MINISTRY OF EDUCATION AND TRAINING
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SOLUTIONS FOR IMPROVING THE EFFICIENCY OF SEINE FISHING WITH LIGHT IN KHANH HOA PROVINCE

KEY FINDINGS

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Introduction

1. Reasons for choosing this thesis

The seine fishing in our country is a long-standing tradition (from the 50s to the 60s of the 20th century), developing quite quickly in terms of the number of boats and engine capacity. , light source power, fishing gear size as well as fishing technology in the past 10 years. However, fishing activities are mainly in familiar fishing grounds, leading to increased pressure on the decline of aquatic resources in coastal areas and lower and lower fishing productivity.

The seine fishing in Khanh Hoa province also has its own advantages:

Percentage of pelagic fish (including inshore pelagic fish, migratory pelagic fish) compared with bottom fish in coastal fishing grounds of South Central Coast provinces (including Khanh Hoa province) is estimated: pelagic fish account for 55-60 % of the reserve and bottom fish account for 40-45% of the reserve. This is also an advantage to develop seine fishing

From some of the above analysis and continuing to inherit the studies on seine vessels in Khanh Hoa province, the PhD student has carried out the doctoral thesis: "*Solutions for improve the efficiency of in Khanh Hoa province*" with the consent of the Ministry of Education and Training, Nha Trang University.

2. Objectives of the study

2.1. Overall objectives

From the scientific and practical basis, solutions have been developed to improve the efficiency of seine fishing with light, to perfect the system of seine nets and lighting on ships in Khanh Hoa province.

2.2. Detailed objectives

Assess the current situation of seine fishing in Khanh Hoa province and neighboring provinces. From there, analyze the effects of fishing gear structure, light source system on board on fishing efficiency.

Perfecting the structure of seine nets to catch effectively, the main object is skipjack tuna (*Katsuwonus pelamis)*

- Completing the lighting system to save fuel and improve exploitation efficiency.

3. Research subjects

Seine fishing in Khanh Hoa province, focusing on trains with a length of over 15m operating in remote waters.

4. Research scope

Research on the structure of fishing gear of seine fishing with light.

Research on using LED lamps to replace traditional lamps.

Proposing some solutions to improve fishing efficiency in seine fishing in Khanh Hoa province

Research period: from 2016 to 2021.

Research location: seine vessels of Khanh Hoa province operate on large fishing grounds in many provinces, so the study focuses on collecting data in the waters of the South Central Coastal provinces.

5. Research content

5.1. Investigate the current situation of seine fishing in Khanh Hoa province

5.1.1. The status of seine fishing vessels

Vessel capacity and equipment;

Fishing gear;

Fishing grounds, seasons and catches of seine fishing;

Labor force, expertise.

5.1.2. The situation of using light sources on seine fishing vessels

Equipped with light source: Capacity, number of bulbs, installation layout ..

Effect of light source on seine vessels

5.2. Determining the scientific basis and developing solutions to improve the seine fishing in Khanh Hoa province

5.2.1. Analysis of the structural elements of seine nets affecting the exploitation efficiency

5.2.2. Analysis and evaluation of light source factors affecting the exploitation efficiency.

5.2.3. Solution to complete the seine structure and lighting system on the seine vessel

5.3. Experimental fishing at the sea

Track and test fishing at sea to perfect the structure of fishing gear

Monitoring experimental fishing at sea to perfect the lighting system

6. Scientific significance and practice of the thesis

6.1. Scientific significance

Supplementing data sources on the current status of fishing activities of seine fishing in Khanh Hoa province.

Supplementing data and evaluating the possibility of using LED lights for seine fishing in Khanh Hoa province.

6.2. Practical significance

The research results of the thesis will help the fisheries management agency of Khanh Hoa province have a scientific and practical basis, to plan the development of the province's seine fishing, and improve production efficiency in remote fisheries. coast, thereby reducing the intensity of exploitation of marine resources in coastal waters.

CHAPTER 1. RESEARCH OVERVIEW

1.1. Overview of natural, socio-economic conditions and aquatic resources of Khanh Hoa province

1.1.1. Natural, economic and social conditions of Khanh Hoa province

Advantages:

Large and abundant sea and island resources are the province's great comparative advantage. It is the only province with 3 famous national and international bays, namely Nha Tranh Bay, Van Phong Bay, Cam Ranh Bay with many interesting natural landscapes; all bays have an ideal depth for the development of large seaports; have abundant aquatic resources, etc. allow strong development of the marine economy.

Disadvantages:

Environmental pollution is becoming serious in recent years; Waste water and waste not meeting the prescribed standards poured into irrigation canals have seriously affected the quality of water sources for agricultural production and aquaculture, especially in production areas located near the coastal areas. industry.

1.1.2. Potential of aquatic resources, fishing grounds and fishing seasons

1.1.2.1. Aquatic resources

The fishery resources of Khanh Hoa province are mainly concentrated in the offshore area, so the main method of exploitation is large ships with storage facilities to be able to catch a long day. In Khanh Hoa waters, scientists have discovered 350 species of coral, accounting for 40% of the total number of coral species in the world.

1.1.2.2. Seasons and fishing grounds for fishing

- Coastal fishing grounds: including the bays of Van Phong, Nha Trang, Cam Ranh, Nha Phu lagoons, the estuaries and coastal waters from 24 nautical miles or more.

- Offshore fishing grounds

According to the southern and northern fishing seasons, offshore fishing boats from Khanh Hoa province have reached far to the high seas of the Gulf of Tonkin in the East Sea, to the Truong Sa and Hoang Sa archipelagoes to the North East Sea. Taiwan and the Philippines in the Southwest Sea to the international sea area bordering Thailand, Malaysia, and Indonesia.

- Fishing capacity

The whole province currently has 9,791 fishing boats, of which 814 ships with a length of 15 meters or more. The average annual catch of aquatic products is 97,000 tons.

1.2. Overview of research works in Vietnam and abroad

1.2.1. Research projects abroad

1.2.1.1. Research on the use of light sources in seine fishing

a) The researches on the relationship between light source and behavior of aquatic species in seine fishing

The personality of fish in the lighting area depends on environmental factors such as in water, flow speed, buoyancy, temperature, moonlight...

b) The studies on the arrangement of light bulbs, light source power and exploitation efficiency of seine fishing

Some studies by foreign authors show that:

When using lights above the water, instead of an upgraded power source light, it is more beneficial to have a high-hanging light.

Clamp the system between the lights and the fish-attractive effect determined through efficiency research work that uses the wattage of the bulb consumed to produce light.

c) Studies on colored light, the efficiency of different types of bulbs in the light grid

Some studies by foreign authors show that:

White light attracts gray sharks (*Mugil Cephalus),* yellow sea bream *(Sparus Auratus)* and striped sea bream (*Lithognathus Mormyrus)* but not European fish *(Dicentrarchus Labrax)*.

Colored light is attractive to dim sharks (*M. Cephalus)* and European fish *(D. Labrax),* especially short-wavelength light. However, the blue and green colors redo European fish run away.

Light unattractive color and yellow sea bream.

Host standard lighting metal halide lamps is 2.5 times more than LEDs installations.

Ships fitted with metal halide lamps have approximately 2.5 times the annual emissions of LEDs

1.2.1.2. The studies on the use and improvement of fishing equipment and gear

Authors such as: MacNeely (1961), Chun-Woo Lee (2011), Cheng Zhou (2013), Liuxiong Xu (2017) focused on research and development of seine structure to continue exploiting tuna objects. The research focuses on adjusting the depth and sinking speed of the net during mining.

1.2.2. The studies in Vietnam

1.2.2.1. Research on the influence of light sources on fishery resources in seine fishing

The works of domestic authors show that:

The relationship between light power and mining efficiency is not clear.

Increased illumination changes the arrangement and morphology of the retina, causing a decrease in fish-eye and squid vision.

The factors that strongly affect the catches of scad fish on offshore seine vessels combined with light in the North Central, South Central and Southeast waters according to the method of information logic analysis are the sum total. light source power, lamp hanging height and lamp hanging angle.

1.2.2.2. Studies on the use and improvement of fishing equipment and gear

Research works of domestic authors show that:

The application of fish detectors in seine fishing has brought high economic efficiency and has become an indispensable device in the tuna seine fishing industry.

The factors affecting fish concentration at the fixed scrub include: phytoplankton, sea water temperature, flow rate, depth, time of use of the site of scrubbing, degree of addition of scrub. , bottom topography, scrub material, number of coconut ships.

The technological process of tuna fishing with tailfin nets in Vietnam's waters has been developed with high efficiency, thereby finding a trawler and fishing equipment system suitable to Vietnam's conditions.

1.3. Analysis and evaluation of domestic and foreign research works

1.3.1. Research works of foreign authors

1.3.1.1. Research works of foreign authors on the use of light sources

a. Theoretical basis and research methods were used

The research works of foreign authors in the field of fishing combined with artificial light brought many successes to fisheries development. Theoretical foundation for:

Fish's ability to perceive light; fish behavior in the illuminated area;

Biological characteristics of fish when gathered around a light source;

Fish concentration methods, factors affecting fish concentration around light source;

b. Regarding the content, research results in solving related problems

Determining the efficiency of fin fishing gear, side hooves, and pyramidal lifting nets using artificial light;

The time when fish gather in schools around the light source and catch;

The arrangement of the height of the lamp, the angle of the lamp, the light source is reasonable.

c. Remaining problems of foreign research projects

The analysis and evaluation are mainly based on lighting efficiency to achieve productivity and catch at the time of experiment, there is no detailed assessment of fuel consumption for each bulb size, cost. fuel in fishing activities in combination with light, especially the fuel consumption used to run generators to supply lighting systems to attract fish.

1.3.1.2. Research works of foreign authors on the design and improvement of fishing gear and equipment

a. Research methods and results obtained

Research related to the improvement of seine fishing gear in the world has been carried out with the development of technology to detect fish stocks and use light in fisheries.

b. The existence

Synchronous researches on improving gold grids and coordination equipment for mining have been developed by the world in order to improve mining efficiency and are very suitable for investment capabilities, especially in the countries with developed fisheries. However, the above implementation is very specific, the investment level is high, only suitable for mechanized fisheries. In order to develop for small and fragmented fisheries, more specific studies, inherited and consistent with fishing traditions, are needed.

1.3.2. Research works of domestic authors

1.3.2.1. Research on the use of light sources

a. Theoretical basis and research methods were used

Although a separate work has not yet formed a full study on the theory of lighting in the context of fishing boats in the tropics, multi-species catches, the authors inherit the previous theoretical basis. In order to serve as a basis for calculating and manufacturing fishing gear that combines light with certain efficiency, it has partly clarified the reality of the fishery with light in the country.

b. Regarding the content, research results in solving related problems

From 2010 up to now, there have been many research projects on LED light sources in order to find solutions to gradually replace incandescent, fluorescent, and high-pressure light sources, which are inefficient, polluting the environment, and reduce costs. luminous energy. The content of these studies mainly evaluates the level of fuel economy.

c. Remaining problems of domestic research works

-The study of fish behavior in the lighting area in our country is still open, especially for high-power high-pressure lamp sources operating offshore.

-About the layout, light source power: The results on light source layout are only at the mathematical statistical level, there are very few experimental light source layout studies.

-About light color: The number of studies on this issue is still small, there is no overall assessment of fishery incorporating light in the whole country.

1.3.2.2. Research on improvement of fishing gear and equipment

a. Research methods and results obtained

- The application of fish detectors in seine fishing has brought high economic efficiency and has become an indispensable device in the tuna seine fishing industry.

Research on improving gold nets: Improvement from gold seine nets in Binh Dinh province to catch large schools of fish.

The factors affecting the concentration of fish at the fixed scrub have been identified, including: phytoplankton, sea water temperature, flow rate, depth, time time of use, location of scrubbing, degree of addition of scrub, bottom topography, scrub material, number of coconut vessels.

b. Existence of research works.

Research to improve gold seine nets combined with the use of horizontal detectors to detect fish stocks suitable for the Southwestern sea. It can be said that the topic has solved the need to apply technology to exploit large schools of fish distributed far from the shore in order to improve efficiency by limiting fuel during the exploitation process. However, the design of the net is still not suitable for the exploited water area, the exploited objects are still schools of floating fish, there is no specific analysis for some species.

1.3.3. Select and identify the problems that the PhD student will focus on solving

In order to solve the problem of improving the efficiency of fishing and protecting fishery resources for seine fishing, the PhD student combines research with equipping a light source corresponding to the length of the net released. Full scientific basis and reliable.

1.3.4. Inheritance points for the thesis topic

1.3.4.1. Research Methods

To carry out the thesis topic, the PhD student will inherit the following basic research methods:

- Documentary research method.
- Non-empirical research method.
- Descriptive statistics method.
- Experimental method.

CHAPTER 2. RESEARCH METHODS

2.1. Research content

2.1.1. Investigate the current situation of offshore seine fishing combined with light in Khanh Hoa province

Boat capacity, equipment;

Structure of fishing gear;

Fishing grounds, seasons and catches of seine fishing;

Labor force, professional qualifications.

2.1.2. Actual situation of using light sources on ships

Light source equipment: Capacity, number of bulbs, installation layout..

Efficient use of light sources;

Relationship between light source and catch.

2.2. Research Methods

2.2.1. Approach

Logical approach to inherit domestic and foreign studies and documents.

Scientific approach: Gather, collect, and investigate reality to have a data set as a scientific basis for designing grids, draw systems, and LED lighting systems accordingly.

2.2.2. Secondary data

Collect information, documents, data, ... from published works.

2.2.3. Primary data

- Information to be collected: Vessels, equipment used on seine vessels; The seine net system being used for tuna fishing and the efficiency of offshore seine fishing in Khanh Hoa province.

- Building a survey form: With the above information, the topic builds a survey form with full and detailed content to be surveyed, in accordance with the research content of the topic.

- Collection method: Using the method of direct interview with fishermen according to the survey sample, focusing on the subjects who are ship owners or captains and crew members with long experience in offshore seine fishing.

2.2.4. Calculation method to improve and perfect the seine structure

2.2.4.1. Principle of improvement

The improved gold seine is mainly designed for the main target of tuna fishing. The technical parameters of the net gold are based on the size, movement speed of the exploited object and the average size of the fish;

The improved gold seine net is designed on the basis of the traditional seine net used by fishermen, including the material, size and specification of the net parts and equipment. The quantity of these ingredients will be improved to suit the tuna catch;

The improved gold seine is suitable for fishing grounds which are offshore areas of Khanh Hoa province and the high seas of Vietnam;

The evaluation of fishing gear factors affecting the catch is inherited from published domestic research works.

2.2.4.2. Improve the length of the gold seine

Determination of optimal length for gold seine nets for tuna fishing (L)

The length of the seine net is calculated according to the formula N.N Andreep:

$$L = K(x+r) \quad (2\text{-}1), \text{ in there:}$$

L: Seine length (m);

x: Distance in front of the fish (m);

r: Size of fish school (m);

K: Coefficient, depends on the catch pattern.

2.2.4.3. Improved grid gold height

Determine the height of the improved grid gold grid (H)

The height is determined through the relationship with the grid length

$$\frac{H}{L} = \frac{1}{10} \div \frac{1}{7}$$

2.2.4.4. Improved lead and float equipment for improved gold nets

- Lead equipment:

According to V.N Mirski, the general sinking force q required for a 1m-long mesh strip and a height equal to the net gold height is calculated by the following formula:

$q = 0{,}81.\frac{H_x^3}{t^2}$, (2-2) in there:

H_x is the allowable sink depth of lead line (m), $H_x = (0.2 \div 0.25).(t.vc - x)$

t is the time required for the lead rod to sink to a depth H_x(s), $t = t_1 + t_2$

$t_1 = L/2v$ is the time to drop the net;

t_2 is the time to prepare to withdraw the ropes, taken from experience from 1 to 3 minutes;

L is the mesh length (m); v is the ship's speed when the net is dropped (m).

The required sinking force on a 1m grid strip is calculated:

$q_{tb} = q - 0.6.q_0$ with q_0 is the calculated net sinking force. $q_0 = \frac{G}{L}.\gamma$, in there

G is the net weight (kg); L is the net shortened length (m); γ is the sinking capacity of the material

The lead sink force on a 1m grid strip is calculated: $q_c = q_{tb} - (q_k + q_{dg})$ with:

q_k is the sinking force of the ring (kgf); qdr is the sinking force and ropes per meter of net (kgf);

The amount of lead to be equipped (in the air) is determined as follows:

$$\text{Lead weight} = \frac{\text{sink force}}{\text{sink}} \qquad (2\text{-}3)$$

The total buoyancy force for the 1m long net is calculated by the formula:

$$Qn0 = k.Qc,$$

In there: Qc is the total sinking force on that strip (kgf); K is the reserve factor, ranging from 1.5 to 3.

- Equip buoys:

The total buoyancy force for a 1m-long mesh strip is calculated by the formula:

Qn0 = k.Qc, with:

Qc is the total sinking force on that grid strip (kgf);

K is the reserve factor, ranging from 1.5 to 3.

2.2.4.5. Improved main drawstring system

With the improved mesh size that has been designed, the main drawstring length is calculated as follows:

According to F.I Baranop, when the friction force between the ring and the main drawstring is not taken into account, the tension on the main drawstring is calculated according to the following formula:

$$T_0 = 3.\frac{d}{a}.L.H.v^2 \quad (2\text{-}4), \text{ in there:}$$

$\frac{d}{a}$ is the ratio of the mesh thread diameter to the mesh edge size.

L is the net shortened length (m);

H is the net reduced height (m);

v_{gr} is the main draw line rate (m/s).

In case of taking into account the friction force, the maximum tension force acting on the main drawstring is calculated by the formula: $T_{max} = T_0.e^{f.\pi}$, where f is the coefficient of friction between the ring and the drawstring. The breaking force of the drawstring is calculated as the product of the maximum tension with the factor of safety (from 2 to 5).

The drawstring length is calculated by the formula:

$$L_{gr} = L + L_{dtr} + Lb \quad (2\text{-}5)$$

2.2.4.6. Number of rings for improved mesh gold

The number of main rings is calculated by the formula:

$$n = \frac{L-(L_1+L_2)}{l}, \quad (2\text{-}6) \text{ with:}$$

L is the length of the net at the lead edge;

$L_1 = L_2$ is the space to install the ring at the ends of the spare and the wing;

l = 10m is the distance between the two rings;

2.2.4.7. Measure the sinking speed of the net

The sinking speed of the gold mesh is mainly concerned with the sinking speed of the lead wire. To measure the sinking speed of lead rods, the research uses a sensor to measure the sinking speed of heavy objects underwater.

The device is fastened to the lead wire in the middle of the net. The sinking position of the lead rod is recorded after 35 seconds.

2.2.5. Calculation method and perfecting the lighting system

Research using handheld light meter to measure light intensity. The light meter FLM400 Data (Lux meter) has a scale of 400,000 Lux (four hundred thousand lux).

From the position of illumination on the water with the distance of 0m; 5m; 10m, 15m, 20m etc... , drop the Selenium cell into the water at different depths, read the corresponding illuminance value until the illuminance is only 0 lux, then stop measuring. Number of measurements n = 10 times.

Use the formula Bughe: $E_i = E_0.e^{-\gamma x}$ (2-7)

In there: E_i- illuminance at the required depth (lux)

E_0- illuminance just above water (lux)

e - base of the natural logarithm, taken as 2.7

γ- light absorption coefficient (l/m); depends on the clarity of seawater measured by Secchi disk.

x - the length of the distance the light reaches the desired depth (m).

$$\sin\beta = \frac{\sin\varphi}{n} \quad (2\text{-}8)$$

$$h = x\cos\beta \quad (2\text{-}9)$$

In there: φ- The angle of incidence of the light ray

β - Angle of light refraction

n - Refraction coefficient between air - sea environment, equal to 1.33;

h - the vertical depth of light (m).

The lighting area on the water surface in the horizontal direction is calculated from the formula for calculating the number of bulbs:

$$n = \frac{E_{TB} \times S \times k}{\Phi} \quad (2\text{-}10)$$

In there: n - number of bulbs; E_{TB}: horizontal average illuminance from light source

position to 1lux illuminance position. S: horizontal illuminated surface area (m^2); k: utilization factor, depends on the optical efficiency of the luminaire and the lamp arrangement, usually taken from 2 ÷ 3. Choose k = 2 : lamp luminous flux (lumen).
The volume of the illuminated water area is approximated by the formula:

$$Vi = \frac{1}{3}\frac{\pi d_i^{\,2}}{4}.h_i \qquad (2\text{-}11)$$

In there:

d_i - The horizontal distance from the position of the light source to the next Lux position is only 1 lux.

h_i - Depth from the illuminated water to the position where the illuminance is 0 lux.

2.2.6. Approximate method for calculating S, V (area, volume) lighting

2.2.6.1. Principle of controlled trial

- The test ship and the control ship operate in the same fishing grounds and at the same time. The captain and crew are experienced in catching and preserving products.

2.2.6.2. Experimental time

The study was conducted experimentally for 2 years, with 4 trips/year after installing LED lights and improved nets *2.2.6.3. Test content*

+ Complete the installation process and complete the LED system on the seine vessel.

+ Measure the level of fuel consumption between ships using LED lights and ships using high pressure lights.

+ Measure illuminance, luminous efficiency of light sources on ships.

+ Determine the sinking speed of the improved mesh gold compared to the traditional grid gold.

+ Determine yield and species composition through nets.

+ Evaluate the exploitation efficiency of ships using LED lights, improved seine nets and ships

1.3.Data processing method

Using Microsoft Excel, SPSS 20 software to process graphing data, statistical functions corresponding to necessary values as a basis for evaluating the efficiency of LED light sources, elements of fishing gear structure. compared to the traditional light source and net used by fishermen.

CHAPTER 3. FINDINGS AND DISCUSSION

3.1. Current status of boats, fishing gear and fishing equipment

3.1.1. Situation of fishing boats in Khanh Hoa province

According to the Khanh Hoa Fisheries Sub-Department, up to February 2020, the whole province has 9,790 fishing boats, of which 259 are operating in seine nets.

3.1.2. Ship size

- The group of ships built with new materials is concentrated only in the group of ships with a length of over 20m, the number of ships in the remaining size group is built of wood.

Thanks to a number of new shipbuilding policies of the Government, Khanh Hoa province now has a number of newly built fishing vessels with a size larger than 26m.

3*.1.3. Motivational equipment*

Main machines: Commonly used are Mitsubishi, Yanmar, Daewoo, ... mainly old machines, converted and used, the remaining quality is about 60 - 80% compared to new machines.

3.1.4. Mining equipment

Fishing equipment arranged by fishermen on offshore seine vessels has many similarities in terms of model, installation location, operation method, etc. include: Winch, Grid receiver, Crane. Fishing racket.

3.1.5. Marine equipment and safety equipment on board

Marine equipment in the group of ships with a capacity of over 20m is more fully equipped than that of ships of less than 20m.

All ships are equipped with cruise monitoring equipment.

3.1.6. Status of equipping fishing gear for offshore seine fishing in Khanh Hoa province

According to the survey results, the gold size of offshore seine nets in Khanh Hoa has the following variation in length:

Group of ships with ship length of 15m ≤ Lmax < 17m: Gold mesh has the shortest length of 638m, the longest is 876m, the average length is 797m. The average height of the net body is 91m.

Group of ships with a length of 17m ≤ Lmax < 20m: Gold mesh has a length of between 596m and 911m, with an average of 746m. The average height of the net body is 101m.

Group of ships with a length of over 20m: Gold mesh has a length of between 596m and 1,226m, with an average of 890m. The average height of the net body is 112m.

The mesh size in the fish-collection unit (retard net) in most vessel sizes is either 25mm or 20mm. This shows that people use the same type of net in the spare part of the net.

3.1.7. Fishing output of offshore seine vessels Khanh Hoa

The average catch per voyage in a group of vessels with a length of 15m to under 17m is 17,711kg/trip.

The average catch per voyage in a group of vessels with a length of 17m to less than 20m is 17,768 kg/trip.

The average catch per voyage in a group of vessels with a length of over 20m is 18,167 kg/trip.

Thus, the average productivity between the two groups of ships from 15m to under 17m and from 17m to less than 20m is similar. While the group of ships over 20 has higher average productivity.

This can be seen that the group of ships with a larger size, larger nets, fully equipped with machinery for exploitation, can catch more efficiently.

3.1.8. Actual situation of labor on offshore seine vessels in Khanh Hoa province

Crew members working on offshore seine vessels in Khanh Hoa are concentrated between the ages of 25 and under 45, accounting for the largest proportion, 29.7% and 31.4%, respectively, followed by from 15 to under. 25 years old has a rate of 21.3%, the number of seafarers over 60 years old working on the ship is very small at 3.1%.

The education level of seafarers working on offshore seine vessels in Khanh Hoa is 50.1% of primary school level, followed by 41.5% of junior high school, and high school of high school. is 8.4%, college and university level, there are no crew members.

3.1.9. The situation of using light source on a seine vessel with combined light

3.1.9.1. Generator usage situation

The generator system for lighting on the ship consists of an auxiliary machine with a capacity of 150 ÷ 350 CV and an ac generator with a capacity of 40 kVA÷ 80 kVA or a dinamo which is directly hybridized from the main engine.

3.1.9.2. Using light source on offshore seine vessel

Through surveying on offshore seine vessels in Khanh Hoa, it was found that the ships are mainly equipped with high-pressure lamps, some ships have both high-pressure lights and LED lights installed, no ships use them. This proves that fishermen have approached LED lights in fishing.

3.2. Analysis of the influence of some light source factors and fishing gear structure on the fishing efficiency of seine fishing

3.2.1. Analysis of the influence of light source factors on the fishing efficiency in Khanh Hoa

The fishing yield on the ship groups is linearly correlated with the luminous efficiency, shown in the dependence of the catch on the luminous efficiency of 67.5%.

3.2.2. Analysis of the influence of fishing gear factors on the fishing efficiency of the fin fishery in Khanh Hoa

3.2.2.1. Analysis of fishing gear factors affecting catches

The catch of seine fishing depends on many factors, such as: fishing grounds, seasons, marine equipment, light sources, and fishing gear. Inheriting the results from the researched works, the thesis focuses on analyzing the 03 most basic elements of gold mesh, including: length of gold mesh, height (average) of gold mesh and weight of lead equipped. over 100m net length.

3.2.1.2. Pearson correlation analysis between fishing gear factors and catches

To find the correlation between fishing gear factors and catches, the study will conduct Pearson correlation analysis to test the linear relationship between these variables. The following results:

The height of the seine net has the most influence on the catch.

The total weight of lead equipping the gold mesh also strongly affects the mining output.

In fact, in the gold structure of the seine, the ring plays both the role of keeping the main draw line active and at the same time acting as the lead of the gold net, increasing the sinking speed of the net when released.

3.3. Solutions to improve the efficiency of using light sources in offshore fishing in Khanh Hoa

3.3.1. Applying LED lights to replace traditional lights to improve light source efficiency and save costs

Based on the technical criteria for selecting LED lamps, at the same time, by surveying the LED lamps on the market and consulting to evaluate the quality from different types of lamps. Research and select LED lights, 35 sets each, to ensure the technical and quality requirements for installation on 2 experimental ships.

3.3.2. Improve gold seine to increase mining efficiency

3.3.2.1. Investigate sample grids

The gold seine nets (can be combined with light) in Binh Dinh, Binh Thuan have a length of about 900m to 1500m, a shortened height from 65m to 70m and at the position of the net body from 120m to 140m. Some gold nets specialize in exploiting all kinds of tuna, so they should use nets with a large number of textures and mesh sizes. Several types of mesh thread are used in gold mesh $PA210^{D}/21$, $PA210^{D}/18$, $PA210^{D}/15$, $PA210^{D}/9$ with mesh size 2a = (22mm ÷ 50mm).

3.3.2.2. Improved calculation of mesh length

Calculation length of improved mesh sections and detailed sample mesh in Table 1

Table 1- Summary of calculations to improve the length of gold mesh

Contents		Bunt 1	Bunt 2	Body	Wing 1	Wing 2	Total
Working length (m)	Sample grid	140	140	140	140	175	735
	Design grid	140	140	525	140	175	1.120
Tensile Length (m)	Sample grid	200	200	200	200	250	1.050
	Design grid	200	200	750	200	250	1.600
Extended length after improvement (m)	Working	0	0	385	0	0	385
	Tension	0	0	550	0	0	550
Stretching length 1 mesh (m)		50	50	50	50	50	
The number of rolls to be increased according to the length (roll)		0	0	11	0	0	

Calculate grid height improvement:

The calculated height of the improved mesh sections and detailed sample grids are shown in Table 2.

Table 2- Summary of calculations to improve grid height

Contents		Tung 1	Tung 2	Body	Wing 1	Wing 2
Working height (m0	Sample grid	48	-	100	-	44,8
	Design grid	64	-	140	-	67,2
Tension height (m)	Sample grid	120	132	147	128	112
	Design grid	160	180	203	184	168
Increased height after improvement (m)	Working	16	-	40	-	22,4
	Tension	40	48	56	56	56
Stretching height 1 roll of net (m)		10	12	14	16	28
The number of rolls to be increased according to the height (roll)		4	4	4	3,5	2

Calculation of necessary materials and spare parts to improve the mesh:

a) Mesh shirt material

Based on the current tensile size of the sample mesh and the results of the design mesh calculation, the amount of mesh material required for improvement is shown in Table 3.

Table 3- Summary of mesh jacket materials needed for improvement)

Improved mesh section	Standard mesh parameters					Amount of mesh required for improvement	
	Thread net	2a (mm)	L_0 (m)	m (◊)	G_i (kg)	Number of nets	Net weight (kg)
Tung 1	PA 210D/21	25	50	400	38	16	608
Tung 2	PA 210D/18	30	50	400	29,6	16	473,6
Body	PA 210D/15	35	50	400	21,4	175,5	3.755,7
Wing 1	PA 210D/15	40	50	400	18	14	252
Wing 2	PA 210D/18	70	50	400	22	10	220
Float	PE 700D/15	30	50	400	86,6	1,20	103,6
Total						232,7	5.412,9

b) Calculate the float edge

From the value of L calculated above, instead of the formula, the length of the float lines (bandage and threading) to be retrofitted is calculated as: : L_{gp} = 405,30m.

c) Calculation of lead line, boundary line, draw line, main draw line

Calculation results for each type of wire required for improvement are summarized in Table 4.

Table 4- Synthesis of wire materials for gold mesh improvement

STT	Name	Material	Specification	Unit Weight (g/m)	Quantity	Length (m)	Weight (kg)
1	Pontoon sling	PP	Φ16, (Z)	120,5	1	405,3	48,8
2	Floating Girders	PP	Φ16, (S)	120,5	1	405,3	48,8
3	Lead Tape	PP	Φ18, (Z)	159,0	1	428,4	68,1
4	Lead Threading	PP	Φ18, (S)	159,0	1	428,4	68,1
5	Spare Parts	PP	Φ16, (Z+S)	120,5	2	17,0	4,1
6	Rims	PP	Φ16, (Z+S)	120,5	2	23,4	5,6
7	Spare Parts Drawstring	PP	Φ18, 8	173,0	1	17,0	2,9
8	Side drawstring	PP	Φ18, 8	173,0	1	23,4	4,0
9	Main drawstring	PP	Φ40, 8	1.833,0	1	1.500,0	2.749,5
	Total						3.000,1

d) Calculate the main ring

The number of main rings is calculated as follows: n = 150 rings.

e) Border ring:

The total number of rings of the improved net is: 31+12 = 43 rounds, corresponding to a weight of 43x0.25 = 10.75kg.

f) Equip Lead

The weight of lead in the air that needs to be fitted to the design grid is calculated as: G_{ch} = 591.7kg.

Number of lead tablets needed to be equipped: n_{ch} = 1,972 tablets.

The distance between two lch pencils is determined as follows: l_{ch} = 58cm.

h) Equipping buoys:

The number of buoys that need to be equipped with nph for gold net is: n_{ph}= 4,214 buoys.

The distance between two floats lph is determined: l_{ph} = 28cm.

Number of buoys needed to retrofit n_{ph1} = 1,556 buoys.

3.4. Experimental results at sea

3.4.1. The result of measuring the sinking speed of the improved mesh gold

From the results of measuring the sinking speed of the unimproved and the improved nets, it shows that the improved net has a faster sinking speed than the old one from 3-4 minutes from the start of the drop.

3.4.2. Results of measuring illuminance on the water surface of ships using LED lights and control ships

The study conducted field measurements of the illuminance between the experimental ship installed with LED lights and the control ship using high pressure lights, resulting in: The total illuminance power of the LEDs is only ¼ of that of the control ship. 7kW LED compared to 24kW of the control ship), but the illuminance of the ship using LED is 1.41 times greater than that of the control ship. The maximum illuminance of the ship using LED lights was 1,753 lux, while the control vessel was only 1,252 lux. The distance of lighting on the water surface of the ship using LED lights reaches a value of 1 lux of 65 m (from each side), while the control ship is only 45m.

3.4.3. Underwater illuminance of light source

The experimental results show that the illuminance on the ship using LED lights is higher than the control ship. Results: the maximum depth and light on the sides and aft of the ship using LED lights are 40.6 (m) and 36.9 (m), respectively, while this figure of the control ship only reached 35.6 (m) and 30.7 (m). This shows that LED lights have the ability to shine deeper than the lights fishermen are using. The research results also show that the light on the side of the ship is hidden, so the illuminance is only 5.3m (the ship uses LED lights) and 4.3m (the control ship). At the survey point at a distance of 5m from the ship, the maximum illuminance and then gradually decreased until the illuminance on the water was 1 lux, the depth was zero.

3.4.4. The effective luminous area and volume of the light source

From the research results, the ship using LED lights is 2.28 times wider than the control vessel.

The depth of the starboard and starboard ships using LED lights is 40.6m and the stern is 36.9m. The total underwater lighting volume of the ship using LED lights is: = 124,530 (m3)

The depth on the port side and starboard side of the control vessel was 35.6 m and the stern was 30.7 m. The total underwater lighting volume of the ship using LED lights is: = 47,568 (m3)

From the above results, the total underwater lighting volume of the ship using LED lights is 2.62 times larger than that of the control vessel.

3.4.5. Efficiency on fuel consumption

The results of measuring fuel consumption in 8 voyages, of which there are 4 experimental trips in 2020, 4 experimental trips in 2021, on average, each voyage of ships goes fishing for 20 days at sea. The average fuel consumption per voyage on a ship equipped with LED lights accounted for only 26.41% to 29.75% compared to a control vessel using traditional high-pressure lights. In other words, for ships using LED lights, fuel consumption (diesel) is from 70.25% to 73.59% compared to the amount of fuel consumed by ships using high pressure lights.

3.4.6. Yield, species composition of exploited products

The study carried out observations and measurements through 8 test voyages, with a total of 28 nets in each vessel, yielding results. Experimental results show:

For ships using only high-pressure lamps, the average output (kg/batch) is 84.73% of the average output (kg/batch) of ships using LED lights, and 75.63% of the average output. (kg/batch) of ships using LED lights and improved grids;

For ships using only LED lights, the average output (kg/batch) is 89.26% of the average output (kg/batch) of ships using LED lights and improved grids.;

In other words, ships using LED lights and improved grids have a higher average throughput than ships using only traditional LEDs and high-pressure lights.

CONCLUSIONS AND RECOMMENDATIONS

1.Conclusions

The fleet of seine fishing with light of Khanh Hoa province has a small number of ships but has an annual output of over 60,000 tons, accounting for a large proportion of the fishing output in the province.

The fleet is fully equipped with equipment for fishing and ensuring maritime safety, especially 100% of ships have installed cruise monitoring equipment.

The basic factors affecting the catches on offshore seine vessels in Khanh Hoa include factors of light source and structure of fishing gear (gold net). In addition to the factors of light source height, light source power, the research also shows that the luminous efficiency of the light source also strongly affects the exploitation output.

The solution to improve fishing efficiency for offshore seine fishing in combination with light in Khanh Hoa is to use LED lights to replace traditional high-pressure lights, and at the same time to improve the gold seine nets to be suitable for the target fishing industry. The catch is mainly skipjack tuna.

Experimental results show that the use of LEDs to replace high-pressure lights combined with improved seine nets on offshore seine fleets has brought about feasible results:

The light indicators of LEDs such as luminous flux, illuminance, lighting efficiency, lifespan,... are all superior to those of high pressure lamps. However, the cost of LED lights is higher than high pressure lamps

Vessels using LED lights save fuel (diesel) from 70.25% to 73.59% compared to the amount of fuel that ships using high pressure lights.

The improved mesh gold sinks faster than the improved mesh gold by 3-4 minutes

The improvement of seine gold in focus for skipjack and tuna fishers needs to be synchronized according to certain design principles, then the improved gold net brings higher efficiency than the traditional gold net. .

Vessels using LED lights and improved nets have an average yield (kg) through nets that is 1.22 to 1.32 times higher than ships using only traditional LEDs and high-pressure lights.

2. Recommendations

It is necessary to continue to study the factors of fishing grounds, seasons, and light colors of LED lights that affect the concentration of fish around the light source, focusing mainly on skipjack tuna.

It is necessary to study the use of LED light sources placed under water, light lines placed on the water surface in clusters as a scientific basis for practical application.

It is necessary to study and improve fishing gear, including research on materials: nets, drawstrings, etc. sinking speed of gold nets when released, working shape of gold nets to increase exploitation efficiency.

LIST OF WORKS ANNOUNCED

1.Nguyen Van Nhuan, Nguyen Duc "The current situation of offshore seine fishing in Khanh Hoa province" Journal of Fisheries Science and Technology, No. 02-2022, pp. 2-9.

2.Nguyen Van Nhuan, Nguyen Huu Thanh, Thai Van Ngan "Research and improvement of offshore seine nets for fishing fleet of Khanh Hoa province" Journal of Fisheries Science and Technology, No. 02-2022, pp. 10-20.