



Testing the Installation of Camera Recorder GoPro Hero 3<sup>®</sup>  
to Observe the Fishes Escapement from Codend of Trawl Net  
in Trawling Operation

Isara Chanrachkij and Prasert Petrasatien

TRAINING DEPARTMENT

SOUTHEAST ASIAN FISHERIES DEVELOPMENT CENTER

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**Testing the Installation of Camera Recorder GoPro Hero 3<sup>®</sup>  
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**Isara Chanrachkij<sup>1</sup> and Prasert Petrasatien<sup>2</sup>**

<sup>1</sup> Southeast Asian Fisheries Development Center/Training Department (SEAFDEC/TD)

<sup>2</sup> Eastern Marine Fisheries Research and Development, Department of Fisheries, Thailand (EMDEC-DOF, Thailand)

**Abstract**

The Testing the Installation of Camera Recorder GoPro Hero 3<sup>®</sup> to observe the Fishes Escapement from Codend of Trawl Net in Trawling Operation was conducted in with Fisheries Research Vessel Pramong No.16 of Eastern Marine Fisheries Research and Development Center, department of Fisheries (EMDEC-DOF) at Rayong Province, 19-24 November 2014. Testing was supported by the FAO/GEF Project Strategies for Trawl Fisheries By catch Management (REBYC-II CTI) through the collaborative efforts of SEAFDEC/TD and EMDEC-DOF, the testing aimed to investigate the applicable of camera recorder GoPro Hero 3<sup>®</sup> with underwater housing and observed on fishes escape from the codend in trawl selectivity experiment.

The results of the survey presented that camera recorder GoPro Hero 3<sup>®</sup> with underwater housing possible to install with codend of trawl net to observe on fishes escape from the codend in trawl selectivity experiment. Limitation of battery capacity, maximum depth of underwater housing, underwater visibility found major hindrance. The best recording on fishes escape from the codend in trawl selectivity experiment can record by the position of camera recorder that installed at outer side of codend at range 1 m from rear part of codend. Camera recorder was head-up set and faced to rear part of codend. Practices on the underwater camera installation should be regularly done with several set of camera recorder in every trawl fishing operation.

**Keywords:** Camera Recorder GoPro Hero 3<sup>®</sup>, REBYC-II CTI, trawl selectivity experiment

**Corresponding author:** Isara@seafdec.org

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\*Southeast Asian Fisheries Development Center/Training Department (SEAFDEC/TD)

\*\*\*Eastern Marine. Fisheries Research and Development, Department of Fisheries, Thailand  
(EMDEC-DOF, Thailand)

# Testing the Camera Recorder GoPro Hero 3 to Observe Codend of Trawl Net in Trawling Operation

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## Introduction

In trawl fisheries, fishing gear modification is a part of tool to concept of gear based management. Fishing gear modification is able to supports the fishing effort control by reducing on bycatch and discard from trawl fishing operation. Fishing gear modification, generally, is able to categorize into the mitigating of impact of bottom habitat. FAO APFIC (2013) recommends several concept to mitigate impact of bottom habitat include apply lighter gear (e.g. net material, footropes, bobbins). In order to reduce bycatch in trawl fishing operation, FAO APFIC (2013) also recommends improving the fishing gear selectivity in fishing operation by minimum of 40 mm mesh size in the codend, development and implement gear designs with industry (BRDs, JTEDs, TEDs, etc.) that reduce impacts on at-risk and ETP species is an option.

These modifications require research techniques and experimental design to obtain scientific evidence to support the policy. In order to enhance efficiency of research study on fishing gear modification, it is often to utilize the underwater image to improve the experiment, i.e. fishing gear adjustment, behavior of catches response to the gear, and etc.

Study on the trawl fishing selectivity is a part fishing gear modification. In order to develop the appropriated design of modification, information of fishes escapement from codend trawl net is one of subject to help understanding on how Improvement of trawl selectivity devices. Even though the observation on the escapement cannot estimate survival catch rate of catch escapement from cod end of trawl net, the record reveal how condition of escaped fishes and sudden death found in after releasing can observe.

To support the study of trawl net modification and suitable techniques, RFU of Project REEBYC-II CTI in collaboration with SEAFDEC/TD and Eastern Marine Fisheries Research and Development Center, department of Fisheries (EMDEC-DOF), Rayong Province, conduct the testing of camera recorder GoPro Hero 3® with underwater housing, aims to investigate the applicable of camera recorder and preliminary observed on fishes escape from the codend in trawl selectivity experiment. Result and discussion of testing is presented to help the understanding of the application and installation of recording camera in trawling operation. Result is presented through the underwater images of all fishing operations. It is able to support the fishing gear technologists to improve the tools and techniques to record escapement catch from trawl and other fishing gear and to find the most suitable devices/techniques to increase the selectivity in the future.

## Objective

1. Testing the Camera Recorder GoPro Hero 3® with underwater housing for the experiment of trawl fishing selectivity includes suitable position for installing the camera recorder with codend of trawl net.
2. Preliminary observations on fishes escape from the codend in trawl selectivity experiment.

## Materials and Methods

### Material

1. Trawler; Fisheries Research Vessel (FRV) Promong 16 in service of Eastern Marine Fisheries Research and Development Center (EMDEC), Rayong Province is use for the experiment . (Figure 1a).
2. Trawl net; Standard bottom trawl net of Department of Fisheries, Thailand. Net particular is shown in annex 1.



Figure 1a



Figure 1b

**Figure 1a:** Fisheries Research Vessel Pramong 16 (ที่มา <http://www.fisheries.go.th/mf-emdec/mainweb/vessel.html>)

**Figure 1b:** Camera Recorder GoPro Hero 3®

3. Camera recorder GoPro Hero 3® with underwater housing (Figure 1b). Specification is shown in annex 2
4. Rigid plastic net size 10 x 10 cm, as base of camera recorder that tightened with net panel of codend (Figure 2b).

## Method

1. Camera setting
  - a. Setting camera function on head up and head down refer to camera installation.
  - b. Setting the resolution to 960 P
  - c. Apply grease with O-ring of housing
2. Tightened rigid plastic plate with codend trawl net
3. Trawling operations were referred to the Station Operational Procedure (SOP) of fisheries resource survey by trawling of Department of Fisheries, Thailand.
4. Standard trawling time is 60 minutes.



Figure 2 (a)



Figure 2(b)

Figure 2 (a) Crew is tightening rigid plastic net with codend trawl net

Figure 2 (b) Rigid plastic net fixed with codend trawl net

5. Camera installation
  - a. There are four (4) patterns of installation improvise in the testing. The first pattern was tested in trawling operation No. 1 and No. 2. Camera Recorder was installed inside codend at the fore part of codend. Camera recorder was head-down set (Figure 2a)

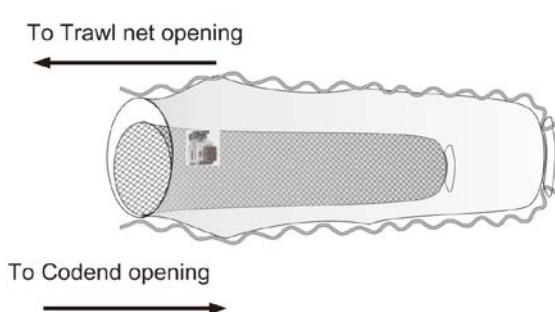
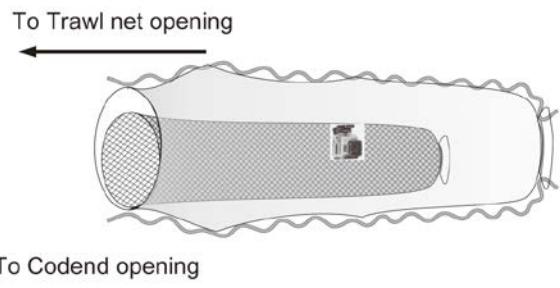


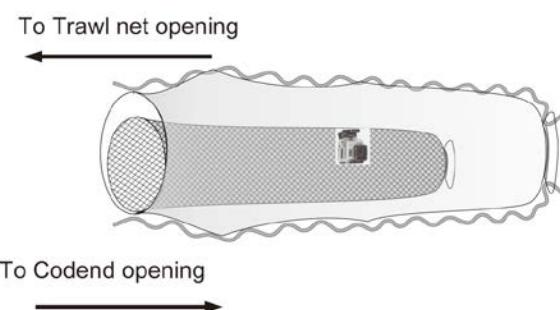
Figure 3 (a) The first pattern was tested during fishing operation No. 1 and No.2

b. The second pattern was tested in trawling operation No. 3 and No. 4. Camera Recorder was fixed inner side of codend at range 1 m from fore part of codend. Camera recorder was head-down set and faced to rear part of codend (Figure 2b).



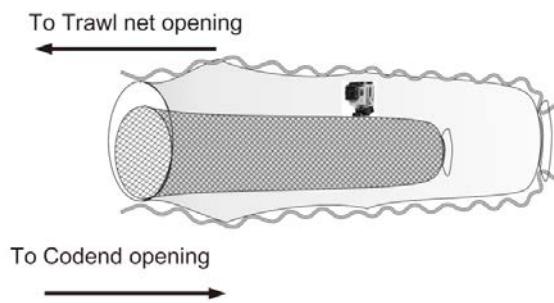
**Figure 3b** The second pattern was tested during fishing operation No. 3 and No.4

c. The third pattern was tested in trawling operation No. 5. Camera Recorder was fixed at outer side of codend at range 1 m from rear part of codend. Camera recorder was head-up set and faced to rear part of codend (Figure 2c).



**Figure 3c** The third pattern was tested during fishing operation No. 5

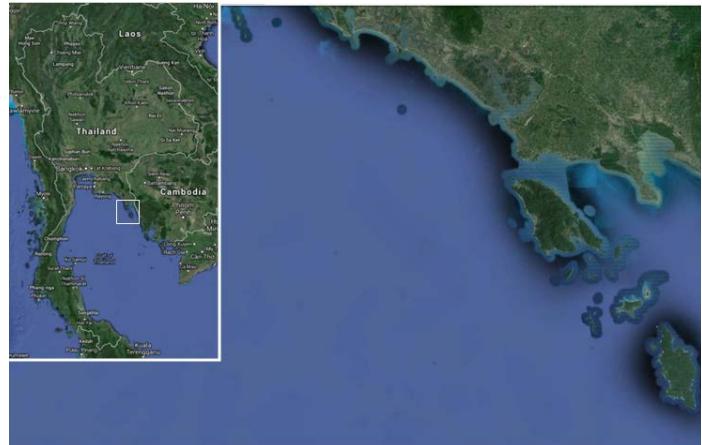
d. The forth pattern was tested in trawling operation No. 6. Camera Recorder was fixed at outer side of codend, similar position to operation No. 5, at range 1 m from rear part of codend. Camera recorder was head-up set and faced to fore part of codend (Figure 2d).



**Figure 3d** The forth pattern was tested during fishing operation No. 6

## Area of Experiment

Testing of the Camera Recorder GoPro Hero 3<sup>®</sup> to observe codend of trawl net in trawling operation were carried out from 19 to 24 November 2013. Area of fishing operation was trawl fishing ground around Eastern part of the Gulf of Thailand, covered area of Rayong Province, Chanburi Province and Trat Province. Area of experiment is shown in figure 4.



**Figure 4** Area of experiment

## Result

Six (6) trawling operations were conducted during the cruise survey of FR/V Pramong 16. Regarding to the instruction of camera housing informs the water resistant of underwater housing is less than 60 m depth, testing the Camera Recorder GoPro Hero 3 to observe codend of trawl net in trawling operation were conducted at minimum depth was 18 m, and maximum depth was 41 m. Positions and sea depth showed by table 1. No leaking found at the camera housing during trial operations.

**Table 1** Partial detail of fishing operation

Operation No.	Date	Time	Trawl setting position	Sea depth (m)
			Latitude (Lat)/Longitude (Long)	
1	19/11/2013	07:29	Lat 11_58.14 N / Long 101_10.18 E	41
2	20/11/2014	06:56	Lat 12_02.83 N / Long 101_49.56 E	38
3	23/11/2014	07:20	Lat 11_44.41 N / Long 102_22.86 E	22
4	23/11/2014	09:00	Lat 11_45.80 N / Long 102_32.24 E	28
5	23/11/2014	11:23	Lat 11_45.80 N / Long 102_00.76 E	18
6	24/11/2014	13:09	Lat 12_24.97 N / Long 101_44.26 E	21



**Figure 5** Station of trawl fishing operations with tests of Camera Recorder GoPro Hero 3<sup>®</sup>

#### Operation No.1

Underwater camera installation at trawl net operation No.1 was set inside of 40 mm codend, at the fore part of codend. Camera recorder was head-down set and faced to the end part of codend. Recording was not able to show the rear part of codend because it was too dark notwithstanding it was clear underwater transparency at sea depth 41 m. Observation found some fishes and squids at fore part, inside codend however camera cannot record fishes escaped from codend.



Camera Preparation onboard  
(Vision from front to rear)



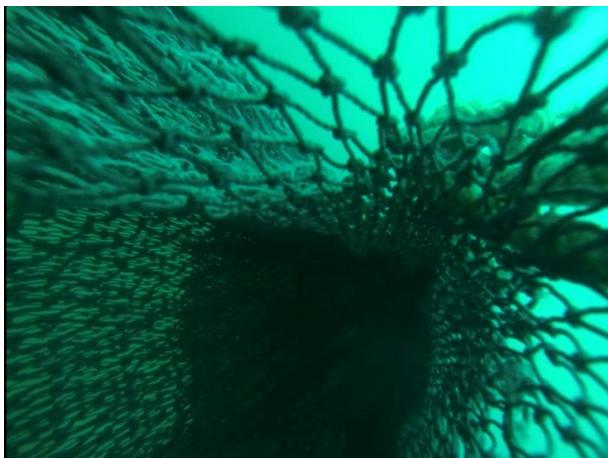
Trawl net setting operation  
(Min 00:10)



Trawl net at sea surface and warp payout  
(00:48 min)



Net at Sea Surface  
(07:25 min)



At sea depth ~35 m.  
(11:36 min)



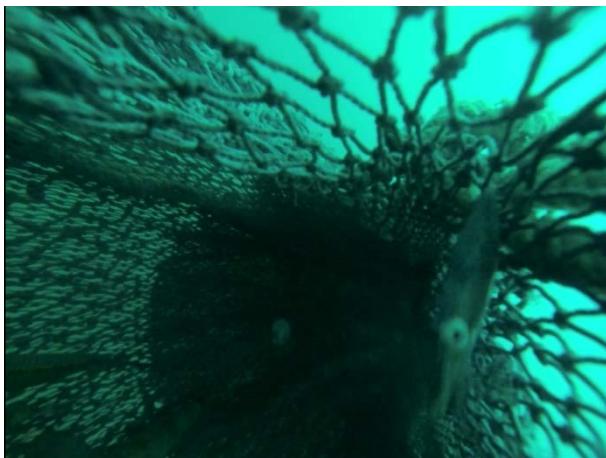
Codend with lizard fish and scallops  
(17:56 min)



Codend with snapper and squid  
(40:50 min)



Codend with lizard fish and squid  
(45:52 min)



Codend Shape underwater with a Lizard fish, scallop and squid  
(53:55 min)



(60:07 min)

**Figure 6** Underwater observation of trawl fishing operations No.1

#### Operation No.2

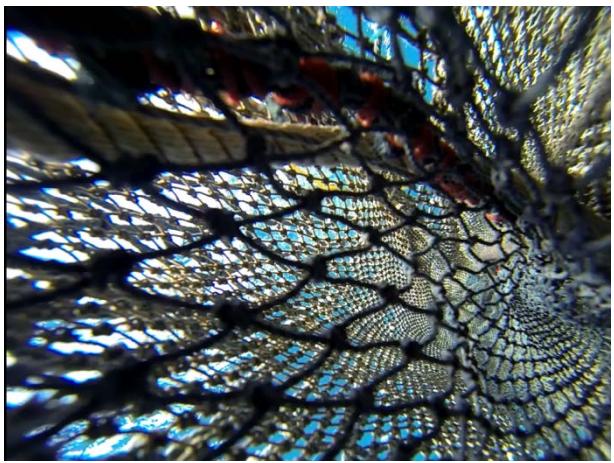
Underwater camera installation at trawl net operation No.2 was the same position as No.1. Observation shows that operation No.2 was not well angle recording camera installation. Camera faced into the net panel and fish can be observed at the bottom of codend. Fishes at bottom part of codend net, however, were not clearly observed because of 1) Distance from the camera to fish inside codend, 2) Turbidity of sea water, and 3) Obstruction of folded net panel. We nevertheless can observe squid was trying to escape from the codend of trawl net.



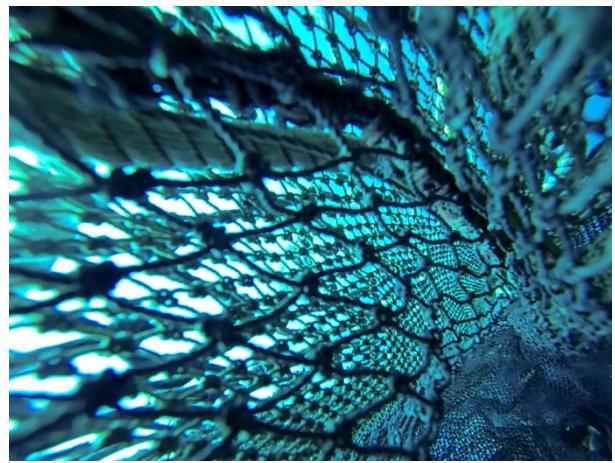
Camera Preparation onboard  
(Vision from front to rear)



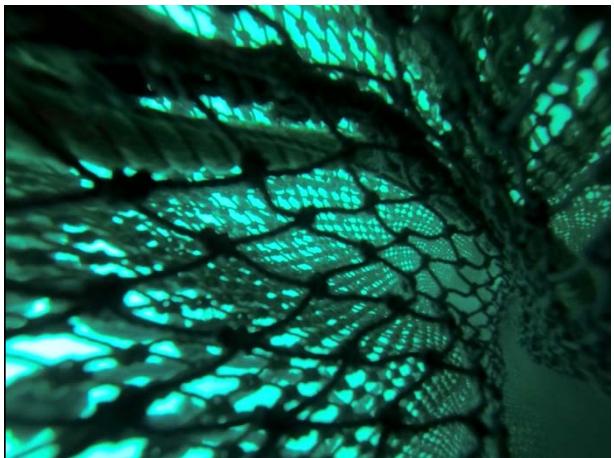
Trawl net setting operation  
(5:18 min)



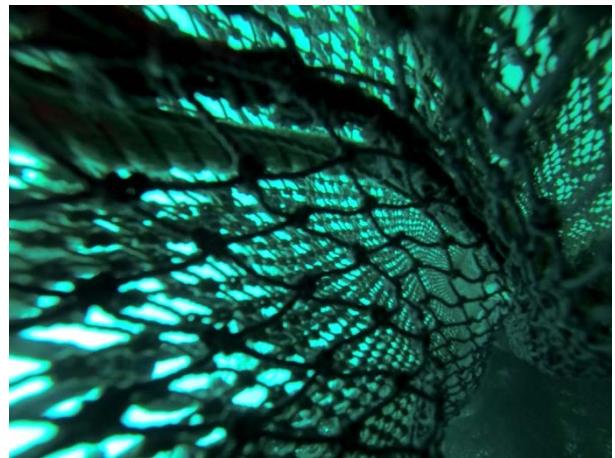
Trawl net at sea surface and warp payout  
(6:08)



Net at Sea Surface  
(10:25 min)



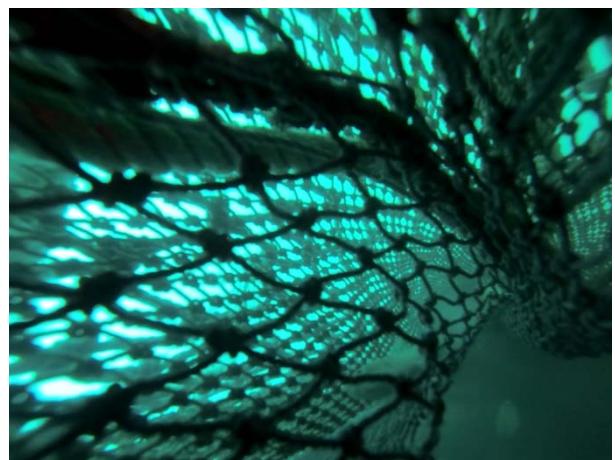
Net at Sea Surface  
(17:10)



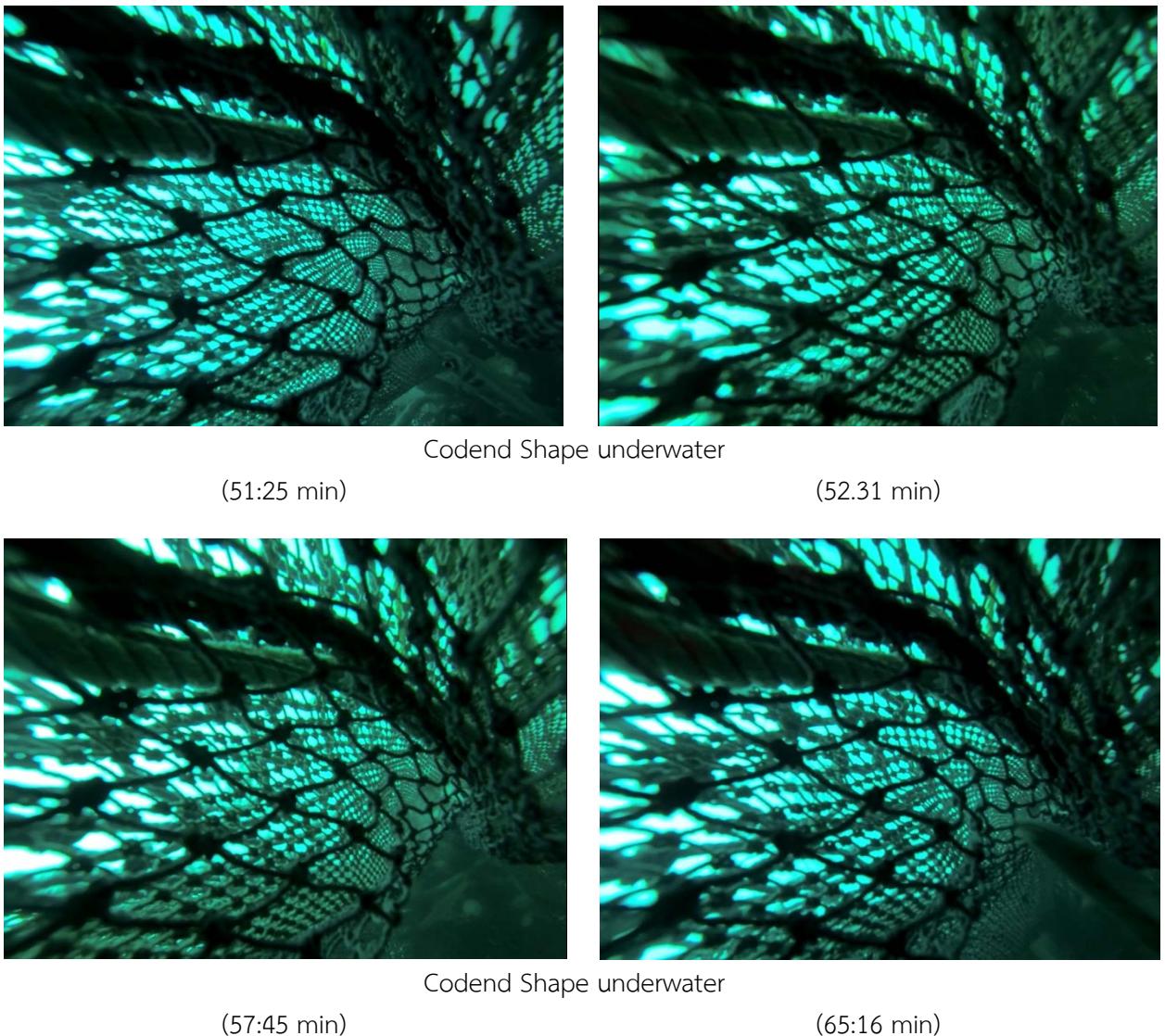
Codend Shape underwater  
(27:40)



Codend Shape underwater  
(46.11 min)



(46:18 min)



**Figure 7** Underwater observation of trawl fishing operations No.2

### Operation No.3

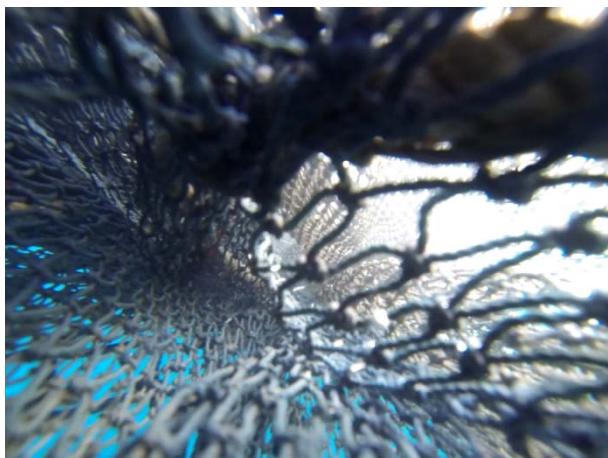
Underwater camera installation at trawl net operation No.3 was set inside of 40 mm codend, faced to rear part of codend, head down, with distance far from codend opening was about 1 m. it was set pointing to rear part of codend. Result of recording of both operations showed clear underwater visibility but cannot observe the rear part of codend because folded net panel obstructed view. Observation found some fishes and squids caught and swam into at the codend but cannot record fishes escaped from codend mesh size 40 mm to cover net space.



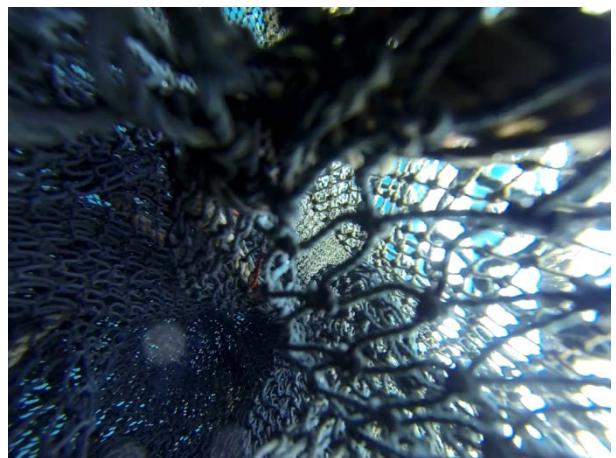
Camera Preparation onboard  
(Vision from front to rear)



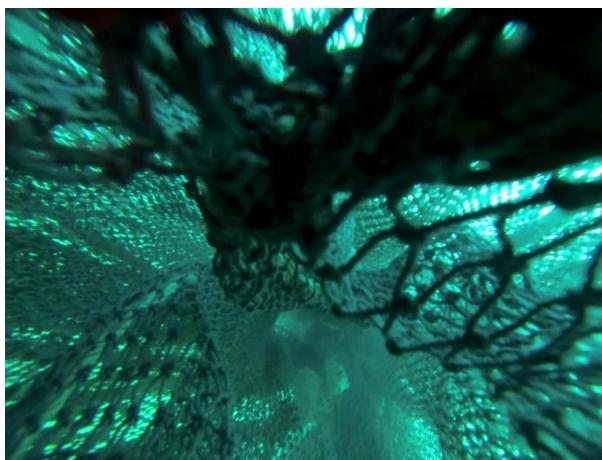
Trawl net setting operation  
(2:35 min)



Trawl net at sea surface and warp payout  
(04:45 min)

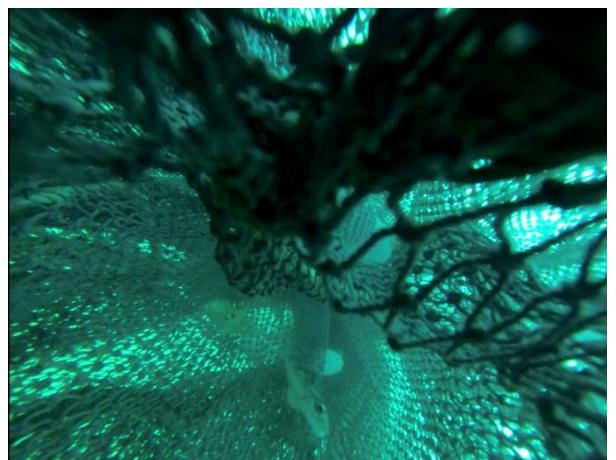


(06:45 min)

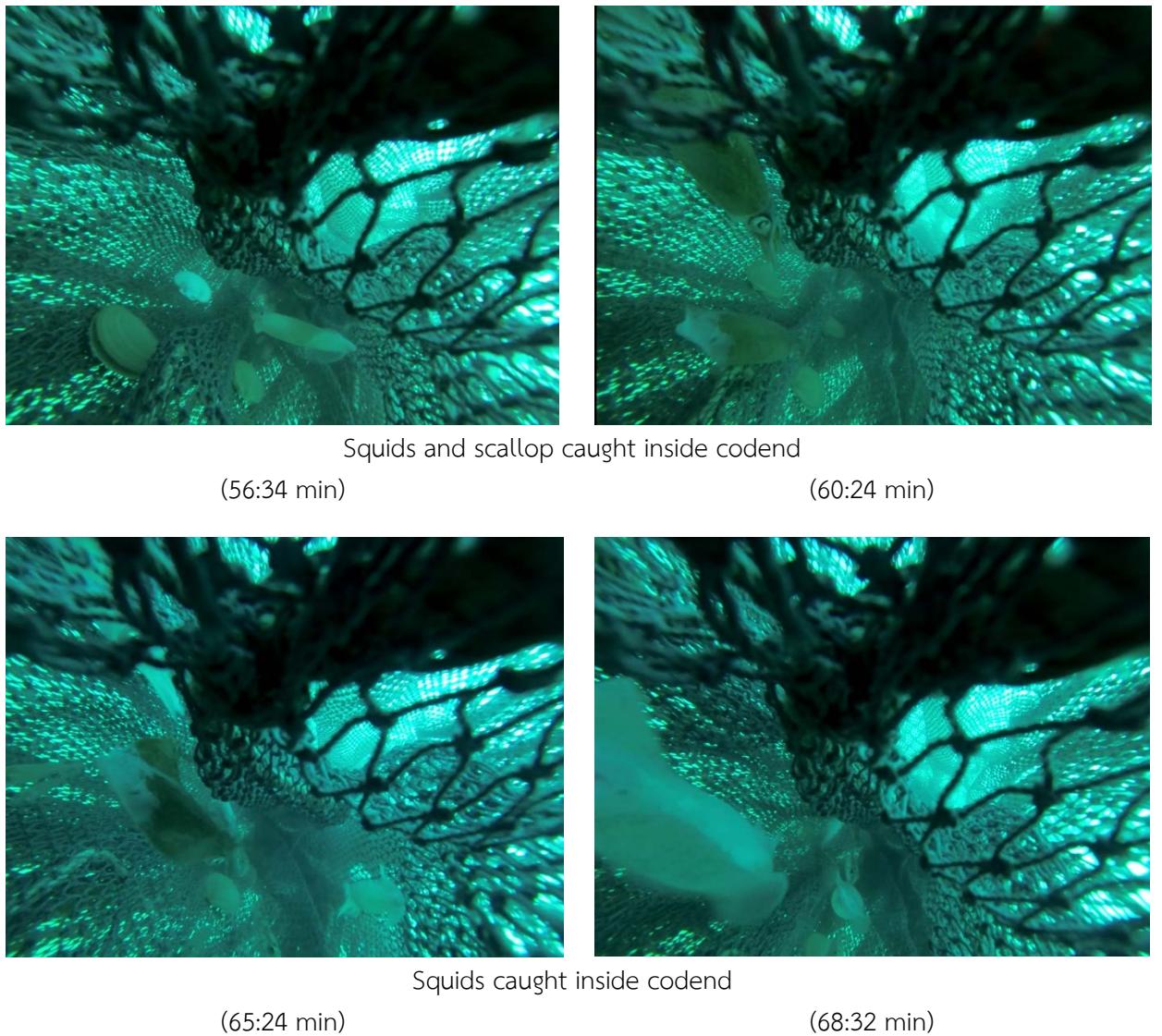


Fishes caught inside codend

(25:42 min)



(39:53 min)



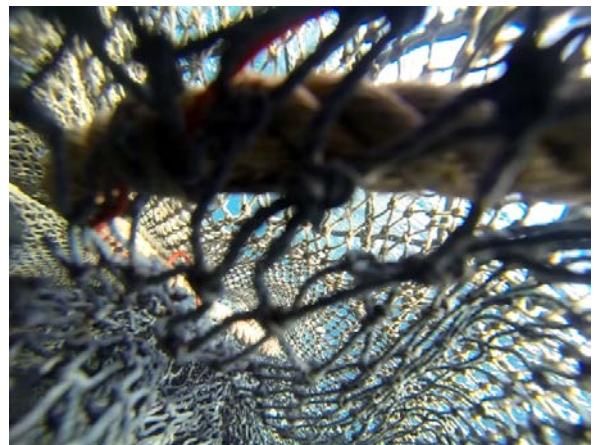
**Figure 8** Underwater observation of trawl fishing operations No.3

## Operation No.4

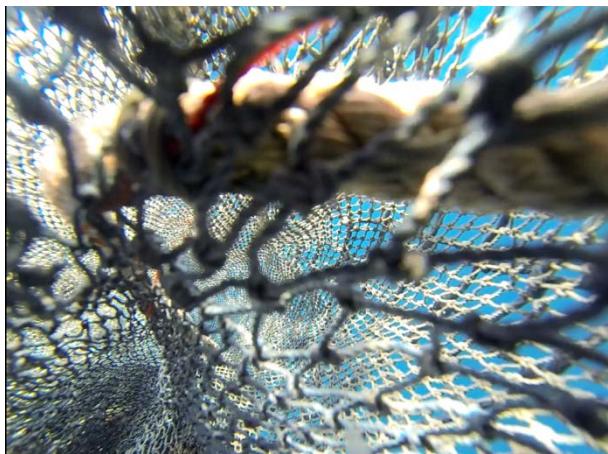
Underwater camera installation at trawl net operation No.4 was the same position No.3. Underwater camera setting at Operation No.4 was not well angle installation. Observation shows the camera faced into the net panel and fish can be observed inside codend. Even though the sea water is transparent, part of net panel obstructed to camera and reduced the visibility inside codend. Camera cannot record the fish escaped from inside codend mesh size 40 mm to cover net space.



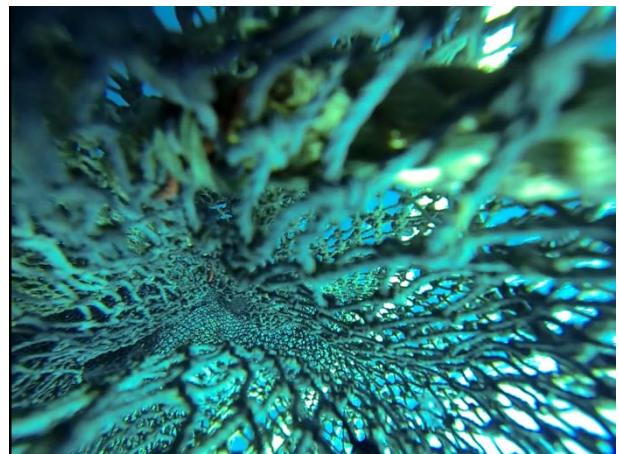
Camera Preparation onboard  
(Vision from front to rear)



Trawl net setting operation  
(05:04 min.)



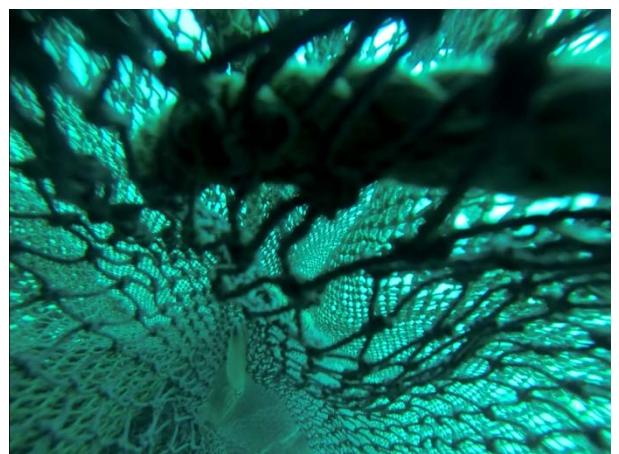
Trawl net setting operation  
(06:01 min)



(10:00 min)



Fishes caught inside codend  
(15:22)



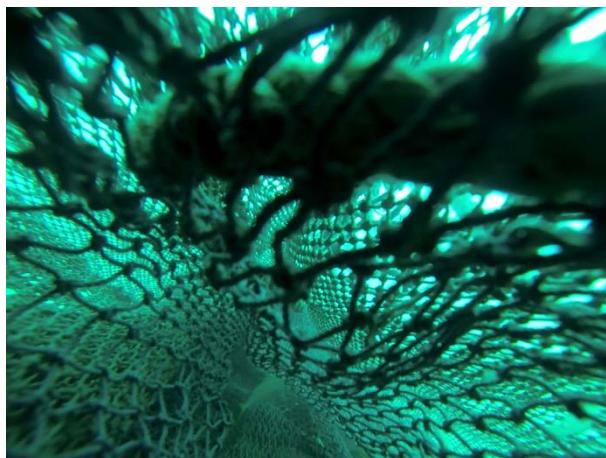
A squid was trying to escape through mesh  
opening of codend  
(20:00 min)



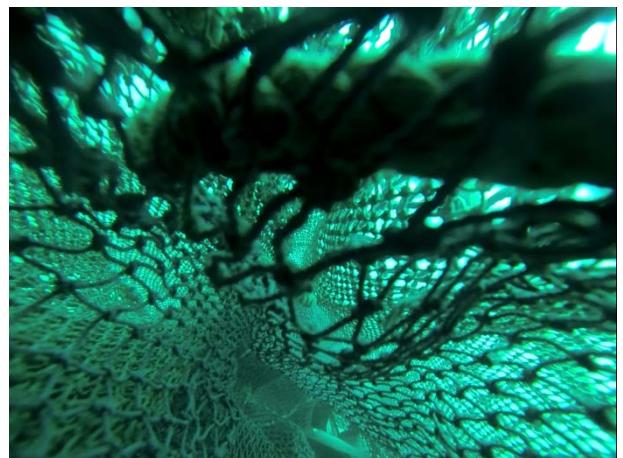
Squids and fishes caught inside codend  
(21:50 min)



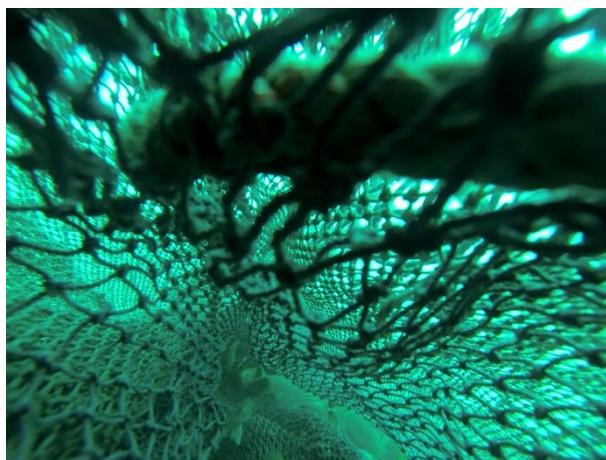
(40:56 min)



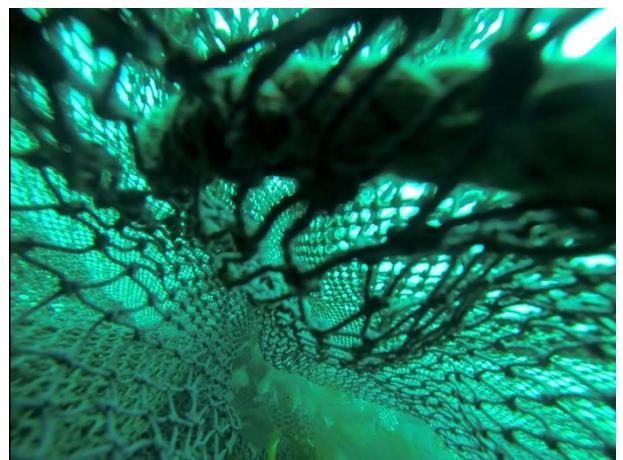
Net panel obstructed the view finder  
(46:58 min)



(56:59 min)



Squids and fishes caught inside codend  
(61:33 min)



Fishes caught inside codend  
(65:12 min)

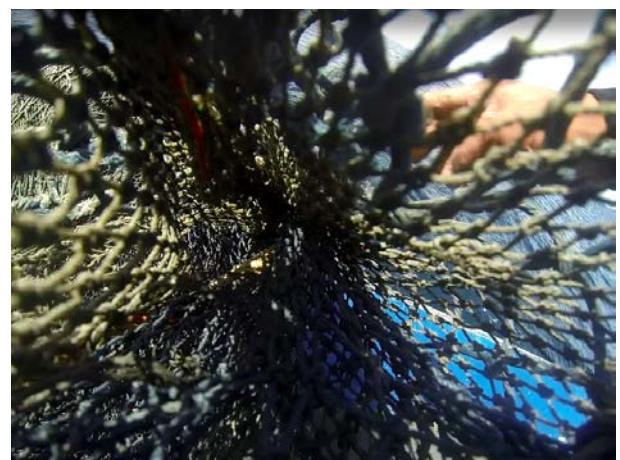
**Figure 9** Underwater observation of trawl fishing operations No.4

## Operation 5

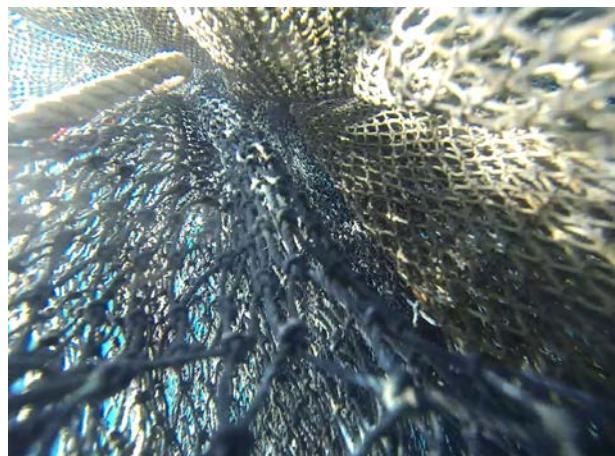
Underwater camera installation at trawl net operation No.5 was set outer of codend, head up, with distance from codend opening was about 1 m. Camera was set to rear part of codend. Result of recording showed clear the underwater transparency was good. With the suitable setting of camera and net panel, shape of codend, space between codend and cover net, and shape of cover net was fair observed. A lot of fishes were able to observe during they were escaping from 40 mm mesh opening of codend. Fish schools performed well swimming in the space between codend and cover net.



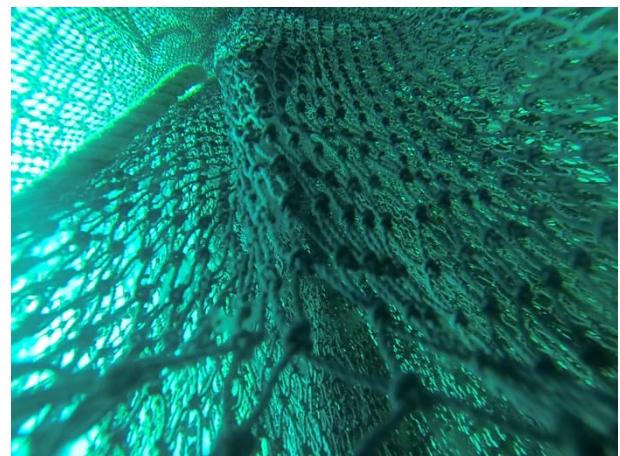
Camera Preparation onboard  
(Vision from front to rear)



Trawl net setting operation  
(01:23)



Trawl net setting operation  
(03:05)



(09:10)



Codend was forming the shape underwater  
(10:39) (12:30)



Fishes started escaping from codend to cover net space  
(17:09) (20:11 min)



Fishes were well swimming in the space between codedn and cover net  
(21:08) (26:30 min)





Fishes were well swimming in the space between codedn and cover net

(31:42)

(34:50)



Fishes were well swimming in the space between codedn and cover net

(40:12)

(51:15)



Fishes were well swimming in the space between codedn and cover net

(54:07)

(58:32)

**Figure 10** Underwater observation of trawl fishing operations No.5

## Operation 6

Underwater camera installation at trawl net operation No.6 was set outer of codend, head up, with distance from codend opening was about 1 m. Camera recorder was fixed at the same range of Station No.5 but camera is faced to the fore part of net (Trawl net opening). Sea Depth was 21 m. Result of recording showed clear underwater visibility. Due to camera setting on net panel was not well installation, there was part of rope and net panel of codend obstructed the view of underwater camera. View finder of camera had been obstructed since operation was started until finish consequent rare escaped fishes were observed at codend and swam in the space between codend and cover net panel.



Camera Preparation onboard  
00:10 min



Trawl net setting operation  
04:10 min



Trawl net setting operation  
(09:48 min)



Net and rope obstructed view finder  
(17:30 min)



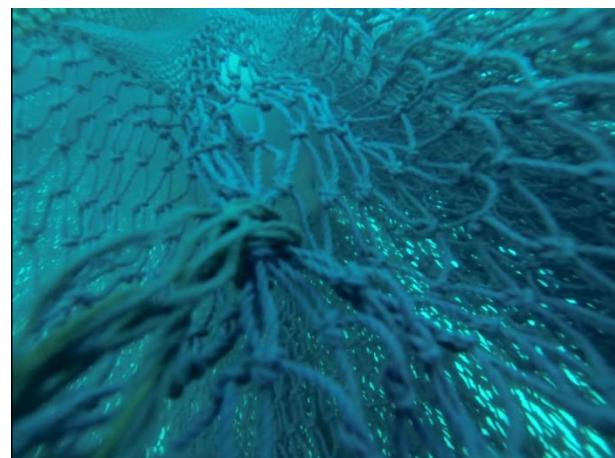
Net and rope obstructed view finder  
(27:30 min.)



(28:35 min)



Net and rope obstructed view finder  
(31:45 min)



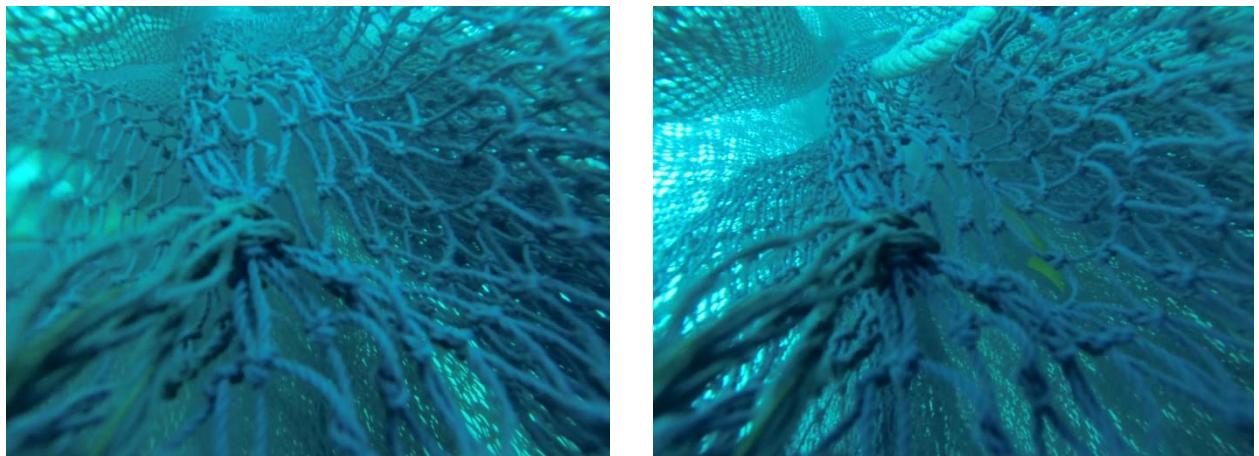
(35:33 min)



Net and rope obstructed view finder  
(55:46)



Squid was swimming inside codend and cover net  
(56:05)



**Figure 11** Underwater observation of trawl fishing operations No.6

## Conclusion

1. Camera recorder Go-Pro Hero 3® is able to use in the experiment of trawl fishing. Setting of camera recorder with VDO resolution of 1280 x 960p at 100 fps. Image is clear enough to investigate fishes escape from cod end and their swimming characteristic for setting recorder.
  2. Camera recorder Go-Pro Hero 3® is not assembled with LCD display. So that it is difficult to properly install the camera to record fish into codend and cover net with the proper observation position.
  3. Camera recorder Go-Pro Hero 3® assembles with WIFI system however it is not able to use while setting camera with the trawl net in the water.
  4. Pressure resistance of underwater housing of Camera recorder Go-Pro Hero 3® is able to use with depth around 40 m. Refer to the specification of underwater housing, pressure resistant is 60 m. in depth.
  5. VDO image is found wide angle that very good for observe fish into codend net or cover net
  6. Quality of VDO Image is affected by water transparency and depth of fishing operation. Low transparency by suspended solid makes low visibility and the recording is able to conduct with short distance.
  7. Underwater VDO image is found blue-green tone. It is because of absorption characteristic of light by sea water. Red color is absorbed while sea depth is more than 33 feet (10 m), so that underwater color turned to blue green tone.
  8. Long codend part reduce clear image to examine fishes gathered into codend because the limitation of visibility in water in particular turbid sea waters.

9. Camera can set both inner and outer of codend and cover net.

10. Memory card, 16 Gigabyte (GB), is able to record VDO image what setting with VDO resolution of 1280 x 960p at 100 fps., approximately 70 min. Specification of Camera recorder Go-Pro Hero 3® is maximum capable to use the 64 GB memory card.

11. Battery pack of camera recorder Go-Pro Hero 3® with full electric capacity is able to use for 70 minute.

12. In order to secure the camera with the waver net sheet, rigid plastic net is one of the material what can be fixed with the net sheet for better securing Camera recorder Go-Pro Hero 3® with housing (see figure 1)

13. Camera recorder Go-Pro Hero 3® is able to both head up and head down install depend on the camera function setting.

14. Camera is able to install by facing to fore net, i.e. trawl net opening, or facing to rear net, i.e. codend.

15. There is only holding position of underwater camera housing what is able to fix with rigid plastic net. To tighten only housing body with net is unable to secure fasten. Camera is able to turn face up of down by current easily. Obviously that trawl net sheet is possible to fold underwater. Folded net sheet always obstructs to the camera visibility.

16. Too long length of codend part makes unclear to examine fishes gathered into codend.

17. To observe condition of escaped fish, fish behavior and swimming characteristic of fishes inside cover net, the best position of camera installation is at the outer of codend (inner of cover net). Distance of setting is far from rear part of net (Codend opening) around 1 m, and camera point into rear part of net (Codend opening).

18. It is not clearly to observe how fishes escape form mesh size, however camera can record a squid was escaping from 4 cm mesh size (Station No.6). Position of camera is the same position of Conclusion No.15 but camera is pointed into front part of trawl net (trawl net opening).

19. Fished and squid escape from codend, mesh size 40 mm, are found alive and active swimming into the space between codend and cover net.

## Recommendation

1. Recommend memory card 64 Gigabyte to obtain full capabilities of camera. They are not only prolonging battery used during recording but also gaining the VDO image high quality.

2. Recording time is the major limitation of camera recorder. It is limited by capacity of battery installed with camera. Recommend to find out the higher battery pack capacity or other method to use battery for 4 hours recording period.

3. To enhance the better result through VDO recording, 3-4 underwater camera recorders should be prepared to assemble with trawl net in different positions.
4. The other VDO camera such as, Go Pro Hero series, Sony Active Camera-100 (AC-100) what developed for the same feature as Go Pro Hero 3, should be carefully studied on the advantage. It is in order to seek for the suitable model for using with trawl or other fishing gear experiment.
5. Metal case should be designed and assembled to protect damage of underwater camera while fixed with the trawl net. Its' design should not only to protect the harm but also easy to secure with the net panel.
6. To obtain better VDO image color quality, underwater flash light or strobe light should be designed and assembled with underwater camera. Otherwise depth of trawl experiment should not be operated deeper than 40 m.
7. In order to protect the camera and housing from higher pressure, depth of capture should not more than 50 m and carefully check the all o-rings condition and apply high pressure resisted grease before use.
8. In order to observe the catches' condition into cover net, underwater camera should be set outer of codend 1-2 m far from codend opening. Direction of camera should be pointed out to rear of net (codend opening).
9. In order to observe the fishes or squid escape from codend, underwater camera should be set outer of codend nearby codend opening. Direction of camera should be pointed out to front of net (trawl net opening).
10. Practice on the underwater camera installation should be regularly done in every trawl fishing operation.

#### Acknowledgement

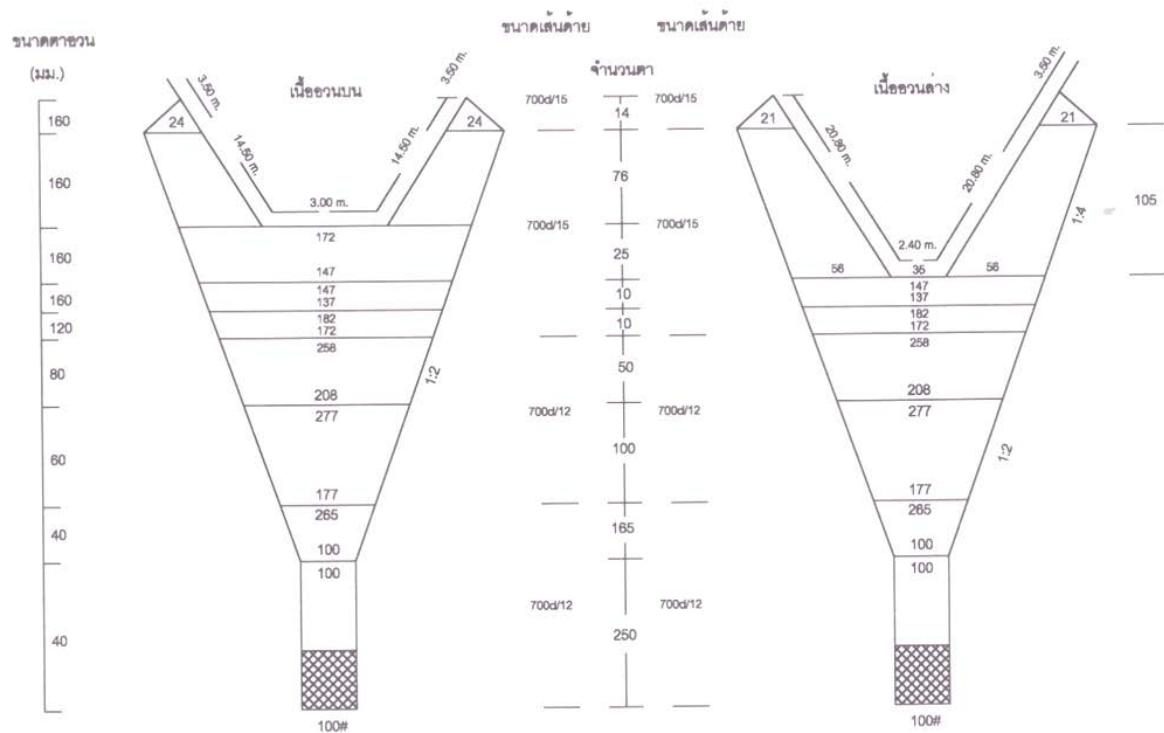
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Go Pro Inc. 2014. **Go Pro Hero 3 User Manual.** Available Source: [http://cbcdn1.gp-static.com/uploads/product\\_manual/file/55/HERO3\\_Silver\\_UM\\_ENG\\_RevC\\_web.pdf](http://cbcdn1.gp-static.com/uploads/product_manual/file/55/HERO3_Silver_UM_ENG_RevC_web.pdf)

## Annex

### Annex 1 Standard trawl net



**Figure 1** Trawl net plan

**Table 1** Specification of bottom otter board trawl net

No.	Parts	Material	Logitudinal
1	Head rope (length)	N/A	39.0 m
2	Ground rope (length)	N/A	44.0 m
5	Number of mesh triangle part	PE 700D/15 Mesh size 160 mm	14 mesh
6	Number of mesh upper wing	PE 700D/15 Mesh size 160 mm	76 mesh
7	Number of mesh lower wing	PE 700D/15 Mesh size 160 mm	105 meshes
8	Number of mesh Square	PE 700D/15 Mesh size 160 mm	25 meshes
9	Number of mesh Belly (1)	PE 700D/15 Mesh size 160 mm	10 meshes
10	Number of mesh Belly (2)	PE 700D/15 Mesh size 120 mm	10 meshes
11	Number of mesh Belly (3)	PE 700D/12 Mesh size 80 mm	50 meshes
12	E Number of mesh Belly (4)	PE 700D/12 Mesh size 60 mm	100 meshes
13	Number of mesh Belly (5)	PE 700D/12 Mesh size 40 mm	165 meshes
14	Number of mesh Codend	PE 700D/12 Mesh size 40 mm	250 meshes

## Annex 2 Specification of camera recorder Go-Pro Hero 3<sup>®</sup>

GoPro is a brand of high-definition personal cameras, often used in extreme action video photography. They are known for being lightweight, rugged, wearable or mountable in unusual places such as outside planes, cars, or boats.

GoPro Hero 3 sells three fixed-lens cameras, all without viewfinders. A 2-bit LCD on the front of the camera allows access to its menu system, which is controlled with the front and top shutter buttons. The cameras have dimensions of 1.6" x 2.4" x 1.2" (42mm x 60mm x 30mm) (HERO2). The range for capturing still images is 5 to 12 megapixels. The cameras are bundled with a clear polycarbonate HD Housing (with glass lens) that is rated shockproof and waterproof to 180 ft/60 meters. The housing consists of a quick-release buckle on the top and threads at the bottom which can be used with a special screw to connect to all of the GoPro mounts. The housing has metal buttons which are synched to connect to the camera's controls. The housing has a "skeleton" backdoor option to allow better capture of audio in situations where it is not necessary for the camera to be water tight or shock proof (but wishing to take advantage of the mounts)

In addition to the usual camera features, the cameras also include an upside down mode to make the photo/video appear upright when played; interval shooting of every 2, 5, 10, 30 or 60 seconds allowing the camera to continuously shoot unattended; 3 photo burst; and self-timer. The camera spec sheet notes they have a proprietary 1050 mAh lithium-ion battery (HERO3), Aperture: f/2.8, and rated >1.4 V/lux-sec in video mode.



Figure 2(a)

figure 2(b)

**Figure 2(a)** Camera recorder Go-Pro Hero 3<sup>®</sup> with underwater housing

**Figure 2(b)** Function of camera recorder Go-Pro Hero 3<sup>®</sup>

In late 2012, GoPro announced the Hero 3 line of cameras. These new cameras came in three editions: Black, Silver, and White. The Black Edition features a new 12 MP sensor that is capable of capturing 4K digital video at 15 fps, 2.7K video at 30 fps, 1440p at 48 fps, 1080p at 60fps, 960p at 100fps, 720p at 120 fps and WVGA at 240 fps. The Black edition also includes the

Wifi Remote. The Silver Edition uses the same 11 MP sensor as the Hero2. Finally the White edition uses the same 5 MP sensor as the HeroHD. All three versions of the Hero3 come in a new 30% smaller and 25% lighter package, with WiFi functionality built in.

### Key Specs

- Professional 4K Cinema 15 fps / 2.7K cinema 30 fps / 1440p 48 fps / 1080p 60 fps / 960p 100 fps / 720p 120 fps and more video capture
- 12MP photo capture with 30 fps burst
- Wi-Fi Built-In
- Wi-Fi Remote Compatible (included)
- GoPro App Compatible (FREE)
- 197'/ 60m Waterproof Housing\*
- Assorted mounts and hardware included for attaching to helmets, gear and more

### Optics

- Ultra sharp f/2.8 6-element aspherical glass lens
- Ultra wide angle / reduced distortion
- 2X Better low-light performance\*

### Video (NTSC/PAL)

**Table 2** Specification of VDO recording

Video Resolution	NTSC fps	PAL fps	STD Mode	Protune Mode	Field of View (FOV)	Screen Resolution/Aspect Ratio
1080p	60, 48, 30, 24 fps	50, 48, 25, 24 fps	YES	YES	Ultra Wide, Medium, Narrow	1920x1080 16:9
720p	120, 60 fps	100, 50 fps	YES	YES	Ultra Wide, Narrow*	1280x720 16:9
1440p	48, 30, 24 fps	48, 25, 24 fps	YES	YES	Ultra Wide	1920x1440 4:3
4K	15 fps	12.5 fps	NO	ONLY in Protune	Ultra Wide	3840x2160 16:9
4K Cin	12 fps	12 fps	NO	ONLY in Protune	Ultra Wide	4096x2160 17:9
2.7K	30 fps	25 fps	YES*	YES	Ultra Wide	2704x1524 16:9
2.7K Cin	24 fps	24 fps	YES*	YES	Ultra Wide	2704x1440 17:9
960p	100, 48 fps	100, 48 fps	YES	YES	Ultra Wide	1280x960 4:3

Note : \*May require a firmware update on camera

- Video format: H.264 codec, .mp4 file format
- White Balance: auto and manual

## Photo Modes

- 12, 7, 5MP resolutions
- Burst: 30 photos per second
- Continuous Photo: 3 photos per second, 5 photos per second, 10 photos per second
- Time-lapse: 0.5, 1, 2, 5, 10, 30, 60 second intervals
- Simultaneous Photo + Video:
  - 12MP + 1440p24 fps
  - 8MP + 1080p30 fps
  - 8MP + 720p60 fps

## Battery & Charging

- 1050mAh rechargeable lithium-ion
- Charge via USB

**Table 3** Specification of battery and camera recording system

HERO3: Black Edition		HERO3: Black Edition with LCD Touch BacPac™	HERO3: Black Edition using with Wi-Fi Remote	HERO3: Black Edition using GoPro App
RES/FPS	Estimated Time	Estimated Time	Estimated Time	Estimated Time
720/60	1:25	1:10	1:20	1:10
1080/30	1:30	1:15	1:25	1:15
1080/60	1:15	1:00	1:05	1:00
1440/48	1:25	1:05	1:15	n/a
4k/15	1:30	1:10	1:20	n/a
2.7k/30	1:20	1:05	1:10	n/a

### Notes

1. Extreme cold temperatures may decrease battery life. For use in these conditions it is suggested to keep camera in a warm place prior to use.
2. To maximize HERO3 battery life when shooting longer duration activities, it's best to use camera with LCD Touch BacPac turned off or unattached altogether. Turning off Wi-Fi will also help conserve power.
3. Using protune mode will increase power consumption. *May vary per mode and camera edition.*

## Audio:

- Mono, 48kHz, AAC compression w/ AGC
- Supports optional 3.5mm stereo mic adapter \*\*

## Storage:

- MicroSD class 10 or higher required
- Up to 64GB capacity supported
- Record times will vary with resolutions and frame rates

**Included Cables:** USB charging cable

**Operating System:**

- Microsoft Windows® Vista, 7 and later
- Mac OS® X 10.5 and later

**For Best Playback Experience on Mac and PC:**

Minimum System Requirements:

- An Intel Core i5 or Intel Core-2 Quad system with discrete NVidia or ATI cards
- 4GB RAM
- Updated/Latest version of default video player from Microsoft\*\*\* or Apple