UiT The Arctic University of Norway

Norwegian College of Fishery Science

Faculty of Biosciences, Fisheries and Economics

Assessing the conditions for compliance in the squid light fisheries in Myeik, Myanmar

Chit Oo Lwin

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Abstract

Light fishing is one of the most advanced and successful methods in several fisheries worldwide. Light fishing operations in Myanmar involve using light luring methods in inshore and offshore fisheries, especially for catching squids and pelagic fishes in squid seine (stick-held falling net) and purse seine vessels. Technological advancements have led fishers to use more power, light intensity, and small mesh-size fishing net to increase catches. The results have decreased the catches of squids and increased the catches of immature fish and vulnerable pelagic species. These negative impacts result from fishers' non-compliance with the regulations of light fishing in Myanmar. This study assesses fishers' knowledge and compliance with light fishing regulations in Myanmar, with a focus on the fishers in the Myeik offshore fisheries. The study explores the possible reasons why fishers disobey the existing regulations of light fishing with the four different hypotheses (ignorance, lack of opportunities, disagreement, and profit-maximising behaviour) to postulate reasons for non-compliance. Profit-maximising behaviour is perceived to be more significant despite the interrelations between the four hypotheses for predicting possible reasons for non-compliance. Weaknesses and insufficient monitoring, control, and surveillance (MCS) systems in the department of fisheries (DoF) contribute to fishers' non-compliance with the regulations of light fishing in Myanmar.

Keywords: light fishing, MCS, compliance, and legitimacy, Myeik offshore fishery.

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List of abbreviations

ASEAN	Association of Southeast Asian Countries
CMMs	Conservation and Management Measures
CPUE	Catch Per Unit Effort
DoF	Department of Fisheries
EEZ	Exclusive Economic Zone
FADs	Fish aggregating devices
FAO	Food and Agriculture Organization
GRT	Gross Register Tonnage
HP	Horsepower
ITQs	Individual Transferable Quotas
IUU fishing	Illegal, Unreported and Unregulated fishing
LED	Light Emitting Diode
LPS	Light luring purse seine
MCS	Monitoring, Control, and Surveillance
MFF	Myanmar Fisheries Federation
MH	Metal Halide
MOALI	Ministry of Agriculture, Livestock, and Irrigation
MSY	Maximum Sustainable Yield
MT	Metric Ton
NGOs	Non-governmental organizations
RFMOs	Regional Fisheries Management Organizations
SEAFDEC	Southeast Asian Fisheries Development Centre
TACs	Total Allowable Catches
TPS	Thai purse seine
VMS	Vessel Monitoring System

Introduction

Artificial light in fishing operations is a technique for attracting and aggregating fishes to capture them using hooks, gill nets, purse seines, beach seines, cast nets, and other methods (Solomon & Ahmed, 2016). Light can be used in surface water and underwater to lure and harvest fish and is used in several fisheries worldwide. The attracting and aggregating ability of light use results in catching immature fish and vulnerable pelagic species, especially when combined with less selective fishing gear or very small mesh-size nets used in fishing (Solomon & Ahmed, 2016).

Mohamed (2016) stated that Japan is one of the most important countries in the world for light fishing. Light fishing is highly popular in Japan as Mohamed (2016) stated that more than half of purse seine vessels, and all stick-held dip nets and squid jigging boats, used artificial light. Fishers consider that more light equals more catches. Both surface and underwater lighting were used in purse-seine fisheries whereas only surface lamps were used in stick-held dipnet and squid jigging fisheries. The maximum power output for lighting is regulated based on fishing methods, regions, boat sizes, and other factors. This helps to avoid light competition within sectors and conflicts across sectors.

Light fishing is a successful modern fishing method, and it has been utilized in different fishing gears in Indonesia (Ben-Yami, 1976). Light fishing with electric lamps such as incandescent, fluorescent, and mercury lamps has been widely disseminated to offshore fisheries to the large-scale commercial level for lift net (Bagan), boat seine, and purse seine (Sudirman et al., 1992). Light fishing technology has been proposed to the fishermen to improve catches and conserve this technology as part of implementing sustainable fisheries in Indonesia. However, the research on the impact of light fishing, particularly purse seine and lift net fishing (Bagan) has been limited. Bagan is a lift net with a fine mesh size of 0.5 cm that is operated with a light to attract pelagic fish (Sudirman et al., 1992).

Gakkaishi (1992) analyzed the catch composition of Indian squids by light luring fishing in the Gulf of Thailand. The study used a 2.5 cm mesh size stick-held cast net with a mouth surrounding the length of 50 m and thirty-four incandescent light bulbs of 500 W, including two red spots-lights to lure and capture squid and fishes. The research vessel was equipped with light bulbs attached to six bamboo poles of 6 m length that stand out from the vessel and

the lights are switched on at night. Four or five hauls were made regularly from the evening to the following day. The cephalopods, commercial fishes, and crustaceans were caught in the net. The catches consisted of over 50 percent squids and nearly 40 percent of commercial fishes, respectively. The author found that the presence of other species had a greater impact on variations in Indian squid catches than the elapsed light luring time. Furthermore, it was claimed that prey size, such as position in a size hierarchy among species, substantially impacted the number of squids caught. The light fishing technology in Thailand described by Gakkaishi (1992) is probably similar to operations with Myanmar squid fishing with the light luring method in the past. Additionally, a 2.5 cm mesh size net is equal to a one-inch mesh size restriction in Myanmar's existing regulations of light fishing. However, fishers use less than a one-inch mesh net in squid light fisheries, resulting in increased bycatches today. These activities of fishers are the main non-compliance issues with the regulations of light fishing in Myanmar.

Maeroh et al. (2019) studied the purse seine fishery involved in light fishing in the Andaman Sea. The authors studied species composition and a CPUE of neritic tuna with three fishing methods: Thai purse seine (TPS), light luring purse seine (LPS), and purse seine with fish aggregating devices (FADs). Three purse seines used a black nylon net with a mesh size of 2.5 cm, a length of 1,000-2,000 meters, and a depth of 100-150 meters. The difference between TPS, LPS, and FADs was that TPS gathered fish using a purse seine and a fish finder, such as an eco-sounder and sonar, to detect fish schools. LPS and FADs used one to four light-luring boats for aggregating and catching fish. This light-luring vessel had an LOA of 14-26 m and was powered by a 100-150 horsepower engine and a 40-kW electric generator with 50-56 light bulbs of 400-500 W. Bamboo poles, rope, and coconut leaves were tied to a concrete block serve as the FADs used fish aggregating devices to catch fish. The authors described their results as species compositions found four species such as Eastern little tuna or kawakawa, long tail tuna, bullet tuna, and frigate tuna, and the neritic tunas were caught in the Andaman Sea by the three purse seine fisheries: 825.0 kg/day (38.5%) in TPS, 161.0 kg/day (9.5%) in LPS, and 148.8 kg/day (7.9%) in FADs. The highest CPUE was Eastern little tuna, long tail tuna, frigate tuna, and bullet tuna was 66.6, 64.9, 33.0 and 24.1 kg/day, respectively. The LPS fishing methods in this study are also used among fishers in the offshore purse seine vessels in the

Tanintharyi region of Myanmar. However, the light luring method is not permitted in offshore purse seine vessels in Myanmar.

The fishers of Myanmar utilize artificial lights in fishing gears such as purse seine and squid seine in both inshore and offshore fisheries. Light fishing is relatively new in the country and was adopted from Thailand and has been popular among fishers for the last couple of decades. Fishers used light luring methods to catch squid in inshore and offshore fisheries and license permission for squid fishing in the offshore fisheries was set in 2010. Technological advancements have led fishers to use higher light intensity combined with very small mesh fishing nets. The squid fishing vessels and offshore purse seine vessels in the Tanintharyi region use a light luring method to catch squids and pelagic fishes at night. However, offshore purse seine vessels in other coastal areas such as the Yangon region, Ayeyarwady region, and Mon state do not use the light luring method for catching pelagic fishes.

Light fishing in Myanmar is developed in the southern part of the country, the Tanintharyi region, including the three districts, Dawei, Myeik, and Kawthoung (Figure 1). Due to the limited time and objectives of the thesis, the offshore fishery in the Myeik district was chosen as a study area because it has good conditions for collecting the data, and it is the biggest of the three. The fishing gears such as trawl, purse seine, drift net, long line, stick-held falling net, and trap are currently used to catch aquatic animals among fishers for offshore fisheries in the Tanintharyi region. The light luring method is utilized by fishers in purse seine and stick-held falling net among offshore fishing gears in the Tanintharyi region. According to DoF (2019), there were 1463 offshore fishing vessels in the Tanintharyi region, and 275 and 381 offshore vessels were purse seine and stick-held falling nets in 2019 respectively. Nearly one-third of offshore vessels used lights to catch squid and fish in the Tanintharyi region. Among them, 172 and 189 fishing vessels were purse seine and stick-held falling nets, respectively, in Myeik offshore fishery.

There are three different types of light fishing practices in Myanmar where fishers use stick-held falling nets and purse seine nets to catch fish. The first targets squid using metal halide (MH) lamps to attract and aggregate squid, and then turn on two spotlight lamps (white and red) at night. The squids gather near the surface of the water and are caught with a stick-held falling net, as shown in Figure 2 and the offshore squid fishing vessel is shown in Figure 3. The

second type of light fishing is found in pelagic fisheries, especially in the anchovy fishery. This group also uses MH lamps to aggregate fish. Nine spotlight lamps (a red one in the centre and eight surrounding white lamps) are used to attract and aggregate fish near the surface of the water, and then fish are caught with a stick-held falling net.

The third type of light fishing involves purse seine vessels using light to attract and aggregate fish before setting the purse seine. Before the introduction of light fishing, fishers in this group previously used a floating cage equipped with light bulbs to lure pelagic fishes near their purse seine vessels. However, fishers currently use another vessel equipped with light-emitting diode (LED) lamps and MH lamps to attract and aggregate pelagic fishes at night. Fish are then caught with fishing nets from purse seine vessels in offshore fisheries. Purse seine vessel and light luring vessel of the third type of light fishing are shown in Figure 4.

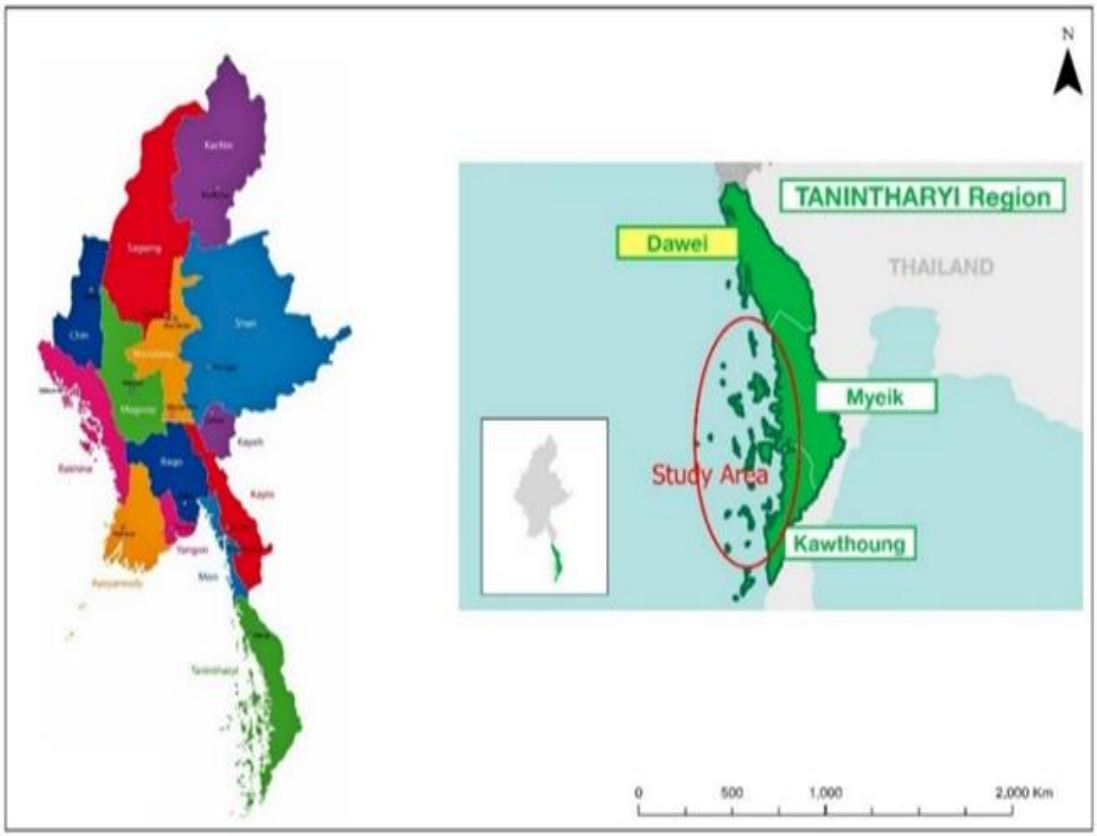

Figure 1. Location of the study area: Myeik offshore fisheries in Myanmar

Source: Myanmar map vectorstock.com and Myanmar travel minglago.com in google

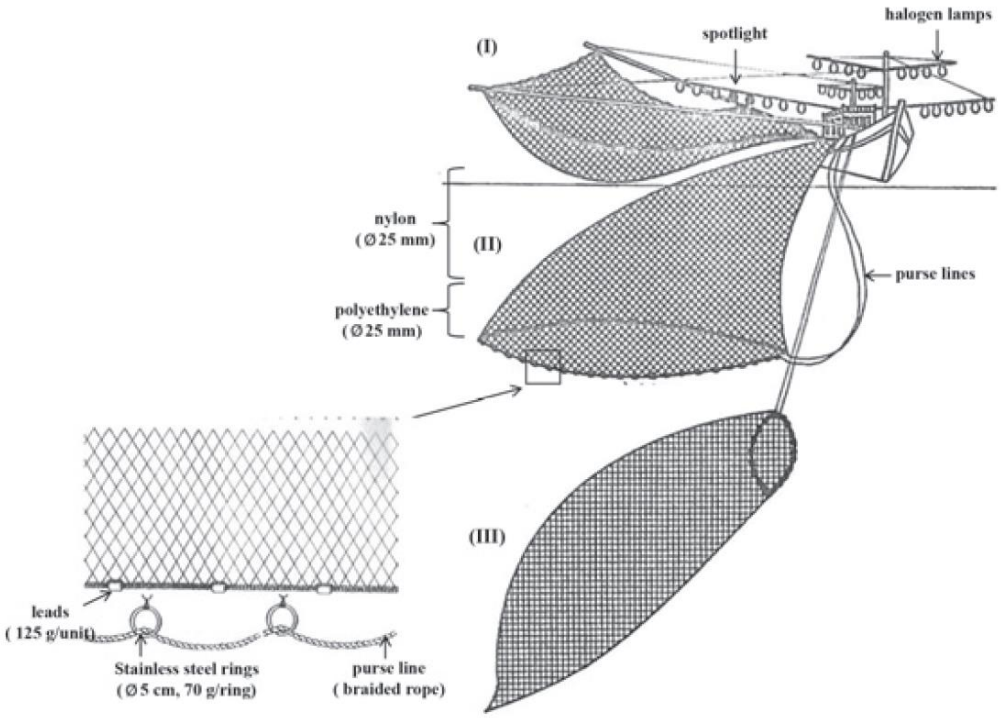

Figure 2. Structure and operation of the stick-held falling net for squid fishing

Source: (Arkronrat et.al, 2017)

Figure 3. Offshore squid fishing vessel in Myeik offshore fisheries in Myanmar

Figure 4. Purse seine vessel (left) and light luring vessel (right) in Myeik offshore fisheries

The state of fisheries and fisheries regulations in Myanmar

Myanmar is among the top ten fish-producing countries in the world with annual catches of more than three million tons of fish, providing 43% of the country's consumed protein (Tezzo et al., 2018). The inshore fisheries cover an area from the shoreline to 10 nautical miles and industrial fishing vessels operate offshore from 10 nautical miles to the border of the Exclusive Economic Zone (EEZ) (DoF, 2019). The township officers from the department of fisheries (DoF) are authorized to give licenses in the Myanmar inshore fishery, and the size of the vessel is restricted to 40 feet length and the engine's horsepower is 50.

There are no restrictions on harvest amounts, vessel numbers, or fishing gear licenses in the inshore marine fishery of Myanmar. Traditional fishing gears such as trammel net, drift gill net, bottom set gill net, beach seine net, stationary lift net, stow net, long line, and traps are popular among fishers in inshore fisheries. Offshore fishing grounds are available to trawlers and purse seiners with a length of more than 40 feet and a horsepower of more than 50. Licensing is done by the union-level DOF (World Bank Group, 2019). Trawl, purse seine, drift

net, stick-held falling net, long line, and trap are found in offshore fishery. The DoF has imposed annual closed seasons and closed areas to protect spawning periods of the fish species in the offshore marine capture fisheries. The closed season from June 1 to August 31 was established during the 2018-2019 fishing season in Myanmar 2018 (DoF, 2019). The fishing industries along the Tanintharyi coast produce products for consumers in Myanmar and some are exported to foreign countries. Thailand is the primary export market for fish collectors and exporters in the Tanintharyi region because of the Myanmar-Thailand normal trade and border trade of fishery products. This part of the country is the primary fishery product market in Myanmar.

One major problem in Myanmar's marine fisheries is declining catch rates in the wild capture fisheries. There is no quota system or limitation on catches for fishing vessels in Myanmar marine fisheries. Fishers want larger catches to enhance their profits and are not interested in conserving fisheries resources, perhaps, because they lack knowledge of how to achieve this. Fishing activities are not recorded in logbooks, which causes difficulties in getting the biological data and fisheries effort data to support proper fisheries management decisions. Fishers must report their fishing records in logbooks for each trip following the restrictions of offshore fishing licenses. Nevertheless, there is a lack of fines or social punishment for not writing logbooks, and fishers neglect to record their fishing activities in Myanmar.

Since 2013, the R/V Dr. Fridtjof Nansen has visited to survey Myanmar's EEZ twice. While differences in survey design make comparisons between surveys difficult, it has been estimated that the standing stock biomass of Myanmar's pelagic fish declined by 80% from one million tons to 190,000 tons between 1980 and 2013. Similarly, the biomass of demersal fish standing stocks fell by 50%, and size compositions suggested a considerable loss in the most valuable commercial species, such as threadfin bream, croakers, sea catfish, and snappers (Thomas-smyth et al., 2020).

In 1980, Myanmar's total annual marine maximum sustainable yield (MSY) was predicted to be 1.05 million tons (Hosch et al., 2021). According to the 2013 R.V. Fridtjof Nansen survey, fish stocks have declined dramatically since 1980. However, Myanmar's official fisheries data do not reflect the biomass decreases observed by the Nansen surveys (Hosch et al., 2021). Official statistics are based on central government-set growth targets, which causes overstated harvest estimates. According to Hosch et al. (2021), the official marine fishery

harvest statistics for the fiscal year 2017–2018 was 3.15 million tons, more than three times the marine fisheries MSY estimated by the 1980 marine fisheries survey and slightly under three times the annual catch predicted and published by FAO for 2016.

No definitions and laws refer to light fishing in the marine fisheries law of Myanmar. However, according to the 1990 Myanmar marine fisheries law, section 22 under chapter seven, the Director General of DoF has the authority to determine the following; (a) type of fishery, the volume of business and duties and fees; (b) method of catching fish, period of fishing, species of fish permitted to catch, size of fish, fishing implement and fishing grounds; (c) license conditions (Law et al., 1990). The light luring method was not permitted legally to catch squids for fishers in Myanmar marine fisheries before 2018. However, squid fishing with artificial light was popular among fishers in the Tanintharyi region. Based on this, the DoF decided to reduce unwanted results from using artificial light from squid fishing in 2018 and imposed the following new rules:

1. To permit 15 kW of light power for inshore fisheries and 40 kW of light power for offshore fisheries
2. If offshore fishing vessels catch fish in the inshore fishing ground, to be punished by cancelling the fishing license
3. Prohibit the use of less than one-inch mesh size (especially 3mm mesh size) fishing net or parkyikyan net (traditional name) in light fishing for both inshore and offshore in this fishing
4. Due to the banning of light fishing in some nations, to decide by discussing how long should the use of light be permitted for squid fishing in the future

Thus, decisions and restrictions on the existing regulations of light fishing, which the DoF published in 2018 influenced only squid fishing with the light luring method in the Tanintharyi region in Myanmar. The letter document of these existing regulation of light fishing is illustrated in the appendix. According to the restrictions and regulations of offshore fishing licenses in Myanmar, fishers who own fishing licenses for stick-held falling nets have to catch squids only in offshore fisheries. However, fishers today use the light luring method in both squid fishing and pelagic fishing in the Tanintharyi region.

The updated Myanmar marine fisheries law is currently a draft, and the DoF had planned to include an amendment and enactment of light fishing regulations in the new marine fisheries law. This progress has the potential to modify the existing regulations of light fishing by simplifying and legislating laws for fishers in the future. On the other hand, fishers should collaborate with fishery managers to discover the appropriate intensity of light power use and fishing gear used in light fishing by discussing target species, bycatch, and catch composition to get biological data for fisheries management.

Lack of compliance with fisheries regulations

The goals of fisheries management are to reduce overfishing and conflicts between user groups (Viswanathan, 1997). Regulations that constrain the use of fishing gears and vessels, seasonal and area closures and quotas, and mandate fishing licenses are frequently used to combat the overfishing that results from open access to fish resources (Anderson 1986; Clark 1990). Gear limitations, and zones that divide user groups are frequently used to address user issues. Fishers are often subjects of monitoring, surveillance, and enforcement, just like most other regulated economic actors (Viswanathan, 1997). Effective management and conservation of natural resources depend on compliance with regulations; however, non-compliance is common and frequently jeopardizes the establishment of beneficial environmental results in both terrestrial and marine ecosystems (Mackeracher et al., 2021). Even brief periods of illegal fishing can quickly reverse decades of protection in marine environments.

According to Flewwelling (2001), Myanmar maintains strict interdisciplinary port state restrictions for vessels that enter and exit their ports but no effective fisheries management. Additional MCS training is essential because the at-sea capabilities are very constrained. Other challenges include a shortage of skilled staff and inadequate fisheries management facilities. Unfortunately, departmental interest in addressing these challenges is greater than the government's priority for the fishery business. Myanmar needs significant help in planning, infrastructural facilities, updating its legislation to comply with international standards and commitments, and suitable integration of sustainable fisheries management processes in the fishery sector (Flewwelling, 2001).

The DoF cooperates with regional and international organizations to supervise marine capture fisheries with international laws and existing marine fisheries laws in Myanmar. To prevent illegal, unreported, and unregulated (IUU) fishing, the DoF monitors the fishing vessels with a vessel monitoring system (VMS) in the offshore fishery and cooperates with the Navy to patrol and arrest vessels acting illegally on the fishing grounds. Illegal fishing activities such as fishing without a license, violating the rules by catching on inshore fishery grounds, and fishing with prohibited fishing gear are mostly found. For example, fishers often use prohibited fishing gears, like a 3 mm mesh fishing net in squid fishing and some fishers operate without a license in the Myanmar offshore fisheries.

Although squid has been the main target species of light fishing from the beginning, fishers have shifted towards higher catch rates of small fish or trash fish because of the high demand from the fishmeal industry in Myanmar. There are five fishmeal producers in Myeik township producing fishmeal from trash fish. In the Tanintharyi region, low-value or trash fish species are used for fishmeal. The artisanal fisheries caught trash fish as bycatch in Myanmar twenty years ago. However, fishers currently intentionally chase trash fish throughout their fishing trips due to price and demand incentives for trash fish. A major portion of this trash fish is intended for the fishmeal industry, which is processed for export (Myo et al., 2018).

These economic opportunities, selling trash fish in fishmeal industries have led to fishers' violation of light fishing regulations in Myanmar. Light luring methods can increase bycatches or trash fish in squid fishing. Some fishers also use very small mesh-size fishing nets to increase catches of trash fish because of the value of bycatch species in light fishing. If there is no restriction for target species (squid) and quota system, the catching rate of non-target species will increase leading to overfishing.

The DoF limited the capacity and resources to monitor or enforce illegal fishing activities in the offshore fishing grounds and EEZ areas. The DoF only influences the monitoring or arrests of offshore vessels in landing sites and checkpoints (one-stop service) where the area can check fishing gears, licensing, and crew lists of each offshore vessel before a fishing trip. In addition, the lack of inspection vessels in DoF results in weak monitoring and patrolling at sea.

In Myanmar, all fisheries subsectors have low resource monitoring and resource management capacity (Tezzo et al., 2018). Fisheries have been primarily used as a source of money by

successive governments, leaving the DoF ill-equipped to manage fisheries resources sustainably (Johnstone et al., 2013). There has been little investment in strengthening national research and extension capabilities. The union government's conservative position towards a sector long known for its corruption is likely reflected in the low political position allocated to fishers (Tezzo et al., 2018). Due to a lack of monitoring, control, and surveillance capabilities, as well as a lack of coordination among the respective authorities in Myanmar, the marine fisheries have been characterized by weak regulation and enforcement (Tezzo et al., 2018).

Possible reasons for non-compliance

This study's overarching research question is why fishers disobey the regulations regarding light fishing in Myanmar offshore fisheries. The study explores the possible reasons influencing fishers' non-compliance with the regulations of light fishing. This study investigates the fishers' behaviours, incentives on their work culture, their perception and understanding of regulations, factors that cause weak management and enforcement, and fishers' reasons to comply or not with existing regulations of light fishing. The study will then assess the motivation of regulations and the work culture among the fishers for implementing the proper regulations and suitable fishing methods of light fishing in Myanmar. Therefore, the study aims to discover the actual light fishing activities of fishers in the Myeik offshore fishery. Besides, when fishery managers consider implementing the appropriate rules and regulations for light fishing in the future, this study will give the DoF a hint for the importance of regulations' legitimacy to modify again.

Four hypotheses are used to discuss possible reasons for the non-compliance attitudes among fishers for light fishing regulations. They are:

- **Ignorance** (fishers have no knowledge about the regulations or do not know the content of the regulations)
- **Lack of opportunities** (fishers have no other alternative than keep fishing the way they do)
- **Disagreement** (fishers find the regulation illegitimate and oppose it by breaking the rules)

- **Profit-maximising behaviour** (the cost of possible punishment for not following rules is less than the gain of acting illegally)

The four hypotheses are presented one by one below, although they could be interrelated in different ways. It is useful to identify specific reasons even when more realistic explanations are more complex and composed to clarify different reasons for non-compliance.

Hypothesis 1: Ignorance

Fishers could conflict with the light fishing regulations without knowing it. Some might prefer to ignore information under certain conditions rather than comply with the regulations. This attitude presents tricky normative concerns, which may be advantageous for people to satisfy their preferences for ignorance in certain instances of gaining more profits. On the other hand, it may be preferable to discourage or fully eliminate people's ability to stay ignorant.

Ignorance of governmental or institutional regulations represents a problem of potential conflicts between people. If individuals break the existing legitimate regulations, representatives from governmental institutions will punish them. Teichman et al. (2020) investigated the institutional consequences of such findings and the policy measures that should be employed in conjunction with deliberate ignorance. According to Teichman et al. (2020), policymakers could enforce the development of information by regulating data collection, removing barriers to the free flow of information, and requiring decision-makers to include the data in their decisions.

Individual's ignorance of information can be facilitated by establishing agreements among them like contracts or making enforceable promises in society. Contracts could affect the ignorance of facts to be restricted agreements that are limited to informational assets (Teichman et al., 2020). Additionally, the proper regulations can enhance the responsibilities and trust to each other among people, like contracts or making enforceable promises. If people ignore the regulations in their works and industries, it can lead to non-compliance behaviours. Default norms, interpretive conventions, and breaching punishments are all ways that legal institutions might assist in the process of ignorance contracting when it is desirable.

Furthermore, when ignorance contracting appears to be unacceptable for normative reasons, legal authorities may impose restrictions (Teichman et al., 2020). Legal authorities are government institutions and they can impose laws and regulations to prevent illegal activities and violations of rules worldwide. Thus, government institutions are essential to administer the people and be aware of the ignorance of regulations among people globally.

The institutional theory is relevant to determining the significance of ignorance to regulations compliance. The institutional theory focuses on social institutions that include individuals who share similar thoughts and behaviour and have stable expectations of the behaviour of others. For different groups and individuals, including members of various academic disciplines, the term "*institution*" may mean different things. It is also one of those words that are widely used, not only by scientists but also among the general public (Tuckman & Lavell, 1960). According to Parsons (1990), institutions are structures of norms that "regulate the relations of individuals to one another" and "define what the relations of individuals should be".

Ostrom (1984) pointed out that individuals use organizations to determine who and what is included in decision making, how knowledge is organized, what actions should be taken and in what order, and how individual actions can be aggregated into collective decisions. The institutional theory focuses on the roles of social, political, and economic systems in which communities operate and gain legitimacy. Institutions are made up of cognitive, normative, and regulative systems and behaviours that provide social behaviour with consistency and significance (Scott, 1995).

Under the regulative pillar of institutional theory, governmental institutions issue codes of conduct, such as quotas and gear restrictions. Fisheries laws are more numerous and unstable than most other industries due to their great variety, complexity, and dynamics. User compliance with rules is a persistent concern for management agencies (Jentoft & Mikalsen, 2004). According to the normative pillar of institutional theory, when rules are well-established, breaking them is seen as immoral. As a result, as argued from a reasonable choice perspective, compliance is not just subject to measured risk on the part of those who fish. It also has moral implications. Honesty is a prized social virtue, and cheating is similar to disobeying the community's voice or any higher power (Jentoft, 2004).

In the cognitive pillar of institutional theory, fishers occasionally break the rules because they are unfamiliar with them. Fisheries management laws are complex, varied, and dynamic, making them difficult to comprehend. If the issue is that fishers are unaware of or do not understand the law, the issue is mostly one of communication when managers do not get the message across to the fishers (Jentoft, 2004). The compliance issues arise in this case when fishers do not fully understand the regulations or have a socially constructed idea or knowledge about the problem.

In Bangladesh, ignorance of the law has been highlighted as the main cause of non-compliance with regulations (Kuperan & Jahan, 2020). Fishers from around 74 percent of gear operators, such as small mesh drift nets and set bag nets did not know the mesh size regulation. According to Kuperan & Jahan (2020), one of the possible explanations for the fishers' ignorance of the legislation was the fishers' insufficient institutional linkage with the DOF and other relevant government and non-government groups responsible for fisheries management. All the gear operators stated that their perspective was never regarded when the fishing laws and regulations were formulated. The fishers have no role in the decision-making process for formulating fisheries rules and regulations.

It may be difficult for fishers to comply with the regulations affecting their livelihoods negatively; thus, fishers may resort to ignorance or lack of knowledge for breaking the laws and regulations regarding light fishing. On the other hand, fishers may not know the regulations due to weaknesses of formal educational background which may affect fishers' perspective of compliance with regulations depending on their morals.

The expression "social capital" refers to the norms and social networks that encourage cooperation among people and groups of individuals (Grafton, 2005). Social capital, as a sort of capital, can be increased (by volunteering) or depleted (by criminal behaviour) on an individual level, as well as through collective acts (such as public education). It is also influenced by a variety of socio-economic factors (such as per capita income, age structure, ethnolinguistic divisions, the rule of law, etc.) (Grafton, 2005).

According to Grafton (2005), the effectiveness or quality of social relationships is influenced by trust, specifically wide-radius trust. In fishing communities, trust is crucial, because it helps to reduce the expenses of fisheries management. If fishers trust one another to follow local

and regulatory regulations to maintain the fishery, and this trust is justified, the costs of monitoring individual fishers' behaviour are decreased. Additionally, altruistic behaviour that motivates fishers to follow the rules can minimize compliance costs. As a result, social capital is valuable since it allows fishers to harvest a particular catch for less money while improving the chances that the resource will be sustained in the future.

When fishers and authorities have a proper working relationship and trust with each other, knowledge and information about the resources are shared (Pomeroy & Berkes, 1997). This type of knowledge sharing can decrease regulatory costs while also improving management outcomes. Fishers, for example, become more aware of the implications of their collective actions on the resource because of an effective exchange of ideas, while administrators gain from appropriate consultation about changes occurring in the stock and environmental situations (Grafton, 2005).

Co-operations among the fishers, and between the fishers and regulators and government agencies are essential to managing well in fisheries operations. Fishers and fishery managers are institutions and community-based co-management is suitable for cooperation among them. When co-management is developed between fishers and fishery authorities, fishers can advise fishery managers by consulting to make the decisions in fish stock assessments, monitoring, and enforcement (Grafton, 2005). Co-management refers to a situation, where the government and fishing communities share management responsibilities (Nielsen et al., 2004). It can be described as a series of institutional and organizational procedures (rights and rules) that define the fisheries agencies and relevant fishing societies' cooperation (Nielsen & Vedsmand, 1999).

Hypothesis 2: Lack of opportunities

People normally depend on their professional business for their livelihoods. However, if people do not earn enough for their living from their business, they need alternative jobs to improve their incomes. For example, most people in coastal areas work in fishing businesses for their livelihoods. Nevertheless, fishers can occasionally break the regulations to get more income, with the result that catch rates decline in fishing. Therefore, an alternative livelihood

or job is important for people to gain more income and they sometimes reduce compliance with regulations to earn extra income.

To improve fisheries management, alternative livelihoods must be offered to fishers due to the current level of fishing pressure and decreasing catches in small-scale fisheries (a step towards reducing fishing effort) (Asiedu & Nunoo, 2013). The establishment of alternative livelihoods is regarded as a successful strategy for reducing the exploitation of local natural resources and enhancing the welfare of its users (Hanh & Boonstra, 2019). Alternative livelihood is viewed as a means of assisting and motivating fishers who depend on fisheries resources to abandon destructive harvesting methods (Asiedu & Nunoo, 2013). Fisheries poverty reduction may be facilitated through alternative livelihoods (Neiland, 2004).

Alternative income sources will decrease fishers' excessive reliance on and overuse of fishery resources, reduce fishing effort and assist stock recovery, all of which will contribute to effective fisheries management (Asiedu & Nunoo, 2013). So, expanding alternative job opportunities for fishers should be a priority for governments and other interested parties (Asiedu & Nunoo, 2013). Fishers with other means of income tend to fish less and are consequently more likely to leave the industry compared to persons for whom fishing is their only source of income (Cinner et al., 2009; Daw et al., 2012; Muallil et al., 2013). Fishers are unwilling to pursue other careers when the incentives and profits from fishing are comparable to other alternative livelihoods. Furthermore, fishers enjoy benefits from fishing that competing employments might not offer, such as autonomy, self-direction, and pleasure (Pollnac et al., 2001).

Aquaculture is a potential alternative livelihood to gain a secondary source of income for people living in coastal areas in Thailand. The country's coastal pond-culture and cage-culture systems demonstrate how beneficial and successful aquaculture can be, more than making up for the lack of exclusive fishing zones (Tokrisna et al., 1997). The development of marine aquaculture is also a result of other factors that accelerate production, including overfishing, high fuel prices, degradation of the aquatic environment, and decreased fish supplies that reduce catch. Additionally, there exist technologies for efficient production and processing as well as optimal locations. The coastal culture can therefore grow further in a technologically and physically possible manner. While reducing fishing pressure on natural stocks, well-

planned activities and efficient production of cultured marine fisheries would improve the standard of living for coastal populations (Tokrisna, 1997).

Thomas-smyth et al. (2020) explained in their study that Myanmar's inshore and offshore marine fishing industries have limited economic resiliency. A shift in catch composition from larger, more valued species to smaller, less valuable species, as well as a drop in overall catch, has put significant economic pressure on fishers and companies to keep fishing harder. While the DoF initiated a project in 2005 to improve aquaculture practices in inland and coastal communities to help rural development and reduce poverty, inshore fishers have few other options. Many community members claim that illegal fishing happens during closed seasons or with illegal gear due to a lack of alternative income sources, and they voice some opposition to more restrictive management methods that would diminish their incomes (Thomas-smyth et al., 2020).

Myanmar marine fisheries are facing excessive fishing pressure and decreasing catches today. Establishing alternative livelihoods for fishers may provide incentives for reducing fishing efforts. Inshore fishing is allowed throughout the year while offshore vessels are not permitted to catch fish during the closed season of the annual year. The offshore vessels currently get 60 days for one trip to catch in the offshore fishing grounds. Squid fishing season differs from other fishing gears in Myeik offshore fishery because squid fishing cannot work in the rainy season (June to September). The rains make it unsafe to use electrical equipment to lure and aggregate fish at sea. Therefore, most squid seine vessels or stick-held falling net users stop their fishing operations during the rainy season, and some owners maintain their vessels to prepare them for the next fishing season. Squid light fisheries on both inshore and offshore usually start in October and end yearly in May (Htoo, 2021). Besides, the light fishing operation is done at night during the period of waxing and waning moon phases in Myanmar. The working days of offshore squid seine vessels are 23 days per month (Htoo, 2021).

Fishers engaged in light fishing catch squid with other fish species in fishing grounds where squid is abundant. Due to the increase of fishing vessels and the unequal usage of light power and fishing nets, the catch rates of squid have declined year to year. Therefore, fishers have shifted to catching squid and trash fish together to maximize their income. Most fishers from light fishing prefer to earn by this fishing method rather than other fishing gear both inshore

and offshore. Fishers lack opportunities to catch squids and fishes during the rainy season and closed fishing season in Myeik offshore fishery.

Hypothesis 3: Disagreement

When people find that regulations are illegitimate, individuals will oppose the rules by breaking them. Despite intensified enforcement efforts, the non-compliance in many fisheries has highlighted the need for legitimacy of fisheries management (Nielsen, 2003). Jentoft (1989) emphasized four factors in this context: (1) regulation content; (2) distributional effects; (3) regulation making; and (4) regulation implementation, with the hypothesis that "the more directly involved the fishers are in installing and enforcing the regulation, the more the regulation will be accepted as legitimate". Legitimacy is viewed as a normative reality and differs from morality because it is related to political authority (Nielsen, 2003).

Since fishers are assumed rational agents, compliance is already understood and illustrated in the fisheries management literature. In the sociology literature, this perspective on compliance is frequently regarded as an instrumental approach. The normative approach of compliance deals with fishers' social relationships and standards. Social relationships can work in either direction, providing incentives or disincentives for compliance. Norms are often defined as regular acts, attitudes, norms, and expectations among fishers that are impacted by peer behaviour and attitude (Nielsen, 2003). This combines moral principles created via interaction with other group members and personal values formed through personal considerations. They frequently impose both positive and negative consequences. According to Nielsen (2003), the fishers' morals and perceptions of what is right and wrong, as well as personal experiences with enforcement officials and the court will significantly impact their attitudes toward compliance and non-compliance.

People's ideas about the normative acceptability of government structures, officials, and processes give rise to legitimacy. It is important to understand that rules and regulations must be followed regardless of who made a choice or how it was made (Tyler, 2006). The term "legitimacy" refers to the public's acknowledgment of government officials' authority to govern (Levi et al., 2009). Individuals who believe that government is legitimate are more likely to respect political authority and follow the law.

Although authority can be used to rule, legal power makes governing easier and more effective (Tyler, 2006). When a new government is formed, one of the most important factors determining its success is its ability to create legitimacy among its population (Gibson, 2004). To promote commitment and agreement, governments must spend more resources on monitoring and enforcement if they lack legitimacy. Governments that control primarily with force spend vast sums of money on building a believable surveillance system that can track public activity, reward desired behavior, and punish rule breakers. The existence of legitimacy decreases governance's transaction costs by minimizing dependence on force and surveillance (Levi et al., 2009).

People's interactions with authorities like the police, traffic court, family court, and governmental organizations impact their perceptions of the legal system (Bilz & Nadler, 2014). Even someone who has never found fault with the legal system personally may see how the prevalence of legal institutions and agencies exists. Perceptions of the validity of the rule, its agents, and its organizations are influenced by how individuals see the enforcement of the law in their daily lives (Bilz & Nadler, 2014). People will consider courts as having the right authority to decide how the law should be applied to the extent that they believe such institutions to be legitimate (Tyler & Huo, 2002; Tyler, 2006).

Legitimation is the quality of being legitimized because of being placed inside a framework that considers something to be correct and proper (Tyler, 2006). As explained by Tyler (2006), a collection of ideas can explain or make sense of a social structure in ways that explain variations in authority, power, position, or wealth that are suitable or acceptable. It has long been recognized in the history of social philosophy that persons with power can apply influence over others. Power is the ability to influence others' profits and losses by intimidating or utilizing compulsion to prohibit undesirable behavior or giving incentives to encourage positive behaviors (Tyler, 2006).

The use of power, especially coercive power, needs a significant investment of resources to gain minimal and restricted control over others (Tyler, 2006). It is therefore critical that people are influenced by others in some situations because they trust that the judgments and regulations set by others are in some manner right or legitimate and should be followed (Zelditch, 2001).

According to Nielsen & Mathiesen (2003), whether the regulation's implementation makes sure that the distributive effects are regarded as fair, or the regulations that have been imposed are regarded as meaningful influences on how fishers accept to comply with the regulations (content legitimacy). The fishers' acceptance of regulation is also affected by the regulation's compatibility with traditional fishing procedures and outcomes (Nielsen & Mathiesen, 2003). The perception that the imposed regulations have benefits is a significant motivation for compliance. Fishers will not follow rules that they do not trust will help preserve the stocks. Thus, fisheries managers should consider meaningful, legitimate laws and regulations before publishing them to fishers and all stakeholders in fisheries industries.

Many present fisheries management regulations are set at the federal level and apply to all regions, with offshore and inshore fisheries having different regulations in Myanmar. The regional offices are currently in charge of licensing and enforcement for their local fisheries (with the assistance of the Navy). As a result, the system is far from being "polycentric" (where multiple governing bodies interact to make and enforce the rules) (Thomas-smyth et al., 2020). Polycentric governance structures are more effective and resilient for managing common pool resources like fisheries. The responsibilities are shared among different groups, including more localized groups with stronger incentives to carry them out (as opposed to a central authority), better data, and/or local knowledge on which to base management decisions in a polycentric system (Thomas-smyth et al., 2020).

The existing fisheries laws and regulations are automatically considered legitimate for the fishers because the DoF in Myanmar sets them all. Concerning the legitimacy of existing regulations in light fishing, fishery managers from DoF, representatives from PyidaungSu Hluttaw and MFF, and a few fishers met to discuss imposing the rules before it was published to fishers. Therefore, the designated regulations on light fishing are also legitimate for the fishers; if fishers break the rules, they will be arrested and punished for illegal activities. Fishers must comply with the regulations such as light power and the mesh size of fishing nets in the Myeik offshore fishery. However, observations of fishers' behaviour in the Myeik offshore light fishing show that most fishers assume higher light power is better to attract and aggregate squid and fishes, and a very small mesh fishing net can be also caught more fish.

In addition, regarding the hypothesis of "*disagreement*", fishers are excluded from discussions when making the regulations under some conditions, and the regulations are also drawn

based on traditional knowledge of fishery managers and other stakeholders without scientific research data in Myanmar. On the other hand, fishers only have experience with fishing as their livelihood and cannot precisely report the pros and cons of light fishing to the fishery managers. These gaps between DoF and fishers have implications for the legitimacy of the light fishing' regulations and seem like fishers disagree with the restrictions of the rules.

Hypothesis 4: Profit-maximising behaviour

The philosophy behind utility maximization is that people and businesses should aim to maximize their satisfaction levels because of their fiscal incentives (CFI, 2022). For instance, managers will establish a strategy for obtaining products or services that deliver the greatest advantage when financial operations are restricted (CFI, 2022). Thus, individuals can represent utility-maximising persons or profit maximizing persons. In addition, fishers are also considered utility-maximizing persons who balance the costs (social and economic) of non-compliance behaviour against the expected benefits (Nielsen, 2003). Nielsen (2003) explained that the choice between compliance and non-compliance is based on calculating the economic advantage of avoiding the regulation and the possibility of detection and severity of the consequence. An example is what Sutinen et al. (1990) explained that the high incidence of non-compliance behaviour in the ground-fish fishery on the US East coasts can be explained in part to the comparatively modest economic fines compared to the enormous economic advantage gathered from illegal fishing. Sutinen et al. (1990) demonstrated the importance of instrumental incentives in understanding fishers' compliance behaviour.

Deterrence, intrinsic and extrinsic factors, influence an individual's compliance in general (Kuperan & Jahan, 2020). According to Kuperan & Jahan (2020), deterrence factors include those factors that influence the motivation of an individual vessel owner or boat operator to maximize profits. The intrinsic factors refer to an individual's moral obligation to follow the law or regulation, which is made up of two parts: the individual's moral understanding and the level of legitimacy that the individual accords to the regulation, and the regulatory institution. Extrinsic factors cover the individual's social status in the community. From a strategic point of view, the causes of non-compliance must be identified and understood to develop policies for ensuring compliance. It is also crucial to consider how compliance is

ensured in high poverty levels while developing resource management programs (Kuperan & Jahan, 2020).

Transferring ownership of a finite resource to several users fighting for it is one of the several global management techniques (Pomeroy & Berkes, 1997; Begossi, 1998). However, depending on their individual or collective objectives, each fisher has various preferences towards resource usage (food, sales, or recreation) in fisheries. Limitations imposed by changes in the environment or the state of the market may also affect how fishers use their resources (Salas & Gaertner, 2004). In other words, considering their specific human, social, cultural, and economic settings, fishers develop and employ fishing methods and techniques in response to the limitations they face and their intended purposes. Conversely, when creating management practices, managers frequently make naive assumptions about the character and attitudes of fishers (Salas & Gaertner, 2004).

Illegal fishing has frequently influenced the breakdown of fishery regulations and the ensuing destruction of long-term fishery advantages (Charles et al., 1999). Illegal behavior is still one of the least researched elements of fisheries worldwide even though this issue and its origins in the inefficient administration of fishery regulations have been widely known (Charles et al., 1999). It is considered that, under the law, a fisher has the choice to fish illegally, but that doing so increases the likelihood that the fisher will be arrested and convicted. Due to the declining fish stocks and overfishing, fisheries managers explored different management strategies for sustainable fisheries. The monitoring, control, and surveillance (MCS) system are one of the popular management systems to detect illegal fishing among fisheries managers. The definition of MCS has been illustrated by the FAO (2002) in the following:

a) “Monitoring - the continuous requirement for measuring fishing effort characteristics and resource yields.
b) Control - the regulatory conditions under which the exploitation of the resource may be conducted; and
c) Surveillance - the degree and types of observations required to maintain compliance with the regulatory controls imposed on fishing activities”.

According to Arnason (2009), the MCS activity has two primary goals: to enforce the fisheries management system's norms and to collect fisheries management data. The first operation is similar to law enforcement. The second phase is data gathering and investigation. The type of enforcement intended is determined by the fisheries management system. For example, when fishing days are limited and areas are closed, it is vital to keep track of the fishing vessels' real fishing days and their movement while out on the water. Harvesting volumes must be monitored under a system of harvest quotas. Much of this enforcement and the research necessitate a significant amount of labor and equipment. This is especially true for the portion that must take place at sea.

The Food and Agricultural Organization (FAO) defines IUU fishing as fisheries done without the permission or in violation of national laws, Regional Fisheries Management Organizations (RFMOs) conservation and management measures (CMMs), or international responsibilities mean illegal fishing. The unreported or misreported fisheries in violation of national laws or regulations, or RFMO reporting processes represent unreported fishing. Unregulated fishing refers to fisheries performed in an RFMO area by vessels without nationality or flying the flag of a non-state party to that organization in violation of CMMs, or fisheries have done in an area without CMMs in violation of State responsibilities under international law (FAO, 2021). MCS operations are needed to tackle IUU fishing under fisheries management. In addition, the MCS system may influence to combat the profit considerations of fishers for engaging in illegal activities during fishing.

According to Battista et al. (2018), the stability of fisheries worldwide is threatened by the major issue of illegal fishing. To increase the consequences of illegal behaviour and prohibit it, policymakers and fisheries managers depend heavily on applying strong punishments and active monitoring and enforcement operations. In contrast, many fisheries lack the funds and necessary governance to successfully prevent illegal fishing. While this approach can be effective in fisheries with the resources to sustain high levels of surveillance and effective procedures for applying penalties, these fisheries are rare (Battista et al., 2018).

It is impossible to realize the true scope and impact of unauthorized fishing due to the absence of information on its frequency and intensity (Battista et al., 2018). But it is evident that highly controlled, strictly enforced fisheries have comparatively low rates of illegal fishing (Agnew et

al., 2009), and many of them have high compliance rates for rules like TACs limitations (Grimm et al., 2012). Many fisheries achieve compliance primarily through the imposition of social costs (such as shame), and by building trust in the institutions in charge of the fishery's regulation (Battista et al., 2018). In addition, demonstrating the effectiveness of the regulations themselves is highly dependent on how regulatory authorities and officers interact with fishers for successful compliance with the regulations (Hønneland, 2000; McClanahan et al., 2006).

However, courts frequently find it difficult to enforce sanctions for fishing violations because many fisheries do not have fines related to breaking regulations that are sufficient to serve as a strong deterrent (Sutinen & Kuperan, 1999). Especially regarding fisheries profits, the cost of establishing enforcement levels that result in the best possibility of discovery is frequently prohibitive. Instead of the levels necessary to prevent criminal behaviour, the real levels of punishment are frequently substantially decided by this implementation cost (Arnason, 2013). Regarding research on the behaviour of people, decision making, and compliance in illegal fishing, Battista et al. (2018) explained that a person's confidence level, opinions of the legitimacy of the rules, degree of trust and suspicion, interests in preventing crime, personality, wealth, understanding or knowledge of the likelihood of being caught, as well as socio-economic, ethics, and other situational factors are all thought to play a role in whether or not they will break the law.

Fisheries managers should fully realize the basic objective and role of MCS, considering the available options and management costs to accomplish these goals. A plan on paper or a great management measure may prove impossible or extremely expensive to implement (Agyekum, 2016). MCS efforts should always be an inherent aspect of fisheries management and involve vessel, plane, and land-based inspections, as well as document control of boats, processors, and exporters (Hersoug & Paulsen, 1996). MCS may also incorporate gear control and involve fishermen in data collection and management. MCS aims to aid in good fisheries management by ensuring that suitable controls (input, output, and technological controls) are established, monitored, and followed. In this context, input, output, and technical controls relate to regulatory instruments used in fishery management to achieve certain goals by controlling fishing efforts directly or indirectly. The limited entrance licensing, gear and vessel restrictions, area closures, time closures, and area zoning, global non-assigned catch quotas (total

allowable catches-TACs), allocated catch quotas, catch taxes, and gear or mesh size selectivity are input and output control processes in MCS system (Hersoug & Paulsen, 1996).

Vessel monitoring systems are crucial devices for fisheries monitoring, control, and surveillance, and have been mandated globally by fishery management authorities to reverse the current dismal status of the world's fisheries (Chang, 2011). Although VMS is commonly used to track vessel positions for fishery control and enforcement, the system's possible functions, or applications, are substantially broader. Chang (2011) explored the potential benefits of VMS by utilizing information on vessels location, improving the quality and quantity of logbooks, gaining access to fishery-independent fishing effort estimates and timely CPUE reporting, allowing for regional management and improving the efficient vessel safety procedures for fisheries management.

Fisheries management and the MCS activities that arise are determined by the government's level of engagement with the fishing industry (Flewwelling, 1995). The government can play a very invasive role in the fishing industry, controlling potential income for fishers and micro-regulating the harvesting sector. According to Flewwelling (1995), MCS activities are more than just enforcement operations; they also include data gathering and quality control for use in stock assessments, social and economic activities, and enforcement exercises, which are all part of fishery management and safety-at-sea. MCS operations must be cost-effective and efficient to be successful in fisheries management.

According to the World Bank Group (2019), the enforcement of MCS activities in marine fisheries regions is limited in Myanmar. Despite the huge contribution of the fisheries sector to regional government revenue, which can reach 56 percent in the Ayeyarwady Region, just 0.8 percent of the MOALI's yearly budget is dedicated to DOF (World Bank Group, 2019). In Myanmar, the DoF has established a VMS control system under the MCS procedures to sustain marine resources, maintain native species, protect threatened species, comply with fishery regulations, and take action against IUU fishing vessels, implementing fisheries policy to achieve objectives (DoF, 2019). In the 2018-2019 fishing season, DOF completed a VMS implementation plan and issued Directive No.5/2018 regarding installing and using type-approved E-MTU/Transponders on offshore fishing vessels and carrier vessels. While implementing the VMS system, DOF held all-inclusive conferences in March 2019 that focused on imposing closed seasons and closed areas, even though the main topic of discussion was

the adoption of VMS in offshore fishery. The installation of transponders began on September 1, 2019, and on January 1, 2020, the main VMS control center in Naypyitaw and VMS sub-control centers in five coastal regions and states began surveillance (DoF, 2019).

The navy, which performs at-sea patrolling and policing actions targeting offshore fisheries operations, is overseen by the Ministry of Defence in Myanmar (Pei Ya, 2016). The navy always anchors at sea to defend the country's sovereignty and guard against all illegal activities such as unlawful trading of drugs and illegal fishing. The navy has the authority to arrest fishing vessels when fishers use illegal fishing methods at sea. Then, the navy transfers the arrested fishing vessels to the DoF for punishment and enforcement of the laws and regulations of fisheries. Among the cases of illegal fishing activities in the light fishing process, using very small mesh fishing nets is mostly found in non-compliant fishing vessels.

Discussion

Limitation of the study

The study focuses on light fishing in the Myeik offshore fisheries, Tanintharyi region in Myanmar. Thus, the thesis does not reflect the entire image of Myanmar marine fisheries. However, the research hypotheses data regarding light fishing in the literature could be applied to Myanmar's marine fisheries.

The study could have benefited from using empirical data from questionnaires and interviews. However, my position as the researcher and an employee of DoF would have implications for collecting empirical data using questionnaires and interviews. The questions and interviews regarding illegal fishing activities are sensitive for fishers, and they would not be answered truthfully on the questions. As a result, it was difficult to know the reality of fishing activities in some parts, and I could get biased results from questions and interviews because respondents could know I work in the DoF, Myeik district office. In addition, I could have encountered potential biases with fishers and vessel owners when discussing their compliance with the existing regulations of light fishing in the Myeik offshore fishery. To deal with this challenge, I decided to use the hypotheses-based method to tackle the research problem of the thesis study.

Light fishing is more prevalent among fishers in the Tanintharyi region than in other coastal areas in Myanmar. I could not travel to Dawei and Kawthaung districts in the Tanintharyi region due to the covid-19 restrictions. However, offshore light fishing vessels are landed more in the Myeik district than in the other two districts in the Tanintharyi region. Therefore, I chose Myeik as the study area of my research. Concerning the data availability of my study, I collected available and related data from annual reports of DoF, journal articles, and previous discussions and experiences with fishers, vessel owners, and fishery managers in Myeik.

Impact of ignorance on light fishing in Myanmar

The 1990 marine fisheries law is Myanmar's existing marine fisheries law (Law et al., 1990). The DoF informs the rules of the fisheries to fishers in the inshore fishery via letters by sending them to quarter or village administrators and township authorities. Fishers in the offshore fishery gain access to regulations via letters, fisheries agents, or industry, checkpoints, non-

governmental associations (NGOs) such as the MFF, and governmental departments such as the DoF and the ministry of agriculture, livestock, and irrigation (MOALI). The DoF publishes the declaration of updated laws and regulations to the fishers monthly and yearly.

Fishers earn their livelihoods by fishing based on traditional knowledge and using traditional fishing methods because most fishers have only basic formal educational levels in Myanmar. However, untraditional fishing methods are adopted in offshore fishing from Thailand. A crew can become a master of the vessel when he has good experience and skills in using different fishing gear in the offshore fishery. The vessel owners offer the incentives of job opportunities to masters of vessels to work in their vessels and gain a sufficient salary or 10 percent of profits for the master of vessels. The vessel captains have the authority to manage the crews throughout the fishing trips. Therefore, vessel captains are important fishers to cooperate with fishery managers for fisheries management. If the masters have no knowledge of regulations or do not comply with designated fisheries laws, fishers could probably violate the fisheries' rules because they do not know about regulations.

Regarding the laws and regulations of light fishing in the Myeik offshore fishery, most fishers know these rules, but they do not fully follow the content of the regulations and the objective of this declaration. They are used to engaging in illegal activities such as using more light power than what is allowed by law and by using non-permitted fishing nets in light fishing. If the fishers do not know the fishery regulations, this factor will lead to breaking the regulations. Most fishers are referred to as blue-collars, and their education levels are mostly found at the basic education middle and high school levels, with few fishers graduating from the university in Myanmar. Although fishers have good experience and are skillful at their livelihoods, they fail to report their fishing activities to the DoF, resulting in a lack of effective scientific knowledge to conserve aquatic ecosystems.

To deal with the challenge of ignorance of regulations among fishers in Myanmar, the DoF must encourage awareness of fisheries laws and regulations by explaining and giving pamphlets to the fishers, television advertisements, and publishing them on social media. The fishery managers should discuss with the fishers before regulations are declared on the fisheries. After listening to their comments and perspectives on the regulations from fishers, they will contribute to getting the best results on the regulations. In this way, fishers can know

the regulations and they will be interested in complying with the legitimacy of fisheries laws and regulations in Myanmar.

Discussions and experiences with fishers in the Myeik offshore fishery show that most of them know the light fishing regulations well, and all fishers regarding light fishing are motivated well by the rules, and fishers from trawl and other gears do not know the regulations of light fishing. However, most fishers want to use higher light power than 40kW in offshore light fishing and wish to modify the regulations of light power usage by increasing between 70 kW and 100 kW. The fisheries managers in DoF assume that 40kW of light power is enough to lure or aggregate squid and the existing regulation of light fishing is imposed only on squid fishing with artificial light. So, the use of artificial light in squid fishing has legal activities. However, it can be considered illegal activities when fishers use light to lure fish and other species.

The decision that "due to the banning of light fishing in some nations, to decide by discussing how long should the use of light be permitted for squid fishing in the future" (see light fishing regulations in chapter 1) is one rule of the existing regulations of squid fishing with artificial light in Myanmar. According to this existing rule, fishers cannot know how long they can apply for permission to light use in squid fishing in Myanmar. Therefore, if the regulations modify again to be simplified and better adapted to the actual light use for all light fishing activities, it may be more successful in complying with the regulations of light fishing among the fishers in Myanmar.

Impact of lack of opportunities for light fishing in Myanmar

Most fishers are poor in Myanmar's inshore fishery. However, some fishers or boat owners who own squid fishing vessels are not so poor because they have the capacity and resources to own expensive vessels and fishing nets. The vessel owners in the offshore light fishery invest in instruments and technologies in their vessels, depending on the vessel size. Comments of some fishers and vessel owners from squid light fishing in Myeik offshore fishery show that squid seine has the lowest costs of investments among the offshore fishing gears. They assume that squid seine can probably be profitable during the short term in the offshore fishery at present.

The designated regulations of light fishing apply to all light fishing vessels in Myanmar. The size of offshore light fishing vessel is found from the gross tonnage (GRT) of 10 to 55 in the Tanintharyi region. Regarding these issues, offshore vessels (40 to 55 GRT) can put high power generators and engines than the vessels (20 to 30 GRT). Thus, the different sizes of vessels in light fishing may encourage the fishers to disobey the designated light power regulations, 40 kW in the offshore fishery. The competition of using light among offshore vessels in squid fishing may affect the capabilities of luring time, and it can be led to the lack of opportunities to catch squids equally for the less than 30 GRT vessels.

Fishing is a source of livelihood for many people in the Tanintharyi region of Myanmar. In addition, the local people in this region engage in agriculture and aquaculture for their livelihoods. With a population density of 32 people per km^2 and a total population of 1.4 million, Tanintharyi is one of Myanmar's least crowded regions (Vagneron et al., 2014). In the Tanintharyi Region, 76% of people live in rural areas; they either stay near the coast or along a river. Despite having a wealth of natural resources, the region has a high poverty rate; at 33%, it is 7 percentage points more than the national average. The main source of income in the area is subsistence agriculture, both permanent and shifting (Vagneron et al., 2014).

Although inland aquaculture is well developed in freshwater fisheries, marine aquaculture is slowly developing in Myanmar marine fisheries. Shrimp farming is the primary type of coastal aquaculture in Myanmar, with small-scale operations for mud crab and groupers (FAO, 2003). The industry already provides a large-scale deployment to export revenues and has an opportunity to develop and expand in the future (FAO, 2003). Therefore, soft-shall crab farms, seabass and grouper farming with cage cultures, shrimps farming with pond cultures, and clam farming are currently existing as marine aquaculture activities in the Tanintharyi region. Some people also cultivate seaweeds in the sheltered areas of tide near islands in the Myeik archipelago. There are over 800 islands dispersed throughout the Andaman Sea, just off Myanmar's eastern coast, known as the Myeik archipelago or Mergui archipelago, and mangroves are abundant along the coastal areas and islands (Seahorse, 2020). Thus, these conditions are very good potential to farm marine aquaculture in these areas to reduce capture fishing efforts and get more income as alternative livelihoods for fishers in Myeik offshore fishery.

However, due to the high cost of investments and weaknesses of technologies in marine aquaculture, few people are interested in cultivating marine aquatic animals in Myeik. Marine aquaculture will develop if the government support technologies and subsidies to fishers. The aquaculture sector can accommodate the demand for fishery products and provide food security to people. Therefore, aquaculture is a clear potential alternative livelihood for fishers in the Myeik offshore fishery and it can support the lack of opportunities to earn with other jobs instead of light fishing in Myanmar.

Additionally, there are many beautiful beaches and islands in the Myeik Archipelago of Myanmar. Lampi island, 115 island, Nyaung Wee Island, Phi Lar Island, Myauk Ni island, and Little Torres islands are popular islands in Myeik Archipelago for diving, snorkeling, and swimming (Resort, 2019). Some people like to travel to the beach and islands for vacations in their free time today. Myeik Archipelago is much less well-known than its Andaman Sea neighbors, the Surin and Similan islands, although Thailand has a small number of islands and Myanmar has crystal clear waters, palm-lined white sand beaches, outstanding dive locations, and rich biodiversity (Seahorse, 2020). Myeik Archipelago is one of the nice treasures in the world because it only allowed tourism in 1997 and continues to be prone to a variety of rigorous regulations (Seahorse, 2020). Therefore, tourism could be a potential alternative livelihood for fishers and local people living in Myeik township.

Impact of disagreement on light fishing in Myanmar

Policies and regulations of fisheries are currently imposed by the union-level authorities of DoF in Myanmar. However, the DoF has weaknesses in communication and cooperation with fishers, researchers, stakeholders from NGOs, INGOs and universities, lawyers, and economists to discuss the contents and objective of regulations before publishing the laws to fishers at the township, district, and regional levels. Thus, the existing rules and regulations of light fishing are sometimes challenged, resulting in a lack of compliance among fishers in Myanmar. The legitimacy and compliance with fisheries laws and regulations are important to manage sustainable fisheries for future resources.

Despite the regulations of light fishing being legitimate and enacted to fishers for squid fishing with the light luring method, the discussions with fishers show that they are well motivated

to disagree on the designated light fishing regulations in the Myeik offshore fishery. Thus, some fishers wish to argue with the designated permission of light power (40 kW) in the offshore fishery because it is insufficient to lure and aggregate fish when catching squids and fishes at night. Fishers mostly preferred the 40 kW, 50 kW, 70 kW, 80 kW, and over 100 kW dynamos or generators depending on the size of vessels and the ability of investment opportunities from vessel owners in light fishing. As a result, most fishers want to use 70 kW of light power in the offshore light fishery. Observations of the light luring methods show that fishers' purposes differ a little from others depending on targeted species and fishing gears. Their primary purpose of light use is to lure and aggregate squid and fish at night, and multispecies catch compositions are mostly found in both inshore and offshore fisheries of Myanmar. In my point of view regarding the use of light in squid fishing in Myeik offshore fishery, fishers know the light luring method is easy to lure phototaxis aquatic animals at night and mitigate the time for aggregating squid and fishes to their fishing vessels.

Fishing with artificial light produces greenhouse gas emissions, such as most commercial motorized fishing activities at night. When utilizing the electrical generators onboard the ship to generate the necessary energy for lights in the light fishing operations, carbon dioxide (CO_2) emissions are an unexpected outcome. About 3.19 kg of CO_2 is produced when 1 kilogram of diesel is burned (Matsushita et al., 2012; An et al., 2017). For example, light fishing contributes to 1.3 percent of the country's CO_2 emissions, or around 85,000 MT of CO_2 per year in Tanzania (Mills et al., 2014). These issues point the requirement of light power use restrictions in light fishing. Fishers should use proper minimum light intensity to reduce greenhouse gas emissions for preserving the marine ecosystem.

Regarding the use of light bulbs for luring and aggregating squids and fishes in light fishing, MH lamps are widely used in Myanmar light fishery and the use of LED lamps are quite a few because of the LED light bulb's price. The 500 W, 1000 W, and 1500 W MH lamps are normally used to lure and aggregate squid and fishes in light fishing in the Tanintharyi region. In my point of view, the regulations of light power use in fishing vessels are completely needed to reduce greenhouse gas emissions and minimize the competition of using light power among the light fishing vessels in Myanmar.

Lack of transparent data in fisheries production leads to consumers' trust crisis in government agencies, and the business suffers because of the ambiguity of the fisheries industry's production and trade operations (Jacquet & Pauly, 2007; Helyar et al., 2014). By increasing the transparency for controlling agents like end consumers, NGOs, and management authorities, emerging data technologies may help to solve some parts of this problem (Probst, 2020).

According to DoF (2016), governmental statistics show that yearly fish production in 2016 was 5.6 million metric tons, with marine fisheries, inland fisheries, and aquaculture contributing 54 percent, 28 percent, and 18 percent, respectively in Myanmar. However, the independent stock assessments and studies of data from food consumption surveys, on the other hand, have revealed discrepancies between these and ever-increasing catch numbers (Tezzo et al., 2018). Myanmar's fish production is expected to be 34% marine capture fish, 33% inland capture fish, and 33% aquaculture fish, for a total of over 3 million metric tons in 2016, according to the re-assessment of production statistics by the FAO (Tezzo et al., 2018).

The comparison of statistical data between DoF and FAO above seemed to be the intention of the uncertainty of official statistics. In addition, the statistical data such as CPUE and logbooks in marine fisheries are challenged because fishers and fish collectors are not interested in reporting the fishing records to the DoF. On the other hand, the Dof has the weaknesses of enforcement to fine fishers for not reporting fishing records during the fishing trips. Therefore, fishers in light fishing wish to disagree on reporting fishing records to the DoF in Myeik offshore fishery.

Regarding the "*disagreement*" hypothesis to adjust the existing light fishing regulations in Myanmar, scientific data or research survey is needed to study the positive and negative impacts of light power use, related fishing net mesh sizes such as purse seine net and stick-held falling net. The survey of catch composition and bycatch in light fishing will also need to classify target species and non-target species, size selection of catch composition, and unwanted or bycatch species. Light power testing also needs to prove that 40 kW is sufficient in the offshore fishery and 15 kW is sufficient in the inshore fishery by the DoF. If not so, the existing permission for light power use should be regulated and backed by scientific data. After that, fishing net mesh size in light fishing should be researched to determine catch rates, and species sizes, and classify the suitable mesh size of target species such as squid, anchovy, and

trash fish. This way, the possible scientific data can be obtained to simplify the existing regulations of light fishing in Myanmar.

Probably one of society's most insidious social injustices is corruption (CoE, 2021). The fulfillment of human rights is disproportionately affected, especially by members of excluded or disadvantaged groups, including minorities, refugees, and convicts. It destroys people's trust in legal institutions and negatively influences economic development (CoE, 2021). Corruption is one of the unacceptable behaviors among people, and this behavior may indirectly violate the regulations in society.

In Myanmar, corruption is still pervasive, the rule of law is poor, and many structural problems that support organized crime and corruption have not yet been resolved (Jenkins, 2019). The military's persistent capacity to engage in impunity, the state's fragility, and the state's authority in disputed areas of Myanmar are of particular concern (Jenkins, 2019). Other factors to consider are the influence of cronies on economic cooperation in many industries. For example, cronies influence businesses such as banks, transportation, mining and gas, trades, and fishing in Myanmar.

Regarding the corruption activities of Myanmar marine fisheries, discussions with fishers can be considered that some fishers are willing to comply with the laws and regulations of marine fisheries. However, some fishers are involved in corruption by paying money or other profits to the authorities for fishing illegally at sea to prevent the punishments of authorities when fishers are inspected at both landing sites and fishing grounds. Thus, corruption may also affect fishers' willingness to comply with the regulations of light fishing and to disagree with the rules in the Myeik offshore fishery.

Impact of profit-maximising behaviour on light fishing in Myanmar

MCS approaches are reliable supply to reduce IUU fishing and enhance compliance with laws and regulations among fishers and fishery industries in fisheries management. Flewwelling (2001) noted that MCS approaches involved a two-pronged parallel approach, the preventative approach, and the enforcement approach. The goal of the preventative approach is to promote "voluntary compliance" by helping people accept and follow management

practices. The enforcement approach is supposed to ensure compliance by fishers who disobey the regulations, damaging the fisheries and the financial benefits to other fishers. Inspection, prosecution, protection, and judicial activities are needed to execute or implement these laws. If stakeholders observe non-compliant fishers avoiding the law and earning unlawful returns at the expense of the complying fishers, then voluntary compliance will fail (Flewwelling, 2001).

The monitoring, control, and surveillance definitions highlight MCS as a three-tiered system. Concentrating on the "S" in MCS, or the enforcement phase, without sufficient regard for the value of the other two phases, is a typical fault in developing MCS systems worldwide (Flewwelling, 1995). MCS provides the knowledge and legal justification for sustainable fisheries management and functional design through its monitoring and control features. Because the surveillance phase of MCS is the most expensive, developing countries must look for the most cost-effective capacity to take out activities connected to it (Flewwelling, 1995).

Laws are the central part of MCS in fisheries management. Establishing MCS in the management plan is essential, and fisheries managers must facilitate all stakeholders to follow and work on the MCS activities. Implementing MCS strategies for different stakeholders may not be certain in the short term. Thus, fisheries managers should establish short-term and long-term strategies for MCS activities in fisheries management.

MCS can support several applications to encourage compliance, improve transparency, and help the efficient conservation and sustainable use of marine resources. The monitoring and controlling of human activity and its effects on marine biodiversity, surveillance of vessels, encouraging obedience to rules through openness, penalties, and taking enforcement actions are procedures of the MCS system. All these MCS operations can stop IUU fishing and other transnational illegal activities like human trafficking, forced labor, drugs, and wildlife (Cremers et al., 2020).

The enhancement of the MCS system in Myanmar depends on funding, owning patrol vessels and equipment, promoting MCS procedures, and enforcing the regulations of marine fisheries. The cooperation of authorities such as the DoF, the Navy, and other government agencies such as coast guards and fisheries communities are also important to improve the MCS system in fisheries management. According to Flewwelling (2001), Bangladesh and Myanmar have

strict inter-agency port state regulations for vessels entering and exiting their ports but minimal effective fisheries management. In both situations, their at-sea capability is extremely constrained, necessitating further MCS training. Other restrictions include a shortage of skilled staff and insufficient fisheries management equipment. Unfortunately, departmental commitment to addressing these challenges exceeds the government's desire for this fisheries business.

VMS system is one of the popular MCS activities for monitoring vessels' location at sea or port in the MCS operations for fisheries management. However, it should be highlighted that VMS is a management system that allows the surveillance of vessels with licenses but not unlicensed vessels (Flewwelling, 2001). So, licensing vessels under input controls is relevant to support these issues. In Myanmar, the VMS system started monitoring offshore fishing vessels in 2018, and it was supported to reduce the conflicts between inshore and offshore fishers due to accusations that offshore vessels catch fish on inshore fishery grounds. The offshore vessels were often caught illegally in inshore areas before putting VMS transponders in offshore vessels last decades. These illegal activities can be controlled with VMS centers in DoF today, but the non-license offshore vessels cannot be monitored in Myanmar marine fisheries.

The DoF lacks the capacity not only for inspecting at sea with patrol vessels and monitoring the catching efforts and fishing records (logbooks) but also for controlling the catches or quota system such as TACs and individual transferable quotas (ITQs) in Myanmar marine fisheries. In addition, the DoF conducts a few inspection activities together with the Navy for surveillance of IUU fishing on the fishing grounds. Therefore, fishers occasionally break and ignore to comply with the regulations at sea due to the lack of effective MCS operations. This type of enforcement impacts fishers' non-compliance behavior (Nielsen & Mathiesen, 2003). Discussions with fishers show that fishers expect the enforcement agencies to act immediately when unlawful actions occur, especially among the chronic violators, to prevent non-compliance behavior (Nielsen & Mathiesen, 2003). If those fishers manage to get away with breaking the regulations, it provides significant motivation for the other fishers to do the same.

When DoF or the Navy arrest illegal fishers who break any laws or regulations in the fisheries, they are punished under the existing 1990 Myanmar marine fisheries law and related regulations for these cases. By applying the authority in the 1990 Myanmar fisheries Act section 22 under chapter seven, the Director-General imposes the regulations for fisheries management (Law et al., 1990). So, regarding the regulations of light fishing in Myeik, the Director-General from DoF imposed the regulation that if the fishers do illegal fishing, although they have license and crew registration cards, they must pay the fines (3,000,000 kyats) and stop fishing for three months or six months for these cases (Law et al., 1990).

Discussions with fishers show that catching rates of squids and trash fish can be different between one-inch mesh and less than one-inch mesh (3mm mesh) fishing nets in squid fishing with light luring operations. For example, fishers who use less than one-inch mesh fishing nets gain 50 tons of trash fish, and fishers who use one-inch mesh gain 20 tons of trash fish during one trip or 60 days. Fishers can profit from 5,000,000 to 10,000,000 kyats from selling trash fish by illegally fishing with less than one-inch mesh size nets in squid fishing in 60 days. In this scenario, fishers look like profit-maximising persons and the cost of fines for not following rules is also less than the gain of illegal activities by comparing the costs of penalties and the profits from illegal fishing. Therefore, the fines for illegal fishing should be increased in Myanmar marine fisheries.

Observations to the annual reports of DoF, the Navy arrested the IUU fishing vessels that broke the laws and regulations of fisheries. The violations such as fishing without a license and fishing with prohibited nets are higher than violations of light power restrictions, 40 kW in the offshore light fishing of Myanmar. The DoF cancels the fishing license in light fishing as a penalty when fishers violate the regulations of light fishery and the vessel owners must change from stick-held falling net to other offshore fishing gear such as drift net, trap, and purse seine.

Regarding the "*profit-maximizing behaviour*" hypothesis to adjust the regulations of light fishing in Myanmar, studies should be conducted to examine the income and profits from light fishing for fishers in the offshore fishery. After classifying what factors are the leading causes for gaining profits in these fisheries, fishery managers should negotiate with fishers and vessel owners to agree with the laws and regulations of light fishing. Then DoF must inspect tightly for the illegal activities of light fishing and punish the illegal fishers according to the revised

laws and regulations by establishing MCS operations. MCS procedures such as inspecting and patrolling will reduce the incentives for profits illegally fishing by breaking the rules and regulations among fishers in Myanmar. Therefore, the establishment of an efficient MCS system is completely covered to reduce the profit maximisation of fishers by monitoring and enforcing IUU fishing activities in Myanmar's fisheries management.

I want to recommend two options to solve these mismatches between fishery managers and fishers in light fishing in Myanmar. One is that the existing regulations should be simplified by using scientific data and fishers' experiments of light fishing on the ground. The DoF should enhance the MCS system and strongly enforce punishing violators in IUU fishing as another option. Concerning the enhancement of MCS operations in Myanmar marine fisheries, the DoF should establish the MCS unit with inspectors, researchers, lawyers, economists, and scientists for sustainable fisheries management. In addition, the budget for MCS procedures such as monitoring, control, and enforcement of manpower and equipment should be reliable and effective in inspecting IUU fishing activities in landing sites and at sea. If there is no budget for the MCS process, it will be difficult to achieve sufficient monitoring and inspection of fishing vessels regarding IUU activities in the future.

Conclusion

Squid fishing with the light luring method is popular among commercial fishing operations and local fishers in Myeik offshore fishery, Tanintharyi region. Squid is one of the top ten exported species and it is exported not only as raw chilled types with ice and dried processing squids to China and Thailand but also sold to consumers in local markets in Myanmar. Squid are caught by traps, stow nets, hook and line, and trawlers in coastal areas, but the catches are smaller than stick-held falling nets with the use of artificial light on the fishing ground at night.

Fishers know the regulations of light fishing in Myeik offshore fisheries and most fishers currently neglect to obey the regulations. Therefore, the hypothesis "ignorance" is a less relevant explanation of illegal light fishing in Myanmar. Perhaps, some fishers are not interested in studying and complying with laws and regulations by themselves and avoid understanding the contents and purpose of the regulations of squid fishing with artificial light in Myanmar.

Squid and bycatch are caught during light fishing season (October to May) in Myeik offshore fisheries. Therefore, fishers compete to maximise their catches on each fishing trip. However, they can replace the fishing gear from stick-held falling net to drift net or trap when they do not want to earn from the light fishing method. Therefore, the "*lack of opportunities*" hypothesis is less relevant to explaining non-compliance with light fishing regulations in Myanmar.

Fishery managers from DoF, MFF, Squid Entrepreneur Association, and the representatives from Pyidaungsu Hluttaw and regional Hluttaw initiated the declaration of light fishing regulations. The stakeholders discussed agreeing to the existing regulations of light fishing before publishing these regulations. However, the regulations are based on the local knowledge and traditional ideas of stakeholders without scientific research or data and lack discussion with fishers from light fishing. Thus, the hypothesis "*disagreement*" is relevant to light fishing regulation compliance in Myanmar.

The vessel owners in offshore fishery gain a good income for their livelihood from fishing. The captains and crews of the fishing vessels receive only wages for their livelihood from fishing. The captains have the authority to manage the crews and they have the chance to gain 10 percent of profits from the vessel owners on fishing trips. The Navy or DoF arrests offshore

fishing vessels because of illegal fishing; for example, when offshore vessels catch fish in the inshore fishing grounds, the owners must pay three million kyats and be banned for three months from fishing. Fishers can occasionally get five to ten million kyats while catching fish on the inshore fishing grounds because the size and price of commercial fish and shrimp are more profitable than on offshore fishing grounds. Therefore, these events seem that the cost of punishment is less than the profits from illegal fishing. However, while the authorities from the DoF and Navy inspect the fishing vessels, they found that fishers catch fish with prohibited fishing gear or catching without a fishing license, they tackle these cases by arresting the captains and crews and the fishing vessels are saved as a state treasury. Therefore, the hypothesis "*profit-maximizing behaviour*" has a significant relevance to fishers' non-compliance with the regulations of light fishing in Myanmar. The study predicts that the weaknesses in law enforcement and lack of MCS procedures are the main possibilities for why fishers disobey the designated regulations in light fishing.

Concerning the observations, discussions with fishers and hypotheses' assessment show that most fishers know the restrictions of regulations in light fishing in the Myeik offshore fishery. However, fishers do not target squid only, and bycatch or trash fish is beneficial to the fishers because of the demand and prices of trash fish from fish meal industries in Myeik. The anchovy and other pelagic species are caught in squid fishing due to catch compositions and food chain consequences of aquatic animals in light fishing. Bycatch or trash fish are caught in one-inch mesh stick-held falling nets of squid fishing, but the catch rates are not so high. Therefore, some fishers use higher light power and less than one-inch mesh size fishing nets to gain more bycatch or trash by violating the existing regulations on light fishing in the Myeik offshore fishery. Besides, most fishers neglect to report fishing records in logbooks during each fishing trip due to a lack of interest and weaknesses in their educational backgrounds. These issues are possible reasons that fishers are not completely following the existing light fishing regulations in the Myeik offshore fishery.

Regarding MCS procedures and collaboration of MCS activities in the DoF of Myanmar, VMS centers have monitored the locations and tracking of offshore vessels registered as fishing vessels in the DoF and had licenses for fishing since 2019. In addition, the annual closed season and closed area are regulated to increase the CPUE of offshore vessels and increase the recruitment of aquatic species in Myanmar marine fisheries. These monitoring and control

activities with VMS centers are appropriate and aid in solving the conflicts of fishing grounds between inshore and offshore fishers for the fisheries management strategy.

However, the DoF has limited skilled staff and officers in MCS activities and lacks the capability of enforcement on the fishing grounds. The patrol vessels, cost-effective MCS process, and cooperation and information sharing with other MCS authorities such as the Navy, coast guard, and courts are essential for effective MCS operations. Discussions with fishers show that few are willing to comply fully with light fishing regulations in the Myeik offshore fishery. The volunteer fishers who obey the fisheries regulations will be supported to get low cost of MCS activities and facilitate MCS procedures regarding compliance with the fishing laws and regulations for fishery managers.

From the fisheries managers' perspective, inspecting dynamo or generator types of light fishing vessels at checkpoints in landing sites before fishing trips and during fishing trips may reduce the violations of light power use in squid fishing with the light luring method. In addition, the fishing gear is inspected at both checkpoints by the DoF authorities and sea by the Navy at present. However, these inspections are only checked on licensed fishing vessels, and those inspections do not influence non-licensed fishing vessels in marine fisheries. Therefore, monitoring and enforcement activities are essential to punish fishing vessels for breaking regulations in Myanmar.

From the fishers' perspective, they know the regulations for squid fishing with lights, and use the light luring method to catch pelagic fish in purse seine offshore vessels. Due to the prohibition of light fishing in some countries and the overexploitation of fisheries resources in Myanmar, the DoF believes that the light luring method should be prohibited in fishing. Thus, fishers and vessel owners should negotiate with fishery managers about their actual use of light power and fishing net mesh size among each community related to light fishing. The modified regulations should be simplified for both fishery managers and fishers, and the responsibilities and functions for both are important to ensure the effectiveness and legitimacy of regulations in the future. After getting the consensus on modified regulations for light fishing, fishers can report to the DoF via the MFF or the Squid Entrepreneurs Association in the Tanintharyi region. In this way, fishers can suggest revising the existing regulations on light fishing in Myanmar.

Most fishers have poor education, and they apply to get only profits from fishing and conservation activities of marine resources within fishing communities as well as fishery managers are probably few among fishers in Myanmar. Thus, the DoF authorities should analyse fishers' behaviours, social cultures, and perceptions of fishing activities, and then simple and appropriate regulations and laws should be imposed to manage fisheries resources for sustainability in the future. In addition, DoF should revise the existing light fishing regulations to simplify and follow the actual fishing grounds.

To improve monitoring and enforcement activities in fisheries management, DoF must practice patrolling and inspecting the fishing vessels with joint-committee members such as the Navy, marine police, and judiciary at both landing sites and fishing grounds. The duties, functions, and responsibilities of each member are important to the success of punishments of IUU fishing vessels and the effectiveness of MCS procedures in fisheries management. The MCS unit or sub-department should be established to enhance or manage the MCS procedures completely from the union level to the township level in the DoF.

The DoF should improve the capacity-buildings of staff and officers inside the department regarding the research perspectives of fishing gears, statistical and biological data of fisheries, and MCS operations for fisheries management. In addition, DoF should support the fisheries communities to establish associations among the fishers depending on the same fishing gear or activities.

Data and information on fishing gears, use of light bulbs, CPUE, target species, and bycatch in light fishing should be collected by DoF or volunteer stakeholders for each fishing community among fishers. Experiences and perspectives of fishers could be filtered through discussions and suggestions during meetings. Research regarding the CPUE and catch composition of the one-inch mesh stick-held falling net compared to other mesh sizes should be conducted as a basis for modifying the regulation of mesh size in squid fishing with artificial light. The difference in catching rates between 40 kW and 100 kW light power use should also be analysed simultaneously during as part of such research. Future studies should investigate the pros and cons of fishing with the light luring method, the comparison of profits between fishing by using light and fishing without light use in Myanmar, and the main incentives of fishers regarding light fishing in Myanmar.

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Appendix

Government of the Republic of the Union of Myanmar

Ministry of Agriculture, Livestock, and Irrigation

Department of Fisheries

Letter no. Ngala/Napata-4/2018 (5893)

Date. 03-09-2018

Content. **The issue of reporting on the operation of squid fishing vessels**

Reference. (1) Date of (14-8-2018) of Tanintharyi Region Fisheries Department Letter no. Tangala/8-1/2018 (2520)

(2) Letter No. dated (17-8-2018) of the National Assembly Office. 1/Ma (Committee-2)/ plantation/2018-049

1. The head of the Navy station based on the Tanintharyi coastal region is an organization that must carry out maritime security and defense duties as well as marine law enforcement duties in Tanintharyi region in Myanmar. In addition, it must implement the duties to support the existing laws issued by the Department of Fisheries in the investigation of fishing at sea. To manage the operation of squid fishing vessels in accordance with the law with a legal permission and to inform the local fishers associations in advance that Tanintharyi Region Naval Station will continue to operate only according to the existing laws from the Department of Fisheries. Therefore, Tanintharyi Region Fisheries Department have submitted the reference (1) letter to the head office for setting the rules regarding squid fishing upon being notified by the Tanintharyi Naval Station headquarters.

2. The Squid Entrepreneur Association in Myeik District, Tanintharyi Region reported to the Committee for the Development of Agriculture, Livestock and Fisheries in Amyotha Hluttaw office regarding the problems and conflicts of marine fisheries for reviewing some of the provisions of the Marine Fisheries Act. According to this submission to Amyotha Hluttaw office, Agriculture Livestock and Aquaculture Development Committee Chairman U Aung Kyi Nyunt and 16 members, and fisheries authorities from Department of Fisheries had a meeting in the National Hluttaw Affairs Office No. (I-14) in the meeting hall of the National Hluttaw from (13:00) to (16:00) in (20-8-2018).

3. As a result of the meeting, the ban on lightening in the squid fishing will be relaxed, and when lightening to lure squid, only those weighing less than 40 kilos will be allowed. This permission is only a temporary permission according to the status quo interval. The fishing with light luring method is prohibited by international fisheries law for the purpose of natural resource management, so it will be difficult to allow this method at the definite time for future. A workshop would be held to discuss whether it would be allowed until 2020 and the following decision was made:

(a) To use 3 to 5 kg dynamo power for inshore squid fishing vessels and to use not more than 40 dynamo power for offshore squid fishing vessels.
(b) If offshore fishing vessels catch the fishes in the inshore fishing grounds and the fines will be imposed as well as fishing vessels' licenses will be suspended.
(c) If fishers catch squid by using very small mesh fishing nets or parkyikyan net (traditional name) in both inshore and offshore fishing vessels, fines will be imposed, and the license of the fishing vessels will be revoked.
(d) Discussions and decisions of the representative's members of parliamentary committees and local people's Hluttaw representatives should be carried out quickly by the Ministry of Agriculture, Livestock, and Irrigation.
(e) Fishing with light luring method is internationally prohibited, so it will be difficult to allow long-term permits. To hold a workshop and decide whether squid fishing activities will be allowed until 2020 or any other year.

4. Therefore, regarding the squid fishing activities that have been permitted only Tanintharyi region was allowed to start since 1990, to permit license numbers only the vessels that operated in the 2017-2018 fishing season when licensing permit to fishers in the 2018-2019 fishing season. Regarding the decisions obtained from the meeting with the Agriculture, Livestock and Fisheries Development Committee in Amyotha Hluttaw in paragraph (3) above, fishery officers in the department of fisheries are informed that the dynamo kilo of vessels will be properly checked and approved in squid fishing.

For Director General

Aung Nyi Toe, Director