's main question was the extent to which abalone poaching is affected by behaviors (perceptions and attitudes) of the different groups of

TABLE 1.—Factors that explain the perceptions and attitudes toward abalone poaching for both cooperative members (cooperativists; legal fishing group) and independent (libres) fishermen (illegal fishing group) operating in a bay off the western coast of the Baja California Peninsula, Mexico (+ = positive relationship with the given factor; – = negative relationship with the factor).

Factor	Variables
(1) Deep-seated practices and knowledge about abalone fisheries	Fisher type (cooperativists or libres fishermen) + poaching frequency by libres fishermen – factors promoting poaching
(2) Between-group violence	Amount of illegal noncooperative boats + higher risk of poaching – behavior of cooperativists toward poachers
(3) Likelihood of failure of an abalone poaching work day	Risk that a poacher will be caught by authorities – frequency with which a poacher is caught in practice

fishermen who harvest abalone and by the conflicts they face in accessing the fishery.

Methods

This work is based on an investigation conducted in a bay located to the south of the Baja California Peninsula's western coast. The data were collected through interviews and questionnaires administered during June 2004 in one of the main harbors in the bay. That harbor had a population of 3,900 inhabitants (INEGI 2000) dedicated mostly to fishing, government posts, teaching, and small businesses. Twenty-seven key informants were interviewed, 10 of whom were cooperativists and 17 of whom were libres fishermen. Interviews lasted between 50 and 60 min, were based on a semistructured questionnaire, and asked for information about poaching logistics.

In this case, the 17 libres fishermen (these fishers represented most of abalone poachers at the bay) mentioned that they had harvested abalone illegally at least once and also could have conducted poaching repeatedly in other abalone fishing areas along the peninsula. The interviewed cooperativists belonged to a 60-member society that was granted a license to harvest abalone in the bay. Snowball sampling was used for contacting the informants.

A first sampling design was elaborated based on the

knowledge of one of the authors, who had lived in the study area for 15 years, which allowed him to identify the first persons or “seeds” (Salganik and Heckathorn 2004) that provided information about the network structure and operation. Once the informants were contacted, they helped to develop a reliable sample that, by the end of the study, included the majority of illegal fishermen of the libres group.

Variables such as fisherman type (cooperativists or libres fishermen), poaching frequency by libres fishermen, factors promoting poaching, poaching risk, and others (see Tables 1–3) were reduced to identify a small number of factors to account for the phenomenon. The libres fishermen and cooperativists were analyzed by exploring a number of variables allocated to each group. Two structured questionnaires were designed, one for each group. Variables common to both groups were identified, and similarities between answers from both groups in relation to poaching were analyzed. Furthermore, perceptions and attitudes of each group's members were identified and explored. A discriminant analysis was carried out using the principal components extraction technique (Johnson 2000; Darren and Mallery 2003).

Details on the correlation analysis and selection of variables are included in Bórquez (2004).

TABLE 2.—Factors that explain the perceptions and attitudes toward abalone poaching for cooperative members (cooperativists; legal fishing group) operating in a bay off the western coast of the Baja California Peninsula, Mexico (libres fishermen = illegal fishing group; + = positive relationship with the given factor; – = negative relationship with the factor).

Factor	Variables
(1) Advantage in favor of libres fishermen	Reasons underlying poaching + how they learn about changes in fishing regulations – likelihood that poachers will be arrested by authorities – frequency with which poachers are caught
(2) Competition between groups for poaching	Portion of harvest not delivered to the cooperative + cooperative boats not reporting the total harvest + how they learn about changes in fishing regulations + reasons underlying poaching – how a fisherman became a cooperativist – number of noncooperative boats fishing illegally
(3) Cooperativists' individuality	How deliveries to the cooperative are recorded + higher risk associated with poaching – frequency with which poachers are caught
(4) Taking the law into one's own hands	Behavior of cooperativists toward libres fishermen – how cooperativists perceive the punishment for poachers

TABLE 3.—Factors that explain the perceptions and attitudes toward abalone poaching for independent (libres) fishermen (illegal fishing group) operating in a bay off the western coast of the Baja California Peninsula, Mexico (cooperativists = legal fishing group; + = positive relationship with the given factor; - = negative relationship with the factor).

Factor	Variables
(1) Failure–success balance of the working day	Number of noncooperative boats associated with poaching + higher risk associated with poaching - behavior of cooperativists toward poachers
(2) Family pressure and justice	Poaching frequency by libres fishermen + reasons underlying poaching + unfair fishing regulations as to fishing rights allocation
(3) Earnings-sanctioned balance	Factors promoting poaching + likelihood that authorities will arrest poachers - importance given to poaching as an issue
(4) Profitability	Number of persons per boat - factors underlying poaching
(5) Probability of success	Risk that authorities will arrest a poacher - amount harvested per working day

Results

General Factors

We first describe the common grounds for the two fishermen groups. The principal components analysis identified three common factors (Table 1) that accounted for 73% of the total variability in the phenomenon studied for members of both groups.

Members of cooperativist and libres groups are influenced by deep-seated practices and knowledge about abalone fisheries (Table 1, factor 1). Cooperativists have a long-term familiarity with a specific fishing area. They have been granted an exclusive license for harvesting abalone in a highly productive area. They fish abalone legally and have lived in the area for 50 years. These fishermen display highly protective behavior toward their fishing rights within what they call “their” territory. They harvest and protect a resource that is licensed to them and their families by the government. They perceive libres fishermen as a true danger to their ability to sustain their families; they also perceive that through their cooperative, they must control this danger by any means available, including the use of violence.

On the other hand, a large number of libres fishermen across the region (according to the current cooperative’s president, there are at least 14 illegal abalone fishing teams working every day) have been poaching abalone for years. For some families, abalone poaching has been a way of living for four decades. Their deep-seated practices and knowledge contribute to the likelihood of success of abalone poaching. Libres fishermen make good use of their knowledge of both fishing and the territory; their boats are well suited for escaping immediately if needed, and the fishers know each possible escape route in case they are caught by surprise. Libres fishermen know the cooperative’s resources very well; the cooperative monitoring team’s logbook is no longer a secret.

Between-group violence is another factor (Table 1, factor 2) influencing abalone poaching, although it is perceived, exerted, and supported in different ways by

each group. For cooperativist fishermen, violence is a resource used to discourage poaching. It is a means to punish libres fishermen caught on site; cooperativists’ actions are supported by the whole team of cooperative members at all times, which leads to defense of what they perceive as their rights. In this way, they are always ready to tackle the issue if needed. In most occasions, the use of violence against libres fishermen represents the only means cooperativists have to protect both their resource and their territory. In fact, only one or two government officials are appointed to controlling poaching in this bay, although it is one of the largest bays in the country.

For their part, libres fishermen perceive between-group violence as one of the risks they must face while poaching abalone; they try to avoid it by all means possible. This difference in approach means that confrontations between the groups most often favor cooperativists. In some way, libres fishermen are passive actors in such confrontations. They try to minimize the risk of failure, and their strategy consists of escaping from the scene and avoiding confrontation. Some persons have been killed during abalone poaching. Sometimes cooperativists attack libres fishermen, resulting in death; occasionally, libres fishermen cut the air hoses of their own divers during the process of escape. Libres fishermen and cooperativists always have something to lose.

The likelihood of failure for any given day of poaching work is another factor (Table 1, factor 3) that affects abalone poaching. Both groups perceive that the likelihood of any government authority catching a libres fisherman is low; furthermore, they both estimate that confrontations between authorities and libres fishermen involve a low risk for the latter. If we imagine a poaching scenario in which only libres fishermen and authorities exist, the likelihood of poaching failure would be virtually zero. However, the scenario is drastically transformed by the monitoring done by cooperativists, who increase the poaching day’s probability of failure. Cooperativists perceive

Downloaded by [University of Saskatchewan Library] at 10:56 03 January 2015

that authorities responsible for the resource are inefficient; therefore, they take measures to increase the likelihood that libres fishermen will be caught.

Fisher Groups

Each group of fishermen was analyzed separately. The members of each group interviewed have their own perceptions and attitudes towards abalone poaching. The factors influencing these perceptions and attitudes in relation to abalone poaching are described below.

Cooperative Members

Based on the principal components analysis, four factors were found to account for 76% of the total variation in the data for cooperativists (Table 2).

Advantage in Favor of Libres Fishermen

Cooperativists estimate that libres fishermen (1) carry out their illegal activities while being sheltered by the scarcity and inefficiency of official monitoring in the fishing area and (2) have only a vague knowledge of the regulations. As a result of the legality under which they operate, cooperative members are better informed about any changes in the legislation regulating abalone fisheries. In practice, this translates into a disadvantage relative to the libres fishermen group, given that the practices of cooperative members are regulated by a changing legal framework, which requires them to adhere to specific shell sizes, fishing quotas, and seasons that are not respected by poachers.

Competition between Groups for Poaching

Cooperativists and libres fishermen share much more than the use of a common fishing zone and an exploited resource; they compete in a highly profitable market, and it seems that they also share a similar ambition for improving their economic income. Generally, abalone is sold to Ocean Garden, Inc., which supervises the canning process for trading in the Asian markets. Abalone that is obtained illegally in this zone is primarily sold fresh (unprocessed) in the regional market or can be canned and sent to the export market. Cooperative members deliver their legally extracted product to the cooperative, where it is processed (cooked and canned) and sold to a distributor that places the final product mainly in the international market. In addition, according to the fishermen, there are several dealers that buy illegally harvested abalone and either sell it to processing plants for whitening (selling as a legal product) or market it frozen in the local market and abroad.

In the black market, 1 kg of abalone sells at about MXN\$400 (pesos), whereas the cooperative pays its

members \$200.00/kg. Therefore, cooperativists and libres fishermen share a similar motivation to poach abalone and sell it in the black market. However, cooperative fishermen have incentives to comply with their commitment to deliver their abalone harvest to the cooperative; such incentives include collective benefits and advantages, such as the license itself and access to economic funds and social security (Ponce-Díaz et al. 1998). A sort of social capital is generated within the group, enabling members to reduce any specific efforts to attain their individual and group objectives. On the other hand, subtracting a portion of the catch delivered to the cooperative and diverting this portion to the black market enable the cooperative members to get a higher income relative to that obtained from delivering the total harvest to the cooperative.

Individuality of Cooperative Members

Although cooperativists are an active part of a well-defined social structure, they keep a certain quota of individuality, granting them freedom of movement beyond the limits of power and scope of the organization to which they belong. This individuality is expressed in the decision each member makes about dealing with poachers, given that at least formally, the cooperative does not endorse any illicit actions taken against other nonmember fishers.

However, cooperative members are individuals, more than simply the cells of a social body. They perceive poaching in a personal way. Each individual possesses a personality that is unrepeatable in others; the individual thinks, acts, and creates awareness about his acts based on personified environmental stimuli generated in a personal environment. However, the individual does not do so in an isolated way; he does not act alone or keep his awareness to himself. The individual transmits, receives, and repeats data that translate into information; information that translates into perception; perception that generates attitudes; attitudes that deliver individual benefits and lead to social and environmental costs; benefits that respond to interests; and interests that induce individuals to act as members of a given group.

Taking the Law into One's Own Hands

Some cooperativists face violent confrontation with poachers caught within the licensed fishing zone. Although there is a regulatory framework that specifies the sanctions applicable to those who violate the legal provisions in fishing matters, the cooperativists estimate that the punishments are so inadequate, the offenders violate the law again almost immediately after the most recent punishment has been applied. Consequently, it would seem that cooperativists seek

more-effective methods to discourage abalone poaching. As a result, the history of abalone fishery in the region has been characterized by violence between groups, despite the fact that most often cooperativists and libres fishermen are part of the same social networks, having attended the same school during childhood.

Libres Fishermen

Five factors (Table 3) were extracted to account for nearly 85% of the total variation associated with abalone poaching among the libres fishermen.

Balance between Failure and Success in the Working Day

The factor with the highest weight on libres fishermen's perception of and attitude about abalone poaching is the balance between the likelihood of failure and success in an illegal operation, which is reflected in the decision of whether or not to poach in any given day. From a libres fisherman's perspective, this is the major factor that defines poaching. For a libres fisherman, failure of a work day may occur when there is an increased likelihood of occurrence of at least three situations beyond the fisher's control: (1) capture by the authorities and subsequent judgment and sanctions; (2) confrontation by any of the abalone cooperativist teams, which can lead to violence by both parties; and (3) failure to harvest a minimum amount of abalone. Consequently, when the estimated likelihood of poaching day failure is higher than the estimated probability of success, the activity is no longer attractive for poachers. If the opposite occurs, poaching takes place, although a number of factors influence this decision in practice.

Family Pressure and Sense of Justice

Although it is true that the libres fisherman acknowledges the existence of abalone fishing regulations, it is also true that the fisher poaches abalone as a result of the pressure exerted by family needs. Family pressure is therefore a stimulus for the fisherman to violate the fishing regulations. The libres fisherman perceives that it is unfair when fishing rights are granted to only some, rather than all, residents of fishing towns. From the fisherman's standpoint, family needs are more legitimate than the legal framework itself.

Earnings-Sanctioned Balance

Although poachers acknowledge that abalone poaching is a serious issue, their perception about it differs considerably from that of cooperativists, given that part of the seriousness is attributed to the libres fishermen's

vulnerability to actions by third parties. On the other hand, for libres fishermen, the likelihood that the benefit of earnings will exceed the cost of sanctions is generally a stimulus for their activity, since they estimate that the earnings derived from poaching are far higher than any sanctions that would be applied if they are caught and arrested by authorities.

Profitability

Being a profitable activity, abalone poaching is perceived as one of the best sources of income for poachers. The profitability of abalone poaching is a factor that stimulates the persistence of poachers in this activity. Only three persons are required on a crew for poaching, and abalone prices in the black market are extremely high, resulting in an income that is well above the income reportedly derived from the poaching of other species.

Probability of Success before Capture by Authorities

The probability of abalone poaching success is a factor with a significant influence on fishermen's perceptions of poaching. The low risk of being caught by authorities and the harvest volume per working day are elements that make abalone poaching a highly appealing activity. Although there are other perceived and actual elements of risk for a libres fisherman, the likelihood of success is relatively high, given that the fisher estimates that capture or arrest by authorities during poaching is unlikely. Closely related to the likelihood of success in relation to the risk of capture by authorities is the fishermen's perceived safety while poaching abalone. Although the main perceived risks are capture by authorities and confrontation with cooperativists, the low estimated frequency of capture enables the libres fishermen to broaden the safety margin for carrying out their poaching activities.

Discussion

Although poaching is a part of the reality of abalone fisheries in the region, it is far from being easily understood and known in detail. This study is the first effort to increase knowledge of the reasons for abalone poaching.

On the one hand, there is the group of illegal libres fishermen. The basis of their behavior rests on the balance between success and failure of their poaching sessions, for which they have developed a *sui generis* typology of risks, threats, opportunities, and strengths to which they allocate intuitive values, enabling them to determine the overall probability of success. Libres fishermen have poached for decades on these grounds. Cooperativist fishermen face an issue that becomes harder to solve with time: abalone yields are plummet-

ing to levels that compromise the fishery's sustainability in the zone. Regardless of the weight of factors influencing the decline in abalone productivity, any current phenomenon (either social or natural) that contributes to the reduction of abalone biomass (even to a minimum extent) is regarded as a threat to the maintenance of a traditional way of living for an important number of fishers and their families living in the bay.

The methodology proposed and applied in this investigation represents a feasible method for analyzing the perceptions and attitudes of the involved parties, making it a valuable tool for increasing our understanding of illegal fishing despite the lack quantitative data on the occurrence, costs, and benefits of poaching incidents. Moreover, principal component analysis, similar to other statistical analyses, has limited value with small sample sizes. The correlation coefficients tend to be less reliable when estimated for small populations, which can be a limitation in the present analysis due to the relatively small number of abalone fishermen in the region. Nonetheless, this study has large potential value for decision makers and policy makers.

The perceptions of parties involved in social phenomena are hard to analyze through conventional quantitative methodologies. The importance of evaluating perceptions lies in allowing one to identify a critical area, determined by the intersection of the factors analyzed, that may guide the authorities in the implementation of more-effective measures to control abalone poaching. In addition to the urgency of reinforcing the inspection and monitoring activities along the littoral areas where abalone harvesting takes place, follow-up is required throughout the various stages in the black market.

One of the largest tasks faced by the government in matters of preserving a threatened resource like abalone is to reach a consensus among all parties involved in the resource's exploitation. The corrective and repressive actions implemented to date have failed to discourage poaching of abalone and other highly profitable species. Although the affected social, public, and private entities interact in a unique environment-reality scenario, the way members of each group perceive such reality differs. The understanding of individual paradigms by actors through research like this may permit development and implementation of the ability to solve an issue that is becoming more complex with time (Hauck and Sweijd 1999).

Acknowledgments

We thank the Consejo Nacional de Ciencia y Tecnología (CONACYT) and the Colegio de la

Frontera Norte for institutional and financial resources given to partially support the research. Support for G.P.D. was provided by SEMARNAT-CONACYT (Grant 2004-C01-0153) and CONACYT Instituto Politécnico Nacional (Agreement D.A.A.J. I100/029/06 MOD-ORD-33-05 PCI-090-01-06). G.P.D. thanks EDI and COFAA scholarship. We are extremely grateful to the anonymous reviewers, whose revisions and suggestions improved this paper.

References

- Anderson, G. L. 1989. Enforcement issues in selecting fisheries management policy. *Marine Resource Economics* 6:261-277.
- Bórquez, R. R. 2004. Perception and attitudes of the abalone fishermen with respect to the abalone illegal fishing; Bahía Magdalena, México. Master's thesis. El Colegio de la Frontera Norte, Tijuana, México.
- CNAP (Comisión Nacional de Acuacultura y Pesca). 2003a. Anuario estadístico de pesca. [Statistical yearbook of fishing.] CNAP, Mexico, D.F.
- CNAP (Comisión Nacional de Acuacultura y Pesca). 2003b. Estudio de la cadena productiva de abulón. [Study of productive chain of abalone.] CNAP, Centro de Investigaciones Biológicas del Noroeste and Banco Nacional de Comercio Exterior, La Paz, Baja California Sur, Mexico.
- Darren, G., and P. Mallery. 2003. SPSS for windows step by step. Pearson, Boston.
- DOF (Diario Oficial de la Federación). 2001. DECRETO por el que se crea la Comisión Nacional de Acuacultura y Pesca. 5 de junio del 2001. [Decree that creates the National Commission on Aquaculture and Fisheries. June 5, 2001.] México, D.F.
- DOF (Diario Oficial de la Federación). 2007. Ley general de pesca y acuicultura sustentable. 24 de Julio de 2007. [General law on sustainable fisheries and aquaculture. July 24, 2007.] DOF, Mexico, D.F.
- Gordon, R. H., and P. A. Cook. 2004. World abalone fisheries and aquaculture update: supply and market dynamics. *Journal of Shellfish Research* 23:935-939.
- Hauck, M., and N. A. Sweijd. 1999. A case study of abalone poaching in South Africa and its impact on fisheries management. *ICES Journal of Marine Science* 56:1024-1032.
- INEGI (Instituto Nacional de Estadística, Geografía e Informática). 2000. Censo general de población. [General population census.] INEGI, Aguascalientes, Mexico.
- Johnson, D. E. 2000. Métodos multivariados aplicados al análisis de datos. [Applied multivariate methods for data analysis.] Thomson International, México, D.F.
- Kuperan, K., and J. G. Sutinen. 1998. Blue water crime: legitimacy, deterrence and compliance in fisheries. *Law and Society Review* 32:309-338.
- León-Carballo, G., and M. Muciño-Díaz. 1996. Pesquería de abulón. [Abalone fishery.] Pages 14-41 in M. Casas-Valdez and G. Ponce-Díaz, editors. Estudio del potencial pesquero y acuícola de Baja California Sur. [Study of aquaculture and fishing potential in Baja California Sur.]

- Ministry of Environment, Natural Resources and Fisheries and State Government of Baja California Sur, La Paz.
- McCay, B. 1981. Optimal foragers or political actors? Ecological analyses of a New Jersey fishery. *American Ethnologist* 8:356–382.
- Ponce-Díaz, G., A. Vega-Velázquez, M. Ramade-Villanueva, G. León-Carballo, and R. Franco-Santiago. 1998. Socioeconomic characteristics of the abalone fishery along the west coast of Baja California Peninsula, Mexico. *Journal of Shellfish Research* 17:853–857.
- Salganik, M. J., and D. D. Heckathorn. 2004. Sampling and estimation in hidden populations using respondent-driven sampling. *Sociological Methodology* 34:193–239.
- Sutinen, J. G., A. Rieser, and J. R. Gauvin. 1990. Measuring and explaining noncompliance in federally managed fisheries. *Ocean Development and International Law* 21:335–372.
- Tailby, R., and F. Grant. 2002. The illegal market in Australian abalone: trends and issues in crime and criminal justice. *Australian Institute of Criminology* 225:1–6.
- Vega-Velázquez, G., G. Espinoza-Castro, and C. Gómez-Rojo. 1996. Pesquería de langosta *Panulirus* spp. [Lobster fishery (*Panulirus* spp.)] Pages 227–261 in M. Casas-Valdez and G. Ponce-Díaz, editors. Estudio del potencial pesquero y acuícola de Baja California Sur. [Study of aquaculture and fishing potential in Baja California Sur.] Ministry of Environment, Natural Resources and Fisheries and State Government of Baja California Sur, La Paz.