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Troubling the Waters: Gendered Dispossession, Violence, and Sea Cucumber Aquaculture in Madagascar

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ABSTRACT

Poverty reduction and fisheries management in Madagascar have converged on the marine seascape, directed at an unassuming creature: the sea cucumber. In southwestern Madagascar, the enclosure of what was once a common pool resource has led to violence and new gendered seascapes. This form of blue grabbing, promoted by private companies and NGOs alike as an avenue to achieve conservation and develop coastal economies, has fundamentally restructured property relations and who benefits from marine resources. Sea cucumber pens, established in some areas with the input of a narrow local elite and guarded at times by the police have become high risk environments where fishers report injury and death, pointing to important questions about the metrics and means of sustainable production in the marine realm, and whose interests and access to marine resources are prioritized.

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Blue-grabbing; enclosure; fisheries; Madagascar; political ecology

scrutinizing

a sea cucumber, we see both

demon and saint

(youku mireba, oni mo bosatsu mo, namako kana)

-Jinen (in Gill 2003 p 102, 368)

Introduction

Marine resource management has garnered a great deal of interest and funding globally due to a rise in concern over declining fisheries production and the degradation or loss of marine biodiversity (Burke et al. 2011; Pauly and Zeller 2016). Spatially-focused approaches such as marine protected areas (MPAs) and nearshore marine aquaculture have become globally dominant strategies endorsed by governmental and non-governmental organizations to help sustain fisheries production and reduce fishing pressure on wild fish (Gaines et al. 2010; Laffoley et al. 2019; Topor et al. 2019; Naylor et al. 2021;

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FAO 2020). Aquaculture constitutes 49% of the global production of aquatic animals and now accounts for a larger global share in sale value than capture fisheries (FAO 2022). There has been a three-fold increase in aquaculture production in the past two decades, accompanied by a broad expansion of coastal area dedicated to aquaculture (FAO 2022; Campbell and Pauly 2013; Gentry et al. 2017; Belton et al. 2020). While a growing engine of the economy globally, aquaculture has a suite of negative local social and ecological impacts that include pollution, the spread of disease and parasites, deforestation for aquaculture pens and more (Naylor et al. 2021).

As of 2010, 69% of sea cucumber fisheries were labeled in FAO reports as over-exploited and 81% have declined in resource abundance due to overfishing (Anderson et al. 2011; Bennett and Basurto 2018). Sea cucumber management efforts have turned to moratoriums as well as a suite of other management techniques such as protected areas and chiefly aquaculture (Purcell 2010a; Grenier 2013). Currently, the global sea cucumber fishery is a multi-billion dollar industry involving nearly every coastal country of the world (World Fishing and Aquaculture 2019; UN Comtrade 2023).

Aquaculture, like sequestering carbon, developing wild caught fisheries, developing offshore renewable energy, and deep-sea mining, is a core facet of the burgeoning blue economy. Marine aquaculture is deemed a win-win form of “blue growth” by a large array of bilateral and multilateral investment and aid organizations, however, is also critiqued by numerous scholars and community groups as a form of “ocean/blue grabbing” (Childs and Hicks 2019; Chuenpagdee et al. 2022). Blue grabbing is defined as “actions, policies or initiatives that deprive small-scale fishers of resources, dispossess vulnerable populations of coastal lands, and/or undermine historical access to areas of the sea” (Bennett, Govan, and Satterfield 2015). The growth of marine aquaculture has had enormous direct and indirect effects on marine commons. Blue grabbing is a form of “accumulation by dispossession,” in which commonly held spaces and resources are enclosed and privatized. The dispossession of marine spaces and marine resources from coastal resource users allows private entities to secure or “fix” capital investment in ocean-based production. This generates more capital, and thus facilitates the expansion and ongoing process of new accumulation and new dispossession (Fabinyi 2018; Harvey 2001, 2003). Those who previously relied on commonly held resources not only lose access to natural resources but are often forced to become wage-earners to survive.

Our work here focuses on three interrelated arguments connected to Harvey’s notion of accumulation by dispossession. The first is that violence and death have marked the privatization and enclosure of previously commonly held marine resources. The second is that aquaculture enclosures disproportionately burden women fishers due to gendered division of labor pre and post aquaculture. The third is that sea cucumber aquaculture is changing local fisher demographics, marginalizing individuals previously engaged in wild capture harvest. Ultimately, we call for a reexamination of whose interests and values shape strategies advanced through public-private partnerships as win-win sustainable development initiatives.

Here we will contextualize the importance of sea cucumbers in terms of their ecological, culinary, and economic niche globally and provide a brief history of sea cucumber harvest in Madagascar, tracing the industry from pre-colonial times to the current moment. Next, we will describe how sea cucumber aquaculture has reshaped the marine

commons, focusing on the interrelated themes of gendered dispossession, violent enclosure and demographic change.

Harvey's Framework and Accumulation by Dispossession

David Harvey's framework of accumulation by dispossession is rooted in Marx's notion of primitive accumulation and is shaped by several key processes. The first process in accumulation by dispossession is the conversion and subsequent privatization of common or collectively held rights to resources (Harvey 2003, 145) (Figure 1). Enclosure of the commons often results in the establishment of private property, however as Alice Kelly (2011) shows, enclosure in the name of conservation does not always result in the establishment of private *property*, but nonetheless enables privatized forms of *accumulation*. For example, in two coastal areas of Tanzania, governmental and non-governmental organizations established marine protected areas to address overfishing and the loss of coral and marine biodiversity, thus enclosing previously commonly held marine spaces and resources (Raycraft 2019; Benjaminsen and Bryceson 2012). These enclosures produced government-held property instead of private property, however private entities including tour operators and international conservation organizations directly benefited from these projects, and the capital they obtained from the dispossession helped maintain and legitimize both the continued enclosure of marine space and external actors' control of the area.

The second set of processes Harvey describes is the commodification of resources and the forceful expulsion of peasant populations. Ocean grabbing is rooted in the commodification of marine resources that necessitates new forms and new spaces of production (e.g., aquaculture) and protection (e.g., MPAs). Global consumer demand and pressure from multilateral lending institutions to increase GDP have turned ocean resources that were previously not consumed or sold into commodities whose

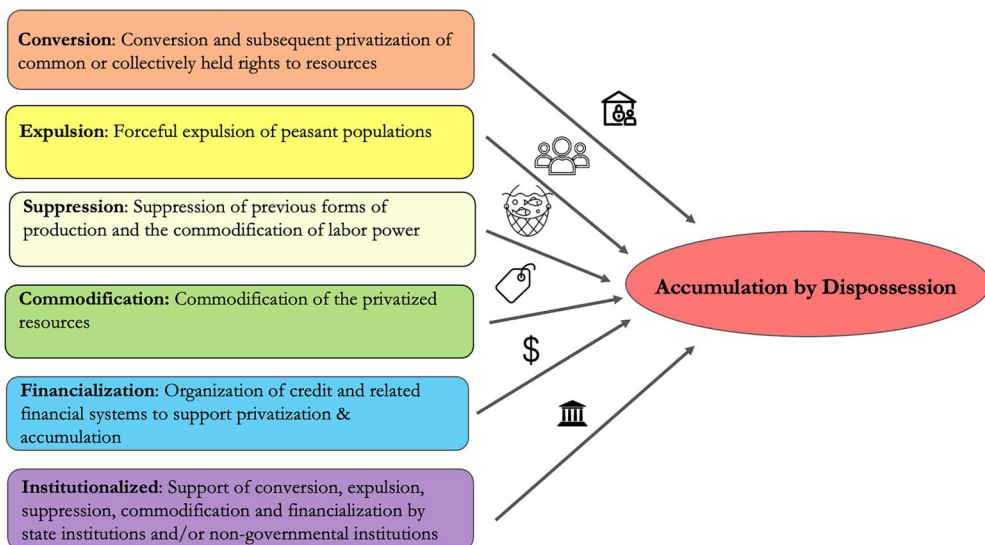


Figure 1. Visual heuristic of David Harvey (2003) accumulation by dispossession framework, reconceptualized by authors.

abundance and production is prioritized over human lives and livelihoods (Bennett, Govan, and Satterfield 2015). As Longo, Clausen, and Clark (2015) argue in their book *Tragedy of the Commodity*, the emergence of a market value on sea space and marine organisms facilitates the process of capital accumulation and sets the terms of exchange for communities of vastly unequal political, economic and institutional power, which then recapitulates unsustainable forms of capital accumulation in the marine realm.

Two other processes co to accumulation by dispossession is the suppression of previous forms of production and the commodification of labor power. For example (Veuthey and Gerber 2012) explain how the dispossession of collectively held mangrove harvest grounds for privatized shrimp aquaculture in Ecuador resulted in previously independent mollusk and crab collectors working as wage laborers for shrimp aquaculture companies. Thus, in Ecuador, wage labor opportunities emerged alongside the illegalization of harvesting mollusks and crabs in privatized regions of the mangrove.

Another dynamic Harvey emphasizes in relation to accumulation by dispossession is the way in which imperialist or neocolonial processes are inextricably tied to the process. Harvey argues that “the state, with its monopoly of violence and definitions of legality, plays a crucial role in both backing and promoting [the] processes” (Harvey 2003, 145). For example, in Tanzania community involvement in the establishment of an MPA was initially favored, but over time and with the encouragement of transnational conservation organizations and tour operators, MPA management became more centralized. Under governmental control and with funding from multinational lenders and transnational conservation organizations, there was increased police presence and reports of violent enforcement of the MPA such as public whipping of local leaders and shooting fishers (Benjaminsen and Bryceson 2012).

The last process Harvey outlines is the way in which credit and related financial systems serve as a means of accumulation and dispossession. Systems of credit relate to marine aquaculture and conservation in several ways. Blue carbon credits based primarily on mangroves, but also seagrass and other marine ecosystems are seen as increasingly important to carbon markets globally (Childs and Hicks 2019; Neimark et al. 2020). Blue carbon credits financially legitimize enclosure of previously commonly held marine resources so that they are managed for the global carbon market (Cormier-Salem 2017). Often, local fishers neither understand nor benefit from the blue carbon credits, managed and traded at the regional and international level (Sovacool 2021; Cormier-Salem 2017).

Credit-related processes are also embedded in the creation of protected areas that theoretically benefit the “global commons,” where host nations secure loans from multilateral institutions, transnational conservation organizations secure donor funding, and loan credit is forgiven through debt-swap-for nature schemes (Kelly 2011; Corson 2011). These systems of credit-based conservation are key mechanisms through which accumulation by dispossession occurs and is reinforced over space and time.

The benefits and burdens of marine resource enclosure vary greatly between those initiating and funding the projects that enclose marine spaces and those who live alongside them. Benefits tend to accrue to actors in governmental or non-governmental organizations and donor groups who are overwhelmingly wealthy, white or from a dominant ethnicity within their nation, male, and supported by well-resourced nations

from the Global North (Bennett 2019; Bennett, Govan, and Satterfield 2015; Baker-Médard 2017; Baker-Médard, Gantt, and White 2021; Chuenpagdee et al. 2022; Barbesgaard 2018). Burdens tend to accrue to those “receiving” these marine conservation and development projects including fishers, gleaners and coastal communities, who are overwhelmingly poor, black or brown, female and self-supported (Veuthey and Gerber 2012; Cormier-Salem 2017; Baker-Médard 2017; Mollett 2017). Feminist scholars have shown how racialized and gendered access, divisions of labor and political agency shape conservation and development outcomes along these social hierarchies (Mollett and Faria 2013; Nightingale 2011; Resurrección 2017; Rocheleau, Thomas-Slayter, and Wangari 2006; Sundberg 2017). As explained by Federici (2004) and Mies and Bennholdt-Thomsen (2001), primitive accumulation and enclosure are necessarily accompanied with segregation and hierarchization, which actively shape categories of gender, race, nationality, ability, etc. Further, capital accumulation projects facilitated through enclosure often target activities and spaces that are already racialized and gendered, working to entrench white supremacy and patriarchy (Sundberg 2004; Mollett 2010; Federici 2018).

Dispossession in the Blue Economy

Many of the processes outlined in Harvey’s accumulation by dispossession framework are commonplace with the rise of funding for and attention on the blue economy globally. Economic development in coastal and ocean spaces is receiving unprecedented attention in sub-Saharan Africa from aid organizations and governmental and non-governmental institutions. Development funding is aimed at both extractive activities such as deep-sea mining and industrial fishing as well as non-extractive activities such as carbon sequestration projects (e.g. creating carbon credits via mangrove or seagrass preservation) and the development of marine protected areas (Campbell et al. 2016; Childs and Hicks 2019; Thoya et al. 2022; Andriamahefazafy et al. 2020). Aquaculture exists at the intersection of extractive and non-extractive pursuits, framed simultaneously as a core facet of local and national blue economy development and an avenue to help relieve fishing pressure from local stocks of marine resources (Gephart and Golden 2022).

Aquaculture companies as well as conservation organizations see sea cucumber aquaculture contributing to fisheries management, biodiversity conservation, and poverty alleviation. For example, a video on the website of a well-known marine conservation organization in Madagascar explains: “before the aquafarms were set up, overfishing had depleted stocks... today there’s once again a large variety of fish along with snails and crabs,” further stating that “the aquaculture here... benefits the entire bay and the animals that live in it” (Blue Ventures 2022).¹ THE CEOs of Indian Ocean Trepang (IOT), a private company engaged in sea cucumber aquaculture along 150 km of coastal shoreline in southwestern Madagascar similarly underscore the benefits of sea cucumber farming: “aquaculture provides... sustainable income which comes in replacement of their [Malagasy fishers] traditional decreasing income” (IOT 2017). IOT’s website has a section for community impact in which they state that their practice “enhances the status of the women, since they very often are the ones carrying this activity; enables better

access to education since this income would first be dedicated to children's education; and leads to the local economy growth" (IOT 2022).

This quadruple bottom line framing of aquaculture – as something that contributes to economic development, fisheries enhancement, biodiversity conservation, and women's empowerment- is enticing, yet belies the politically fraught processes of establishing use and alienation (to sell or transfer) rights in an aquaculture site as well as the immense social and ecological consequences of introducing aquaculture in an area (Bennett et al. 2021; Gephart et al. 2021). Unfortunately, aquaculture often exacerbates existing socio-economic vulnerabilities due to dynamics such as elite capture of aquaculture profits, a narrowing of markets available to those not participating in aquaculture, and the shift from self-employment to a wage labor economy (Eriksson, de la Torre-Castro, and Olsson 2012; Bryceson 2002).

Sea Cucumbers and Madagascar in Context

Ecological & Cultural Niche

Sea cucumbers play a significant role within the marine ecosystem. As sediment feeders, they are essential to maintaining and increasing the productivity where they reside. They consume detritus, diatoms and bacteria (Conand et al. 2006), while excreting phosphate, ammonium, and smaller amounts of dissolved organic nitrogen and organic phosphorus. Sea cucumbers are believed to be important in maintaining high productivity in benthic and coral reef communities by consuming particulate organic matter that collects on rocks and benthic vegetation (Purcell 2010b).

Besides the ecological role they play in marine ecosystems, sea cucumbers are an important part of human society. Small-scale fishers across the globe rely on the profits gained from the sea cucumber industry (toral-Granda 2008). Sea cucumbers also present a cultural importance to consumers and the dried products have played an important role in eastern Asian culinary and medicinal tradition for more than 1,000 years with China, Hong Kong, Singapore, and Taiwan being the main importers (Anderson et al. 2011; Máñez and Ferse 2010). Sea cucumbers are believed to provide multiple nutritional benefits and have medicinal properties that are neuroprotective, antitumor, anti-coagulant, antimicrobial, and immune boosting (Pangestuti and Arifin 2018; Purcell 2010a). Since the 1980s, demand for luxury seafood, like sea cucumbers, has increased in China, as more Chinese have been moving into the middle and upper classes (Fabinyi 2012).

History of Trade in Madagascar

The Indo-Pacific region has been trading and harvesting sea cucumbers for more than one thousand years (Anderson et al. 2011). French colonists in Madagascar documented a robust sea cucumber fishery existing in the 1800s (Ader 1970). A monthly periodical produced by the Haut Commissariat de la République Française à Madagascar et Dépendances called the *Bulletin de Madagascar* underscored the immense potential to expand and develop sea cucumber fishing in Madagascar, pointing to the existing

production and trade along the west coast of Madagascar, notably Nosy Be, Maintirano, Barren Isles, and Toliara), facilitated by Chinese merchants (Fourivjanoir 1951, 17).

Georges Petit, a naturalist working for the colonial branch of the Museum of Natural History, documented sea cucumber export data from Madagascar in 1920 to 1928, which fluctuated between 50 and 140 metric tons annually (Petit 1930). However, he wrote that “In the northwest, northeast, and southwest in particular, this industry has been in full swing for years,” showing that before it was recorded, sea cucumbers were already harvested and exported from Madagascar. The earliest date mentioned concerning this is 1913, when “the Compagnie des Messageries Maritimes refused to load sea cucumbers on their ship in Nosy Bé because of the unbearable odor they gave off.” (Petit 1930, 147). Petit explains that the “Chinese and Hindus” were the primary intermediary traders between Malagasy sea cucumber collectors and processors, and French and other European and Asian merchant shipping companies (Petit 1930).

The legacy of French colonialism in Madagascar is still present in fishing culture and written law. Petit highlights several colonial laws pertaining to sea cucumbers including the 1922 Decree focused on preventing overfishing of sea cucumbers. In the June 5, 1922 Decree, Article 19 Title 4 restricts harvesting live sea cucumbers under 11 centimeters and dried sea cucumbers under 8 centimeters.² This language and these minimum size restrictions were folded into postcolonial Malagasy law in 1947 (Loi 75-525).³ However, minimum size limits as a management technique for sea cucumbers is not well supported ecologically given that size at sexual maturity and size-specific fecundity vary widely across sea cucumber species, nor are minimum size limits favorable in most management contexts given the difficulty of monitoring and enforcing them (Purcell, Williamson, and Ngaluafé 2018). Furthermore, research shows that these particular minimum size limits are not ideal or appropriate for *Holothuria scabra*, which is currently the most targeted and exported sea cucumber in Madagascar (Scarffe 2020).

There is a significant gap in reported capture and export of sea cucumbers from the 1920s to the late 1980s. Missing and conflicting global sea cucumber export and import data makes longitudinal analysis challenging. For example, Anderson et al. (2011) found that in 2006 global sea cucumber imports exceeded sea cucumber exports by 2.3 million tons, underscoring an enormous amount of illegal, unreported or unregulated sea cucumber harvest and trade globally. Combining data from four sources, our analysis shows that exports from Madagascar averaged 200 metric tons of dry sea cucumber per year with a peak of 980 metric tons in 2002 (Figure 2). Wet sea cucumber exports from 2009 to 2014 averaged closer to 1340 metric tons per year (Conand 2017).

Reports indicate that sea cucumber exports brought in US\$3.1 million to Madagascar in 2002 (FAO 2008). Significant declines and signs of overexploitation are evident from 2002 onward, however between 1996 and 2005, Madagascar remained the main supplier of imports by China Hong Kong SAR from the Africa Indian Ocean region (FAO 2008).

The Aquarian Turn in Madagascar

Despite the long history of wild capture of sea cucumbers in Madagascar, in the past decade sea cucumber aquaculture has intensified. Reports in the early 2010s showed

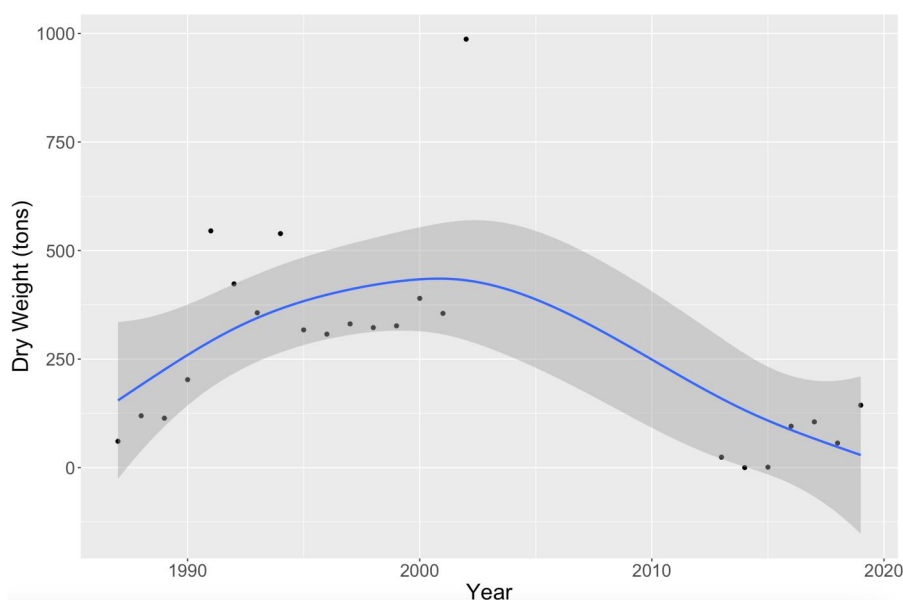


Figure 2. Dry sea cucumber exports out of Madagascar from 1980 to 2020 represented by a generalized additive model. Data aggregated from UN Comtrade database <https://comtrade.un.org/data>; Rasolofonirina, Mara, and Jangoux (2004); INSRE: National Institute of Statistic and Economic Research of Antananarivo; and Infopêche 1995, march, n°8 <https://www.insee.fr>.

declining catch across multiple fisheries (Le Manach et al. 2012). Fisheries declines, coupled with the status Madagascar holds internationally as a biodiversity hotspot, led a suite of international conservation organizations, in conjunction with the Malagasy government, to call for greater conservation efforts in the marine realm (Ratsimbazafy et al. 2019). In 2017, Madagascar received \$74.15 million from the World Bank, the Global Environment Facility, and the Japan Policy and Human Resources Development Fund to develop small-scale fisheries and aquaculture in Madagascar (World Bank 2016, 2020b). This funding came at a time where aquaculture was already expanding but helped financially and legally propel public-private partnerships in sea cucumber, seaweed, and shrimp aquaculture to the next level.

Madagascar is home to the third largest coral reef system in the world and is globally renowned for its biodiversity as well as its high species extinction rates (Ratsimbazafy et al. 2019). Several million people in Madagascar depend on small-scale fishing (Gough et al. 2020) and 78% of the population is living on less than \$1.90 per day (World Bank 2020a). The fisheries and aquaculture sectors account for more than 5% of Madagascar's GDP, approximately 13% of total exports (Everett and Andriamampiray 2016). Aquaculture's share of exports continues to grow and in 2017, Madagascar produced over 28,000 metric tons of seafood from aquaculture (World Bank 2022).

This turn away from wild capture and toward sea cucumber farming stems from a combination of dwindling wild capture stocks, increases in sea cucumber prices, and an interest from the Malagasy government, foreign corporations, and conservation organizations in an “untapped” development opportunity in coastal regions, especially in southwestern Madagascar.

In 2003, after years of research, commercial sea cucumber aquaculture started in a few pilot sites in southwestern Madagascar (Eeckhaut et al. 2008; Rasolofonirina 2007). Researchers who helped develop aquaculture practices for this organism emphasized that sea cucumbers were perfect candidates for aquaculture given that they can live in dense populations, are low on the food chain and thus depend on widely available resources in the water and marine substrate, and are a lucrative commodity (Eeckhaut et al. 2008; Purcell 2010a). However, researchers also emphasized that sea cucumber aquaculture may introduce a variety of ecological and social problems. Examples of ecological problems include genetic inbreeding, pathogens and diseases spreading from captive to wild populations, and alternations to the benthic community which impacts the broader marine ecosystem. Examples of social problems include inflated promises from sea cucumber aquaculture companies to local resource users, theft and socio-political upheaval (Eriksson, de la Torre-Castro, and Olsson 2012).

The pivot from wild capture to aquaculture in Madagascar relates to a phenomenon that political ecologist Dorian Fougères calls “aquarian capitalism.” Akin to theories of agrarian change, “aquarian capitalism” draws attention to the way in which neoliberalism and globalization produce new networks of production, trade and consumption that fundamentally reorganize human-nature relations and generate new inequalities between producers, traders and consumers (Fougères 2005). Fougères carefully lays out the way in which property rights, a cornerstone of capitalism, are formalized in marine spaces that are legible to governmental control and private investment through new technologies and rapid market access. In the case of sea cucumbers in Madagascar, technological innovation included the rigorous scientific development of sea cucumber rearing techniques (Eeckhaut et al. 2008) and direct access to voracious overseas sea cucumber markets aided by real-time investment and reliable transportation from coastal Madagascar to areas of high consumer demand (Louw and Bürgener 2020).

Aquarian capitalism is the foundation upon which accumulation by dispossession occurs in the marine realm in Madagascar. The processes through which sea cucumber aquaculture was established and perpetuated in Madagascar exemplify many of the key processes Harvey outlined in relation to accumulation by dispossession.

Fishers in Madagascar do not have formalized, or governmentally recognized sea tenure; instead, fishers emphasize that it is culturally taboo for an individual to lay claim over a particular area of the ocean (Diver et al. 2019). With the arrival of sea cucumber aquaculture, many farming pens were placed in corridors to fishing areas or within fishing spots, disproportionately impacting community members who do not participate in the aquaculture project (Ateweberhan et al. 2018). The combination of these factors makes Madagascar an especially interesting case study to understand the ways in which MPAs and marine aquaculture have reshaped access to and control over the marine environment, and influenced how the benefits and burdens of marine conservation and fisheries development are distributed within and across communities.

Gendered Divisions of Labor and Benefits

Sea cucumber harvesting in Madagascar occurs year-round and efforts tends to be concentrated around fringing reefs, atolls, and barrier reefs. More than thirty species of sea

cucumber are harvested including key species such as *Holothuria scabra*, *Holothuria nobilis*, *Stichopus horrens* and *Thelenota ananas* (FAO 2008). As the high-value species are harvested at higher rates and thus remain harder to catch, harvesting has converted from fisheries focused on harvesting low volumes of high-value species, to harvesting high volumes of low-value species, a phenomenon which is common globally (Anderson et al. 2011).

Historically, women have been the dominant sea cucumber harvesters in coastal communities in Madagascar, a phenomenon common to many other developing countries given that the harvest techniques require little equipment, occur close to shore, and can be done by foot instead of from a boat (Grenier 2013; Rasolofonirina 2007; Purcell et al. 2016). However, with dwindling near-shore sea cucumber stocks accompanied by an increase in price per kilo, more men have entered the industry, fetching higher prices for more lucrative and deeper dwelling species, and using a variety of techniques including SCUBA to harvest sea cucumbers (Grenier 2013; Baker-Médard, Rasoanandrasana, and Saula 2011). In a study done on Fiji, Kiribati, Tonga and New Caledonia, men received 1.3 times more payment for fresh products than women (Purcell et al. 2016). The study attributed this phenomenon to traders taking advantage of women, as men reported being less satisfied with prices and most likely consequently asking for higher payment. It also described that women tend to catch smaller sea cucumbers as they only have access to shallower areas, which have smaller specimens, whereas men harvest more lucrative and/or larger sea cucumbers in deeper waters. SCUBA diving for sea cucumbers, while deemed illegal by the Malagasy government, is common throughout Madagascar (FAO 2008; Baker-Médard, Rasoanandrasana, and Saula 2011). Middlemen and exporters often provide equipment (motorized boats and diving gear) and hire Malagasy men to dive 2–10 times/day, with a total 4–6 hours of dive time per person (Rasolofonirina, Mara, and Jangoux 2004; Baker-Médard, Rasoanandrasana, and Saula 2011). Unfortunately, given the scarcity of more lucrative sea cucumber species, divers are spending longer times at deeper depths, and thus paralysis and fatalities have increased within coastal communities, especially along the western coast of Madagascar (Baker-Médard, Rasoanandrasana, and Saula 2011; Baker-Médard and Ohl; Eriksson, de la Torre-Castro, and Olsson 2012).

Female sea cucumber fishers in Madagascar tend to focus their efforts in the shallow areas behind the reef crest. While some families harvest together, women historically dominated processing and selling the sea cucumbers to intermediaries or directly to exporters (Rasolofonirina, Mara, and Jangoux 2004; Grenier 2013; Baker-Médard, Rasoanandrasana, and Saula 2011). In 1923, George Petit noted that women, men and children harvested macroinvertebrates, including sea cucumbers, from shallow reef areas (Petit 1923). Grenier similarly claims that starting in the mid 2000s, due to an increase in sea cucumber export prices, men started participating more frequently in “an activity they once disdained” along with the women and children (Grenier 2013, 10). Other authors provide evidence that the proportion of men versus women who harvest sea cucumbers changed depending on one’s location in Madagascar, however women dominated processing and selling across all locations (Rasolofonirina 2007; Rasolofonirina and Conand 1998; Robinson and Pascal 2009). Increased fishing pressure and foreign demand likely contributed to declines in near shore and shallow sea cucumber stocks,

driving market prices up and favoring technologies such as SCUBA and snorkel diving to access sea cucumbers, both of which encouraged more men to enter the sea cucumber fishery. A similar process has occurred with octopus: previously women would fish for octopus only during spring tides, which ended up protecting the sustainability of the fishery given the break in harvest during neap tides. However, men now participate in this lucrative fishery at all times of year, preventing octopus populations from recuperating (pers. comm. L. Augustave and P. Antion Blue Ventures, SWIO Cephalopod Symposium, October 15, 2020).

Methods

We relied on a suite of quantitative and qualitative methods. With the help of a team of eight Malagasy researchers, in 2011 and 2012 we conducted 889 randomized surveys, stratified by gender across 19 fishing villages in two regions of Madagascar. All sites were located adjacent to marine conservation projects, and all sites contained at least one marine reserve. Surveys were randomized by estimating the number of houses from Google Earth maps or recent village census data available at district government offices, assigning a number to each house, and then generating a random number table online at stattrek.com (30 numbers/houses for villages over 200 houses, 15 for villages under 200 houses) to select a house. Each survey team, stratified by gender with separate number tables, surveyed the first willing female or male respondent in each randomly selected house. The survey, a standardized questionnaire, focused on a variety of topics including the fishing techniques, frequency, area fished, and price fetched for one's catch, and a suite of other topics described previously (Baker-Médard 2017, 2019; Baker-Médard and Faber 2020).

We also conducted archival research at Les Archives Nationales d'Outres Mers in Aix-en-Provence, France, as well as four weeks at the Tranobokin'ny Arisivam-pirenena in Antananarivo, Madagascar. We collected documentation concerning sea cucumber harvest practices both during and prior to French colonization of Madagascar.

Sea cucumber aquaculture was not an initial focus of our social surveys, however, became part of our analysis when it emerged in open-ended response to survey questions regarding rights and access to marine resources. We found, for example, that on average more women reported a decrease in access to marine resources than men in areas where sea cucumber aquaculture occurred. Only a small subset of our survey respondents mentioned aquaculture and changes in access to marine resources, so we decided to develop a different method to investigate the specific impacts of sea cucumber aquaculture on coastal communities. In 2019, we received IRB approval to conduct semi-structured interviews in southwestern Madagascar. Two Malagasy researchers, who due to safety reasons prefer not to have their names listed as authors, helped create the interview guide, select sites, and conduct interviews from December 2020 to May 2021. Six men and six women of varying ages and marine-related professions were asked to discuss their livelihoods, their knowledge of sea cucumber aquaculture in the area, and the changes that aquaculture has brought to them personally and to their communities (Appendix I). Once people reported violence and murder as risks associated with the arrival of aquaculture, we took extra steps to protect people's identities as well as

confirm people's reports. We triangulated by interviewing people with different livelihoods, age, gender, involvement in aquaculture, and time since arrival. To further triangulate, we reviewed four newspaper outlets publishing in Malagasy and French to confirm the veracity of our informants' reports.

Accumulation by Dispossession through Sea Cucumber Aquaculture

Commodification of the Seabed

Commodification of both marine space and marine resources manifests in Madagascar as aquaculture pens give market value not only to sea cucumbers but also the three-dimensional space touching and above the ocean floor. These privatized areas have drastically reshaped the marine commons, shifting both the rights and abilities of fishers to benefit from the spaces and resources they have lived off of for hundreds of years.

Despite the optimistic picture painted on the websites demonstrated above, the enclosure process which has occurred up and down the coast of Madagascar has in some cases negatively impacted locals (especially women) and deprived them of coastal territory, resources, and jobs. For example, one fisher explained that "People didn't foresee that places where people have fished forever, places where people have made their living are now completely off limits/forbidden. There are a lot of fish in or near the sea cucumber pens, but you are not allowed to fish for them, you are not allowed to harvest them. (*tsy azo haza, tsy azo ala*). This has a big impact because a 50 to 100 meters zone around the sea cucumber pens is now off limits to fishing" (pers. comm. elder male fisher southwestern Madagascar, 28 December 2020).⁴ He described that since the establishment of sea cucumber aquaculture in the area "you are not allowed to net fish, not allowed to line fish, not allowed to fish on foot." He goes on to explain "We were duped/defrauded (*fitaka mihintsy*) and "We don't like it, but we agreed to it because it's our livelihood," but that if they knew then what they know now, they wouldn't have agreed to it.

Most of the respondents expressed a similar sentiment, that the sea cucumber pens had been placed in spaces that were historic fishing grounds, depriving them of livelihoods and a food source. For example, a female seaweed aquaculture farmer from a neighboring village said "blocked... our fishing is blocked and now we must go much further to fish" (pers. comm. southwestern Madagascar, 10 April 2021). She continued to exclaim that "all our space is occupied by sea cucumber aquaculture, all our previous fishing grounds."

Suppressing Live Capture and Internalizing Free Labor

In relation to the shifting seascape of labor, whereas traditionally fishers were paid per sea cucumber and worked on their own time and accord, private sea cucumber aquaculture companies have created a monopoly on the sea cucumber market in the area, forcing fishers to depend on and serve the export company. Another fisherwoman who now also farms seaweed explained that "IOT controls everything, the number they sell to you, the timeframe of purchase, even if you are dying of starvation, you cannot sell your products" (pers. comm. Southwestern Madagascar, 10 April 2021). The export

company that owns the aquaculture pens does not purchase wild sea cucumbers, and instead focuses on a single sea cucumber species *Holothuria scabra*. In villages where IOT now works, fishers report that no other sea cucumber collectors now operate there.

Furthermore, in order to work with IOT, a certain quotient of sea cucumbers must be produced each cycle, and one must adapt to punctuated seasons or cycles of production and therefore income. Interestingly, while some of the previously self-sustaining sea cucumber fishers have become wage workers who clean or guard pens for daily wages, or aquaculture workers who sell all sea cucumbers to the export company, many aquaculture workers are not from the community previously inhabiting the coastal area. Instead, they come from inland agricultural communities without marine fishing backgrounds. The difference in livelihood backgrounds parallels differences in linguistic and cultural ethnic differences between those previously occupying coastal area. For example, in one small village in southwestern Madagascar working with IOT, approximately half of the pen owners were Masikoro (inland agropastoralists who have a long history of trade with coastal Vezo fishers) (pers. comm. Masikoro resident, 12 April 2021).⁵

Transnational actors and the Role of the State

One dynamic Harvey underscored is the imperialist or neocolonial nature of accumulation by dispossession. The process of establishing both MPAs and aquaculture in Madagascar seemingly contradict this claim because they are explicitly community-based. However, when one examines the way in which community involvement and interests were integrated in the planning and execution of these enclosed spaces, we see how central international actors have been to the rise of MPAs and aquaculture in Madagascar. In the case of MPAs, many villagers were not included in decision-making regarding where and whether these spatial enclosures should occur (Baker-Médard 2017; Baker-Médard, Gantt, and White 2021). This dynamic continues now that both MPAs and aquaculture are also framed in terms of strengthening Madagascar's rapidly expanding "blue economy," funded primarily by international conservation organizations through multi-lateral agreements and multi-lateral funding organizations such as the World Bank (World Bank 2020b).

IOT is the primary exporter of sea cucumbers in southwestern Madagascar and is directed by both national and transnational actors. Despite a broad acknowledgement that stakeholder involvement should be core to the establishment of any sea cucumber fisheries project in Madagascar (Eriksson et al. 2015; Rasolofonirina 2007; Conand and Muthiga 2021), fishers in the sites we visited indicated that there was little local community input and consultation by IOT regarding where aquaculture pens should be placed, or if they should exist at all. A few village leaders acknowledged that they were consulted regarding the existence and location of sea cucumber pens; however, they admitted that most villagers were only informed of the location of the sea cucumber pens once IOT had started working in the area. One middle-aged man who is a seaweed farmer and net fisher said, "Only one person was consulted (*olo raiky avao ro nanampan-kevitsy*), there was never a village meeting [about the aquaculture project]." He then pointed out to the current location of the sea cucumber aquaculture pens and clarified that "They, IOT, chose where to put [the pens], they are the ones who put

them there” (pers. comm. April 10, 2021). A middle-aged woman who used to fish on foot confirmed that “They came and said: this is where we are going to put it. Only IOT chose where to put the [aquaculture] enclosures, not the community” (pers. comm. 28 December 2020). One elder male fisher said that he knew of a few people who were consulted and voiced a strong opinion against having the aquaculture project in the area, but their opinions were ignored. He said some of the villagers “had a meeting [with IOT] but didn’t agree to the project (*tsy nanaiky fokonolo*) and so they were saddened and surprised that the project went ahead anyway (*ka nefa gny nahagaga niory avao raha toy*), perhaps because it came from the mayor’s office (*vasa na avy amin’Maire*)” (pers. comm. April 10, 2021). These quotes underscore a pattern of top-down decision-making regarding marine resource use, favoring primarily international organizations and actors working directly with the Malagasy government over small-scale producers (Corson 2016). The Malagasy government has sovereign authority over marine area within 200 nautical miles from Madagascar’s coast (the exclusive economic zone), thus, companies like IOT are only required to obtain governmental approvals. Consultation with local fishers and community-members regarding what occurs in marine spaces thus exists as a courtesy instead of a requirement.

Ongoing Accumulation and Forms of Credit

Lastly, in relation to Harvey’s assertion that credit is a common conduit through which accumulation by dispossession occurs, the Malagasy government received and continues to receive loans from multinational lenders and organizations such as the World Bank, African Development Bank, International Monetary Foundation and others for aquaculture development. For example, in 2022 Madagascar received approximately 870 million USD in aid (Trading Economics 2023). This aid shapes what the Malagasy government prioritizes in relation to development strategies, and fisheries-focused infrastructure and incentives for private aquaculture investment are core to the plan (Knack et al. 2020). In 2017 an 83 million (USD) World Bank project called the Second South West Indian Ocean Fisheries Governance and Shared Growth Project (SWIOFish2 for short) developed in Madagascar as part of a broader regional effort to sustainably and economically grow the “blue economy” (Andriamahefazafy et al. 2020; World Bank 2017b, 2020). A World Bank press release articulates this effort, stating that SWIOFish2 project “will substantially improve Madagascar’s ability to reverse the decline of marine fisheries, improve local livelihoods of fishing communities, and enhance fisheries management along the supply chain in cooperation with the private sector” (World Bank 2017a). Funding aquacultural expansion through multi-lateral lending processes will undoubtedly perpetuate the cycle of capital accumulation, enclosure of the marine commons, and dispossession of certain marine resources from small scale fishers in Madagascar.

Inequitable, Gendered, and Violent Impacts of Sea Cucumber Aquaculture

Gendered Division of Work, Power, and Access

Our survey data found that 60.6% of female fishers harvest sea cucumber, whereas 37.2% of male fishers harvest sea cucumber in a sample size of 559 fishers (Figure 3).

Percentage of Fishers Who Harvest Sea Cucumber

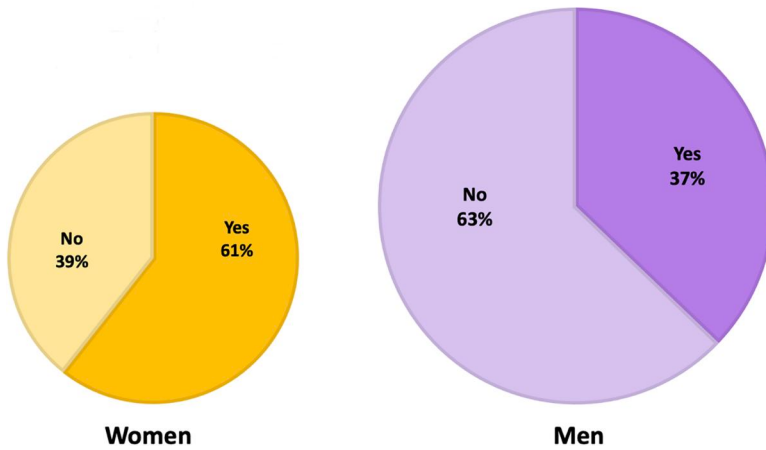


Figure 3. Percentage of female ($n = 193$) and male ($n = 366$) fishers who harvest sea cucumber. Pie graphs are proportionately representative of the number of self-reported male and female fishers (2011).

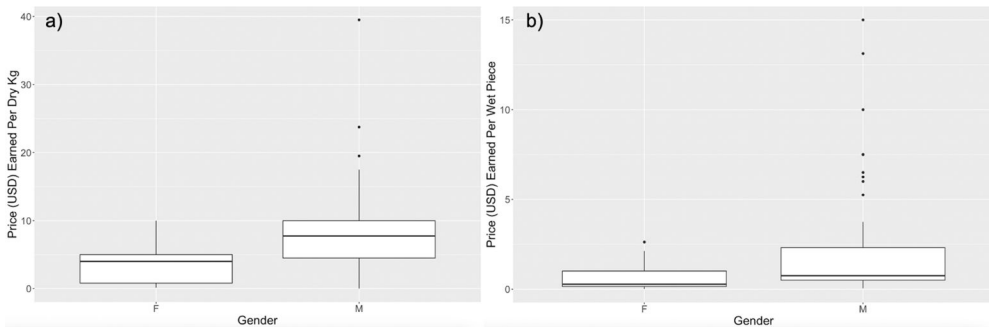


Figure 4. Price (USD) of sea cucumber fetched per (a) price per dry kilogram (t -test, $p < 0.001$) and (b) price per wet piece (Wilcox test, $p < 0.001$) for self-reported women and men fishers (2011).

Although few fishers rely entirely on sea cucumbers for their livelihood, a larger proportion of women (5.2%) than men (1.9%) reported sea cucumber fishing as their *primary* source of income. However, similar to findings from other areas of the world, we found that men fetch significantly higher prices than women for both dry kg ($p < 0.001$) and wet pieces ($p < 0.001$) of sea cucumber (Figure 4a,b).

Although the total number of men who harvest sea cucumbers is greater than the total number of women, sea cucumber harvesting constitutes a larger portion of women's fishing activity than men. Women receive a lower price per kilo for their sea cucumber than men. These findings demonstrate that because women rely more heavily on sea cucumber fishing for their livelihood, the effects of aquaculture and recent shifts to the sea cucumber industry disproportionately impacts them.

According to numerous oral histories collected in both southwestern and northeastern Madagascar, sea cucumber harvest used to be primarily the work of women, with fewer men participating until the early 2000s.⁶ However, gendered disparities have been found within labor, ownership, and profit of sea cucumber aquaculture. When asked

who works in sea cucumber aquaculture, an elderly fisher replied that “There are a lot of women who work in aquaculture. Women clean the mesh (*mamafa grillage*), because there is algae that grows on it. Every low tide they clean it because the sea cucumbers’ health will suffer if you don’t clean the mesh. There are also a lot of men who work doing sea cucumber aquaculture” (pers. comm. elder male fisher southwestern Madagascar, 28 December 2020). Another interviewee responded to the same question: “More men work in sea cucumber aquaculture. The company doesn’t mind if men or women want to do the work, but mostly men raise the sea cucumbers. Women aren’t used to working at night (*tsy zatra miasa haly*), staying alone on one of the raised platforms (*trano abo igny*) out at sea used to monitor the sites, they are scared.” (pers. comm. middle aged male fisher southwestern Madagascar, December 28, 2020). However, despite female participation, it appears that there is discrimination in the roles women are allowed to take, as multiple respondents explained that only men process the sea cucumbers, that very few women own pens, and that more men participate overall in this previously female-dominated fishery. Women do not participate in the processing of sea cucumbers as the work cuts up your hands and occurs late at night. Women are also mainly delegated to cleaning the nets, earning a small stipend, which was considered “help” instead of ownership. In one village in southwestern Madagascar, multiple informants indicated that no women owned pens, they only cleaned pens. In another adjacent village multiple informants reported that only four out of fourteen enclosures were owned by women. Beyond ownership, in this second village, a total of 38 men and 2 women worked in sea cucumber aquaculture. One woman added that sea cucumber pen ownership was especially tenuous for women. For example, she explained that in the case of a divorce or separation, a pen owned by a woman would be taken away and given to her husband (pers. comm. 11 April 2020). These gendered disparities exist within enclosed spaces due to a gendered division of labor even before ocean spaces in Madagascar became enclosed.

Understanding Community “Benefits”

Although the problems associated with aquaculture are clear, benefits did accrue to some. Even interviewees that were broadly critical of aquaculture shared that they hoped for greater benefit, asserting that benefit was possible if aquaculture as a practice was set up differently. For example, one man explained that “Here we haven’t received any benefits (*tsy misy tombontsoa*) from sea cucumber [aquaculture]. But [an adjacent village] received a new elementary classroom (*nahazo laclasy EPP*).” Another woman mentioned that with the arrival of IOT, she is now able to buy the things she wants and send her children to school in Toliara. Two other interviewees mentioned that although they were anxious about the possibility of death and arrest, they had no personal problems with aquaculture and thought it could be a positive.

While some individuals clearly benefit from aquaculture, as mentioned above, many of these individuals are more recent arrivals to the area. Aquaculture has led to an interesting shift in fisher demographics in several sites we visited, disproportionately marginalizing individuals previously reliant on wild capture harvest. As mentioned before, there is a disparity between Vezo residents who previously relied on wild

capture, and an influx of Masikoro who are now full-time residents participating in sea cucumber aquaculture. One middle-aged female Vezo fisher emphasized that “the original villagers here hate that there are now aquaculture enclosures here because the sea is their livelihood/living.” (pers. comm southwestern Madagascar, 28 December 2020). She went on to explain that that Masikoro like aquaculture because they have been able to benefit from it (ibid).

Due to time constraints, we were not able to include sites operated by Blue Ventures, a UK based nonprofit focused on marine conservation and sustainable small-scale fisheries, which engages a community-based model of sea cucumber aquaculture (Skowronski 2015; Trenchard and Marrier d’Unienville 2019; Djerryh 2020). In a video produced by Blue Ventures regarding their aquaculture efforts, they state that “50+% of farm leaders and farmers are women.” One local, Séraphine Kiry, explains some of the benefits locals have experienced working with BV’s aquaculture initiatives: “Before the sea cucumber farms, I had no way to improve my standard of living. By setting up my own pen I’ve earned enough to send my children to school, and been able to buy some nice and useful things for my house. I also have a herd of goats now” (Blue Ventures 2022). In another Blue Ventures report, an aquaculture farmer shared that “Sea cucumber farming is time-consuming and makes me feel stressed. Guarding the pens gives me less time to fish. Fishing is my passion and makes me happy,” but nonetheless continues to do aquaculture because it is a source of income (Skowronski 2015).

While a single company dominates the sea cucumber aquaculture industry in southwestern Madagascar, there is a spectrum of how aquaculture projects are carried out—from a more privatized and individualized approach to a more community-based approach that also explicitly works to involve women. While these approaches differ in important ways, commonalities exist, notably the enclosure of a space once used as a commons, and a shift from autonomous wild capture fishers to aquaculture workers dependent on a company for the provision of juvenile sea cucumbers and the purchasing of mature sea cucumbers. What was perhaps most shocking was the normalcy of violence in and around sea cucumber aquaculture.

Violent Environments

Violence associated with sea cucumber theft was common across our sites, primarily associated with theft where armed guards shot and injured or killed people entering sea cucumber pens at night. During an interview, a man explained how some villagers were murdered in the sea cucumber enclosures: “The security guys shot people, and then the people were also scared and started saying “we are dying here,” and things like that. People [from this village] became scared, but the people from here were not the ones who stole. They were shot at because [the security guards] didn’t recognize them, didn’t know them, but they were [aquaculture] workers.”⁷ When further questioned about the deaths, he responded “Some security [agents] don’t have guns, only batons. But the police also provide security, and obviously the police have guns. People died. People died from here. There were [he thinks and counts on his fingers] one, two, three people who died from here.”⁸ He then went on to explain, “Many people died, a copious

number, but only three people died from our village” (pers. comm. elder male fisher southwestern Madagascar, 28 December 2020).⁹

After this startling interview, other interviewees were asked about police guarding sea cucumber pens. Five interviewees mentioned shootings in IOT pens. People’s death toll estimate reached as high as 30 for a single event, amidst the mention of many other one-off shootings. One respondent explained “It’s a difficult death because people didn’t talk, people were secretive about finding bodies in the ocean and secretive about burying them” (pers. comm. young female sea cucumber farmer southwestern Madagascar, 10 April 2021). She explained that some bodies were thrown out to sea or “hidden” by IOT (*ibid*). There was a general sense of fear and intimidation surrounding conversations about sea cucumber aquaculture in the area, with some interviewees stating that “We take these enclosures seriously, we consider them with the fear of God” (pers. comm. female seaweed aquaculturist southwestern Madagascar, 10 April 2021).¹⁰ Others explained that they were worried that we were spies for IOT who would throw them in jail. For example, one respondent stated, “No one is going to give you the whole truth about raising sea cucumbers no matter what you do.”¹¹ Fear of arrest or punishment was mentioned in half of our interviews, with one describing that at one point 50 people had been put in jail after IOT thought they were robbing the sea cucumber pens. One female aquaculture pen cleaner expressed concern over the confidentiality of the interview and identity of the interviewers, stating “we are afraid because we believe that you are backed by IOT and all that we say could land us in jail” (pers. comm. 10 April 2021).¹²

In attempt to verify attestations of death and injury, we inquired at the police station in Toliara twice, once in late 2021 and early 2022. The police said they were unable to talk to us about the topic, but neither denied nor confirmed the shootings and deaths. Several local news sources covered some of the more large-scale events of alleged theft of sea cucumbers and subsequent injury and death of those involved (M.L. 2022; Manase 2019; D.R. 2019). These reports broadly align with the region and timing of some of the shootings and deaths shared in our interviews, however the number of deaths reported in the news article were approximately half the number that was reported in interviews – six to seven deaths instead of several dozen.

Discussion

Interviews with fishers as well as review of historical literature shows that the rise and spread of sea cucumber aquaculture in southwestern Madagascar has slowly enclosed spaces which were historically communal and used primarily by women. In our research sites, these enclosures have resulted in financial gain for a select few, have disproportionately impacted women’s livelihoods, and favored new arrivals instead of longtime residents. While aquaculture is beneficial to some in the community, these pens exclude those who do not want to or do not have the chance to be involved in sea cucumber farming. Moreover, due to the enclosure of marine spaces to raise a lucrative resource, these spaces are monitored by armed guards and an increase in violence and death by shooting has occurred.

Dispossession is a complex and multifaceted process. Our research shows that dispossession can be partial, incomplete, and uneven. The suite of processes we discuss above often work in tandem and can occur sequentially, however resistance to and subversion of accumulation by dispossession may occur through more community-based or more communally shared forms of aquaculture. Although dispossession in these cases is still partial, where one's previous mode of production is rendered illegal as was the case for wild capture sea cucumber fishers in some areas, there is a partial preservation of the commons if decision-making over and access to marine resources is commonly held. Harvey refers to the process of accumulation as dispossession as “inchoate, fragmentary and contingent” (2003: 174), thus one must ask, long-term, how much control can a community truly have when juvenile sea cucumbers are supplied by one company and sold back to that same company once grown? While our work is not explicitly comparative, based on publicly available information regarding sea cucumber aquaculture in southwestern Madagascar, the more privatized form of aquaculture conducted directly by IOT seem to fare worse in terms of level of reported violence, gender inequality and community support than explicitly community-based aquaculture sites where Blue Ventures works alongside IOT.

Our findings help underscore the importance of understanding the social and ecological differences that exist across aquaculture sites. Aquaculture may introduce or exacerbate intra-community stratifications (across gender, ethnicity, wealth, etc.) in relation to who benefits and who bears the costs of aquaculture. Our findings show why whole community interests, needs, and marine-based practices should be centered in planning and decision-making.

In relation to Harvey's framework, the conversion and subsequent privatization of previously common resources was clearly represented by the construction of sea cucumber pens in communal spaces where people have fished for centuries. The lack of marine tenure in these areas allowed the federal government and private companies to make decisions about who owns these spaces without adequate consultation of local resource users. Expulsion in this case was represented by new regulation deeming harvest illegal in and around sea cucumber pens, thus removing all but the pen owner from that space. These two processes (conversion and expulsion) lead to increased levels of violence, as these previously common areas were guarded. Harvey's notion of suppression was represented by agreements between aquaculture companies and aquaculture tenants and the emergence of waged workers. The aquaculture company commodified sea cucumbers by setting their own prices, shaping profits of both sea cucumber aquaculture workers as well as wild-catch fishers. These processes were all enabled via financialization and institutionalization. Organizations like the World Bank provided loans to enhance growth of the blue economy in Madagascar, which partially or fully dispossessed local communities of resources and previous modes of production. The government and non-governmental organizations institutionalized this process by facilitating the introduction and spread of aquaculture into new areas deemed “open access” or areas without preexisting marine property relations (Figure 5).

Our findings here, while eye opening, are still cursory and the dynamics outlined here require much deeper study. Our findings regarding violence parallel global trends in sea cucumber fishing and aquaculture (Conand 2018; Bondaroff 2021;

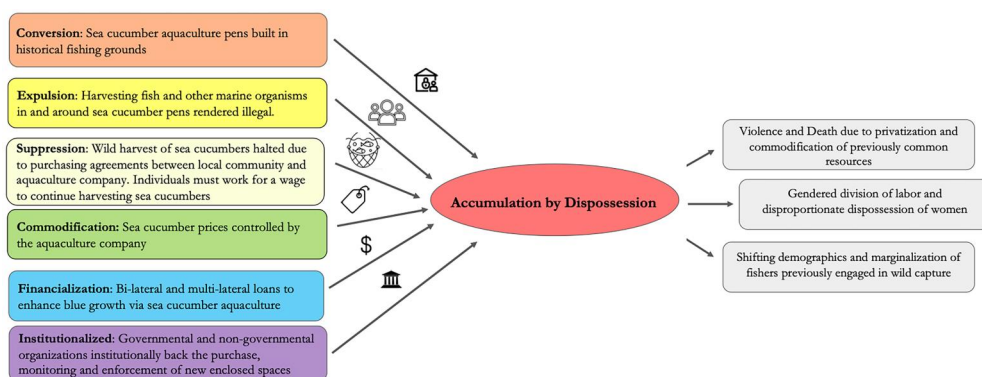


Figure 5. Privatized sea cucumber aquaculture relative to Harvey's accumulation by dispossession framework.

Muralidharan and Rai 2020), however many details regarding the violence reported were conflicting or hazy. We were not granted an interview with police in the area, and local representatives of government were similarly hesitant to talk about anything negative regarding sea cucumber aquaculture occurring in their region. Future research should prioritize conversations with surviving “thieves,” police guarding aquaculture pens, as well as local government leaders. These kinds of interviews will facilitate a more nuanced understanding of the frequency and kinds of violence that occur in these areas, and how this has changed over time.

Additionally, there is a need for research that incorporates additional sites in southwestern Madagascar *and* other parts of the island to better understand the spectrum of ecological and social contexts and outcomes of aquaculture. For example, how has the introduction of single-species sea cucumber aquaculture impacted the genetic diversity of wild stock? What are risks in terms of disease outbreak from aquaculture to wild sea cucumbers and vice versa? Are there ways in which this low-input aquaculture has improved water quality in areas it is implemented? Or, for example, are there places where wild capture sea cucumber fisheries thrive alongside aquaculture, or does sea cucumber aquaculture necessarily extinguishing wild capture? Are there instances where communities experience decreased violence due to the arrival of armed guards protecting sea cucumber pens? In areas explicitly dedicated to community-led and collectively held aquaculture, are the gendered and ethnic-based divisions as present? Are there instances where communities stop aquacultural production of sea cucumbers? Why did they and what are some of the outcomes?

Conclusion

Global demand for marine products alongside an increasing awareness and concern for the marine environment has led to the dramatic expansion of conservation and fisheries enhancement projects globally, in many cases enclosing ocean spaces and resources that were previously commonly held. Our research shows that sea cucumber fishing has a very long history in Madagascar, existing prior to the colonial period and extending until today. However, the industry, especially in southwestern Madagascar, has shifted

from a wild-capture fishery, with women fishing on foot and men primarily skin or scuba diving for sea cucumbers, to place-based aquaculture. This privatized form of aquaculture entrenches gendered divisions of labor, where men are the primary “owners” (*tompony*) of sea cucumber pens and fetch a set price per sea cucumber, and women are the primary “cleaners” (*mpanasa*), who are paid weekly or monthly for their labor. This is a large shift from the historical dominance of women in the wild sea cucumber fishery, thus pointing to a disproportionate impact of these new spatial enclosures on women.

While this dispossession has occurred slowly, with the buy-in of a few local leaders and the strong support of regional and national government officials, privatization of sea cucumber production has led to extreme violence and deaths in some areas due to armed policing of these new lucrative spaces. This violence stands in stark contrast to the win-win environment and development narrative advanced by aquaculture companies in Madagascar and requires that aquacultural advocates think more carefully about the processes and check points of developing the blue economy.

This burgeoning industry has and will continue to shape Malagasy coastal communities and ecosystems for decades to come. Further research should be done regarding how the benefits and burdens are distributed across sea cucumber aquaculture in Madagascar. It is clear, however, that local community voices, of both previously existing and newer inhabitants of an area, need to be centered in discussions about how to mitigate existing or future social, economic and environmental issues associated with sea cucumber aquaculture.

Notes

1. For more video documentation see: <https://www.youtube.com/watch?v=ostMQZTHLD0>
2. “Les holothuries (trévang) d’une longueur inférieure à 11 centimètres mesurés sur des individus vivants. Cette longueur est réduite à 8 centimètres pour les holothuries à l’état sec.” (p 303; (Petit 1930, 303)).
3. “Il est interdit de pêcher, faire pêcher, de traiter en vue d’une conservation quelconque, de commercialiser, les holothuries (trévangs) mesurent moins de 11 cm pour les individus à l’état frais et moins de 8 cm pour les individus à l’état secs.” (Loi 75-525): <http://extwprlegs1.fao.org/docs/pdf/mad1750.pdf>
4. Similar rules around sea cucumber pens exist elsewhere. For example, Maharey Andrianahy, a Blue Ventures employee explains in an interview that “There are rules safeguarding the hatcheries. We worked these out with the breeders. For example, it’s forbidden to enter the pens of other farmers without their consent. All fishing is also forbidden, except for crayfish. You’re allowed to catch them because they feed on the sea cucumbers” (Skowronski 2015).
5. According to one Masikoro resident, Masikoro and Tanalagna have strong historical ties to the area and have lived there in the past but have always returned to their inland farms for part of the year. However, due to climate change stressing agricultural viability, some Masikoro and Tanalagna have turned to ocean-based livelihoods for survival (pers. comm 12 April 2021).
6. Based on oral histories conducted with six male and thirteen female sea cucumber fishers in southwestern Madagascar on June 16, 2009; September 7, 2010; March 14 & 18, 2011, and in northwestern Madagascar on July 17, 2009; October 23–30, 2010; and July 6–20, 2011.
7. “Sitra-pon’drozy [head of IOT] nampialan’drozy satria misy nangalatra, de zalahy securite iro nitifitara, de nahataotra izireo hoe ‘matimaty izahay etoy’ sahalamizao hoe. De nataotra, fa le olo baka etoa tsy nagalatra. Nitifitra securite satria tsy nahalala, tsy hain’tegna, fa piasa.”

8. “Misy securite tsy manana basy, fa kobay avao. Fa gendarme manao securite koa, de gendarme tsy maintsy manana basy. Tena maty mitsy. Misy maty tamin’ny etoy. Misy firy, [he counts on his fingers], misy iray, roa, telo olo maty tamin’ny zay.”
9. “Maro ty maty, tena maro, fa telo avao maty bakaminay etoa tamin’ny 2018”
10. “aminay eto raha zay sarotsy ary raha ty fa atonay tahotsy Ndragnhary ie egnny igny.”
11. “tsy misy olo ahazoanareo gny marina zao gn’eto fa leo, matahotsy, ndra nareo hanao akory hanao akory”
12. “Matahotsy zahay fa ataonay ho vazaha IOT koa nareo ka laha bototsy koa gny volanay dradradradra bakeo hampigadra”

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Appendix I.

Supplemental Semi-Structured Interview Questions (English Version)

1. What kinds of work do you do?
2. Do you work in the ocean (*miandriake*)?
3. How long have you been in this village?
 - a. (if not from here) Why did you come here?
4. Do you harvest sea cucumbers?
 - a. (if yes) What kinds of sea cucumbers do you harvest and where?
 - i. Who do you sell to?
 - ii. How much do you fetch for your sea cucumbers?
 - iii. What are the biggest changes you've observed about sea cucumber harvesting in your lifetime?
5. Sea cucumber aquaculture
 - a. Please explain how, when and by whom were sea cucumber pens introduced in the area.
 - b. What was the process of deciding where they will be placed? Who made the decision?
 - c. Who is allowed to participate in sea cucumber aquaculture?
 - i. How does pen-ownership or use work?
 - ii. Who process sea cucumbers from aquaculture?
 - iii. Who does the upkeep?
 - iv. Who pays for the labor? Input materials?
 - d. How many people use/own a pen?
 - e. Do you own/use/work in a pen? Why or why not?
 - i. (if yes) What do you do?
 - ii. How do you feel about aquaculture in the area?
6. Gender
 - a. Do women and men's roles in aquaculture differ?
 - i. Do more men or women own/use pens? Clean pens? Harvest? Process? Sell?
7. Risks
 - a. Are there risks and/or problems associated with sea cucumber aquaculture?
 - b. Have you personally experienced any of these?
8. Benefits
 - a. What are the positives or benefits associated with sea cucumber aquaculture?
 - b. Have you personally experienced any of these?
9. Ecological change
 - a. Have there been changes you've observed in the marine environment due to the establishment of sea cucumber pens?
 - i. E.g. changes in the ecosystem, or changes in the abundance, diversity and/or location of other species in the area?
10. (If informant is an elder from the area)
 - a. Please share with us what you remember about the history of the sea cucumber industry in the area.
 - b. Are there other facets of the history of this place that you'd like to share?
11. Do you have any questions for us?
12. Demographic information
 - a. Self-reported gender
 - b. Approximate age
 - c. Livelihood (*fivelomenpo*)
 - d. Ethnicity (*tanindrazana* and/or *foko*).
 - e. Any other important demographic info.