Reducing the Impacts of Fishing Activities through the Application of Improved Fisheries Technology

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Fishing is an essential source of employment and protein for coastal communities. However, irresponsible fishing practices, such as the discard of unwanted catches, carbon emissions, destruction of seabed, and overfishing, may create negative impacts on fishery resources and the environment if not properly regulated. The impacts can be mitigated by promoting responsible fishing by using selective fishing gear. Moreover, the design of fishery vessels could be improved to enhance energy efficiency and safety at sea to alleviate living conditions and hygiene of the fishing crew onboard. In addition, the improvement of appropriate fishery machinery, tools, and refrigeration system is envisaged to optimize the required workforce of the fishery vessels, while maintaining the quality of the catch prior to landing.

In this regard, the project "Responsible Fishing Technology and Practices" supported by the Japanese Trust Fund is implemented by SEAFDEC Training Department (TD) from 2020 to 2024. The objectives of the Project are to: 1) promote responsible fishing technology and practices to mitigate fishing impacts on the marine ecosystem, 2) promote marine engineering technologies and their applicability in enhancing the capability of fuel consumption efficiency and safety in fishing operations, and 3) enhance human resource capacities on fish handling techniques onboard fishing vessels. It is envisaged that through the Project, the fishing and marine engineering technologies at the national and regional levels will be improved as well as human resource capacities in the Southeast Asian region are enhanced.

Furthermore, the activities undertaken by TD through this Project are also in line with the Resolution on Sustainable Fisheries for Food Security for the ASEAN Region Towards 2030 stipulating the need for the ASEAN Member States (AMSs) to undertake relevant actions, *i.e.*:

> *RES 7: Promote sound management of fishing capacity and use of responsible fishing technologies and practices, recognizing increasing emphasis on rights-based fisheries; and at the same time, secure the rights and well-being of inland and coastal fisheries communities as well as the ecological well-being;*
>
> *RES 9: Support the efforts to promote low carbon development technologies by minimizing the contribution of the fisheries sector to greenhouse gas emissions, with emphasis on promoting the use of energy-efficient equipment and alternative energy sources; and*
>
> *RES 21: Optimize the utilization of catch/harvest by reducing post-harvest losses and wastes to increase fish supply and improve economic returns through promotion of appropriate technologies, facilities and best practices along the supply chain.*

In 2020, the SEAFDEC Training Department (TD) acquired the 29.98 GT M.V. Plalung—a multipurpose wooden fishery vessel—with a size of 18.32 m length, 4.40 m breadth, and 1.71 m depth. In the following year, the vessel which is a typical Thai fishery vessel was modified to enhance its compliance with relevant international requirements particularly to improve onboard working conditions, safety at sea, and sanitation for fishers, while applying the low-impact and fuel efficiency (LIFE) concept. Since then, the vessel has been utilized to support the training and research activities of TD including the development of responsible fishing technologies that could be applied by fishers in the Southeast Asian region. Auxiliary devices and tools were installed and techniques were applied in M.V. Plalung to lessen fuel consumption, reduce workforce, and improve safety while operating at sea. These include reconditioning propulsion engines, selecting appropriate engine and generator sizes for the vessel, and monitoring fuel consumption by installing fuel flow meters. Using LED bulbs and proper fish handling practices were also promoted by TD as energy-efficient practices to minimize energy consumption on board, while renewable energy such as solar energy is being planned as an additional sustainable energy source.

Compliance with the Work in Fishing Convention No. 188

Appropriate fishery vessel design is crucial to ensure the well-being and safety of the onboard crew. Adequate and comfortable living conditions should be provided for the crew to increase job satisfaction, reduce the crew turnover rate, and ultimately improve the efficiency and profitability of the fishery vessel. In addition to the basic amenities such as food, drinking water, and sanitation facilities, it is also important to consider the crew's recreational needs by providing an entertainment corner and a comfortable space for rest to help reduce stress and fatigue during long fishing trips.

Therefore, M.V. Plalung was modified in 2021 to be a model vessel that complies with the Work in Fishing Convention No. 188 (C188) of the International Labour Organization with the objective of ensuring that fishers have decent conditions of work on board fishing vessels with regard to minimum requirements for work on board; conditions of service; accommodation and food; occupational safety and health protection; medical care and social security. The space allocated for crew members was made to be sufficient and

well-designed where each crew member has a personal cabinet to store their belongings and the living space (main deck) has a height of at least 2.0 m to allow comfortable movement. The bedroom was renovated to accommodate all crew members and consists of comfortable beds that are at least 0.70 m × 1.90 m in size.

Hybrid refrigeration system

Hybrid power sources in the refrigeration system are being applied onboard M.V. Plalung with power either from the propulsion engine or generator (**Figure 1**) to deliver power and a relatively steady amount of torque and speeds that match the requirement for the refrigeration system. Besides, the split shaft power take-offs were applied to enable multiple sources of power to drive fishery machinery as the source of the prime mover of auxiliary devices *e.g.* nets drums, cranes. The compressor of the refrigeration system of M.V. Plalung is driven by an electric motor. The size of the motor depends on the cooling load capacity of the compressor times and storage temperature. This means that a lot of electricity is needed from the diesel generator. Hence, the demand for electricity is defined as fuel consumption. In the case of a fishery vessel moored at the fishing port, it is able to operate the refrigeration system via the electric motor. This is because fishing vessels must run the diesel generator ordinarily or utilize the shoreline power source by the main engine stop. But whenever the fishery vessel leaves the port, the main engine is in use. The refrigeration system can change the mode of operation to engine mode to drive the compressor. The merit of the refrigeration system is driven by the propulsion engine. Whenever the fishing vessel leaves the fishing port to the fishing ground or during the fishing period, it will take time to operate the engine until it reaches the fishing ground. Therefore, using the engine drive mode will result in energy utilization without the need for sources from a diesel generator.

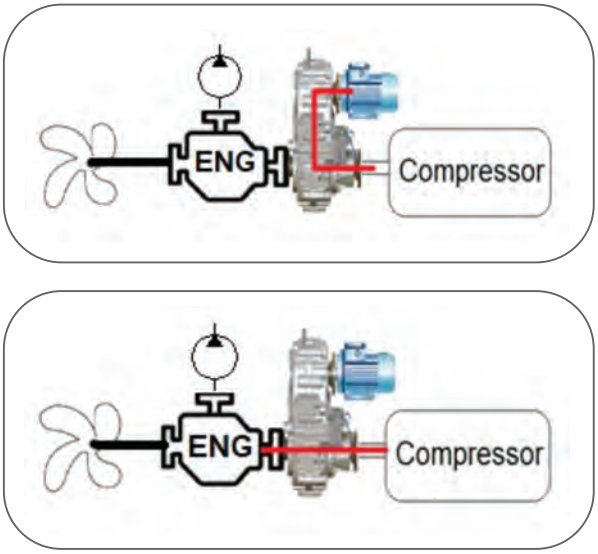

Figure 1. Hybrid refrigeration system: driven by an electric motor *(top)* and propulsion engine *(bottom)*

V-shaped otter board

Basically, the design of M.V. Plalung resembles typical Thai trawlers. However, bottom trawling is an indiscriminate fishing method and is considered one of the most destructive ways to catch fish causing significant harm to the seafloor. The bottom trawl (**Figure 2**) is an unselective fishing gear that often catches juvenile fish and results in overfishing due to a large number of dead fish discarded. With the goal of promoting responsible fishing practices to decrease the negative impacts of trawl fishing on the marine ecosystem, reduce carbon emissions, and mitigate climate change, TD applied the V-shaped otter board to the bottom trawl of M.V. Plalung. Sea trials were performed to examine the energy-saving efficiency and performance of the fishing gear design since 2018 in Tarutao Island, Satun Province, Thailand in the Andaman Sea.

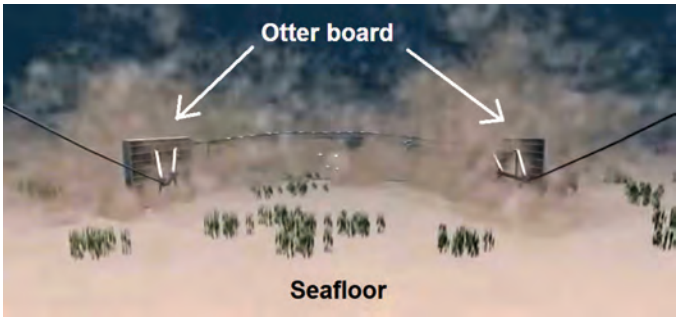

Figure 2. Otter boards of bottom trawl damage the seafloor

The otter board is a critical component of single trawlers as its hydrodynamic performance significantly affects catch and fishing efficiency. The main function of the otter board is to accelerate the settling of the trawl net by increasing the horizontal expansion of the trawl net. The negative impacts of bottom trawling can be reduced through responsible fishing practices. The V-shaped otter board (**Figure 3**) was applied for M.V. Plalung. The hydrodynamic force acting on the otter boards is decomposed into an expansion force, which is perpendicular to the flow velocity (**Figure 4**). This force increases the lifting force of the otter boards, reduces damage to bottom fauna, expands the sweeping area of the bottom trawl, and minimizes fuel consumption by allowing the trawl doors to avoid contact with the seabed.

Figure 3. V-shaped otter board

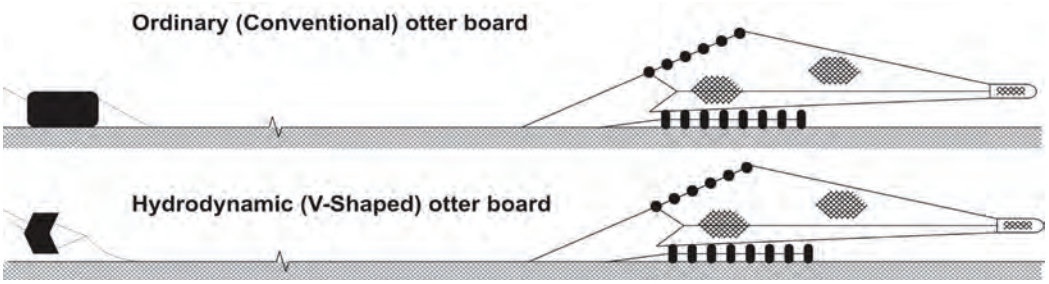

Figure 4. Hydrodynamic V-shaped otter board

The use of a V-shaped otter board resulted in a 5 % reduction in fuel consumption compared to the conventional otter boards, with engine speed reduced from 1,100 rpm to 1,050 rpm while maintaining the same trawl speed. This indicates that operating with V-shaped otter boards can save fuel by 5.4 % while maintaining the same trawl speed. Additionally, the V-shaped otter boards allow for longer trawling distances due to the vessel being able to trawl faster than before, all while using the same engine rotation speed as the conventional otter boards. Regarding vessel control, the V-shaped otter board made the maneuvering of the vessel easier, including turning, compared to the use of flat otter boards. Furthermore, there were a few marks on the painted footer plate (**Figure 5**) of the V-shaped otter board which indicated that the lifting force of the V-shaped otter board decreased the touch or drag of the bottom trawl resulting in reduced seabed destruction.

Figure 5. Fewer scratches on the painted footer plate of the V-shaped otter board of M.V. Plalung

Adjustable U-shaped gallows

The inverted U-shaped gallows are commonly used to hitch up heavy otter boards and for shooting and hauling towing warps in trawl fishing. TD designed a new type of gallows, the beam gallows, which can function as an outrigger or beam trawl and can adjust to the waterline angle, allowing for an extension on each side of the towline (**Figure 6**). The position of the gallows was crucial, as they must be located forward of the rudder axis to ensure the vessel has sufficient maneuverability.

Figure 6. Adjustable U-shaped gallows of M.V. Plalung designed by SEAFDEC/TD

Hydraulic net drum

Improving appropriate fishery machinery, tools, and fishing operation techniques includes using a power take-off for winch drives. The power take-off unit takes power from the main engine for the winch drive. It is recommended to use a belt drive from the power take-off point instead of a chain drive due to its greater flexibility. The hydraulic drive may be a cheaper option in the long run if expertise and spare parts are available locally. On small fishery vessels, the most commonly used power take-off is for a warp line winch or hydraulic oil pump for the net drum in the trawl fishery. TD used the hydraulic net drum and towline winches during the hauling and shooting process (**Figure 7**). These wide-powered spools helped to facilitate the hauling and releasing of the trawl nets and towline. A power takeoff from the propulsion

Figure 7. Operation of the hydraulic net drum of M.V. Plalung

engine was implemented to power these spools. The net drum, which consists of hydraulic components, was placed at the stern portion, while the towline was placed at the middle of both sides. This helped to improve the efficiency and safety of the vessel during trawling.

Way Forward

It is important to mitigate the impacts of fishing activities on fishery resources and minimize greenhouse gas emissions by monitoring energy consumption and implementing fishery vessel energy audit programs. Moreover, efforts should be made to reduce waste, discard, and oil pollution generated by fishery vessels.

In recognizing the need to reduce the use of fossil fuels, which is the biggest source of greenhouse gas emissions, TD would promote the use of renewable energy to mitigate the adverse effects of climate change. Specifically for trawl fishery, TD intends to promote responsible trawl fishing by extending its reach, facilitating collaborations, and working with experts and researchers from Member Countries to improve technology, techniques, and materials used in fishing to reduce its impact on fishery resources and marine environment.

On the other hand, many fishers reported a lack of funding to improve their vessels and they are concerned that the return on investment might not be justifiable, making it difficult for them to make improvements. To reduce costs and increase income from fishing operations, TD would focus on improving energy efficiency, storage methods, and maintenance of fish and fishery products to retain their original nutritional value. TD would also promote sustainable fisheries development both at the national and regional levels, with a focus on energy-saving fishing activities to reduce poverty among fishers.

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