

Winter is coming: a study of poaching motives and scenario-based modelling of population changes in wild abalone populations in the Eastern Cape, South Africa

I. Introduction

● *Ecological Role of Abalone*

Abalone, a sizeable mollusk that is consumed as food in various parts of the world, also have a relatively significant role in marine ecosystem, as the competitor with sea urchins. While the excessive latter have a potential threat to the macroalgae ecosystem. Sea urchins are an important taxon with regard to community structure on many temperate reef systems where abalone are found. Fluctuations in the abundance of urchins in many areas leads to alternating ecosystem states between ‘barrens’ dominated by urchins and crustose coralline algae, and kelp dominated systems (Tegner and Dayton 2000). Sea urchins and abalone co-occur in reef ecosystems in the North Pacific, Australasia and South Africa (Tegner and Dayton 2000). Abalone and sea urchins are potential competitors for food because both feed on drift algae (Lowry and Pearse 1973). However, sea urchins have a greater potential to modify reef ecosystems because they also graze directly on macroalgae (Andrew and Underwood 1993). Meanwhile, research have proved that macroalgae as the primary producer in marine ecosystem, have much more vital structural functions compared with the drift algae. Macroalgae are distributed in marine habitats from polar to tropical latitudes and from intertidal shores to the deepest reaches of the euphotic zone. These algae play critical ecological roles including being key to a range of invertebrate recruitment processes, functioning as autogenic ecosystem engineers through provision of three-dimensional habitat structure, as well as contributing critical structural strength in coral reef ecosystems (Macreadie et al., 2017). Calcified macroalgae contribute significantly to the deposition of carbonates in coastal environments (Nelson, 2009).

Besides, juvenile abalone may be a major component of the diet of certain species, for example, the banded morwong, *Cheilodactylus spectabilis* (Jenkins, 2004). Some species like whelk *Haustrum baileyannum* may even specialize their diet on abalone. This whelk bores through abalone shells at the muscle attachment site and has not been found to prey on any other species (Thomas and Day, 1995).

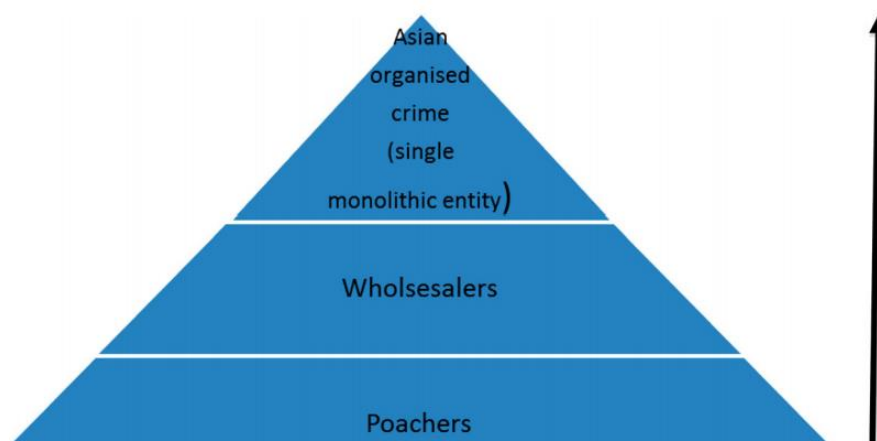
● *The Motivation for Poaching: Abalone as an Ingredient*

Apart from its ecological role, abalone is believed to have a range of health benefits within the scope of Chinese traditional medicine, including improving circulation, enhancing immunity, and promoting longevity. It is widely believed that abalone possesses remarkable therapeutic properties, which make it an effective remedy for a variety of illness such as respiratory diseases, liver and kidney disorders, and arthritis. Apart from its cultural and medicinal significance, abalone is also highly sought-after in Asian cuisine. The culinary versatility of abalone, which can be prepared through various cooking methods such as stir-frying, braising, and grilling, has contributed to its cultural significance and perceived health benefits in Asian markets. However, the high demand for this delicacy has also led to illegal harvesting and trade (Steinberg, 2005).

The South African abalone species *Haliotis midae* is an established top-quality product in the Asian market due to its unique flavor, texture, and size. Such local species of abalone has

been heavily depleted in the Cape region of South Africa since commercial harvesting began in the late 1940s. In an effort to curb overexploitation, the strategy called seasonal quotas were introduced to the domestic abalone aquaculture system in the year of 1968; however, weakened border controls in the 1980s enabled foreign criminal organizations to enter the country and engage in poaching, which escalated into a highly organized and illicit industry in the 1990s (Goga, 2014). To safeguard the Cape region, the Cape Town Table Mountain National Park was established in 1998, followed by the declaration of smaller sanctuaries within the park as restricted zones in 2004, where fishing is prohibited (Brill and Raemaekers, 2013). Yet this prohibition has been a subject of controversy as local communities who have relied on fishing for their livelihood for centuries are often impoverished. The banning of legal fishery industry, to some extent, may potentially intensify the black industry of illegal wild abalone poaching with the participation of desperate local impoverished fisher communities as the underlying actors.

According to the relevant research, abalone syndicate usually constitutes hierarchy of individuals with varying functions (De Greef, 2013). The hierarchy comprises three layers; large organized syndicates, wholesalers and poachers. At the top of the hierarchy are the nationwide syndicates who export the poached abalone to the Far East. These syndicates are said to be run by Chinese triads (Dabrowski et al., 2017). Wholesalers form the second layer of the hierarchy. Wholesalers purchase de-shelled abalone from poachers and sell it to the larger syndicate. At the bottom of the hierarchy are the poachers who poach and sell abalone to middlemen. The cessation of fishing as a result of the establishment of the reserve, and the widespread poverty, has somehow spurred local community residents in the Eastern Cape to join the poaching syndicate as poachers at the lowest level, and has since rounded out the entire transnational criminal chain. The process could be speculated from the existed research on other poaching-existing areas (Reyes et al., 2009).



Poaching institution hierarchy (De Greef, 2013)

● ***Abalone Aquaculture and Aqua tourism***

In South Africa, aquaculture has been recognized as a pivotal economic sector and employment cluster. A range of policies, plans and initiatives have been formulated and implemented to facilitate the development of the aquaculture industry. Several key initiatives have been established to support the development of the aquaculture industry, including the National Aquaculture Strategic Framework (NASF), the Aquaculture Development and

Enhancement Program (ADEP), and the Phakisa initiative. The primary objectives of these policies, plans, and initiatives are to accelerate the growth of the aquaculture sector so that it can play a pivotal role in supplying fish products both domestically and internationally, contributing to employment opportunities and enhancing national economic development. Additionally, this sector has been identified as a key industry capable of influencing rural community and township development and reindustrialization in the South (UE, 2018).

Until now, aqua tourism has been considered a traditional form of tourism in coastal and water-rich regions. However, it is an emerging concept that is still being studied in the field of tourism science, thus the potential added value of aqua tourism remains debatable. However, studies have confirmed the potential benefits of aqua tourism for biodiversity conservation and urban development. Aqua tourism can provide job opportunities for local residents and promote infrastructure development (Bartwal et al., 2013). The latest version of Eastern Cape's final strategic plan explicitly calls for the development of aqua tourism based on diving and wild abalone fishing in the Eastern Cape (Eastern Cape, 2019). According to a study conducted in the Bitumen Bearing Wetlands of Ondo State, Nigeria, the development of aqua tourism has played a crucial role in protecting the local wild fish population. Additionally, significant government funding has been allocated towards ensuring an adequate supply of pearl grouper - an endemic flagship species - and ultimately safeguarding its local population size (Akeredolu & Ayoola, 2010). Therefore, it is plausible that the promotion of aqua tourism in South Africa could yield similar conservation benefits for indigenous abalone species.

II. Problem Statement

In South Africa, abalone poaching is a highly profitable environmental crime (De Greef 2013). In contrast to rhino poaching, for example, it is arguably a crime "without a face," therefore, media campaigns, funders, and scholars draw far less attention to the issue. There are only several environmental associations undertake the majority of the scientific and targeted study on abalone poaching, and abalone, as a commodity is usually only listed as one of several endangered species. Statistics show that levels of abalone poaching are at their highest since 2003, and it was claimed in February 2016 that the South African government is losing the battle against the practice (Nkalane 2016). This is a sign that the state is unable to effectively manage the resource and fight crime.

Abalone is not considered to be an illegal good in Asian nations, which is a problem at the core of wildlife crime. Additionally, it makes it nearly impossible to prosecute anyone found in possession of abalone once it reaches Asian coasts and makes cross-border collaboration between enforcement authorities more challenging (N. A. Sweijd, 2017). Abalone grows slowly; it often takes four to five years for it to reach the size needed for commercial harvest (Lafarga de la Cruz & Gallardo-Escárate, 2011).

Wild abalone off the coast of South Africa are on the verge of extinction due to the widening gap between maturity and procreation (as the abalone are illegally harvested too early) as well as other environmental pressures, with levels estimated to be at 8% of pristine levels in 2011—the level required to sustain the organism (Macleod 2011).

Currently, in South Africa, there are only 300 valid commercial license holders who are only permitted to take out 150 tons of abalone annually. It is understood that it is quite challenging to give precise information on the quantity of abalone stolen. A wildlife trade monitoring group assessed the illicit extraction during 2012 at about 1200 tons (Roelf 2014), which means that illegal fishing surpass 10 times the legal total permissible catch. Estimates of the extent of the poaching business appear feasible when one considers that 58 tons of

abalone were seized in 2012 (News24,2013) and that abalone seizures and confiscations represent a small portion of the entire value of abalone trafficking. The Department of Agriculture, Forestry and Fisheries (DAFF) made the surprising revelation in early 2016 that more than 7 million abalone were poached in 2014, with an estimated worth of 1 billion Rand each year. In China, abalone, along with dried sea cucumbers and fish maw, and is sold for over \$90 per pound (Lambrechts & Goga, 2016). Over the past 25 years, according to the non-governmental organization TRAFFIC, up till now, which monitors illegal wildlife trade, a consortium supported by Chinese nationals has illegally transported more than 55,000 tons of South African abalone to Hong Kong, the core of the industry (De Greef & Raemaekers, 2021). This quantity has almost destroyed South Africa's legal abalone fishery, and the local abalone population structure.

Poaching is in fact an international problem that signifies transnational illicit crime and black industry collaboration, and therefore far from accurate results that can be obtained from a targeted study of one single location, South Africa (Gehring & Ruffing, 2008). In addition, the widespread poaching in South Africa is also linked to complex political issues such as the country's disparity between rich and poor, the prevalence of racism due to mass immigration, and the deep-rooted nature of the grey industry, so poaching should be considered in the context of the divisions over international cooperation and the wider and more complex political and livelihood factors within the country (Huang, 2018).

III. Research goals

Although a number of actions taken by the South African government have contributed to some degree to the recovery of wild abalone populations, such as captive breeding, establishment of protected areas, and anti-poaching campaigns, these actions have been ineffective on the one hand, and were largely based on economic rather than ecological considerations in the first place, and most of them are still in their infancy and far from mature (Wagner & Engel, 2021; Overberg District Municipality, 2018; Ivy, 2021). To better guide subsequent conservation efforts for wild abalone populations, and due to the opaqueness and lag of available data, it is imperative to estimate the abalone population size. This study aims to establish a more up-to-date database of wild abalone populations by evaluating the existing abalone population, and to predict the development of abalone population based on both the potential developing route based on abalone population in the future and a primitive data simulated through the database. Thus, the project mainly embraces two goals:

1. Estimate and calculate the wild abalone data in the Eastern Cape to form an annual database.
2. Model to estimate the effectiveness of the future development of abalone aqua culture and aqua tourism, and the direct ban on poaching for wild abalone conservation.

IV. Methodology

● *Research region, the Eastern Cape, South Africa*

To streamline the research and enhance its focus, this project has selected Eastern Cape, South Africa as the regional subject of study. The region boasts a rich history of abalone fishing, which has been a crucial source of livelihood for local communities in the past (DEFF, 2020). Moreover, the Eastern Cape has never had a viable commercial abalone fishery due to the fragmented and discontinuous distribution patterns and abundance of abalone, which are not sufficient for commercial exploitation according to marine resource managers (Raemaekers & Britz, 2009). These two factors have resulted in local fishermen being unable to legally

sustain their livelihoods through abalone fishing, leading them to resort to participating in wild abalone poaching syndicates. Furthermore, as the West Cape has already conducted a more comprehensive research series due to its well-established abalone industry, there has been limited investigation in the Eastern Cape (Van, 2022). Therefore, this study is innovative in



exploring the obscure poaching issue and underlying improvement measures.

Map of Eastern Cape, South Africa. (DAFF, 2016)

- ***Data source for the establishment of abalone population model in Eastern Cape, South Africa***

In this study, it was first necessary to model the abalone population change. The variation was built on two dimensions: population abundance and mean size. Natural disturbances were excluded from consideration because of their unpredictability. Population size fluctuations due to poaching were mainly considered. Changes in abalone population density and mean size removed from the original data related to abalone targeting the Eastern Cape. Abalone poaching results in the removal of abalone from the marine ecosystem with shell lengths greater than a certain value, and therefore the average size of the abalone decreases, along with a decrease in abalone population density. The average density was multiplied by the shoreline area to obtain the total number of abalone in the Eastern Cape. By coupling the reproductive rate into the equation, we can obtain the equation for the change in the total number of abalone, and then coupling the abalone shell growth rate to obtain the change in the average shell length of abalone. The annual average South African abalone poaching numbers will be estimated by subtracting the global abalone imports from the South African legal abalone production, and due to the unavailability of data, we cannot directly know the number of poached abalone in

the Eastern Cape. The Eastern Cape poaching numbers will be calculated here by multiplying the total South African poaching numbers by the ratio of Eastern Cape abalone poaching confiscations to national abalone poaching confiscations. Data sources will be listed below:

Average annual average individual shell length of abalone in South Africa, from DAFF(<https://www.daff.gov.za/>) and DFFE (<https://www.dffe.gov.za/>).

Abalone population reproduction rate, from Cape Town Marine Resource Assessment, 2020.

Density of abalone along the Eastern Cape coast, from Warren, 2016.

Eastern Cape coastline area scale, from Warren, 2016.

Average annual growth rate of abalone (degree of shell variation), from Warren, 2016.

Total global imports of abalone from South Africa, from import data of main abalone importing countries¹.

Eastern Cape abalone poaching confiscations. from State Security Agency of South Africa (SSA) (<https://www.ssa.gov.za>)

South Africa Abalone poaching confiscations, from State Security Agency of South Africa (SSA) (<https://www.ssa.gov.za>)

South African legal abalone production, from DAFF(<https://www.daff.gov.za/>) and DFFE (<https://www.ssa.gov.za>).

● ***Scenario Establishment based on aquaculture, aqua tourism, and direct ban***

Future conservation efforts based on wild abalone populations will be proposed in two ways: alternative industries and direct poaching bans. According to the available literature and the future development plans of the South African Department of Agriculture, the alternative industries are mainly focused on aquaculture and abalone aqua tourism (Wagner & Engel, 2021). statistical tools were used to predict the biological impact of alternative industries and direct poaching bans on abalone populations in the Eastern Cape. In this step, several different scenarios need to be created to estimate the sensitivity of abalone populations to different instruments. The variables are focused on three areas:

- The degree of development of abalone aquaculture,
- The degree of development of tourism,

¹ China: China Customs, Statistical Information Service; http://www.eiahk.com/consult_e.html

Hong Kong, SAR: Hong Kong Trade Development Council (HKTDC); http://bso.hktdc.com/bso/jsp/bso_home.jsp

Japan: Japan Customs, Ministry of Finance; www.customs.go.jp/toukei/info/index_e.htm

Macau, SAR: Macau external merchandise trade statistics database; <http://www.dsec.gov.mo/NCEM.aspx?lang=en-US>

Malaysia: Department of Statistics Malaysia; <http://www.statistics.gov.my>

Singapore: International Enterprise Singapore; <http://www.singstat.gov.sg/statistics/browse-by-theme/trade>

Taiwan, ROC: Bureau of Foreign Trade – Trade Statistics; <http://eweb.trade.gov.tw>

- The degree of improvement of poaching.

These three conservation approaches would be considered as having theoretical mathematic influence on the wild abalone number. Their principle is as follow:

- Aquaculture would have the potential to reduce total poaching and adequately maintain wild abalone populations.
- tourism abalone fishing would lead to an acceptable range of abalone fishing behavior while more strongly reducing poaching yields, with improvements in poaching directly reducing poaching levels.
- Direct poaching ban eliminate the poaching as human disturbance to wild abalone species.

Scenarios must take into account the actual patterns, for example tourism must match the increased level of poaching, as good security is the basis for the development of tourism. Through which way the number of scenario type decreases as well.

V. Expected Results

According to the expected results, without intervention, abalone populations in the Eastern Cape will be drastically reduced in size due to poaching-induced overfishing and eventually extinct in the wild due to the Allee effect, ocean acidification, etc. A certain amount of intervention may not necessarily contribute to the recovery of wild abalone populations, and comprehensive and stringent poaching regulations must be implemented to completely eliminate abalone poaching. Both the aquaculture and aqua tourism industries can alleviate the abalone population to a certain extent, but on the one hand, the aquaculture industry may have long investment cycles and low competitiveness due to its late start, so it needs to be supported by the central government to enhance the attractiveness of free capital investment (Oakes & Ponte, 1996). The tourism industry also has a protective role. On the one hand, tourism development based on tourist abalone fishing signifies that abalone has become a regional flagship species of global concern, and on the other hand, tourist abalone fishing is an industry with much higher added value than wild abalone fishing alone. However, there are also hidden environmental threats to the tourism industry. Unregulated aqua tourism can lead to more serious problems of man-made environmental pollution and species invasion than poaching, and can even cause significant damage to the entire marine ecosystem in the Eastern Cape (du Rand, 2006). At the same time, tourist abalone fishing must be based on a certain population size, and a more scientific population monitoring and strict rationing system should be adopted to maintain the stability of the abalone population and prevent it from collapsing due to a small population size.

Both approaches have a positive impact on the well-being of coastal residents. Both aquaculture and tourism are labor-intensive industries that can contribute significantly to employment and alleviate the problem of coastal residents' livelihoods due to depleted fisheries resources. Aquaculture and tourism provide an effective way to transform communities. But at the same time, a corresponding crackdown on poacher syndicates should also be on the agenda in order to destroy the ground for crime and provide a better and safer living and working environment for residents. Therefore, in addition to proposing a central regulatory support policy based on aquaculture and aqua tourism, the establishment of a tight anti-poaching security system to safeguard the development of a legal abalone industry in the Eastern Cape community will also be proposed, both in terms of domestic construction and international

cooperation.

VI. Implications and Significance

The three main objectives of this study were to provide a method of data enumeration for poached species that are under-appreciated and difficult to count using biological methods, and to create a regionally representative database of wild abalone. The database will allow a better understanding of the population dynamics of wild abalone populations. Such a universal approach could be equally applicable to other poached species that are regionally significant but often not valued worldwide (e.g. birds of paradise as pets). Secondly, based on the structure of poaching syndicates, the methodology of documentary and empirical analysis is used upstream and downstream, respectively, to delve into the motivations and reasons for the difficulty of curbing poaching in South Africa, and to synthesize the corresponding convincing conclusions. Such a discussion of the motivations for poaching and the patterns of international cooperation could help to institutionalize the future development of South Africa and lead to better international anti-poaching action. Thirdly, it provides data-based predictive advice on the way forward, using different scenario simulations to observe the sensitivity of wild abalone populations to different variables in order to determine the best way to protect abalone.

VII. Reference

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